Allenwest Systems Division

Simplex Electrical Ltd, Moulsecoomb Way, Brighton, East Sussex, BN2 4QE, U.K.
Telephone: 0273 606666. Telex: 87291.ALWEST G. Fax: 0273 606107

INSTRUCTIONS

SOURCE DOCUMENT GEK 24918
INSTRUCTION No. VSDI 305

CRANE DRIVE

MG SET - STATIC FIELD WARD-LEONARD

INSTALLATION - OPERATION - MAINTENANCE

Manufactured by
ALLENWEST
BRIGHTON
ENGLAND

A Member of the Simplex Electrical Group Ltd.

ALLENWEST - POWERCENTRE - SIMPLEX - WALLACETOWN

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INTRODUCTION

This instruction book contains helpful suggestions for placing the Maxspeed Crane 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 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.

Floor mounted power units have lifting lugs, or holes for lifting bars, so that crane hooks may be used to pick up the unit. Spreader bars should be used as required.

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 %	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 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.

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 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. CIRCUIT BREAKERS, IF SUPPLIED AS PART OF THE TOTAL SYSTEM, MAY NOT DISCONNECT ALL POWER TO THE EQUIPMENT. SEE SYSTEM ELEMENTARY DIAGRAMS. 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.

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 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 TROUBLE SHOOTING THE EQUIPMENT. FOLLOW THE START UP PROCEDURE STEP BY STEP.

READ AND HEED ALL WARNINGS, 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 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 from 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.

LATER

FIG. 1 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.

CONNECTIONS

All internal electrical connections between components in DC 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 0.5mfd capacitor in parallel with the relay coils is recommended for 115VAC control circuits.

NOTE

SOME SYSTEM TRANSFORMERS AND OTHER APPARATUS MAY BE 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.

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 A SEPARATE POWER TRANSFORMER IS USED AND IF THE SECONDARY OF THE TRANSFORMER MUST BE GROUNDED, IT IS RECOMMENDED THAT HIGH RESISTANCE GROUNDING BE USED.

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 MAY BE DEGRADED.

CAUTION

DO NOT USE POWER FACTOR CORRECTION CAPACITORS WITH THIS EQUIPMENT WITHOUT CONSULTING THE SPEED VARIATOR PRODUCTS OPERATION, GENERAL ELECTRIC COMPANY. 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 filters 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 AND GENERATORS

Maintenance instructions covering brushes, commutator and lubrication are in GEK-2304 which is found elsewhere in the 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 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 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

*Trademark of E. I. DuPont Company.

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 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.

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.

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

The Elementary diagrams represent (in symbolic form) the fundamental operation and relationship of the electrical parts of a system. These diagrams are drawn so that the operation of the control system may be easily understood. Connections made between control devices and power devices within the enclosure are also shown in this type of diagram.

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.

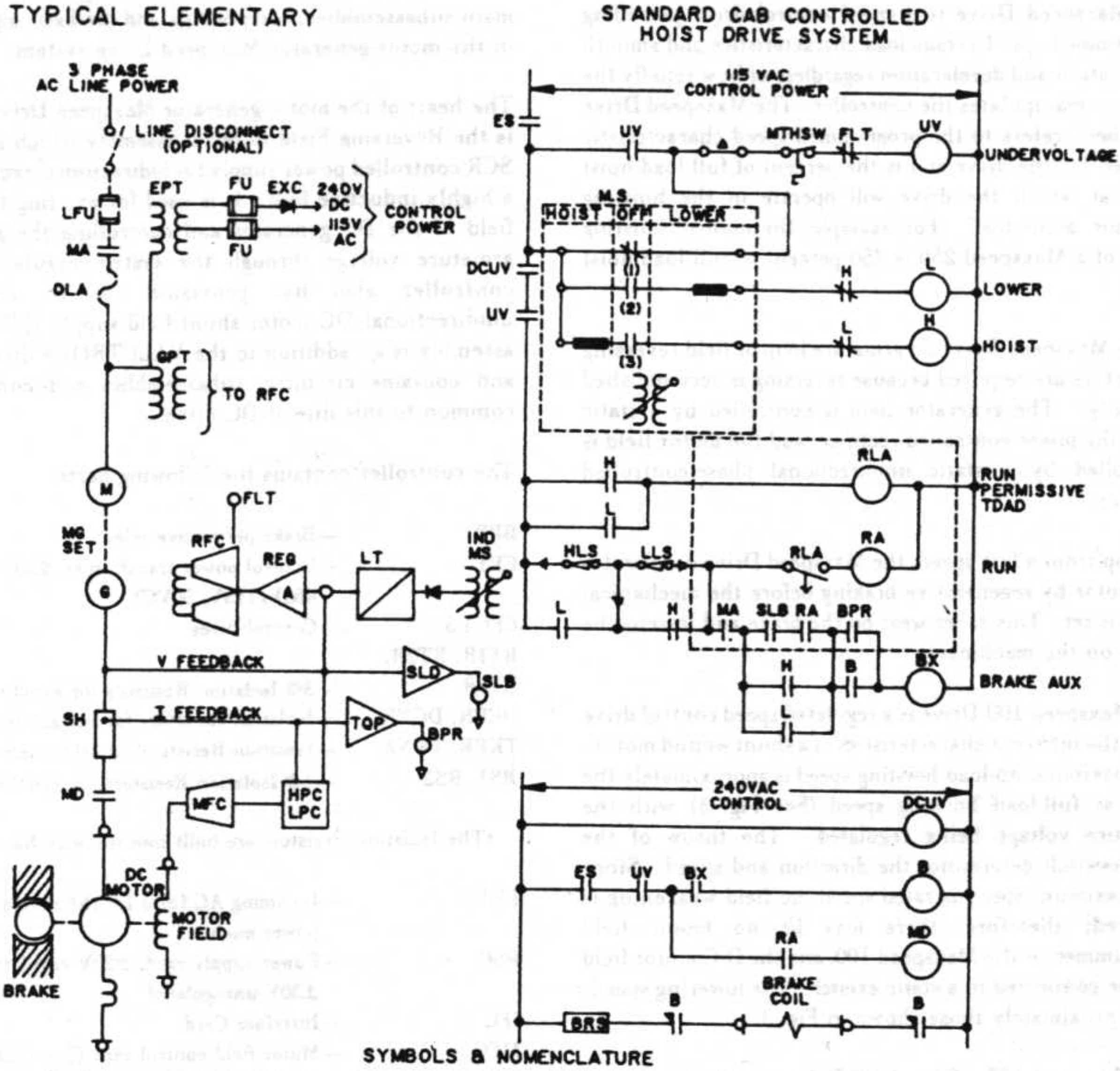
The Elementary diagram also identifies adjustments, signals and test points. In this instruction book, adjustments are in special type. Example: ***FMAX*** (Maximum motor field adjustment).

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

PRINCIPLES OF OPERATION

MAXSPEED CRANE DRIVE DESCRIPTION

The Maxspeed Crane Drive System is a D-C adjustable-voltage drive operating from an A-C power source. The basic drive consists of a D-C shunt wound motor, a motor-generator set operating on A-C power and supplying adjustable voltage D-C power to the D-C motor, an A-C/D-C control panel and a masterswitch or pendant station for controlling direction of rotation and speed. In addition, the drive includes provision for a brake, normally magnetic shunt wound and spring-set, and limit switches. The MG set and control panel may be furnished as a packaged unit complete with internal wiring and interconnections, plus terminals for external power and control leads. The



SYMBOLS & NOMENCLATURE

- TERMINAL BOARD JUMPER WHICH MAY BE REPLACED BY AN EXTERNAL FUNCTION SUCH AS A LIMIT SWITCH OR AUXILIARY CONTACT
- — COLLECTOR
- A — AMPLIFIER
- B — BRAKE CONTACTOR
- BPR — BRAKE PERMISSIVE RELAY
- BRS — BRAKE RESISTOR
- BX — BRAKE AUXILIARY RELAY
- DCUV — DC UNDERVOLTAGE
- EPT — EXCITER POWER TRANSFORMER
- EXC — STATIC EXCITER
- FLT — FAULT RELAY
- FU — FUSE
- HLS — HOIST LIMIT SWITCH
- G — DC GENERATOR
- GPT — GENERATOR POWER TRANSFORMER
- HPC, LPC — MOTOR FIELD PROGRAMMING FUNCTION
- LT — LINEAR TIME
- M — AC MOTOR
- MA-JLA — MG SET STARTER
- MD — LOOP CONTACTOR
- MFC — MOTOR FIELD CONTROL
- MS — MASTERSWITCH - INDUCTION TYPE
- MTHSW — MOTOR THERMAL SWITCH
- RA — RUN RELAY
- RFC — REVERSING FIELD CONTROL
- RLA — RUN TIMER
- SH — SHUNT
- SLB — VOLTAGE RELAY
- UV — UNDERVOLTAGE RELAY
- ES — EMERGENCY STOP RELAY
- H — HOIST RELAY
- L — LOWER RELAY
- TQP — TORQUE PROVING

FIG. 2 TYPICAL SIMPLIFIED ELEMENTARY DIAGRAM enclosure doors are removable for increased accessibility. See Fig. 2 for simplified crane drive elementary diagram.

The Maxspeed Drive is a speed control drive providing programmed speed versus load characteristics and smooth acceleration and deceleration regardless of how rapidly the operator manipulates the controller. The Maxspeed Drive "number" refers to the programmed speed characteristic selected for the drive and is the percent of full load hoist speed at which the drive will operate in the hoisting direction at no-load. For example, the no-load hoisting speed of a Maxspeed 250 is 250 percent of full load hoist speed.

In the Maxspeed Drive no armature loop or field reversing contactors are required because reversing is accomplished statically. The generator field is controlled by a static reversing phase-controlled rectifier, and the motor field is controlled by a static unidirectional phase-controlled rectifier.

To stop from a fast speed, the Maxspeed Drive decelerates the motor by regenerative braking before the mechanical brake is set. This saves wear on the brake and lessens the strain on the machinery.

The Maxspeed 100 Drive is a regulated speed control drive using the inherent characteristics of a shunt wound motor. The maximum no-load hoisting speed is approximately the same as full-load hoisting speed (See Fig. 3) with the armature voltage being regulated. The throw of the masterswitch determines the direction and speed. Since the maximum speed is rated speed, no field weakening is required; therefore, there may be no motor field programmer in the Maxspeed 100, and the D-C motor field may be connected to a static exciter. The lowering speeds are approximately those shown in Fig. 3.

The Maxspeed 175, 250 and 320 Drives are common speed versus load characteristics (See Fig. 3); however, intermediate characteristics are provided to meet various applications. The curves on Fig. 3 show the range of speeds from minimum throw of the masterswitch to full throw for each characteristic where speed is a function of hook load. The particular characteristic selected for a drive is determined by the application requirements and the capability of the D-C motor. How this characteristic is set-up in the regulator is covered in later sections.

GENERAL DESCRIPTION

The simplified typical block diagram, Figure 4, shows the main subassemblies, components and the basic signal flow in the motor-generator Maxspeed Drive system.

The heart of the motor-generator Maxspeed Drive System is the Reversing Field Control Assembly which is a static SCR controlled power supply for bidirectional excitation of a highly inductive load. It is used for exciting the shunt field of the DC generator and controlling the generator armature voltage through the system regulator. The controller also has provision for an adjustable unidirectional DC motor shunt field supply (MFC). The assembly is an addition to the VALUTROL® drive family and contains circuitry, subassemblies and components common to this line of DC drives.

The controller contains the following parts:

BPR	—Brake permissive relay
CPT	—Control power transformer, 230V or 460V/115V, 50VCT
CFU1-3	—Control fuses
RT1R, RT2R, RT3R	—3Φ Isolation Resistors for synchronizing
DCPR, DCNR	—Isolation Resistors for voltage feedback
TKPR, TKNR	—Isolation Resistors for tachometer feedback
RS1, RS2	—1Φ Isolation Resistors for synchronizing

(The Isolation Resistors are built into the wire harnesses)

FU1-2	—Incoming AC fuses for the reversing power module
PSC	—Power supply card, ±20V regulated, ±30V unregulated
IFC	—Interface Card
MFC	—Motor field control card (See GEK-24971)
DGC	—Diagnostic card
MCC	—Main Control Card
MDR	—Card rack with custom wired S-22 cards
SCR	—Reversing field control power module
MAX	—Main control relay
FLT	—System fault relay
GPT	—Center tapped power transformer for the reversing field control power module
SH	—100 millivolt shunt for motor armature current signal
MD	—DC loop contactor
CB	—Circuit breaker or disconnect device

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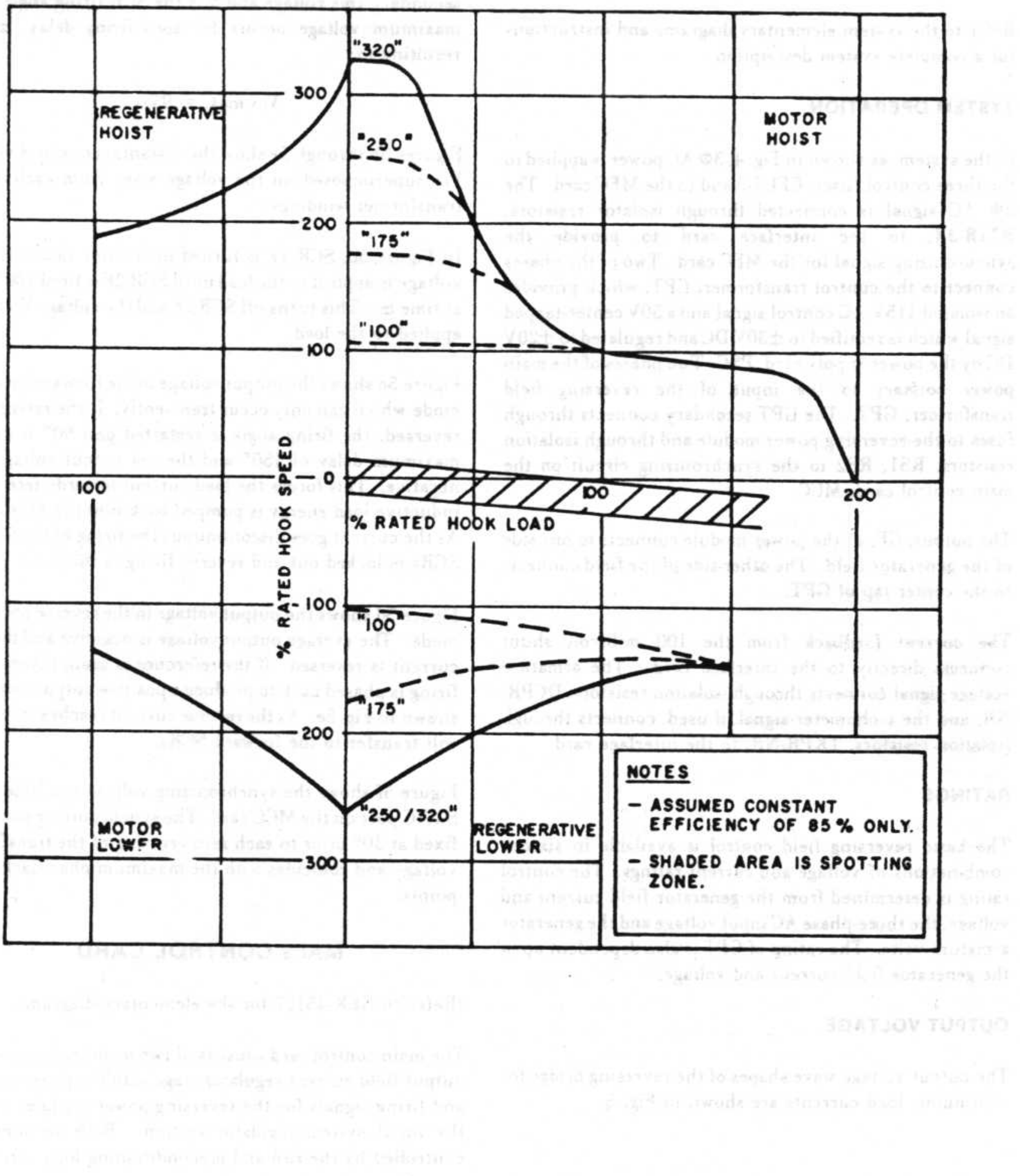


FIG. 3 TYPICAL SPEED-LOAD CURVES FOR MAXSPEED HOIST DRIVES

Custom features of the Maxspeed Drive are found in the modification rack. These features include a reference card (REF) and a torque proving card (TQP). If motor field programming is required, hoist and lower programming cards (HPC and LPC) are provided. The brake permissive relay (BPR) provides a pilot signal to the brake contactor.

Refer to the system elementary diagrams and instructions for a complete system description.

SYSTEM OPERATION

In the system, as shown in Fig. 4, 3Φ AC power is applied to the three control fuses, CFU1-3 and to the MFC card. The 3Φ AC signal is connected through isolator resistors, RT1R-3R, to the interface card to provide the synchronizing signal for the MFC card. Two of the phases connect to the control transformer, CPT, which provides an isolated 115V AC control signal and a 50V center-tapped signal which is rectified to ±30V DC and regulated to ±20V DC by the power supply card, PSC. Two phases of the main power connect to the input of the reversing field transformer, GPT. The GPT secondary connects through fuses to the reversing power module and through isolation resistors, RS1, RS2 to the synchronizing circuit on the main control card, MCC.

The output, GF, of the power module connects to one side of the generator field. The other side of the field connects to the center tap of GPT.

The current feedback from the 100 millivolt shunt connects directly to the interface card. The armature voltage signal connects through isolation resistors, DCPR-NR, and the tachometer signal, if used, connects through isolation resistors, TKPR-NR, to the interface card.

RATINGS

The basic reversing field control is available in sixteen combinations of voltage and current ratings. The control rating is determined from the generator field current and voltage, the three-phase AC input voltage and the generator armature volts. The rating of GPT is also dependent upon the generator field current and voltage.

OUTPUT VOLTAGE

The output voltage wave shapes of the reversing bridge for continuous load currents are shown in Fig. 5.

The average output voltage, V_{GN}, applied to the load is found by averaging the instantaneous voltage applied by one-half of the transformer between two firing points.

The relationship between the output and the input voltage is $V_{Gn} = .9V_{1n} \cos \alpha$ where V_{1n} is one-half the transformer secondary rms voltage and α is the SCR firing angle. The maximum voltage occurs for zero firing delay, $\alpha = 0$, resulting in:

$$V_{GN} \text{ max.} = .9V_{1n}$$

Figures 5b through 5e show the instantaneous load voltage V_{GN} superimposed on the voltage wave from each of the transformer windings.

In Figure 5b, SCR 1F is turned on at time t_{1F} and the V_{1n} voltage is applied to the load until SCR 2F is fired 180° later at time t_{2F}. This turns off SCR 1F and the voltage V_{2n} is now applied to the load.

Figure 5c shows the output voltage in the forward inverting mode which can only occur transiently. If the reference is reversed, the firing angle is restarted past 90° towards a maximum delay of 150° and the net output voltage goes negative. This forces the load current towards zero as the inductive load energy is pumped back into the AC supply. As the current goes discontinuous the firing of the forward SCRs is locked out and reverse firing is initiated.

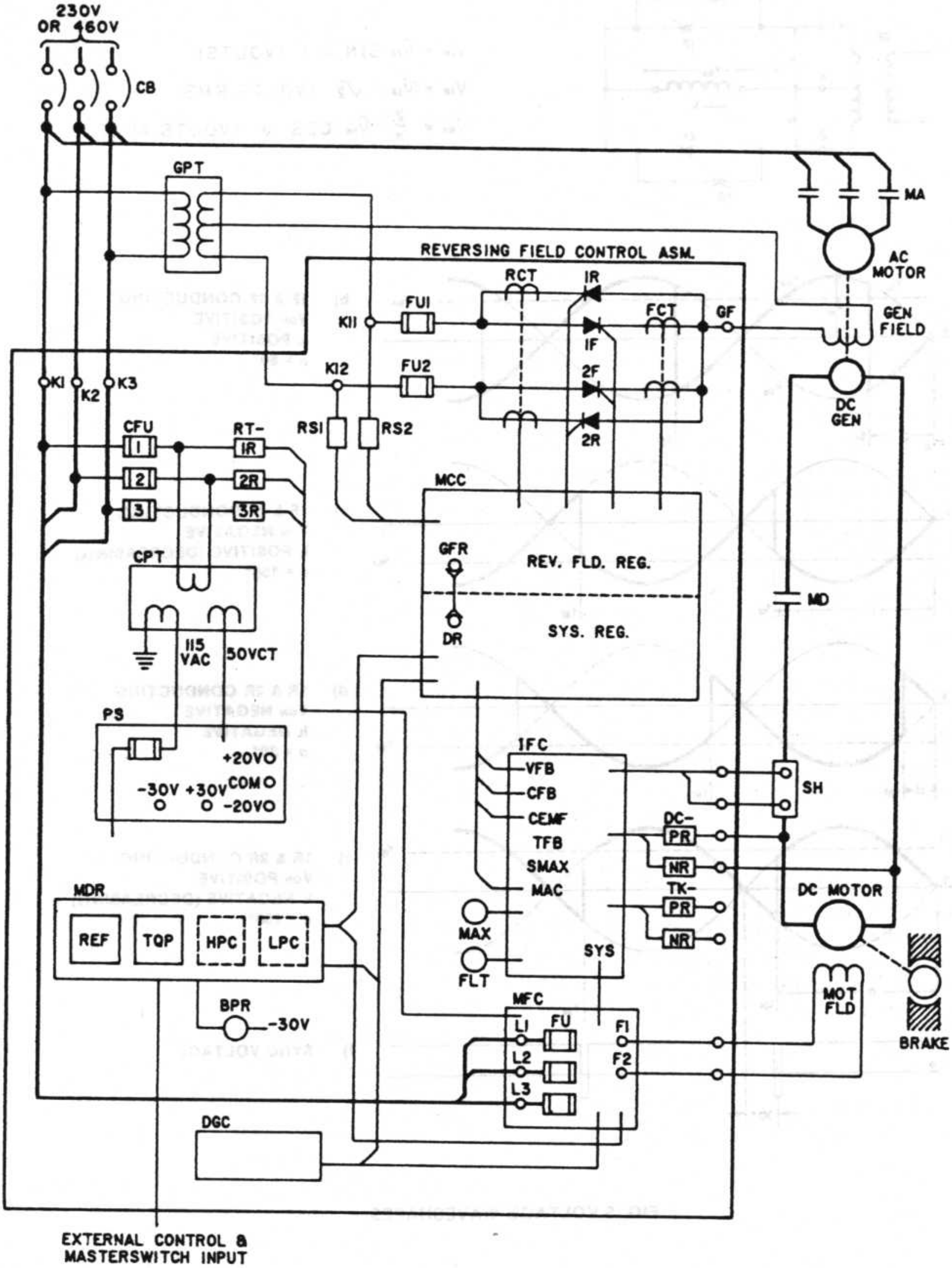
Figure 5d shows the output voltage in the reverse operating mode. The average output voltage is negative and the load current is reversed. If the reference is again reversed the firing is phased back to produce a positive output voltage as shown in Fig. 5e. As the reverse current reaches zero firing will transfer to the forward SCRs.

Figure 5f shows the synchronizing voltage available at the SYNC post on the MCC card. The synchronizing pulses are fixed at 30° prior to each zero crossing of the transformer voltage and coincides with the maximum phaseback firing points.

MAIN CONTROL CARD

(Refer to GEK-45127 for the elementary diagram).

The main control card consists of two main sections, — the output field current regulator stage with the phase control and firing signals for the reversing power module, — and the input system regulator section. Both sections are controlled by the run and preconditioning logic circuits.



© FIG.4 MAXSPEED DRIVE BLOCK DIAGRAM

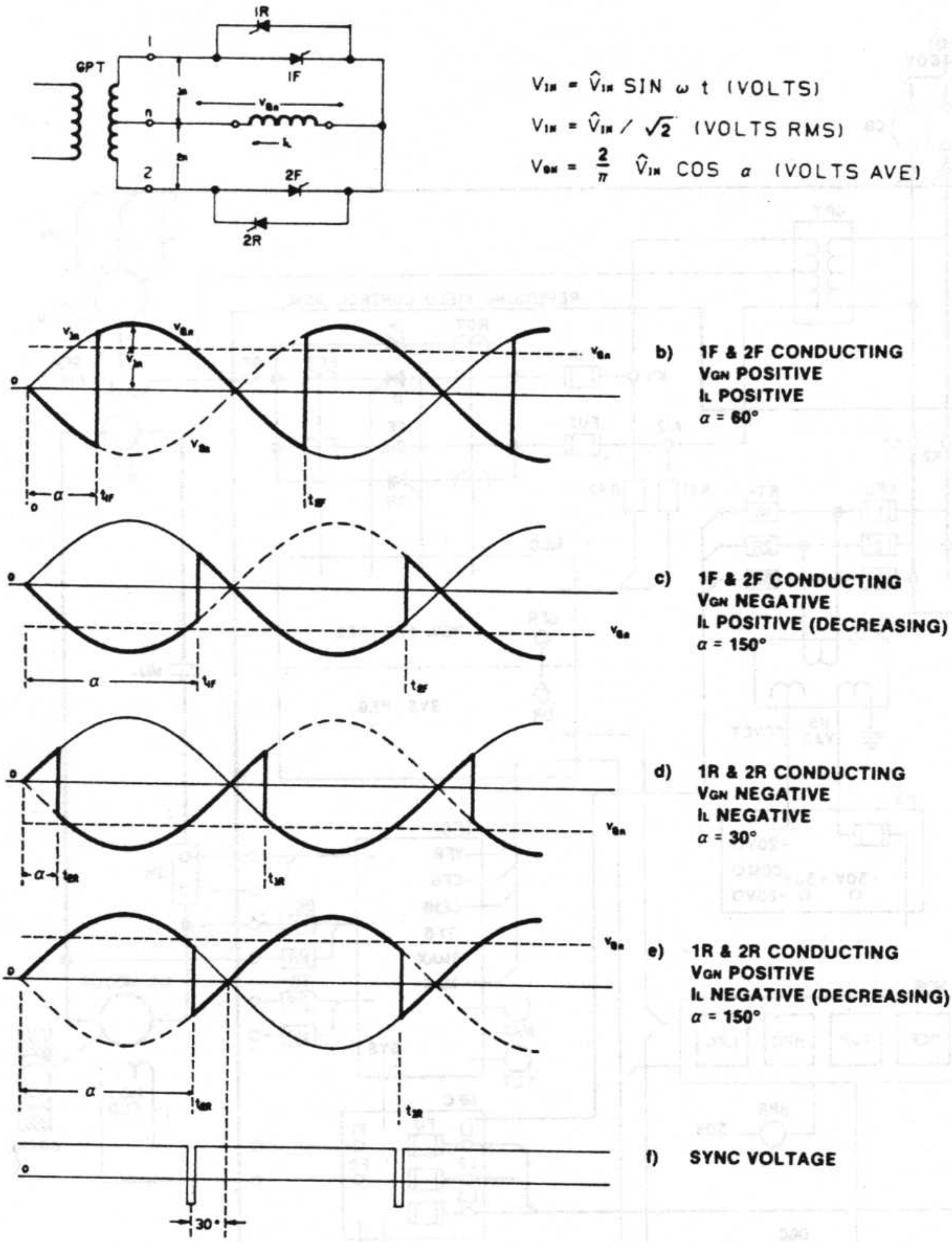


FIG. 5 VOLTAGE WAVESHAPES

SYSTEM REGULATOR

Timed Reference: The maximum input voltage range at SR is ±5V to ±10V, or ±10V to ±20V with a jumper between SRH and COM.

With maximum reference applied at SR the voltage at TR is adjusted for ±10V with the ***REF SCALE*** potentiometer.

The timing range is .3 sec. to 7 sec., or 2 sec. to 60 sec. with 332 ohm connected between LT1 and COM. The timing is set by the ***LIN TIME*** potentiometer. If +20V is applied at ALT the ***LIN TIME*** potentiometer is disabled and the timing is set by the ***AUX TIME*** potentiometer.

Regulator: During normal operation the function of the regulator is to make the system feedback voltage, SFB, equal to the inverse of the timed reference voltage, TR (i.e., SFB = —TR). The ***ZERO ADJ*** potentiometer is factory set to counteract any DC offset in the SFB and TR signals at low speeds. The gain in the feedback amplifier makes SFB = +10V for TFB = —5.6V.

In a voltage regulated system VFB is connected to TFB. Since VFB = ±5.6V at rated armature voltage, rated armature voltage is obtained with TR = ±10V. In this arrangement the ***MAX SPEED*** potentiometer is bypassed and any adjustments in the maximum output voltage is made by adjusting the ***REF SCALE*** potentiometer.

In a speed regulated system the output of the tachometer circuit on the interface card is connected to the TFB input in place of the VFB signal.

NOTE: Only a DC tachometer can be used for speed feedback.

The regulator output, DR, is normally connected by a card jumper to the field current regulator input, GFR.

CEMF: The CEMF signal is generated by subtracting a portion of the current feedback, representing the motor IR drop, from a filtered voltage feedback. The amount of "IR Compensation" is set by the ***COMP*** potentiometer. This signal represents motor speed at base speed and below.

Current Limit: If the level of the armature current feedback signal, CFB, exceeds the setting of the current limit reference, the output of the current limit circuit will override the regulator. The voltage level at DR or the rate of change in the DR voltage is modified to keep the current at the set limit.

The current limit can be adjusted from 80% to 215% of a rated CFB level of 2.5 volts with the ***CUR LIM*** potentiometer.

With +20V applied at ALM the current limit is set by the ***ALIM*** potentiometer which also has a range of 80% to 215%.

With +20V applied to BLM (with ALM open) the current limit is set by the ***BLIM*** potentiometer over a range from 20% to 110%.

NOTE: When operating in current limit the drive speed or voltage does not follow the timed reference, TR (i.e., SFB ≠ —TR).

RUN/Preconditioning: Starting of the drive is initiated by the application of —30V to RUN. This will apply —18V to MAC which provides the turn-on signal to the interface card for the MAX relay. If no fault conditions exist, the MAX relay is energized and the voltage at PRE goes to —3.5 volts. The FET switch, T6 around the timing integrator is opened. After a time delay of about 80 milliseconds, — the delayed firing power, DFP, is applied to the pulse transformer circuits, — the input switches T1 and T2 are opened to apply the SR signal to the timing circuit, — the T7 switch is opened to release the regulator preconditioning.

In the reversing field control circuit the T25 switch is opened to release the current regulator preconditioning, — and the T33 switch is opened to release the lockout of the firing signal.

A normal stop sequence is initiated by disconnecting —30V from RUN. The reference switches, T1 and T2, closes and the timed reference, TR, ramps down toward zero. The —18V at MAC is removed, but the MAX relay stays picked up until the CEMF signal drops below the level set by ***RSTOP*** on the interface card. When the MAX relay is deenergized the voltage at PRE goes from —3.5 to 0 volts. The timed reference is immediately preconditioned by the closing of switch T6. After a time delay of .4 to .6 seconds the firing power, DFP, is disabled and switches T7, T25 and T33 close to precondition the regulating system.

FIELD CURRENT REGULATOR

Regulator: The reference, GFR, is compared to the field current feedback, FGC and RGC by the regulating amplifier to produce the phase-control reference, PCR. The current feedback is applied to FC1 and FC2 from the forward current transformer and to RC1 and RC2 from the reverse current transformer. Correct signal voltage is produced by making jumper connections to insert the proper loading resistors according to the level of the field current. The transformer signals are then rectified and any offsets are cancelled by the zero adjust potentiometers, *FIZ* and *RIZ*.

The *IMAX* should be adjusted for rated field current with 10 volts at GFR, and the max. value of FGC and RGC should be from 4.5 to 10 volts.

The current transformer loading resistors should correspond to the field current ranges listed in Table II.

TABLE II
Reversing Field Current Ranges

Max. Field Amps	Jumper Suffix	C.T. Prim. Connection
.8—1.7	None	2 turns
1.3—2.7	B-D	2 turns
2.6—5.5	A-B	2 turns
3.7—8.2	A-B, C-D	2 turns
7.4—15	A-C	2 turns
12.3—25	A-C, B-D	2 turns
23—49	A-E	1 turn
45—70	A-E, A-C, B-D	1 turn

Fwd./Rev. Lockout: The lockout switching amplifiers are controlled from the regulator error signal, PCR, and the current feedback signals, FGC and RGC.

With PCR negative the forward lockout output, FLO, will switch positive provided the reverse current signal, RGC, is zero. As forward current is established, the negative FGC signal will keep the forward lockout released.

When PCR changes positive the forward SCR are phased back forcing the forward current and the FGC voltage to zero. As FGC reaches zero, the forward firing signals are locked out and the reverse lockout is released with RLO switching positive.

During transfer, both the forward and reverse gate signals will be locked out for about 8 milliseconds.

Synchronizing: The synchronizing for the phase control is generated from the transformer voltage applied to the SCR power module. The signal is isolated through external resistors to produce a 6.7V AC signal, phase shifted 150° at post SX. The voltage at SYNC will be at a positive level with negative going pulses at the zero crossings of the SX signal. The SYNC signal is applied to the unijunction oscillator circuit to reset the timing capacitor during each negative pulse.

Phase Control: The programmable unijunction transistor, T29, will turn on to produce an output pulse when the voltage on the timing capacitor, C29, exceeds 10 volts. With PCR equal to zero, the circuit is biased such that firing occurs at a phase lag of 150°.

The unijunction pulses are amplified and applied to the pulse transformer circuit inputs, FGP, in the forward mode, and RGP, in the reverse mode.

Each pulse transformer has two output windings applying pulses simultaneously to both forward SCRs in the forward mode and likewise to both reverse SCRs in the reverse mode.

For 50 Hz operation, the circuit should be rebiased by removing the jumper between posts X and Y.

Ready to Run: The green Ready to Run indicating light on the MCC card must be on before the drive can be started.

If a fault occurs the light is extinguished and the drive shuts down. After the fault condition is removed the drive can be reset by pushing the RESET button.

Miscellaneous: A spare, unity gain, inverting amplifier is available with input and output at connector posts X1 and XDR.

Regulator points available at connector posts can be connected to spare output terminal points by jumper connections to any of the eight "dummy" posts DM1 through DM8. This feature is primarily used for interfacing between the MCC card and the MDR rack.

In a speed regulated system a tachometer lead circuit can be added by connecting a resistor between posts RJ and TL and a capacitor between posts TL and SFB.

The rate feedback from DR to the current limit circuit can be strengthened by adding a capacitor between posts DR and CLI, and a resistor between posts CLI and CLJ for the purpose of reducing current limit overshoots.

The field current regulator response can be trimmed by adding a resistor from post PCJ to PCI or a capacitor between posts PCI and PCR.

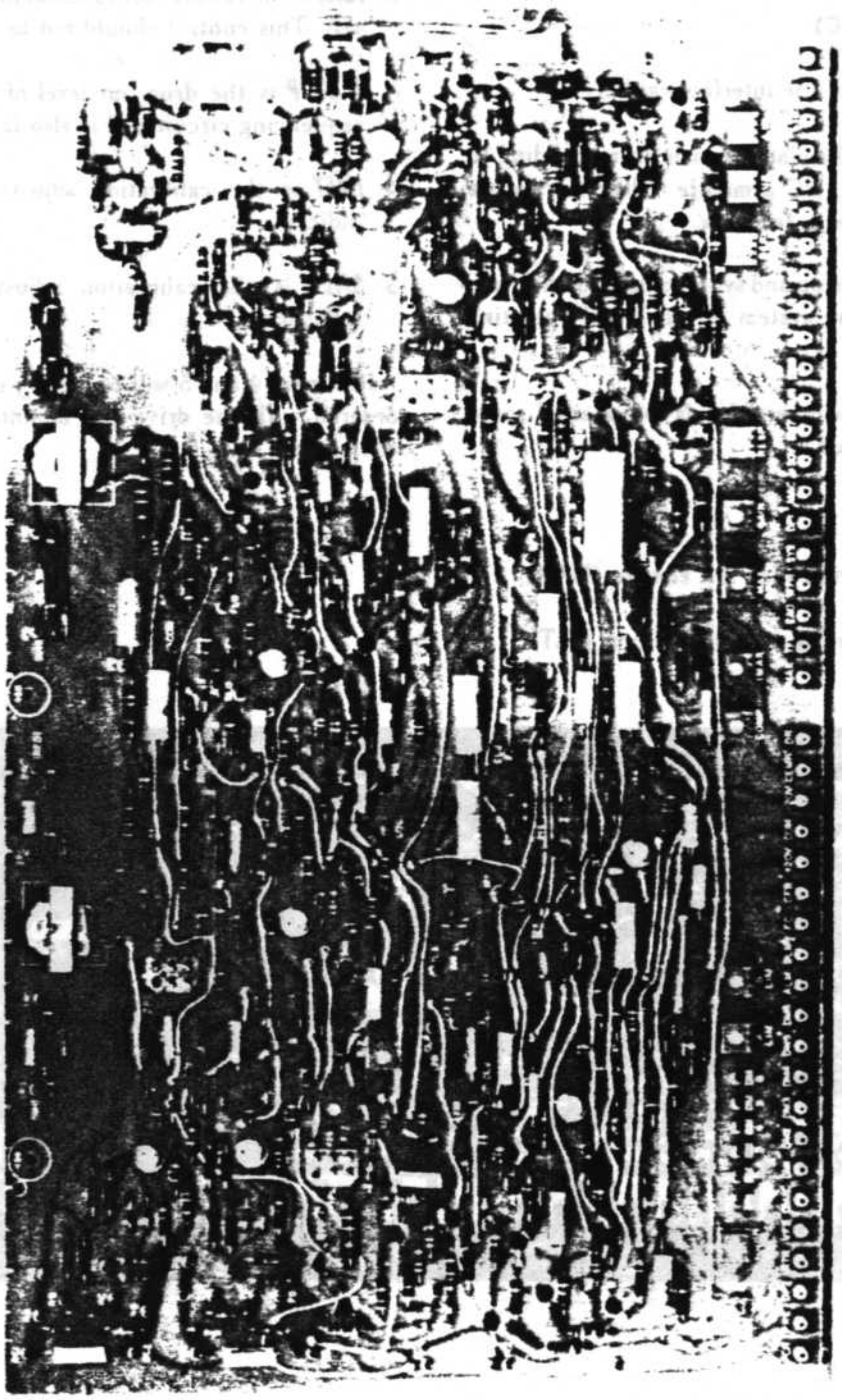


FIG. 6 MAIN CONTROL CARD
(NOTE: TEST POSTS ALONG LARGE EDGE)

By connecting +20V to post NRG, the system feedback, SFB, is inhibited and the regulator gain is reduced to unity. This makes DR = —TR (unless the drive is in current limit) such that the input to the field current regulator is set by the external reference. This modification can be used temporarily during troubleshooting or tune up.

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 one milliampere signals for external speed and current indication.

Other outputs provide:

1. A NO/NC contact indicating MA closure (MAX).

2. A NO contact indicating a fault condition (FLT).

There are (5) potentiometers on this card.

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

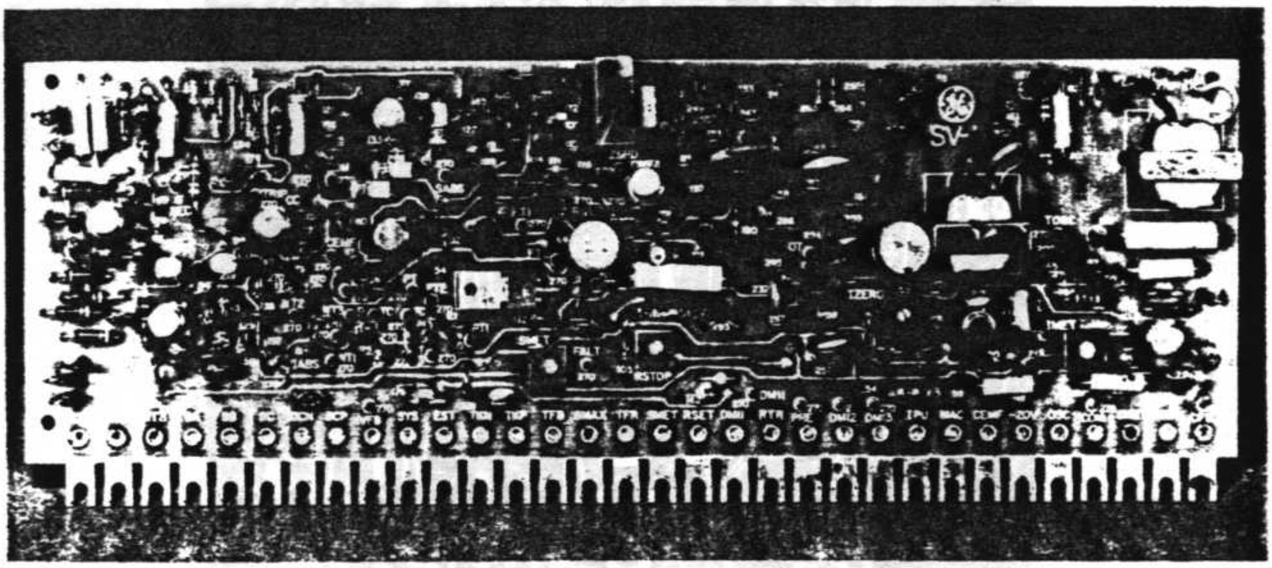
2. ***ICAL*** is the calibration adjustment for CFB and is factory set. This control should not be disturbed.

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.

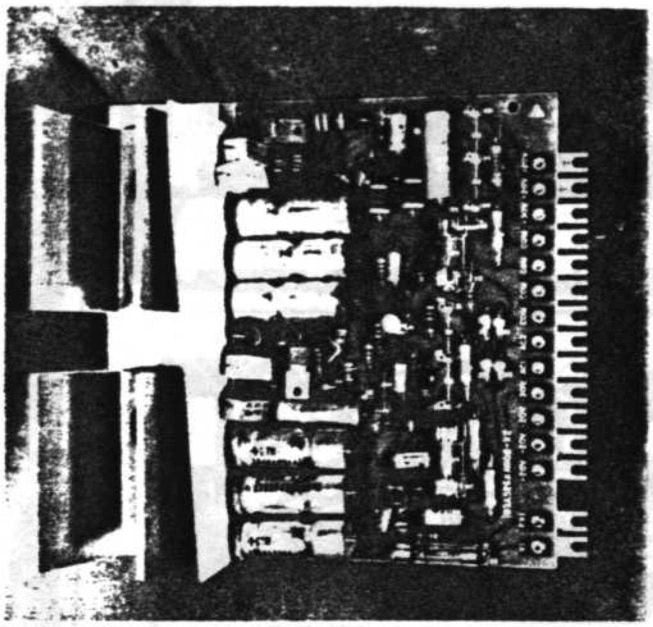
5. ***SMET*** is the calibration adjustment for the speed indicator.

Adjustment 4 and 5 will be factory set if the indicators are ordered with the drive and mounted in the power unit enclosure.



(Photo MG-5236-13)

FIG. 7 INTERFACE CARD



(Photo MG-5236-20)

FIG. 8 POWER SUPPLY CARD

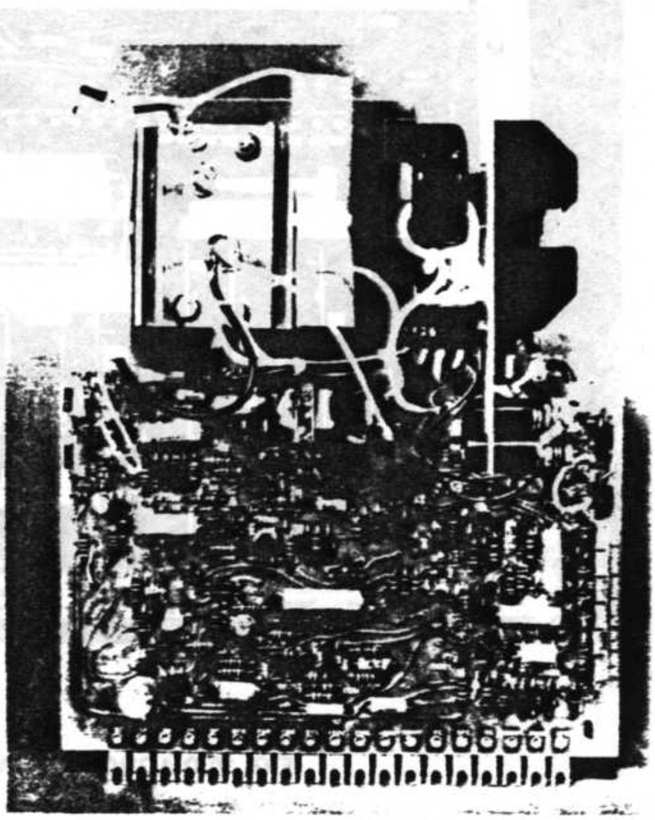
POWER SUPPLY CARD (PSC)

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 MAX relay. 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.

MOTOR FIELD CONTROL CARD (MFC)

This card provides a current regulated motor field supply for the DC motor. Constant field excitation is supplied for Maxspeed 100 Drives. On Maxspeed Drives where field programming is required, the current reference is modified by the hoist or lower programming card to achieve the desired speed versus load characteristic.

The tachometer monitor circuit is used to monitor SFB and detect an overvoltage. Loss of motor field is also detected by this card. Any of these faults will shut down the drive. A field economy circuit is also included on this card, which automatically reduces the level of motor field excitation whenever the drive is shut down, thereby avoiding the possibility of excessive temperature (at stand still) and/or reduced insulation life. See GEK-24971 for detailed instructions.



(Photo MG-5236-15)

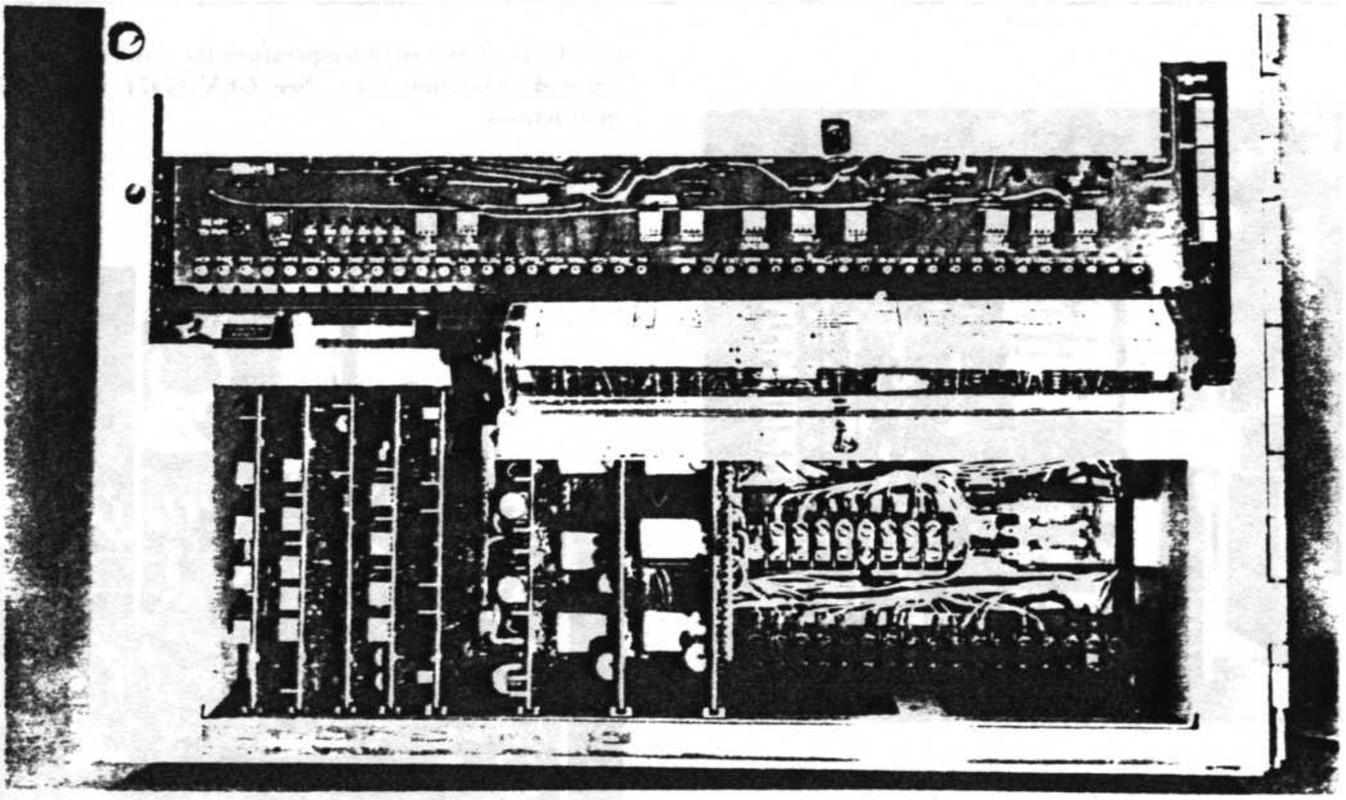
FIG. 9 MOTOR FIELD CONTROL CARD

TEST INSTRUMENT AND PROBE

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.

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.



(Photo MG-5543-1)

FIG. 10 DIAGNOSTIC CARD AND MODIFICATION RACK

POWER CONNECTIONS

The power connections to the reversing field control are the single-phase AC input K11 and K12 on the fuses and the generator field connection, GF, directly to the heat sink. Power terminal boards for the motor and generator are provided separately on the enclosure panel.

SIGNAL CONNECTIONS

All signal connections are made on the ATB, BTB, 2TB, 3TB and 4TB terminal boards. Signals appearing on these terminal boards and their functions are described in Table III.

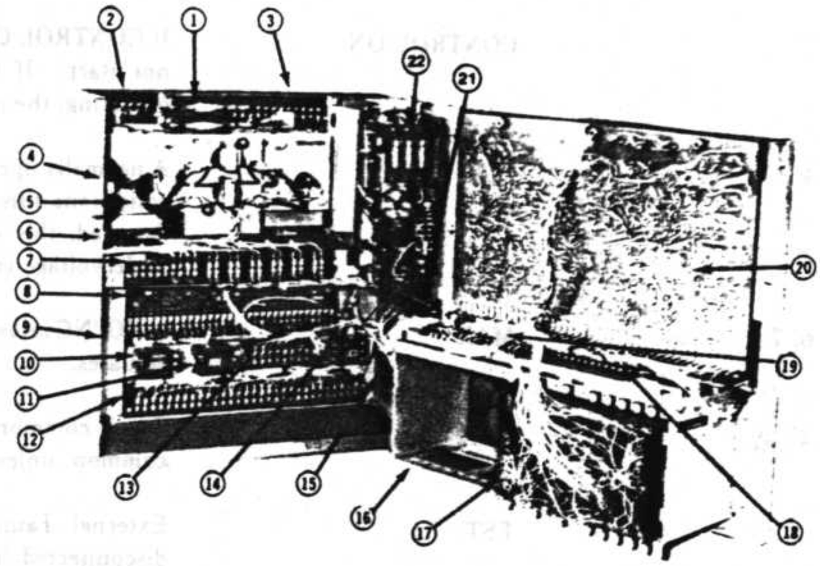
MODIFICATION RACK (MDR)

Provided on printed circuit cards located in the modification rack below the main control card are the special features and functions of the Maxspeed Drive. These features include:

Operational check
Provision for induction masterswitch
Torque proving
Slowdown or spotting control
Hoist Motor Field programming

See Modification Features for details of these functions. Other special functions such as stepped reference or independent timed acceleration and deceleration adjustments may also be added.

1. FUSES
2. ATB
3. BTB
4. CONTROL FUSES
5. HEATSINK MODULE
6. FANS
7. MODULE TERMINAL BOARD (MTB)
8. INTERFACE CARD (IFC)
9. POWER SUPPLY (PSC)
10. MA AUXILIARY RELAY (MAX)
11. FAULT RELAY (FLT)
12. 2TB
13. 3TB
14. BRAKE PERMISSIVE RELAY (BPR)
15. 4TB
16. MODIFICATION RACK (MDR)
17. S-22 CARDS
18. 5TB
19. RTB
20. MAIN CONTROL CARD (MCC)
21. MOTOR FIELD TERMINAL BOARD (MFTB)
22. MOTOR FIELD CONTROL (MFC)



(Photo MG-5543-2)

FIG. 11 COMPONENT AND SIGNAL CONNECTION LOCATION

TABLE III SIGNAL CONNECTIONS

ATB	NOMENCLATURE	DESCRIPTION
K1, K2, K3	K1, K2, K3	Three-phase power for motor field (MFC) and control transformer (CPT).

BTB NO.	NOMENCLATURE	DESCRIPTION
DCP, DCN	V FDBK	Voltage Feedback from DC generator armature. NOTE: DCP must be positive with SR negative.
IP, IN	CURR FDBK	Current Feedback signal from DC line, 100MV shunt. NOTE: IP must be positive for forward motoring.
F1, F2	MTR FLD	DC Motor Field connection from MFC.

TABLE III SIGNAL CONNECTIONS (continued)

2TB NO.	NOMENCLATURE	DESCRIPTION
1	—30V	Unregulated negative DC voltage used as the return line for the CONTROL ON function and the static switch RUN 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 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. Usually connected in the undervoltage circuit to remove control power.
5, 6, 7	MAX	A NO/NC relay contact which actuates when the contactor actuates.
8, 27	COM	Signal common. All signals are measured with respect to common, unless otherwise noted.
9	EST	External Fault Stop input. If EST is momentarily disconnected from common, the 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). (See RESET below).
10, 11	FX1, X2	The internal 115V AC. FX1 is fused for external use.
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 to SP8	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 RUN is connected to —30V, either at 2TB or by special purpose logic in the MDR. When RUN is 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, −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. ***IMET*** is an absolute (—) signal.
23	SMET	Output to a 1ma speed instrument. The instrument is calibrated with the ***SMET*** potentiometer on the Interface Card. ***SMET*** is an absolute (—) signal.
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 MUST BE POSITIVE WHEN SYSTEM REFERENCE IS NEGATIVE AND DCP IS POSITIVE WITH RESPECT TO DCN.**

3TB NO.	NOMENCLATURE	DESCRIPTION
1	RLA	Input to time delay relay card (TDR) for relay RLA.
2	RA	Input to logic relay RA used for run.
6, 7, 8	BPR	A NO/NC relay contact which actuates when the brake permissive relay actuates. BPR responds to a signal from the torque proving card.

4TB NO.	NOMENCLATURE	DESCRIPTION
1	RUN	Run signal which is time delayed after deenergization which is connected to the CONTROL ON input through a UV contact.
2	NSW	Negative switch input to reference card to enable negative reference.
3	PSW	Positive switch input to reference card to enable positive reference.
7, 9, 10, 11 12, 13, 14	SP37, SP39 to SP44	Special purpose wires for additional signals.
15	+30V	Unregulated positive DC voltage for reference card input switches.

START-UP

The Maxspeed Drive is factory tested with the complete drive system. It is ready to operate provided the external power and control connections have been properly made and 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 the incoming wiring is complete and correct.

3. Set the diagnostic switch to its NORMAL (center) position. Apply power to the drive. If the green "Ready to Run" light located on the lower left hand corner of the main control card (MCC) is not illuminated, press and release the RESET pushbutton on the panel below. If the light does not turn on, the most probable cause is incorrect incoming phase rotation. Remove power, reverse any two of the incoming AC power leads and repeat.

4. Verify that the reference voltage, SR, from 2TB(28) to 2TB(27) is variable with the external speed adjust controller. (SR must be negative in the hoist or forward direction).

   When an induction masterswitch is used, the reference polarity may be changed by interchanging the wires on terminals X1 and X3 and on X2 and X4 on the masterswitch terminal board.

5. With the generator rotating, set the local speed reference ***LOC REF*** potentiometer to its center position and switch into the diagnostic run ***DIAG RUN*** position. The MD contactor should not pick up. Slowly turn the ***LOC REF*** potentiometer away from the control until the generator voltage increases. Verify that the system feedback signal on the SFB test point, located on the bottom of the main control card (MCC) has electrical polarity opposite to signal LR. Turn the ***LOC REF*** potentiometer back to the center position and switch to ***NORMAL***. If the feedback polarity was incorrect, remove power and interchange the generator field connections F1 and F2.

6. Slowly move the master controller until the motor starts to rotate. Check motor rotation. If incorrect, remove power and interchange the motor field leads.

7. Run the drive from the external speed reference up to top speed. Adjust ***MAX NEG*** and ***MAX POS*** as may be required to set the maximum armature voltage.

   If field programming is used, adjust ***MFH*** on the hoist card, for the no-load hoisting speed and ***MFL***, also on the hoist card, for the no-load lowering speed. The value of FC at the top no-load speeds should be recorded for future reference. DO NOT OVERSPEED.

8. Close and secure the doors of the power unit.

WARNING

BEFORE LIFTING A LOAD, THE BRAKE LININGS SHOULD BE "WORN IN" SUFFICIENTLY PER THE MANUFACTURER'S INSTRUCTIONS.

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.

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%).

SWITCH LOGIC

RUN will be connected to —30 volts by an RA contact which is a function of the run permissive relay and masterswitch. The 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 pilot relay MAX.

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

When PRE is released from common, it switches to —3.5 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 ia applied to the linear time section. The timed reference output TR will ramp to a voltage proportional to SR. The ***MAX NEG*** or ***MAX POS*** adjustment is used to set TR to 10.0 volts when the masterswitch 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 VFB feedback from the motor is isolated with a resistor network in the feedback harness. VFB is connected to the system feedback at TFB. The output of the system feedback section is SFB, and will be 10 volts at top voltage.

The timed reference, TR, and the system 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 voltage. EAO will not be low when the drive is in current 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.

To protect the system, the current limit drives the regulator integrator and will override the error amplifier. The current limit is set with the ***CUR LIMIT*** adjustment. Typically, the current limit is set at 150% of the motor nameplate current or 3.75 volts (±10%) of current feedback, CFB.

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. For most Maxspeed Drives, the ***COMP*** adjustment is set so there is no IR compensation. CEMF is then equal to the voltage feedback, VFB.

The driver reference, DR, is connected by a card jumper to GFR, the generator field current reference. This signal is compared with the generator field current feedback to produce the field current regulator output, PCR.

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 10 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.

STOP

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

NORMAL STOP — Move the masterswitch to the OFF position. NSW or PSW on the reference card opens, removing the reference from SR.

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

Signal level detector relay, SLB, will drop out at a low value of CEMF and set the brake to stop the drive. After a time delay, set by run permissive relay, RLA, RA drops out removing power from the MAX coil, which in turn drops out MD. The time delay allows jogging of the drive without dropping out MD and sets the brake in the event SLB does not drop out or the drive does not respond to a stop command.

FAULT STOP — Fault detected (See Table IV) or CONTROL ON is open. An emergency stop will initiate a fault stop sequence by opening CONTROL ON and removing control power.

The preconditioning signal, PRE, is immediately applied to the main control card, forcing TR to zero. After about .5 seconds, preconditioning is established throughout the card.

The MAX relay unconditionally drops out 100 milliseconds after the fault condition occurs. The brake contactor drops out immediately.

The drive cannot be restarted until the motor has come to rest and the masterswitch has been returned to the OFF position.

After the motor has stopped, push the RESET button.

DIAGNOSTIC STATIC (SWITCH TO LEFT)

LOGIC

The RUN input is inhibited. This prevents the reference. SR, from activating the drive and holds the 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 system feedback section. The local reference is also connected to the field diagnostic reference, DFDR. Refer to the motor field programmer description for details of operation.

To simplify tracing, the gain of the regulator and drive is reduced and the system 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 system 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. The signal from SFB into the regulator error amplifier is inhibited. The primary purpose of exercising SFB is to check any special function circuits in the modification rack which are programmed from SFB, and/or SFB functions of an 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 zero. When 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.

The current reference 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 field current regulator is reduced so that the phase-control reference, PCR, is proportional to the magnitude of the driver reference, DR, and the setting of the ***IMAX*** potentiometer.

With an oscilloscope, the pulse output, PO, may be monitored to verify proper operation.

DIAGNOSTIC RUN (SWITCH RIGHT)

In diagnostic run, the local reference, LR, and the diagnostic switch are substituted for the reference, SR, and the RUN switch input just as in diagnostic static. MAX is inhibited from picking up in diagnostic run on Maxspeed Drives to prevent running beyond operating limit switches.

The system regulator operates at unity gain. The net effect is that the drive operates as a generator field 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 13 may be used.

Make all connections prior to applying input power.

*All connections may be made to the test posts on the front of the main control card except for DFDR which is located on the 5TB terminal board.

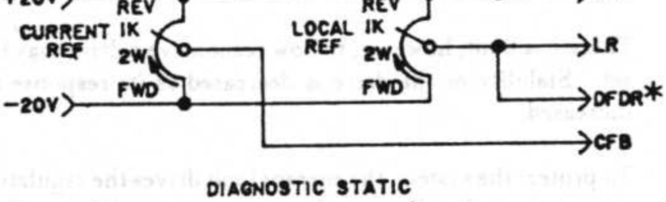


FIG. 13 DIAGNOSTIC TEST CIRCUIT

To avoid confusion and possible interaction, the adjustments should be made in the following sequence. The hoist and lower programming card adjustments are necessary only when motor field programming is provided. Refer to the system elementary to determine what has been furnished.

TABLE V
Recalibrating Adjustment Sequence

	MCC, MFC AND IFC ADJUSTMENTS	MDR ADJUSTMENTS
DIAGNOSTIC STATIC MODE, ADJUST	***FIZ, RIZ*** ***FMAX*** ***FMIN**** ***FLOSS*** ***SLIM*** ***CROSS**** ***LIN TIME*** ***AUX TIME*** ***(IF USED)*** ***COMP*** ***CUR LIMIT*** ***A LIM*** ***(IF USED)*** ***B LIM*** ***(IF USED)*** ***IMET*** ***(IF USED)*** ***ALIGN***	***A LEVEL*** ***B LEVEL*** ***ZERO ADJ.*** ***SFA*** ***MFH*** ***HB*** ***MFL*** ***SL1*** ***LB2*** ***SL2*** ***LB3*** ***SL3***
DIAGNOSTIC RUN MODE ADJUST	DIAGNOSTIC RUN MODE IS INHIBITED	
NORMAL MODE, ADJUST	***REF SCALE*** ***IMAX*** ***GAIN*** ***RESPONSE***	***MAX NEG*** ***MAX POS*** ***SLOW*** ***(IF USED)*** ***MFH*** ***MFL***

*NOTE: A motor field control card is furnished on base speed drives (constant field) to provide field economy, voltage monitor, and field current regulation. Set ***CROSS*** full CW and ***FMIN*** per test data sheet.

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: On a 240V motor 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%.

All readings can have a tolerance of ±10%.

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

FIZ, RIZ **(Forward and reverse current zero adjust)**

Adjust ***FIZ*** for FGC = 0 to —.05 volts.
Adjust ***RIZ*** for RGC = 0 to +.05 volts.

FMAX **(Maximum Field)**

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

FMIN **(Minimum Field — Limit)**

Set ***LOC REF*** potentiometer for —7 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 Rev 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 **(Overvoltage Fault)**

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

Monitor SFB and move the ***LOC REF*** potentiometer Fwd 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) (For drives with field programming).

Set **CROSS** full CCW to enable field programming CRS on the MFC card should also be jumpered to common.

LIN TIME (Linear Time)

Monitor TR and set to zero with the **LOC REF** potentiometer. Rapidly turn the **LOC REF** full Fwd and measure the time for TR to ramp to 10 volts (±10%). Adjust **LIN TIME** until this time corresponds to the test data sheet linear time.

AUX TIME (Auxiliary Linear Time) (If used)

With +20V at ALT, adjust **AUX TIME** using the same procedure as with **LIN TIME**.

COMP (Compensation — IR)

COMP should be set full CCW. IR compensation is not used on voltage regulated drives.

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.

ALIM, BLIM (Alternate Current Limit) (If used)

ALM connected to +20V enables **ALIM**. BLM connected to +20V enables **BLIM**. Adjust **ALIM** or **BLIM** using the same procedure used to set **CUR LIMIT**.

IMET (Load Instrument Calibration) (If used)

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.

ALIGN (Tachometer Loss Align—Fault)

Set **ALIGN** full CW for voltage regulated drives.

The following adjustments are located on printed circuit cards in the modification rack (MDR).

A LEVEL / B LEVEL

(Sets dropout point of signal level detector relays SLA and SLB. Refer to GEK-24946 for details).

Set **COMP** full CW. Adjust **CUR REF** until CEMF is .3 volts (5% CEMF). Adjust **A LEVEL** until SLA drops out.

Adjust **CUR REF** until CEMF is at the desired level for brake setting. Normally .6 volts (10%) for travel drives and 1.2 volts (20%) for hoists drives. Adjust **B LEVEL** until SLB drops out. Return **COMP** full CCW and **CUR REF** to center.

ZERO ADJ (Reference Card)

(Used with induction masterswitches).

With the masterswitch in the OFF position set **ZERO ADJ** for 0 ±.1 volt at DIS on the reference card.

The following adjustments are on the Hoist and Lower Programming cards in the modification rack. If motor field programming is not provided, proceed with the normal run adjustments. Set all adjustments on the Hoist and Lower card.

SFA (Standby Field Adjust)

Adjust **SFA** until FC corresponds to standby FC on the test data sheet.

MFH (Minimum Field Hoist)

Monitor LR and set to —5.6 volts with **LOC REF**. Set 0 volts at CFB with **CUR REF**. Adjust **MFH** until FC equals the minimum field hoist value of FC on the test data sheet.

HB (Hoist Breakpoint)

Adjust **HB** until HB on the hoist card corresponds to the value on the test data.

MFL (Minimum Field Lower)

Monitor LR and set at +5.6 volts with **LOC REF**. Set 0 volts at CFB with **CUR REF**. Adjust **MFL** until FC equals the minimum field lower value of FC on the test data sheet.

***SL1* (Slope 1)**

Set CFB at the value listed on the test data. Adjust ***SL1*** until FC equals the value listed.

***LB2* (Lower Breakpoint 2)**

Adjust ***LB2*** until LB2 on the lower card corresponds to the value on the test data.

***SL2* (Slope 2)**

Set CFB at the value listed on the test data. Adjust ***SL2*** until FC equals the value listed.

***LB3* (Lower Breakpoint 3)**

Adjust ***LB3*** until LB3 on the lower card corresponds to the value on the test data.

***SL3* (Slope 3)**

Set CFB at the value listed on the test data. Adjust ***SL3*** until FC equals the value listed.

Return the Diagnostic switch to Normal.

Return ***REF SCALE*** full CCW.

***MAX NEG / MAX POS* (Maximum Reference)**

Move the masterswitch to the full hoist or forward position. Adjust the *MAX NEG* potentiometer until SFB is +10 volts. This normalizes the timed reference TR and system feedback, SFB for 10 volts at top voltage. Move the masterswitch to the full lower or reverse position. Adjust the *MAX POS* potentiometer until SFB is —10 volts.

***IMAX* (Field Current Reference Calibration)**

With the generator operating at rated voltage and no load, monitor DR and adjust *IMAX* until DR = 10V.

***SLOW* (Slowdown or Spotting Reference) (If used)**

With the masterswitch at full throw, actuate the thumb switch, spotting pushbutton or slowdown limit switch to drop out the slowdown relay. Adjust ***SLOW*** for the desired slowdown or spotting speed. Normally ***SLOW*** is set at 20 — 25% of maximum voltage.

***MFH* and *MFL* (If used)**

With the masterswitch at full throw, trim the *MFH* and *MFL* adjustments for the no-load hoisting and lowering top speeds.

***GAIN* and *RESPONSE* (Stability Adjustments)**

1. **Set the *GAIN* adjustment by calculating the *GAIN* number and referring to the chart (Fig. 14).**

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

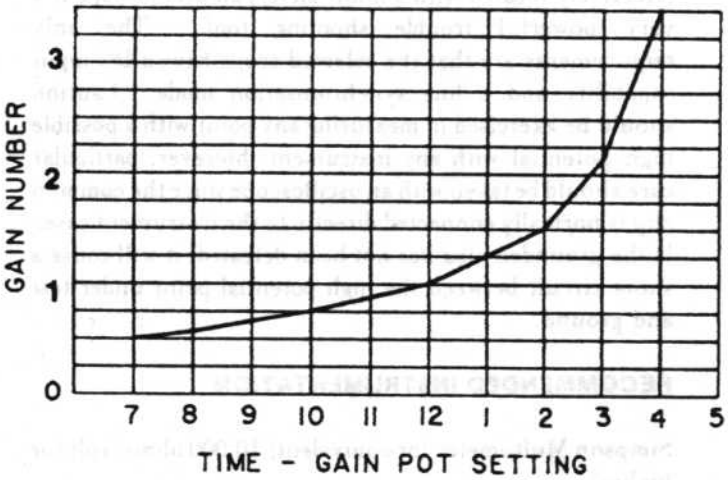


FIG. 14 GAIN ADJUSTMENTS

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

See motor nameplate under — Speed.

Motor Base Speed/Maximum Operating Speed.

Example: 1150/3600RPM

2. **Set *LIN TIME* potentiometer at minimum (7 o'clock).**
3. **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 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.

4. 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, 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 1300 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. 13). 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) without motor field programming (Maxspeed 100) and (2) with motor field programming (Maxspeed Hoist Drives).

Detailed adjustments are found in GEK-24971 for the MFC 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 (MD) is open.

2. Using a multi-meter selected to read ohms on the times 1K scale, check the forward and reverse resistance of SCR cell pairs. This is done by reading across power terminals, K11 and GF, and K12 and GF. Be sure that the AC line fuses FU1 and FU2 are not open in the above check. If a zero reading is obtained, disconnect the anode leads and check each SCR individually.

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:

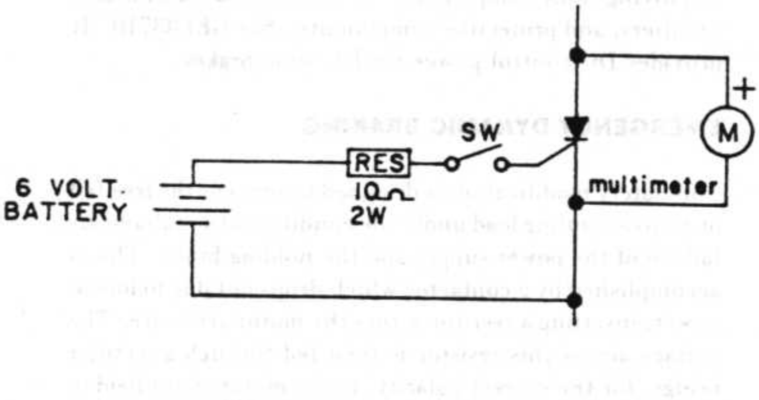


FIG. 15 SCR TEST CIRCUIT

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 fault 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 should be removed. After the SCR cathode and gate leads have been disconnected, recheck the forward and reverse resistances before replacing the SCR. 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

SCR REMOVAL

An SCR is best removed as follows:

Disconnect the cathode lead from the current transformer stud.

Disconnect the SCR gate leads from the terminal board MTB. If markings are not legible, remark prior to removal. Remove the nut on the SCR anode and remove the SCR.

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.

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 30 inch-pounds.

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.

NOTE

There should be no need to retune the drive after removal/repair of an SCR or any other removable subassembly unless, of course, an adjustment was inadvertently 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, DR, CLI, CLJ, PCJ, PCI, PCR, LT1 or DM1, DM2, etc.

3. Set the potentiometers on the replacement printed circuit card to the position as was set on the card that was replaced or the position shown on the test data sheet. Recheck the recalibration procedures described.

4. Use caution when connecting or disconnecting stab-on connectors on the printed circuit cards to avoid breaking of the connector posts. Support the card if possible and use a pair of long-nosed pliers to hold on to the connector crimp. Avoid pulling on wires when removing connectors.

MODIFICATION FEATURES

With the various types of crane drive applications, there are many special features required which differ from one crane drive system to another. Below are listed some of the more frequently used features which may be found in a particular crane drive.

LIMIT SWITCHES

There are various functions of limit switches. An "operating" limit switch may bring the drive to a stop or slowdown the drive as part of normal operation. The stop is by regenerative braking before setting the brake, and the slowdown may simply recalibrate the regulator reference for a slow speed.

A "back-up" or "overtravel" limit switch is designed to initiate an immediate stop by setting the brake and preconditioning the drive. Such a limit switch may be an overhoist or end-of-travel limit switch.

A "power" limit switch is sometimes required as an overhoist limit switch which actually interrupts the power loop of the D-C motor and connects a dynamic braking resistor across the motor armature (Fig. 16). A contact on the power limit switch (PLS) deenergizes the brake directly. When backing out of the limit switch, the masterswitch picks up the lower contactor (L) which bypasses PLS energizing the brake.

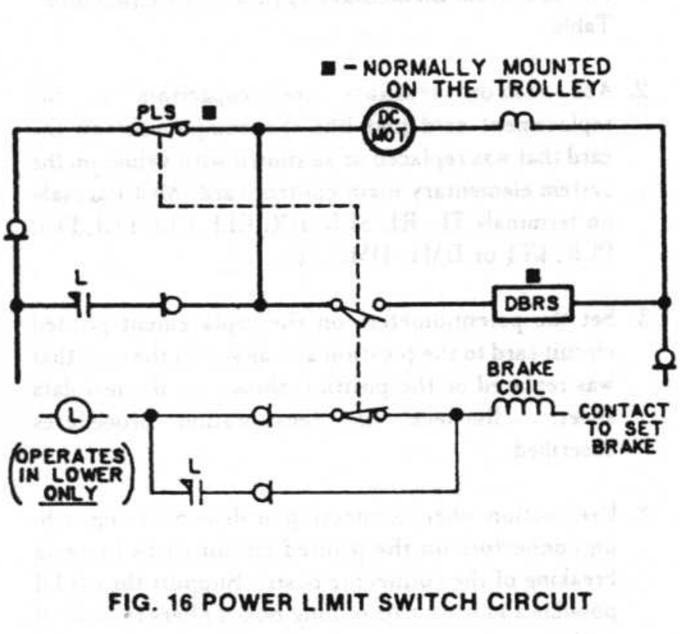


FIG. 16 POWER LIMIT SWITCH CIRCUIT

STATIC EXCITER

The static exciter is a full-wave, single-phase bridge supplying constant-potential, direct-current power supply, employing static components. It consists of a transformer, rectifiers, and protective components. See GEI-43710. It provides DC control power for DC shoe brakes.

EMERGENCY DYNAMIC BRAKING

This safety modification is designed to prevent the free fall of an overhauling load under the condition of simultaneous failure of the power supply and the holding brake. This is accomplished by a contactor which drops out due to loss of power, inserting a resistor across the motor armature. The voltage across this resistor is then fed through a rectifier bridge, for the correct polarity, to the motor shunt field to self-excite the motor for a controlled lowering speed.

LOAD SPOTTING

The masterswitch is recalibrated to provide 25% speed at full throw. This reduces the minimum hoisting & lowering speeds and gives the operator more accurate speed control for spotting the load.

LOAD FLOAT

The load float or spotting zone control is to enable the operator to hold or spot the load without the use of the holding brake. Load float control is initiated by depressing the masterswitch thumb latch or a pushbutton which releases the brake and recalibrates the drive speed relationship. Top drive speed now becomes 20 to 25 percent of normal speed.

NOTE: The motor capability limits the time of stalling at absolute zero speed.

TRANSFER SWITCHING

For some crane drive systems the same crane drive may be operated from different control locations, in which case it is necessary to transfer the crane drive control from one masterswitch to another. This transfer may be accomplished by SB type switches or relays.

RADIO REMOTE CONTROL

Radio control can be substituted for the masterswitch for remote operation. By the nature of radio control, all speed control is stepped and all functions and interlocking must be performed by relays.

PENDANT STATION

A pendant station may be substituted for the masterswitch for a floor-operated crane. On a pendant station, the speed potentiometer is operated by depressing the hoist or lower pushbutton proportional to the speed required. While a masterswitch can have twelve contacts (standard maximum) for interlocking, the interlocking must be performed by relays for a pendant station control. Other functions supplied in an operator's cab, such as a spotting pushbutton, are supplied on the pendant station.

TRAVEL MOTIONS

Many crane drives require bridge, trolley, gantry, or a combination of motions to be incorporated in one crane drive system. Depending on the application and duty cycle, the travel motions may be operated simultaneously with the hoist, in which case separate drives are used for each function; or the travel motions may be operated with the hoist on a first-come, first-serve basis powered by the same drive. In this case, the hoist or travel motion is chosen by a selector switch or by whichever masterswitch is operated first, locking out the other functions.

Each travel motion then has the same protective devices, brake circuitry, and provisions for limit switches as described previously for the hoist function. Two differences for travel motions are that (1) the torque of current limit function is normally set for 150 percent of rated torque, and (2) the drive is allowed to regenerate to 10 percent armature volts before setting the brake on a stop. These lower settings prevent skidding of wheels and make braking less severe.

TRAVEL DRIFT

The travel drift modification is to enable the operator to "coast" the crane drive for a travel motion. Drift control is initiated by depressing the masterswitch thumb latch or pushbutton which releases the travel brake and recalibrates torque or current limit. The current limit now becomes 50 percent instead of 150 percent of rated current, thus reducing the braking torque during the regeneration to a low value.

HOIST MOTOR FIELD PROGRAMMER

(Refer to GEK-45130 and GEK-45131 for hoist and lower programming card elementary diagrams).

The purpose of the motor field programmer is to control motor field current as a function of armature current to obtain a constant horsepower characteristic. From no load to some small hook load, depending on the characteristic, the motor shunt field is held constant; from that point to approximately 100 percent rated hook load, armature current is constant and the field is varied to change speed and torque to give a constant horsepower characteristic. At 100 percent rated load, the motor field control reaches a maximum output, and the motor field is essentially constant for further increases in load.

The motor field programmer consists of the motor field control, the hoist programming card (HPC) and the lower programming card (LPC).

In the OFF position, the field is set by the field economy circuit on the motor field control which reduces the field excitation to 70% of the ***SFA*** setting whenever the drive is shut down.

A direction sensing circuit on the hoist card senses the polarity of the CEMF signal. When the CEMF signal is negative, pin 23 will switch positive to open a FET switch and provide an off-bias signal (KL) to the lower card. When the CEMF signal is positive, pin 23 will switch negative to open another FET switch and provide an off-bias signal (KH) to the hoist card.

With zero volts at CFB and CEMF, the ***SFA*** potentiometer on the hoist card has an adjustment range of 75% to 100% of the nominal field current as set by ***FMAX*** on the MFC card. This allows ***SFA*** to be set at the rated field level and ***FMAX*** to be set for a field forcing level of up to 33%.

HOIST

In the hoist direction, a negative CEMF signal on pin 25 of the hoist card is inverted to provide a positive signal at pin 30. This signal weakens the motor field. The ***MFH*** adjustment adjusts the amount the field is weakened and, therefore, is used to set the no-load hoist speed (Point A on Fig. 17). If the CFB signal, which is negative in hoisting, exceeds a preset bias level, the voltage at pin 6 will go negative to strengthen the field as a function of armature current. Field strengthening (Point B in Fig. 17) can be adjusted to occur from 80% to 100% of rated current by hoist bias potentiometer ***HB***.

The gain of the field strengthening circuit (Slope C, Fig. 17) may be decreased by connecting pin 5 to pin 6. It may be increased by connecting pin 5 to common.

During regenerative hoist operation, when CFB is positive, a bias signal is applied to OA2-2 to prevent field strengthening.

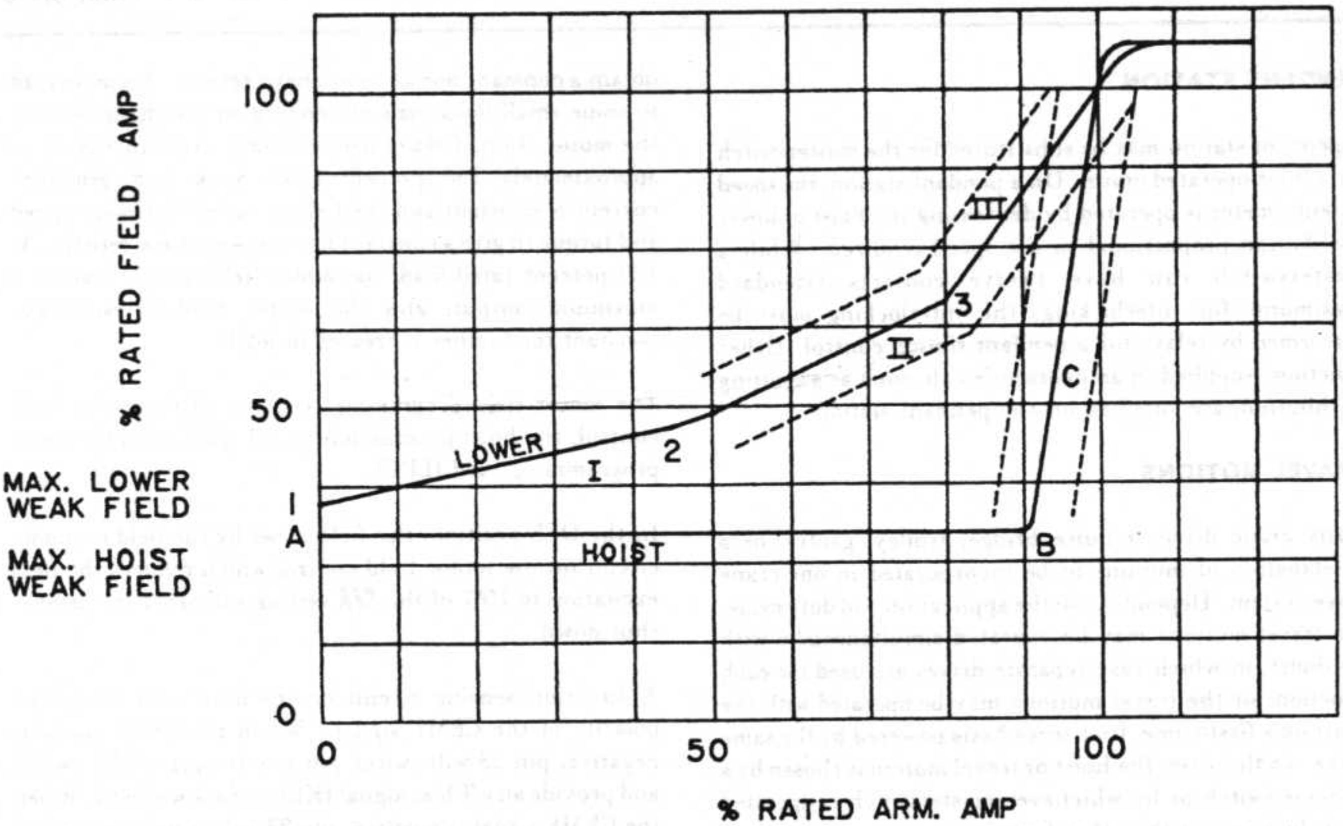


FIG. 17 MOTOR FIELD VERSUS ARMATURE CURRENT SIGNAL (Typical Curve)

LOWER

Positive CEMF in the lower direction will cause LV to go positive and weaken the motor field. The ***MFL*** adjustment on the hoist card is used to set the no load lower speed. (Point 1 on Fig. 17).

The field increase as a function of 2CFB is controlled by three amplifier stages. The first stage (OA2-1) increases the field current with no offset bias. The gain (Slope I on Fig. 17) is adjusted by ***SL1***. The second stage (OA3-1) is biased such that additional field increase starts at a given armature current (Point 2 on Fig. 17). This bias is set by potentiometer ***LB2***. The gain (Slope II on Fig. 17) is set by ***SL2***. ***LB3*** sets the bias for the third stage amplifier, OA3-2 (Point 3 on Fig. 17). ***SL3*** sets the gain of OA3-2 (Slope III on Fig. 17).

The adjustments for the lower characteristic must be made in the sequence as listed in the Calibration Procedure.

Output filtering on both the voltage and current programming sections of the lower card controls the rate of change of the motor field. The time constants of OA1-2 and OA4-2 may be changed by jumpers connected from pins 3 and 30. The time constant in the voltage section may be increased by moving the jumper from pin 18 to pin 21, 24, or 25. The time constant in the current section may be increased by moving the jumper from pin 10 to pin 7, 8, or 6.

Increasing these constants will decrease the amount of speed overshoot when lowering full load but will also increase the lower no load acceleration time to top speed.

The motor field may be set up in the "Diagnostic Static" mode. The CEMF signal is replaced by FDR (Field Diagnostic Reference) which is changed with the ***LOC REF*** potentiometer on the diagnostic card. The ***CUR REF*** potentiometer allows for varying the CFB signal to program the field.

In the "Diagnostic Run" mode —20V is applied from DGC (MAC) to DMAC on pin 29 of the lower card and pin 3 of the hoist card. This signal closes FET switch T2, applying diagnostic reference LR to the MFC (FDR) and inhibits the hoist card output CRM. This allows the ***FMIN*** and ***FLOSS*** values to be checked.

REFERENCE CARD (REF)

(Refer to GEK-45129 for the reference card elementary diagram).

The reference card provides a circuit to convert the output of an induction masterswitch to a bidirectional DC reference for a reversing drive. With the induction switch connected to pins 8X, 9, 8 and 6 the output (D1S) at pin 10 will vary from —20V ±2V to +20V ±2V for full throw of the masterswitch.

A reference polarity check is also provided. A negative input at pin 19X can be supplied to pin 30 or 30X only if +30V is applied to pin 11 (NSW). A positive input at pin 19X can be supplied to pin 5X or 3X only if +30V is applied to pin 13 (PSW).

The voltage monitor circuit will generate a fault trip signal at SYS when a 25% error exists between the driver reference, DR, and the system feedback, SFB. When the voltage at pin 28X exceeds 10V, the output of the latch circuit on pin 23 (SYS) will exceed +10V to initiate a system trip. The OCK indicating light will also turn on. With the error voltage at pin 28X reduced to less than 10V, the circuit can be reset with the reset pushbutton.

This circuit will also indicate an overvoltage fault (TF) as detected by the overspeed circuit of the MFC.

TORQUE PROVING CARD (TQP)

(Refer to GEK-45128 for the torque proving card elementary diagram).

The basic card function is to prevent releasing the motor brake until proper current response to both a positive and negative reference has been detected.

SEQUENCE OF OPERATION

When preconditioning is released and a reference signal is applied, the TR voltage will time up as a function of the reference signal until the clamp level of 1.6V to 2.0V is reached.

The TR voltage is now inverted by OA1 such that ATR = —TR. This ATR signal is applied to the regulator in addition to the TR signal, but at twice the current level resulting in a net effect of inverting the applied reference.

The initial test involves checking for proper current polarity in response to the inverted reference.

For a negative input the TR voltage is negative and the ATR voltage is positive which should result in a positive CFB signal. If CFB > +.8V with ATR > +.8V the voltage at pin 27 is pulled low (<1V), the voltage at pin 13 swings high (>+15) and the voltage at IC1(4) swings low (<1V) to latch in the circuit. When IC1(4) swings low, LED1 (LC) is illuminated to indicate the detection of a positive CFB signal with ATR positive.

The second test is then initiated by checking for a current response to the TR reference only. As IC1(4) swings low, transistor T8 is turned on to close the FET switches T6 and T7. This changes OA1 to a non-inverting amplifier such that ATR = TR. The auxiliary timed reference is now removed from the regulator by the closing of T7. The regulator then only sees the clamped TR voltage which should result in a current reversal.

For a negative reference as described above, both TR and ATR is negative and a negative CFB voltage should result. Thus if CFB <—.7V with ATR <—.7V the voltage at pin 12 is pulled low, pin 10 swings high and the voltage at IC1(8) swings low to latch in the circuit. Now as IC1(8) swings low LED2(HC) is illuminated to indicate the detection of a negative CFB signal with ATR negative.

If the input reference is positive the test would be performed in the reverse order by LED2(HC) being illuminated before LED1(LC).

With both current polarities detected, pin 10 and pin 13 have both changed to a high state (>+15V) making IC1(10) swing low. The output of the second half of OA1 at pin 22 then switches from positive saturation to negative saturation. This turns on transistor T17 to energize the external BPR relay. At the same time T2 is opened to remove the TR clamp, but now the T1 switch is closed for a period adjustable by P1 from zero to .5 seconds to clamp the TR voltage at zero until the brake opens.

If the input signal is removed shortly after application, it is possible to detect and latch up in one direction, but not in the other as the reference is removed. If the test is not completed, i.e., if the voltage at pin 22 does not swing negative within 1 second following the detection of one current polarity transistor T16 will turn on to reset the circuit.

When the drive is preconditioned by the PRE voltage changing from —3.5V to zero, transistor T14 turns on to reset the circuit. In the Diagnostic mode a positive signal, DP2, is applied at pin 5 to override the preconditioning reset which allows a diagnostic check of the circuit.

TORQUE PROVING CHECK (TQP)

(A) Switch the Diagnostic switch to static.

(B) Turn the ***LOC REF*** pot CW (+LR).

(C) Quickly turn the ***CUR REF*** pot CW, then CCW. Both lights on the Torque Proving Card should light (HC first, then LC) and BPR should pick up.

(D) To reset TQP, return the Diagnostic switch to Normal, then back to static.

(E) Turn the ***LOC REF*** pot CCW (—LR).

(F) Quickly turn the ***CUR REF*** pot CCW, then CW. Both lights should come on (LC first, then HC) and BPR should pick up.

GLOSSARY OF TERMS

PAGE

*ALM — A Current Limit Switch Input 17, 32
*ALT — Auxiliary Linear Time Switch Input 17, 32
ALIGN — Tachometer Loss Align Adjustment .... (1), 28, 31, 32

*BLM — B Current Limit Switch Input 17, 32
BPR — Brake Permissive Relay 11, 12, 14, 15, 25, 39, 40

*CEMF — Counter EMF .... (1), 15, 17, 28, 29, 30, 32, 37, 38
*CFB — Current Feedback 15, 17, 20, 23, 28, 29, 30, 32, 33, 37, 38, 39
*COM — Regulator Common 17, 24, 27
COMP — IR Compensation Adjustment 17, 28, 29, 30, 31, 32
CPT — Control Power Transformer 12, 14, 15, 23, 26
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*DMAC — Diagnostic MAC Signal 38
*DM1—DM8 — Dummy Input/Output Points 18, 35
*DP1—DP2 — Diagnostic Switching Signals 30, 40
*DR — Driver Reference 15, 17, 18, 20, 29, 30, 32, 33, 39

*EAO — Error Amplifier Output 29
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*FC — Field Current Signal .... (1), 26, 31, 32, 33
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FEA — Field Economy Adjust .... (1)
FF — Field Fault .... (1)
*FGC — Forward Current Signal 17, 18, 31
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FLT — Fault Relay 11, 12, 15, 20, 24, 26, 27
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GAIN — Speed Loop Gain Adjustment 28, 29, 31, 33
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HPC — Hoist Programming Card 11, 14, 15, 21, 22, 32, 37, 38

*TEST Points Located on Door Front (See MCC Illustration, Fig. 6)
(1) Also see Motor Field Control Instructions, GEK-24971

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IFC — Interface Card	12, 14, 17, 20, 25, 26, 28, 31
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*TEST Points Located on Door Front (See MCC Illustrations, Fig. 6)

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

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SLIM — Speed Limit Adjustment .... (1), 28, 31
SLOW — Slow Speed Adjustment 31, 33
*SMET — Speed Instrument Output and Adjustment 20, 25, 28
*SMIN — Minimum Speed Reference Adjustment and Input 25
*SR — Speed Reference 17, 23, 25, 26, 29, 30
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*TR — Timed Reference 17, 28, 29, 30, 32, 33, 39

*VFB — Voltage Feedback 15, 17, 23, 28, 29, 31
*WFR — Weak Field Reference .... (1)

*TEST Points Located on Door Front (See MCC Illustrations, Fig. 6)
(1) Also see Motor Field Control Instructions, GEK-24971