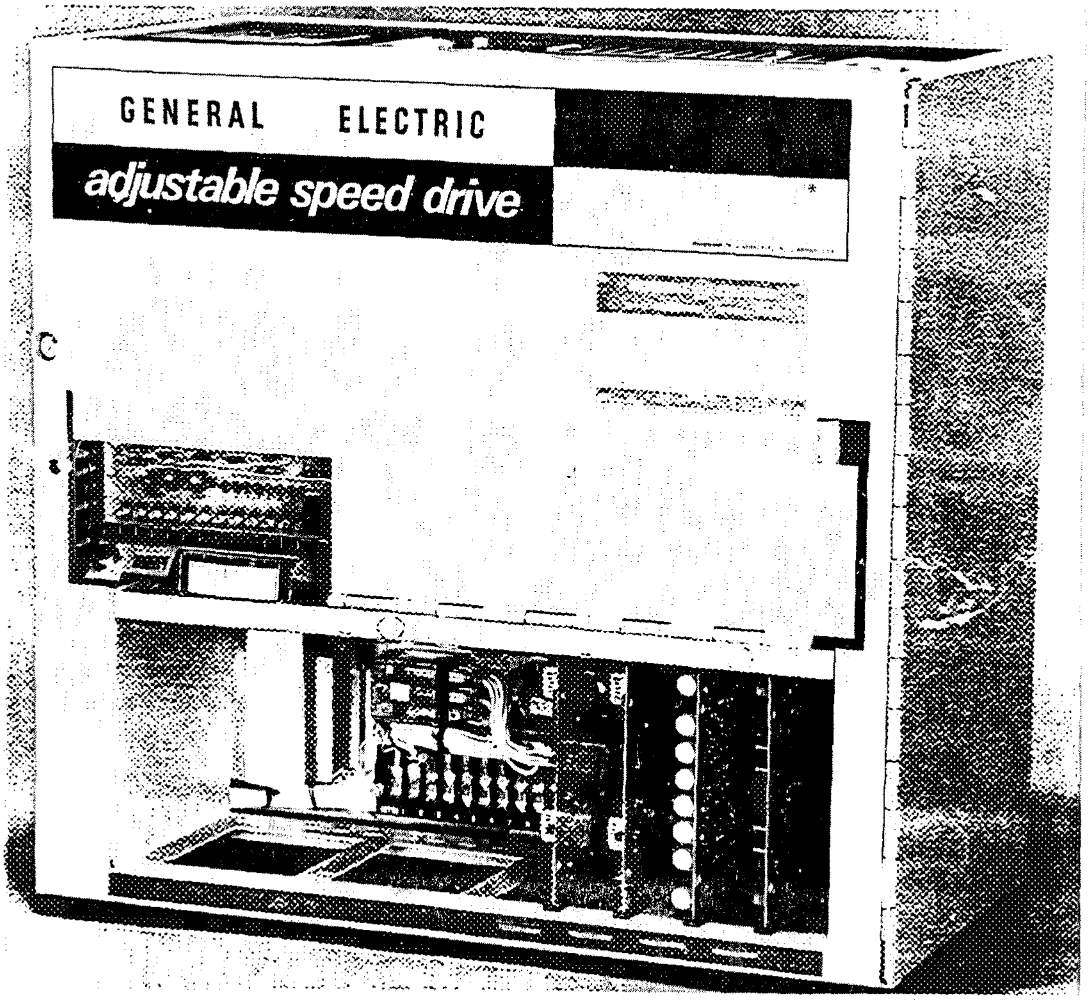
INSTRUCTIONS

GEK-24910A

DC3035R

VALUTROL* INDUSTRIAL DRIVE SYSTEM HALF-WAVE REGENERATIVE

INSTALLATION — OPERATION — MAINTENANCE



(Photo MG-5690-65)

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°C (-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 a 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 of the air and its relative humidity at that 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 %	WEIGHT 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 inside the equipment. Adding heat to keep the air temperature above its dew point can prevent 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 General Electric Company.

When a drive that has been in operation is 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. Power, ventilation or heating and air conditioning (if used) should be left on during the down-time to prevent large changes in temperature and possible moisture condensation.

SAFTEY FOR PERSONNEL AND EQUIPMENT

The following paragraphs list some general safety reminders and saftey 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 LETTERING ON 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 TEST INSTRUMENTS ARE USED TO WORK ON LIVE EQUIPMENT, GREAT CAUTION MUST BE USED. WHEN ONE OF THE INSTRUMENT LEADS IS CONNECTED TO THE CASE OR OTHER METAL PARTS OF THE INSTRUMENT, ***THIS LEAD SHOULD NOT BE CONNECTED TO AN UNGROUNDED PART OF THE SYSTEM UNLESS THE INSTRUMENT IS ISOLATED FROM 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 untis are suitable for most factory areas where other industrial equipment is installed. They should be installed in well-ventilated areas with ambient temperatures ranging from 0°C (32°F) to 40°C (104°F) and relative humidities 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.

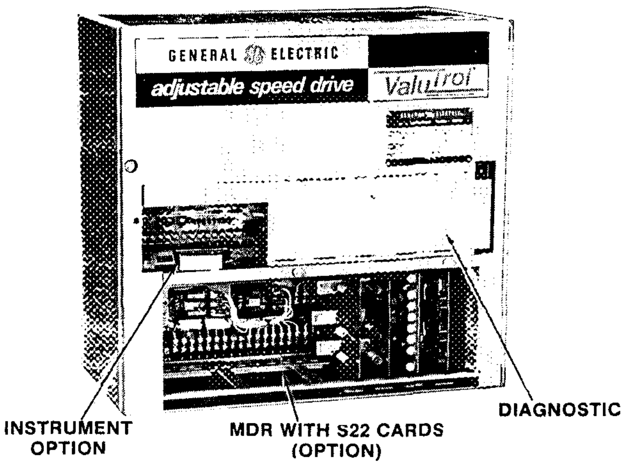

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FIGURE 1
Valutrol Power Unit

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 available 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.

WARNING

SHORT CIRCUIT AVAILABLE CURRENT AT THE THREE-PHASE INPUT TERMINALS SHOULD BE LESS THAN 5000 AMPS.

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.

Another mounting arrangement is also available which consists of two external brackets.The one at the top rear is standard, and the one at the bottom rear of the power unit enclosure is optional. 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. Refer to tables on pages 42 and 43 for proper terminal sizes.

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 0.5mfd 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.

NOTE

SEE NEMA REQUIREMENT FOR A SEPARATE DISCONNECT TO BE MOUNTED NEXT TO THE DRIVE.

WARNING

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

NOTE

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 COMPANY

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.

WARNING

115 VOLTS AC MAY BE PRESENT EVEN IF THE CIRCUIT BREAKER IS IN THE OFF POSITION.

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 (particularly 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 over heating 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 the filter.

Be sure to install filters with air flow direction as indicated on the 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 follows:

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

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 solvents: Freon* RE or TF.

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

SILICON CONTROLLED RECTIFIERS

Keep SCR's 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. Oily 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 contact 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.

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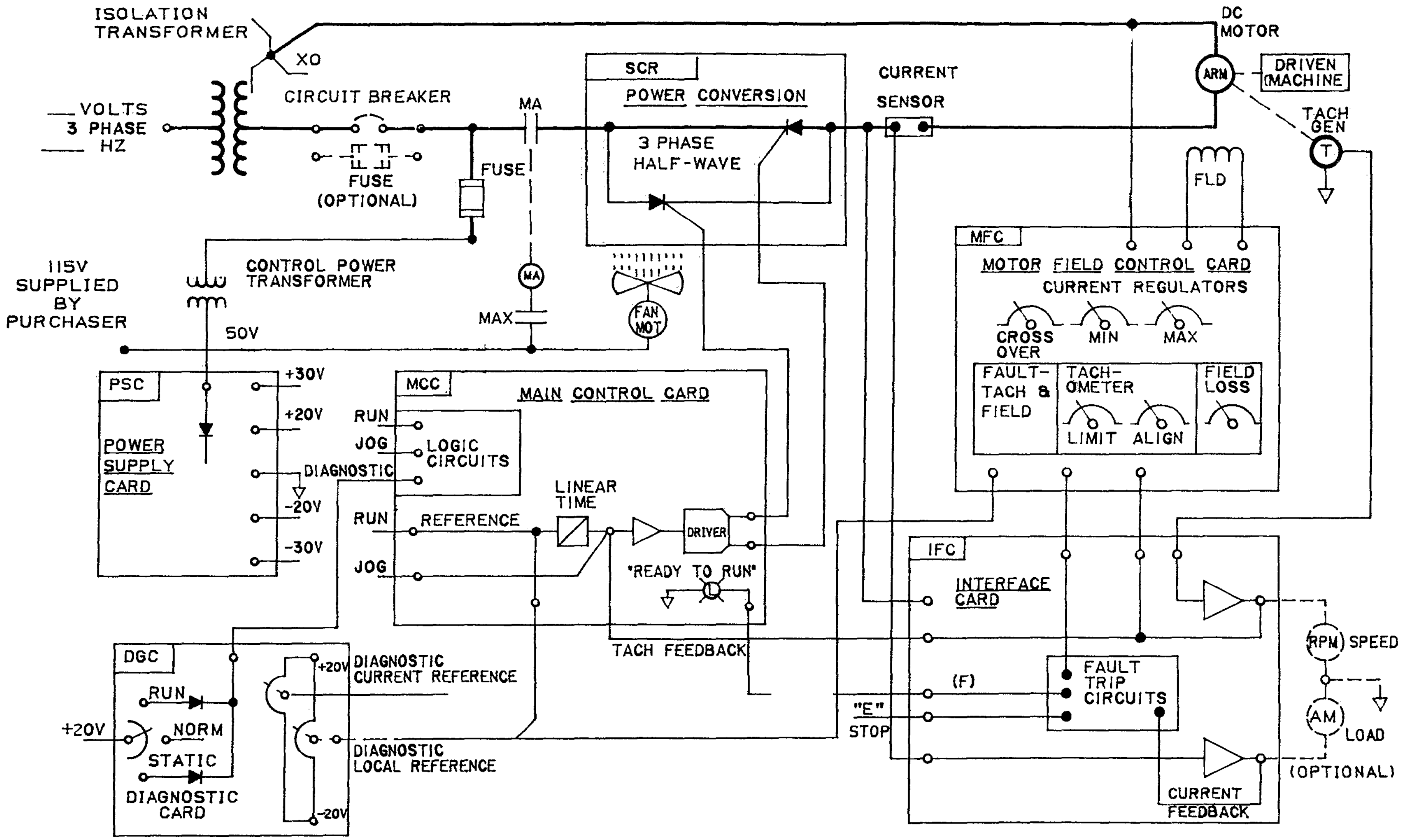


FIGURE 2
VALUTROL DRIVE BLOCK DIAGRAM

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(s) 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.

THE FOLLOWING INFORMATION IS OF PARTICULAR IMPORTANCE.

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 represent (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 ITALICIZED. Example: ***FMAX*** (Maximum motor field adjustments) — in this instruction book.

Signals and test points are CAPITALIZED only, Example: CFB (Current Feedback).

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, Figure 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 an isolated 50 volt tapped secondary which provides the AC input to the Power Supply card. The 115V AC control power supplied from an external source runs the fan and MA Contactor coil.

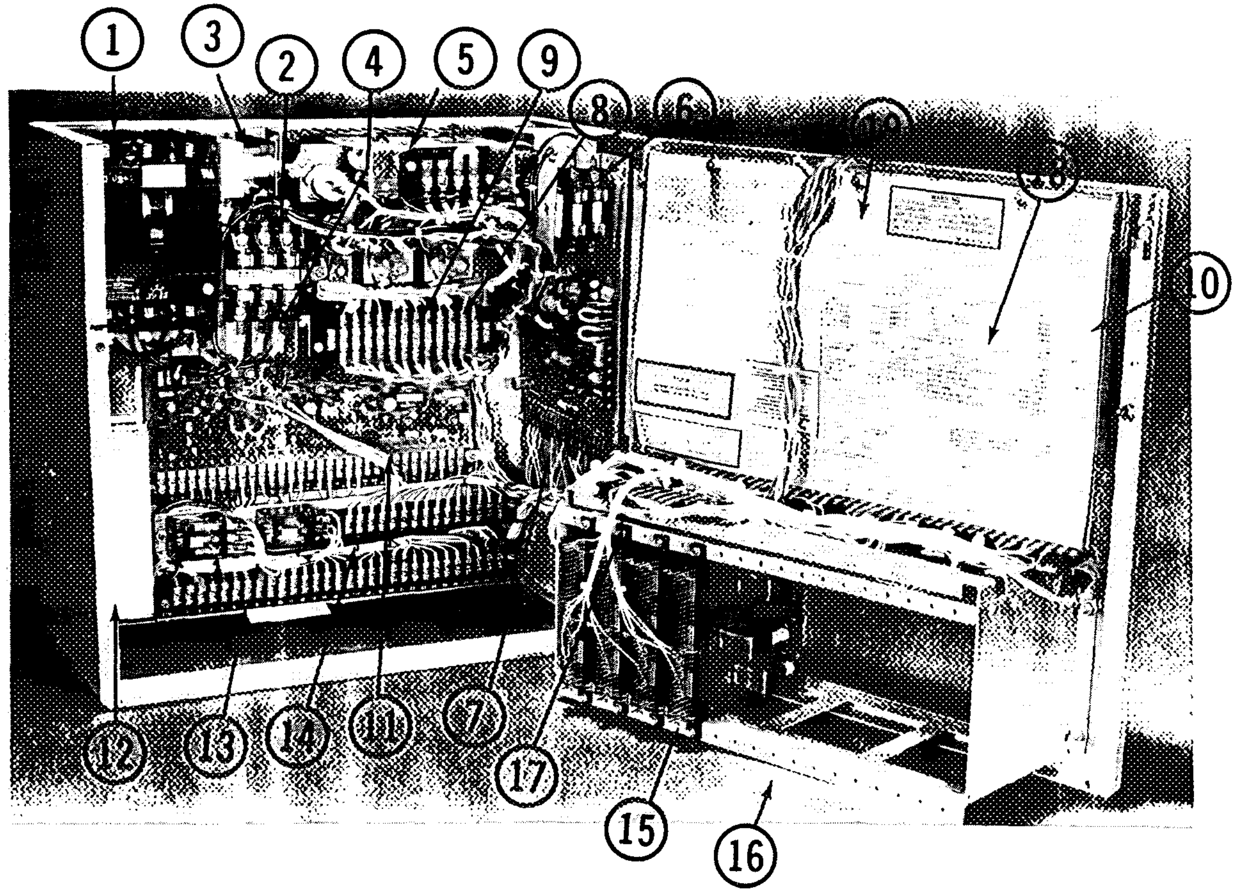
POWER SUPPLY CARD (PSC)

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 off" 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-5690-54)

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. MOTOR FIELD TERMINALS (MFTB)
8. FAN
9. MODULE TERMINALS (MTB)
10. MAIN CONTROL CARD (MCC)
11. INTERFACE CARD (IFC)
12. POWER SUPPLY (PSC)
13. 2TB
14. 3TB (OPTIONAL)
15. S22 CARDS (OPTIONAL)
16. MODIFICATION RACK (MDR — OPTIONAL)
17. RACK TERMINALS (RTB)
18. TEST DATA SHEET
19. HI VOLTAGE SHIELD

FIGURE 3
Valutrol Power Unit (Door Open)

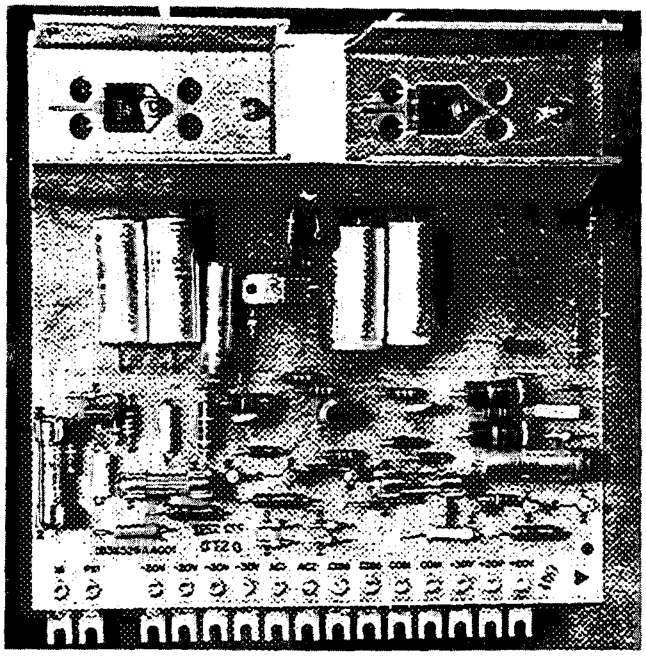


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FIGURE 4
POWER SUPPLY CARD

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 variations 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 "read out" 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 the reading is below 4 volts, switch to the 4 volt connection for improved accuracy of the read out.

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 operating conditions.

3. **To provide a one 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. ***ICAL*** is the calibration adjustment for current feedback output and is factory set.

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

4. ***IMET*** is the calibration adjustment for the current indicator.

5. ***SMET*** is the calibration adjustment for the speed indicator.

Adjustment 4 and 5 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 crossover, ***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 field loss circuit similar to the circuit on the motor field control card (MFC) is also provided.

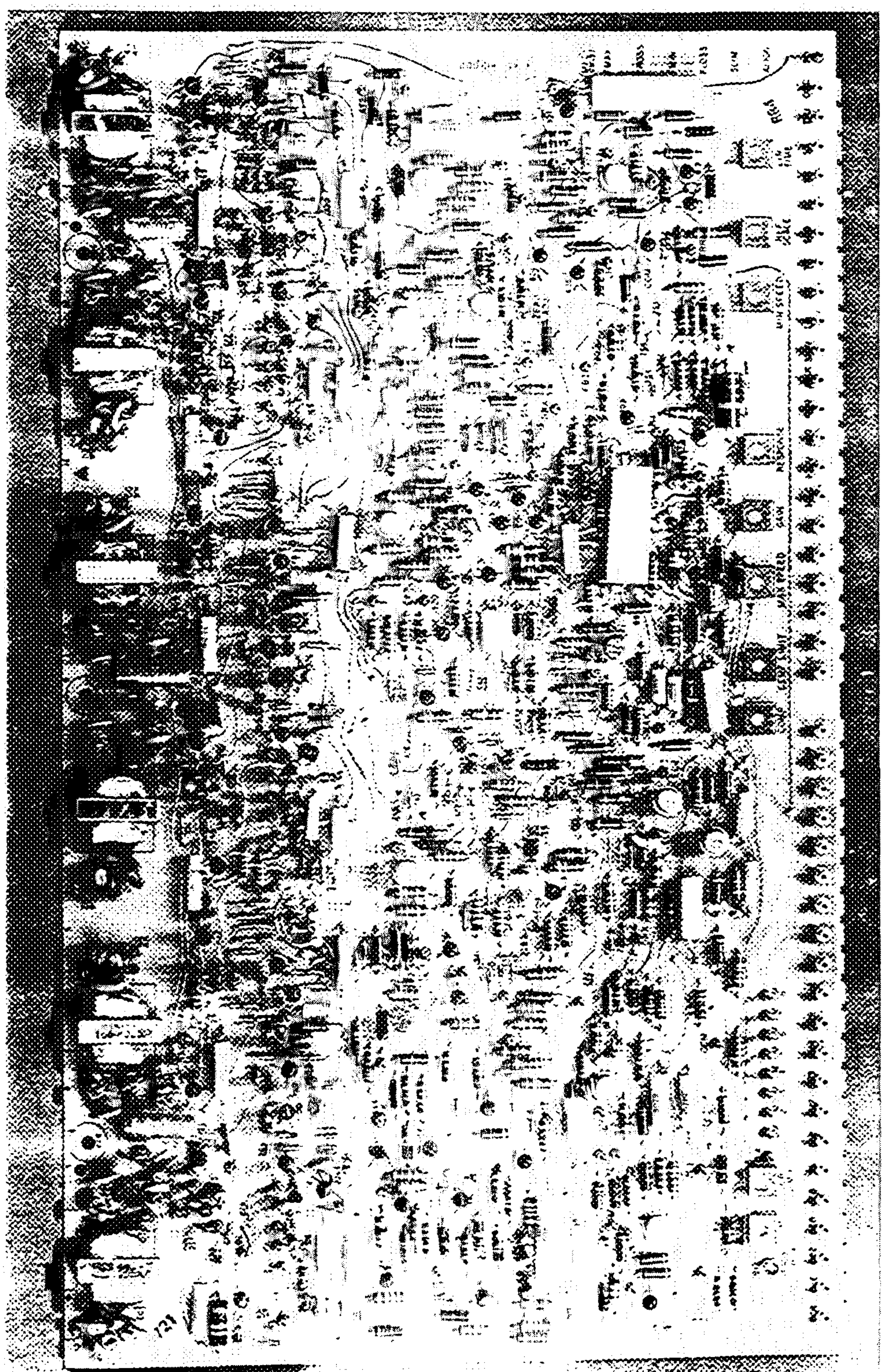

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FIGURE 5
Main Control Card

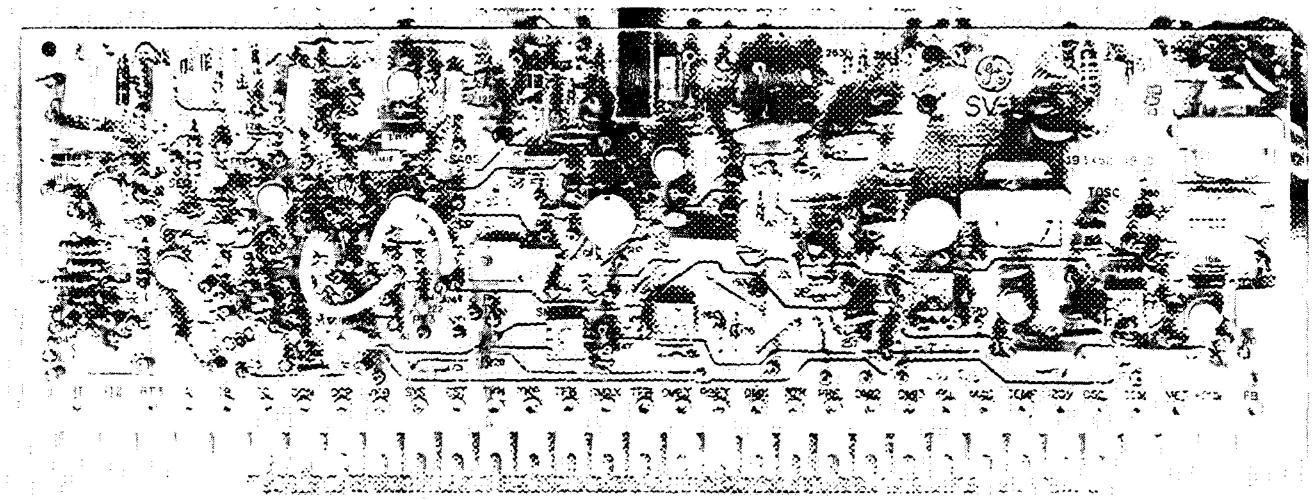

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FIGURE 6
Interface Card

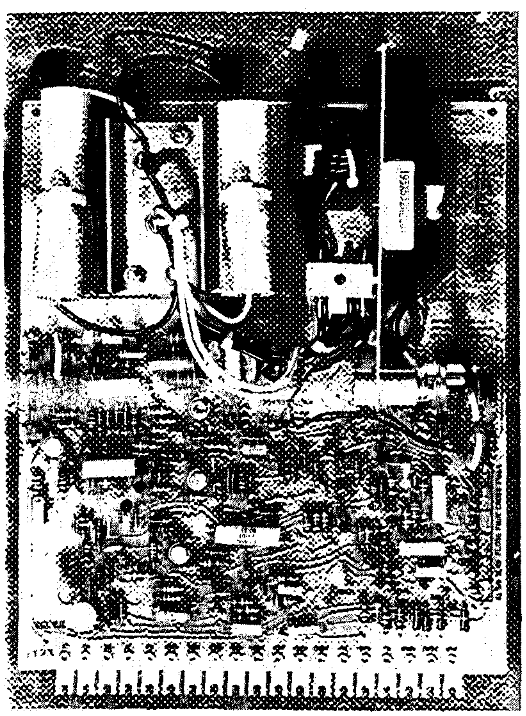

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FIGURE 7
Motor Field Control Card

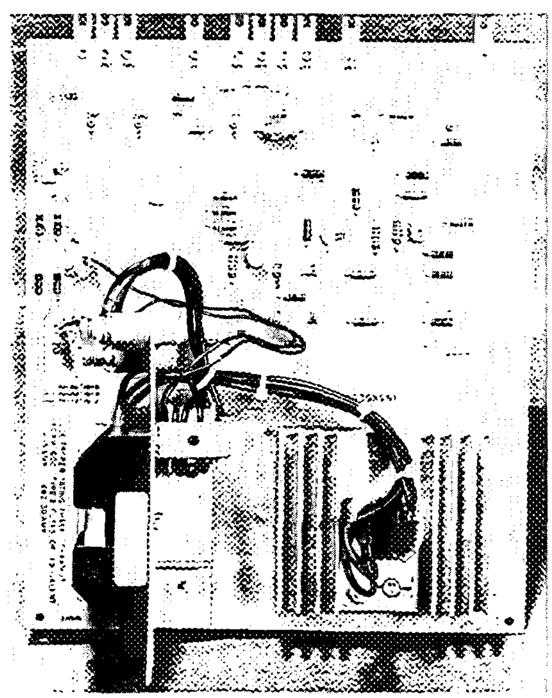

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FIGURE 7A
Motor Field Exciter Card

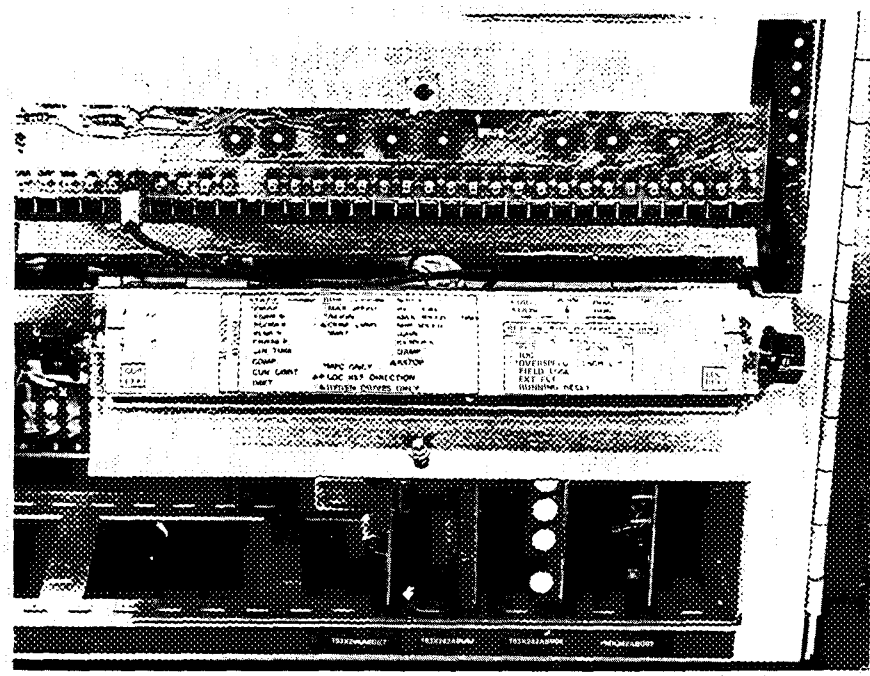

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FIGURE 8
Diagnostic Card

DIAGNOSTIC CARD (DGC)

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 is open.

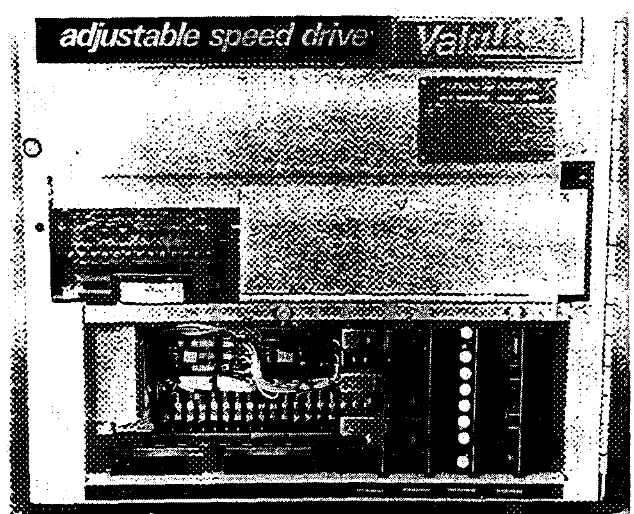

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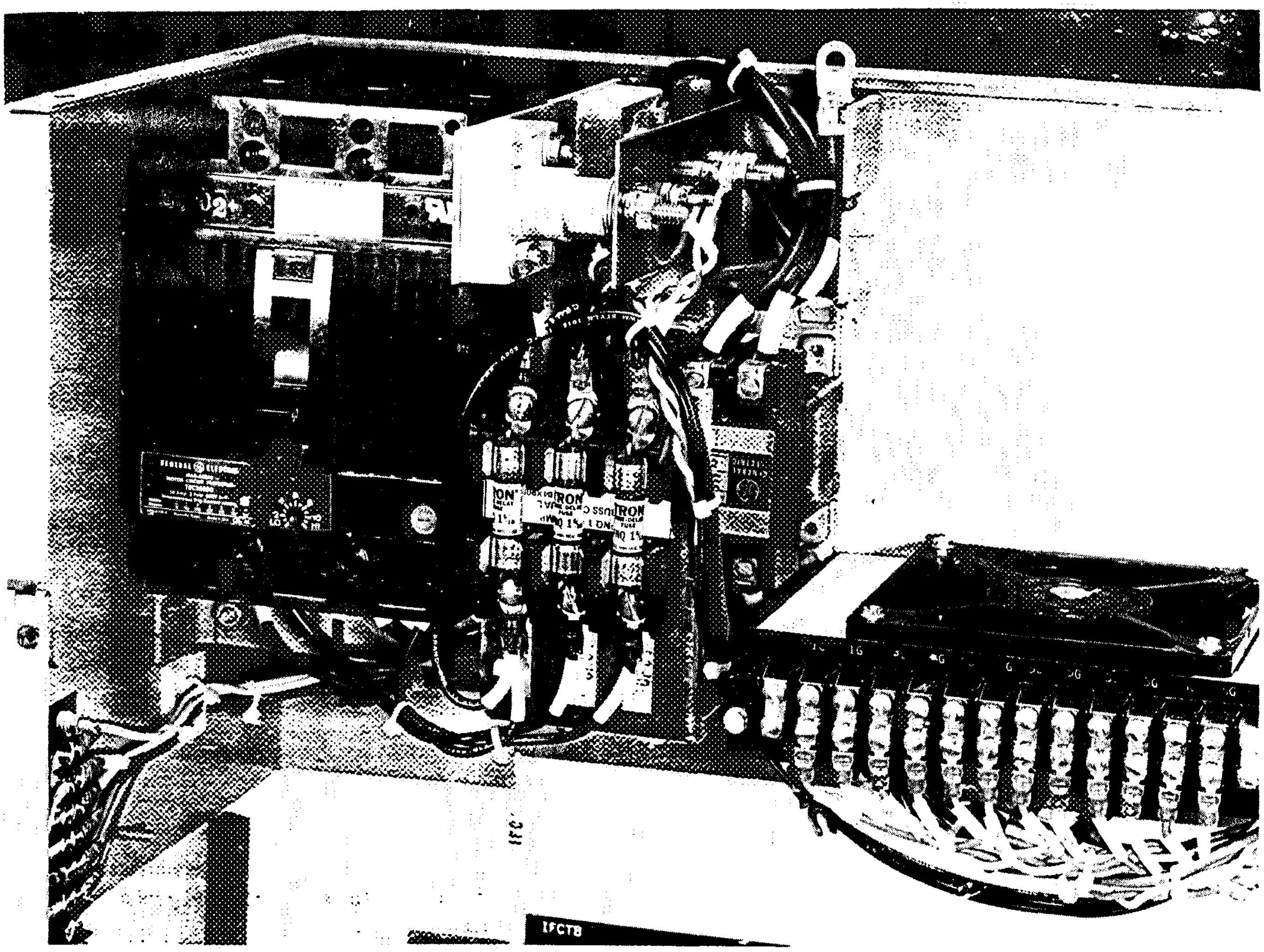
FIGURE 9
Modification Rack



(Photo MG-5690-44))

FIGURE 10
Control Fuses

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.

Connect 115 Volts AC 50/60 Hertz external to 2TB10-2TB11 with 2TB11 the grounded side, fuse 2TB10 at 10 amps MAX.

SIGNAL CONNECTIONS

All Signal connections are made on the 2TB, 3TB and 4TB terminal boards. Terminal boards 3TB and 4TB will 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 may be easily started-up and adjusted for satisfactory operation by following these step-by-step procedures.:

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 probable cause is incorrect incoming phase rotation. Remove power, reverse any two incoming leads and repeat.
4. Turn the local speed reference (***LOC REF***) potentiometer on the diagnostic card to the center of its rotation and switch into the diagnostic run (***DIAG RUN***) position. As the local speed reference (***LOC REF***) 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.
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 fan (if supplied) is energized by 115 VAC externally supplied by the user.
The power supply card is energized and the DC outputs (±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 in 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 Figures 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 operator 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.

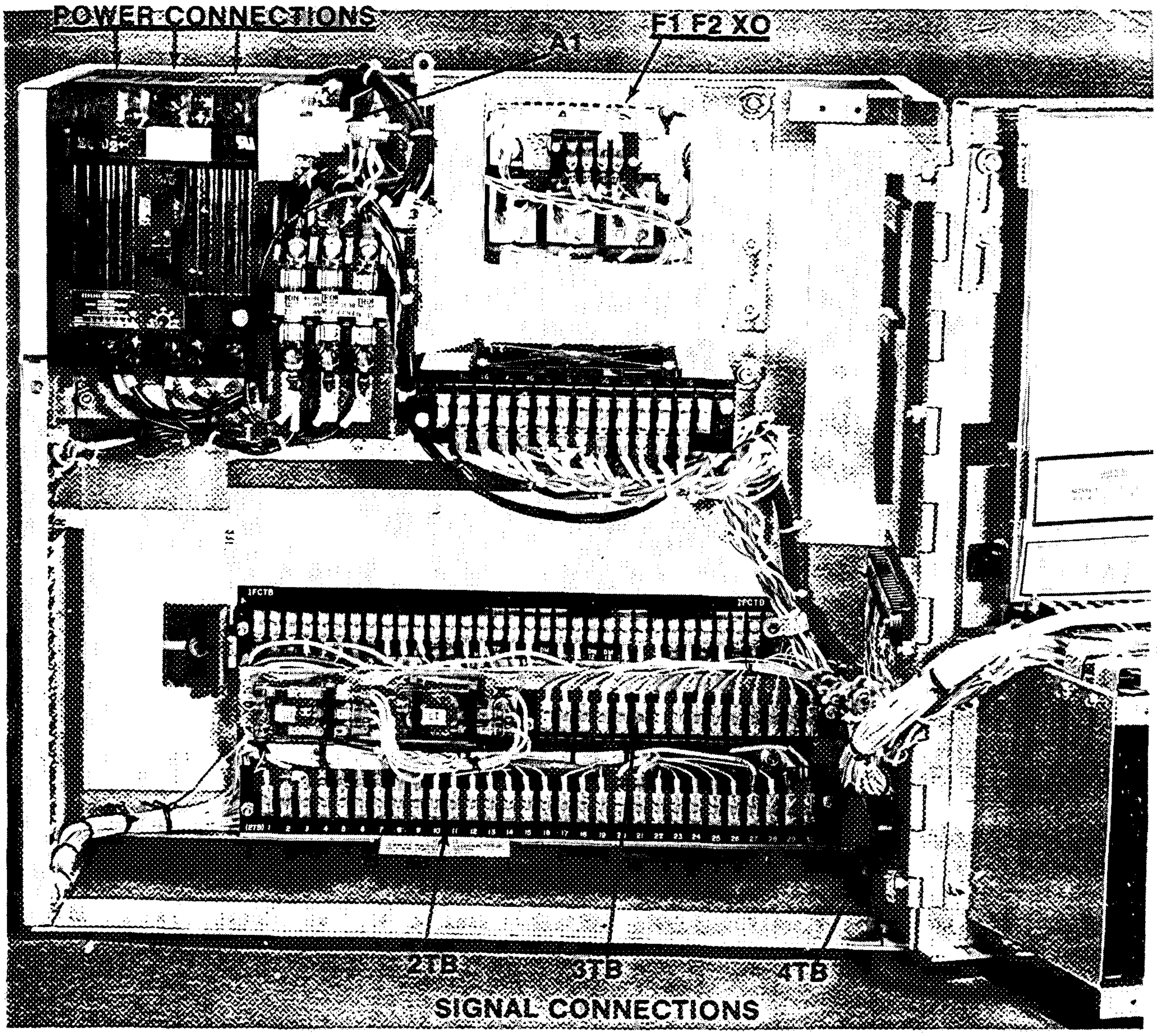
MAX picks up, releasing the preconditioning signal PRE from common and applies power to the coil of the MA contactor.

Whe 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 SCR's 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 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.).



(Photo MG-5690-45)

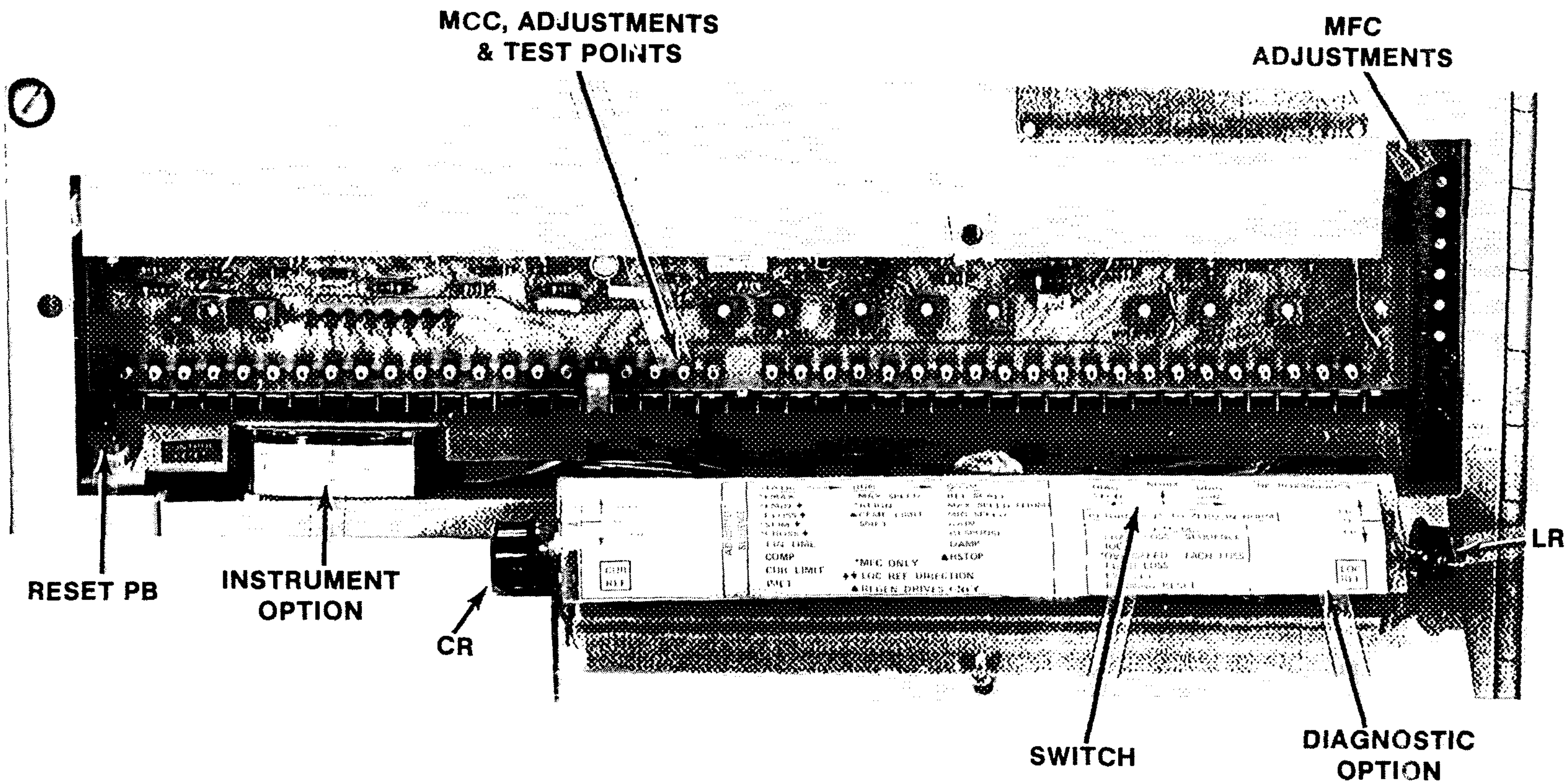
FIGURE 11
Signal and Power Connections

TABLE III
SIGNAL CONNECTIONS

2TB NO.	NOMENCLATURE	DESCRIPTION
1	—30V	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	115V AC	115V AC Control Power input.
12	RSET	Reset input All fault shutdowns 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.



(Photo MG-5690-61)

FIGURE 12
Diagnostic Card and Lower Portion of Main Control Card

TABLE IV
FAULT CONDITIONS

A fault has occurred 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 overcurrent (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 re-apply 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

____

____

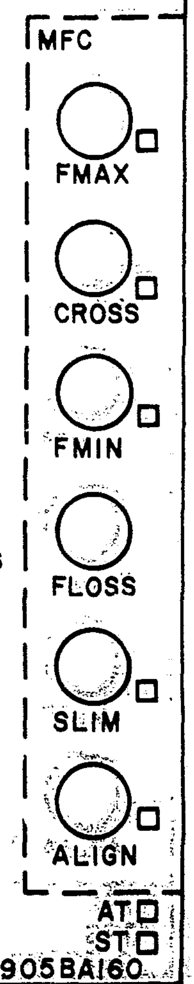
____

____

____

____

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



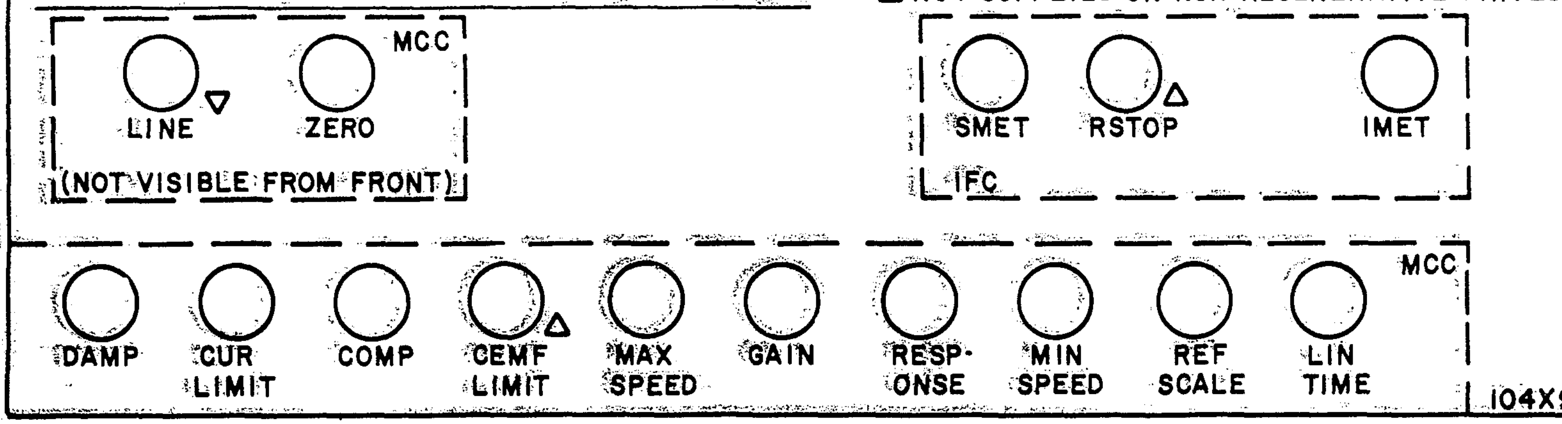
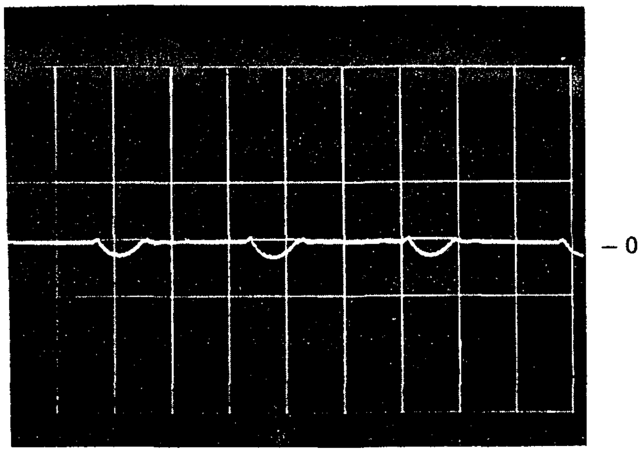


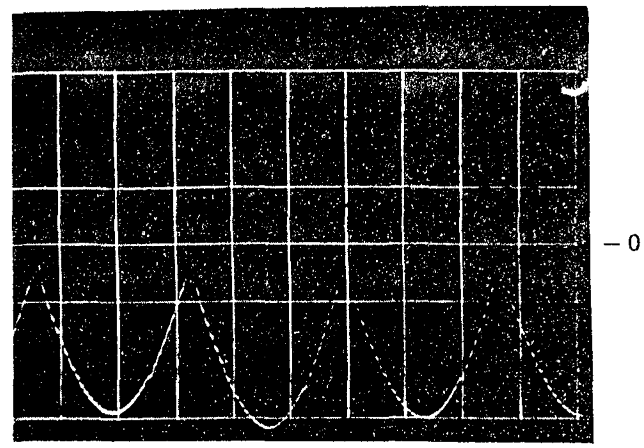
FIGURE 13
TEST DATA SHEET

WAVEFORMS

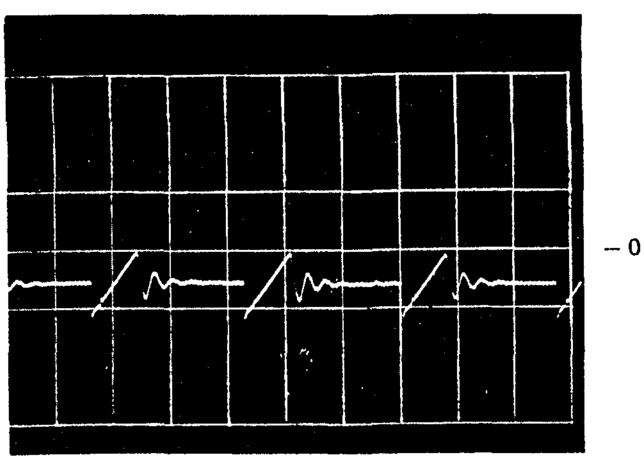
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



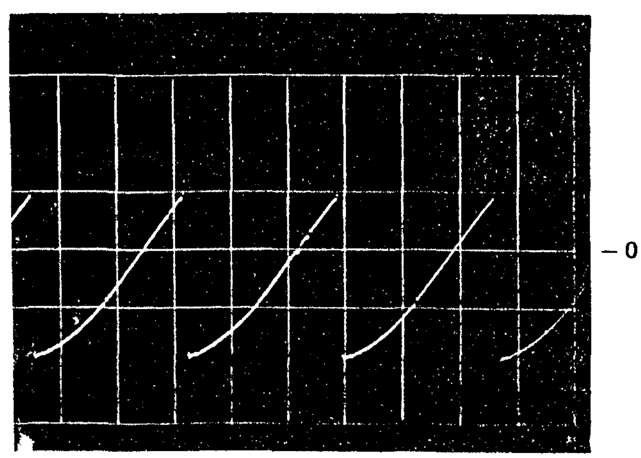
2 msec/div
At low current level 1 volt/division
FIG. 14 Current Feedback (CFB)



2 msec/div
At continuous current 1 volt/division
FIG. 15 Current Feedback (CFB)



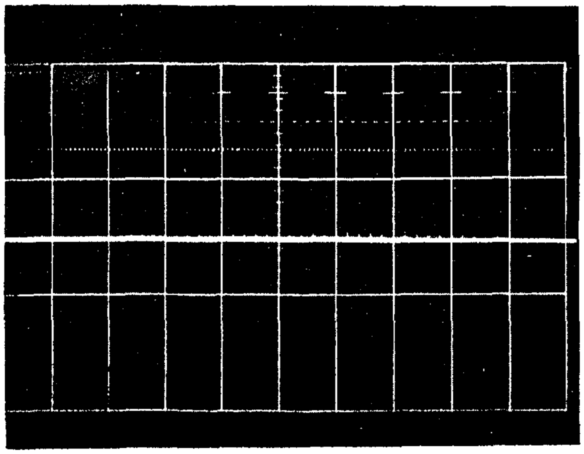
2 msec/div
At low current and 100 volts 5 volts/division
FIG. 16 Voltage Feedback (VFB)



2 msec/div
At continuous current and 100 volts 5 volts/division
FIG. 17 Voltage Feedback (VFB)

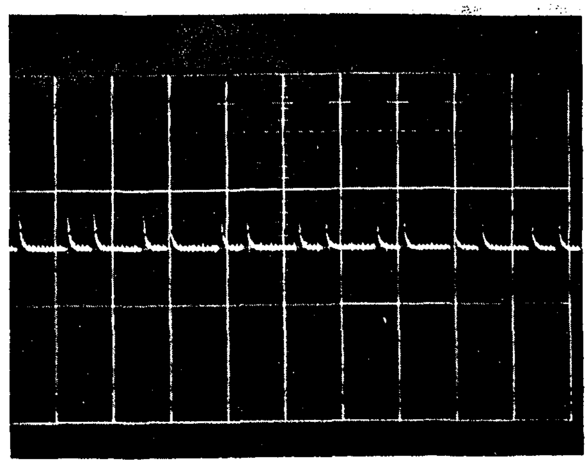
WAVEFORMS

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



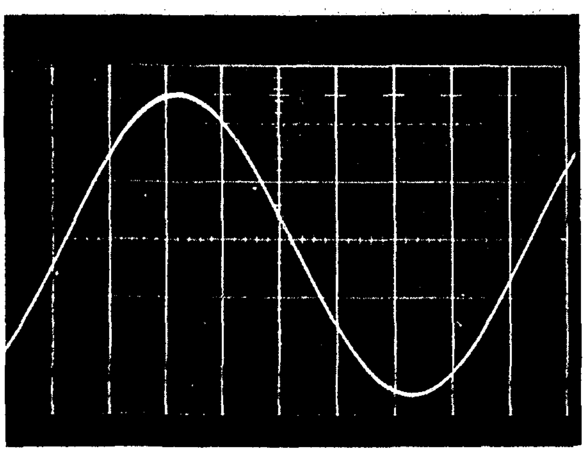
— 0

2 msec/div
10 volts/division
FIG. 18 Oscillator (OSC)

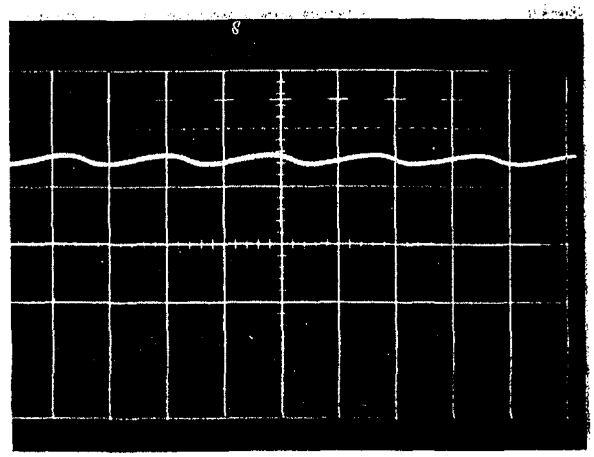


— 0

2 msec/div
2 volts/division
FIG. 19 Initial Pulse (IPU)



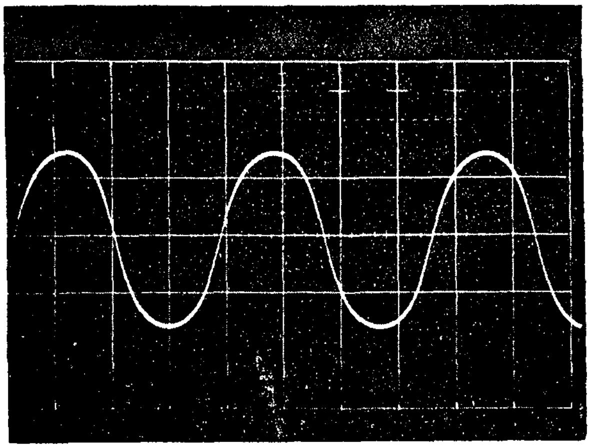
2 msec/div
Typical of SA, SB & SC
SB lags SA by 120°
SC lags SB by 120°
5 volts/division
FIG. 20 Synchronizing Signal (SA)



2 msec/div
With an AC tachometer at 450 RPM
1 volt/division
FIG. 21 Speed Feedback (SFB)

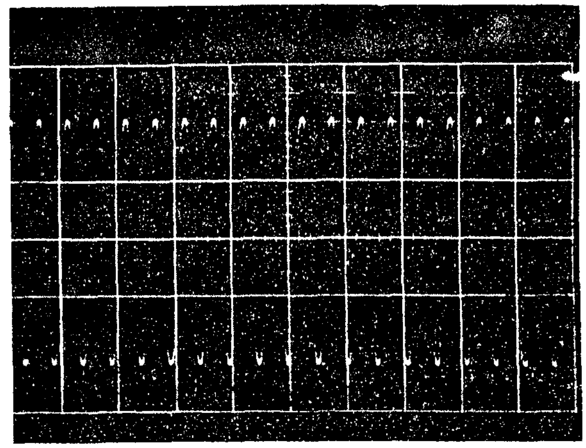
WAVEFORMS

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



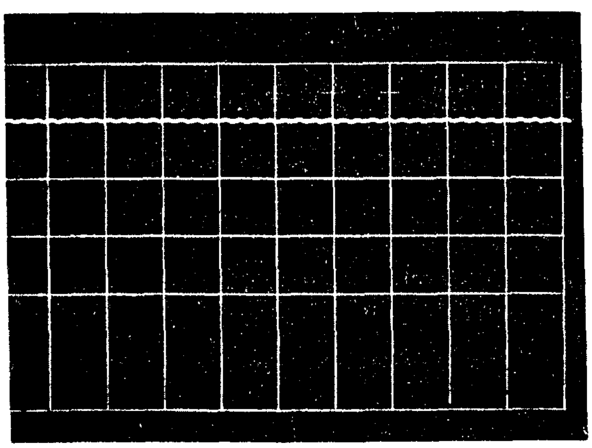
2 msec/div
With an AC Tachometer at 450 RPM
1 volt/division

FIG. 22 Tachometer Feedback (TFB)



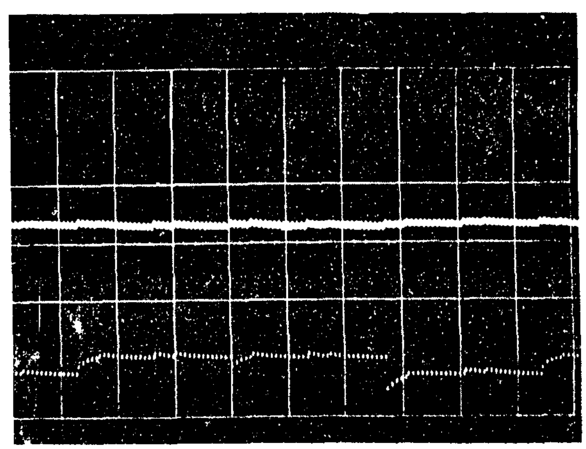
2 msec/div
With an AC Tachometer at 3160 RPM
5 volts/division

FIG. 23 Tachometer Feedback (TFB)



2 msec/div
With an AC Tachometer at 3160 RPM
5 volts/division

FIG. 24 Speed Feedback (SFB)

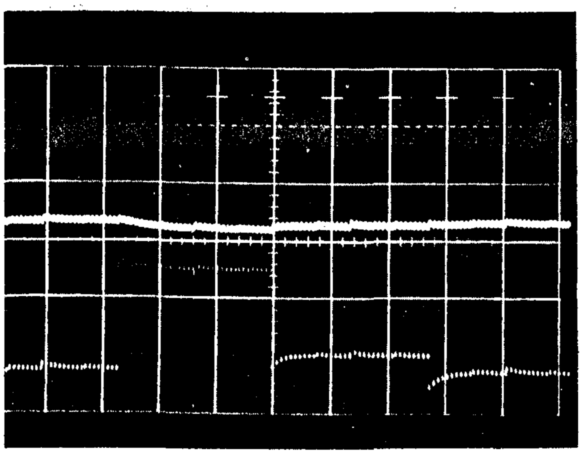


2 msec/div
Normal
1 volt/division

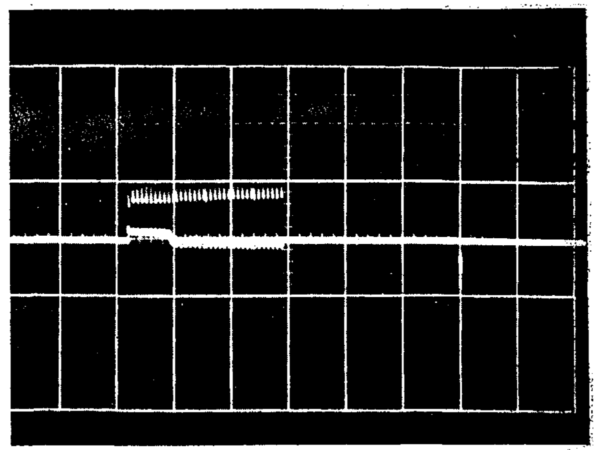
FIG. 25 Pulse Output (PO)

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
FIG. 26 Pulse Output (PO)



2 msec/div
Gate to Cathode Firing Signal 1G-1C
Typical of all six Signals
FIG. 27 Gate to Cathode Firing Signal

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, and 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 overshoot.

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 Figures 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 stops 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) 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 reponsibility 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 on ***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 Figures 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 ouput ***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 oscilloscope, the initial pulse output, IPU, and the pulse output, PO, may be monitored to verify proper operation. See Figures 19, 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

NOTE: Calibration can proceed with greater ease if the adjustments are initially positioned to approximate settings according to the indicating arrows on the test data sheet, rather than turned to an extreme position. If an adjustment can not be accomplished, continue with as many as possible and begin the procedure again.
The diagnostic card is used to generate the appropriate test signals and operating modes to calibrate the drive.

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 IV
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) ***RSTOP*** ***MIN SPEED*** (IF USED) ***COMP*** ***GAIN*** ***RESPONSE*** ***DAMP***	***REF SCALE*** ***MAX SPEED*** (TRIM) ***RSTOP*** ***MIN SPEED*** (IF USED) ***COMP*** ***GAIN*** ***RESPONSE*** ***DAMP***

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 or ±10%.

CALIBRATION WITH MOTOR FIELD CONTROL (MFC)

All readings can have a tolerance of ±10%.

Select Diagnostic static and set ***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 —6 volts 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 (Crossover — Field)

Set ***CROSS*** full CCW. Turn the ***LOC REF*** potentiometer (—LR) until LR corresponds to the crossover, 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 verfiying 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 LIM*** 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.

MAXSPEED/ALIGN (Maxspeed/Tachometer Loss Align-/Fault).

Turn ***MAXSPEED*** full CW. Turn ***ALIGN*** full CW. Adjust the ***LOC REF*** potentiometer until CEMF reads 5 volts (±10%). Adjust ***MAXSPEED*** 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/MAXSPEED **(Reference Scale/Maxspeed)**

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 **MAXSPEED** (if necessary) until the actual RPM corresponds to the desired top speed If actual top RPM was off by more than 5% reset **ALIGN** only 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 25	225

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

Example: 20 to 25 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. 28).

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

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)

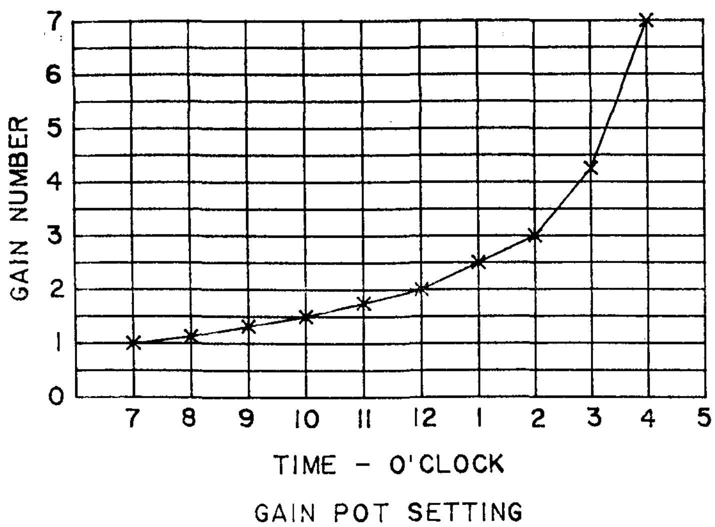
6. Set **RESPONSE** potentiometer at minimum (7 o'clock).

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 28
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.

MAXSPEED **(Maximum Speed)**

Adjust the ***LOC REF*** until the motor is running at actual top speed. Adjust ***MAXSPEED*** 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 **(Regeneratve 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 25	225

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

   Example: 20 to 25 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.

TROUBLESHOOTING

Although many of the problems which may arise can be effectively located with a multi-meter, an oscilloscope is a very powerful troubleshooting 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 0.01V/CM to 1300V peak to peak deflection when used with appropriate attentuator probes.

PROCEDURES

In troubleshooting 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). This is another powerful tool for quickly locating drive system faults.

If the malfuction 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

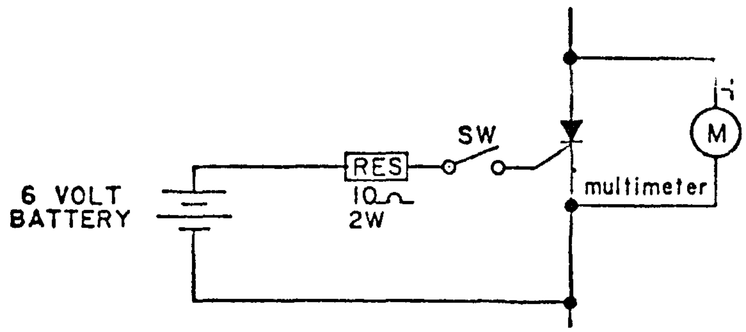
ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS THROUGHOUT THE SYSTEM.

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:



© SCR TEST CIRCUIT

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, 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.

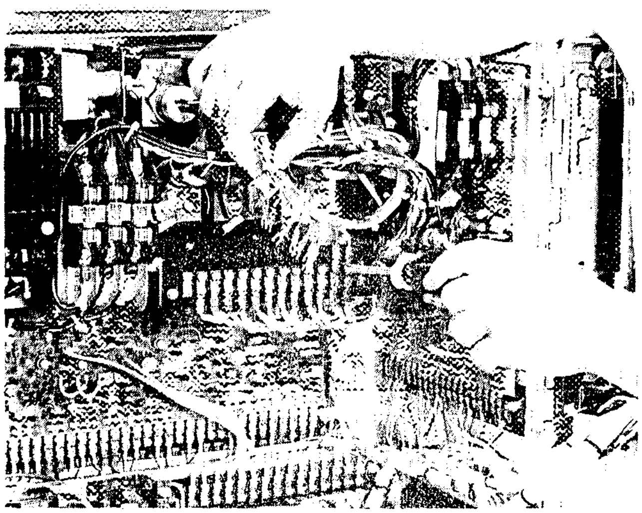
REMOVAL/REPAIR

CONVERSION MODULE

The conversion module is best removed as follows:

Disconnect the three AC input power and DC output leads as shown.

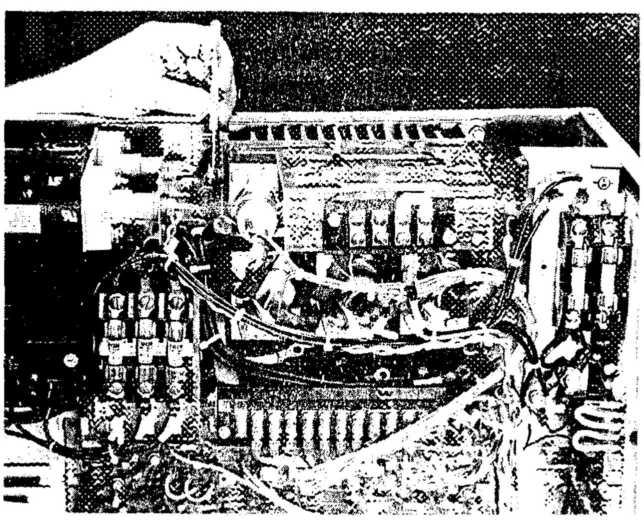
(NOTE: Disconnect external 115 vac control power from 2TB10 and 2TB11.)



(Photo MG-5690-53)

FIGURE 29
Removal of Gate Leads

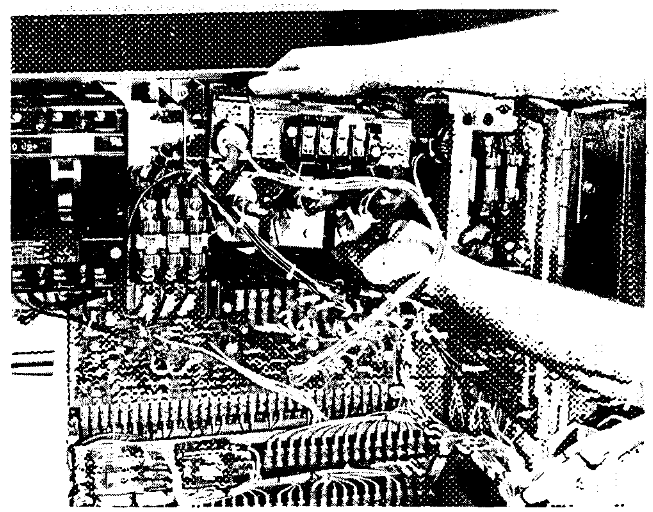
Disconnect the SCR gate leads from the terminal board MTB. If markings are not legible, remark prior to removal.



(Photo MG-5690-52)

FIGURE 30
Loosening Slotted Mounting

Loosen one screw on the right and left hand sides and remove the heat sink from slotted mount.



(Photo MG-5690-51)

FIGURE 31
Removal of Conversion Module

Slide module out.

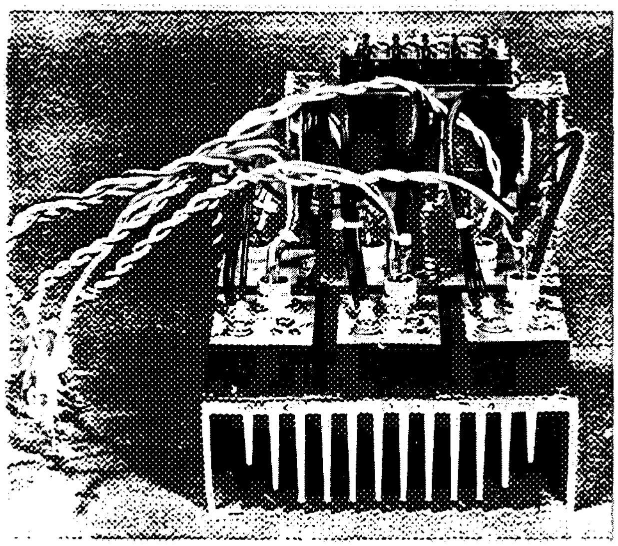
SCR REPLACEMENT

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 and SCR to the heat sink as follows:

STUD MOUNT SCR's

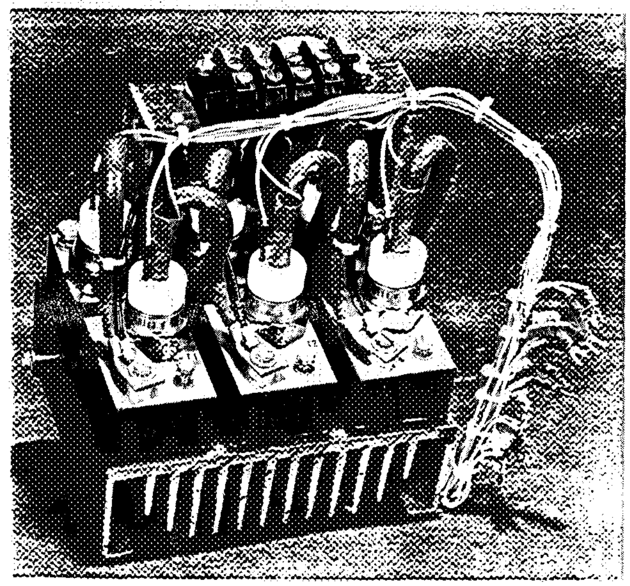
Clean all surfaces of old lubricant and stray dust. Apply a thin film of General Electric G322L VERSILUBE™ and tighten with a torque wrench to the following specifications:

STUD SIZE	TORQUE
1/4 — 28	30 inch lbs.
1/2 — 20	135 inch lbs.
3/4 — 16	275 inch lbs.



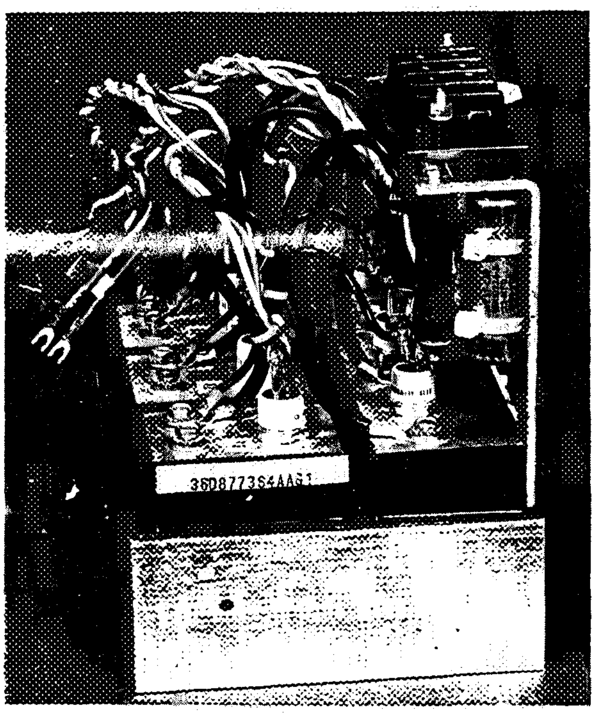
(Photo MG-5690-24))

FIGURE 32
Small Stud Mount Heat Sink (Front View)



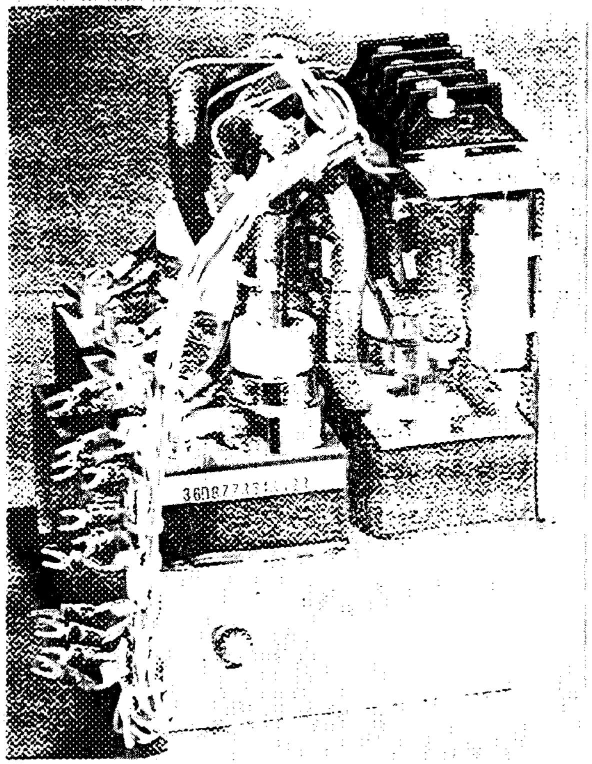
(Photo MG-5690-41)

FIGURE 34
Large SCR Heat Sin:: (Front View)



(Photo MG-5690-25)

FIGURE 33
Small SCR Stud Mount Heat Sink Side View

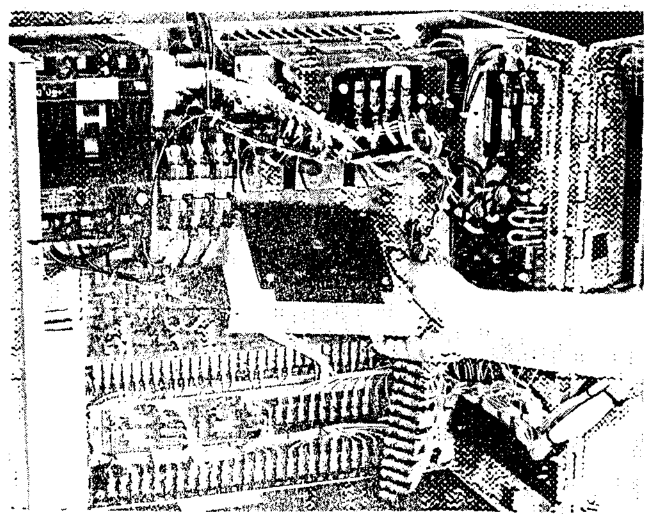


(Photo MG-5690-40)

FIGURE 35
Large SCR Heat Sink (Side View)

FAN (if supplied)

Remove the fan wires from the power supply terminal board at PJ1 and PJ2, and remove the two screws holding the Terminal Board Assembly to the fan shelf. Remove the two screws holding the fan shelf to the panel and slide the fan bracket out.

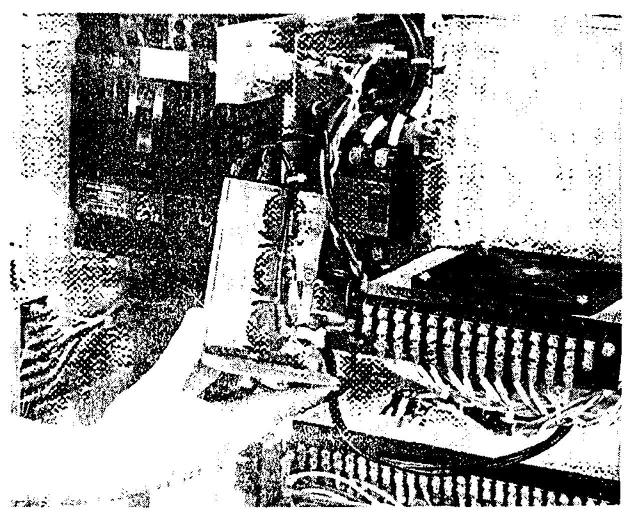


(Photo MG-5690-50)

FIGURE 36
Removal of Fan

MOV'S

The drive has 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.



(Photo MG-5690-43)

FIGURE 37
MOV's

NOTE

THERE SHOULD BE NO NEED TO RETUNE THE DRIVE AFTER REMOVAL/REPAIR OF A CONVERSION MODULE, AND 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.

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

TABLE V

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

TABLE VI
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.

GLOSSARY OF TERMS

Page

ALIGN — Tachometer Loss Align Adjustment 33

* CEMF — Counter EMF 16,30,31,33,34,35
CEMF LIMIT — Counter EMF Adjustment 14,30,33,35
* COM — Regulator Common 16,22
COMP — IR Compensation Adjustment 14,29,30,31,33,34
CPT — Control Power Transformer 11,20
* ***CFB*** — Current Feedback 16,26,30,35
CUR REF — Diagnostic Current Reference Potentiometer 30,33,34,35
CROSS — Crossover Adjustment .... (1),15,31,33
CUR LIMIT — Current Limit Adjustment 14,25,29,30,32,33,35

DA1 — Positive Armature Connection 37
DAMP — Dampening Adjustment 14,29,31
Diagnostic — Normal 32,35,33
Diagnostic — Run 20,32
Diagnostic — Static 32
DCC — Diagnostic Card 11,18,20,37
* DM1-DM8 — Dummy Input/Output Points on MCC 16
* DP1-DP2 — Diagnostic Switching Signals 16,31
* DR — Driver Reference 16,29,31

* EAO — Error Amplifier Output 16,29
EST — External Fault Stop 22

FLT — Fault Relay 14,22,20,25
F1-F2 — Motor Field Connections 19,20
* FC — Field Current Signal 16,33
FDR — Field Diagnostic Reference 30,31
FEA — Field Economy Adjust 16
FF - Field Fault 17
FLOSS — Field Loss Adjustment .... (1),32,33,35
FMAX — Motor Field Maximum Adjustment .... (1),32,33
FMIN — Motor Field Minimum Adjustment .... (1),32,33

GAIN — Speed Loop Gain Adjustment 14,29,32,34,35,36

IFC — Interface Card 11,14,17
IMET — Current (Load) Instrument Output and Adjustment 14,23,30,32,33,35
* IPU — Initial Pulse 16,29,30,32

* JOG — Jog Switch Input 16,20,29,30,32
* JOGR — Jog Reference Input 16,29,30,32

L1, L2, L3 — AC Power Connections 19,20,21
LIN TIME — Linear Timing Adjustment 14,29,30,32,33,34,35,36
* LR — Local Reference From DCC 16,24,30,33,35
LOC REF - Diagnostic Local Reference Potentiometer 20,30,31,33,35

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

GLOSSARY OF TERMS
(continued)

MA — Line Contactor 20,30,34,35,36
* MAC — MA Control Signal 16,20,30
MAX — Pilot Relay for MA 22,20,30
MAX SPEED — Adjustment 14,20,29,32,33,35
MCC — Main Control Card 12
MDR — Modification Rack 13,18
MFC — Motor Field Control Card .... (1),11,15,17,29,30,31,33,36
MFE — Motor Field Exciter Card .... (2),11,15,17,31,35,36
MIN SPEED — Adjustment 14,20,32,34,35
MOV — Metal Oxide Varistor 18,40

* OSC — Oscillator 16,27

P1 — Motor Thermal Switch Output 25
P2 — Motor Thermal Switch Output 25

* PCR — Phase Control Reference 16,30,32
PO — Pulse Outputs 28,29,30,31
* PRE — Preconditioning 16,20,30
PSC — Power Supply Card 11

REF SCALE — Adjustment 14,20,32,33,35,30
RESPONSE — Speed Loop Response Adjustment 14,29,32,34,36,37
RESET — Pushbutton 22,25,31,33,34,35
RSTOP Regenerative Stop Adjustment 14,30,31,34,36
* RTR — "Ready to Run" Indicator 16,24,25
* RUN — Run Switch Input 16,20,22,30,32

SCR — Power Conversion Module 20,30,31,37,38,39
* SA, SB, SC — Synchronizing Signals 16,20,27
* SFB — Speed Feedback 16,27,28,29,30,33
SLIM — Speed Limit Adjustment .... (1),32
* ***SMAX*** — Maximum Speed Adjustment and Output 16,32
SMET — Speed Instrument Output and Adjustment 14,23,32,33,35
* ***SMIN*** — Minimum Speed Reference Adjustment and Input 16,20,33
* SR — Speed Reference Input 16,20,24,30
* SYS — System Fault Trip 16,25

* TA — Tachometer Align Output 16,33
* TFB — Tachometer Feedback Signal 16,28
TKN — Negative Tachometer Input 20
TKP — Positive Tachometer Input 20
* TR — Timed Reference 16,20,29,30
TRIP — Fault Trip Amplifier Output 17

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

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

GLOSSARY OF TERMS
(continued)

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

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

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