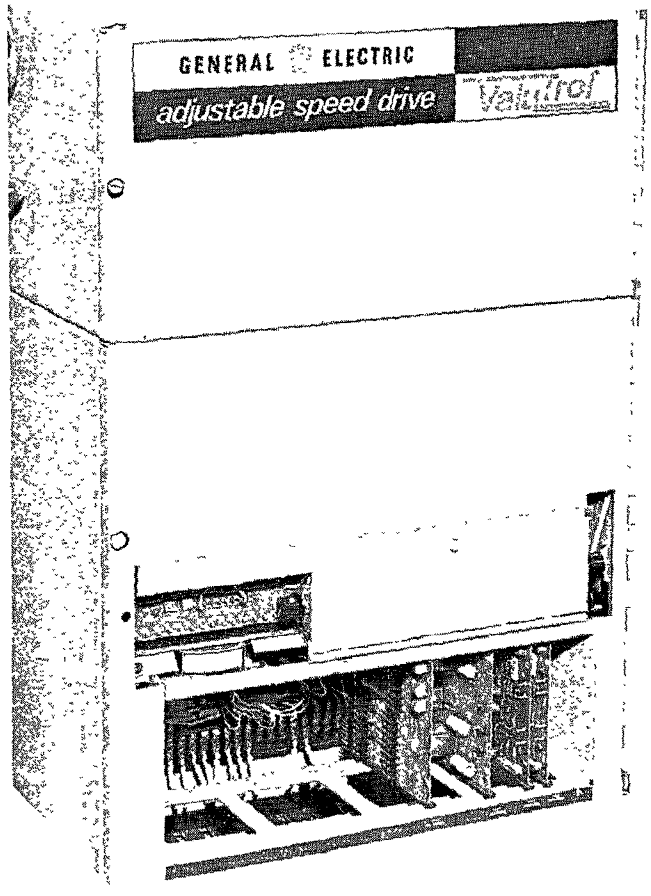
GEK-24994

INSTRUCTIONS

VALUTROL* MAIN CONTROL MODULE
FULL WAVE, REGENERATIVE

INSTALLATION - OPERATION - MAINTENANCE



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

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GENERAL DESCRIPTION

The basic elements of a typical VALUTROL industrial drive system are shown in the simplified typical block diagram, Figure 1. This diagram indicates the basic elements contained in the VALUTROL main control module which functions to control output from a three-phase full-wave conversion assembly.

Three-phase AC power enters the system through fuses and is fed into power conversion modules (SCR) where it is converted to adjustable voltage DC power for the DC motor armature. Two conversion modules may be used as in Figure 1 to provide motoring and regenerative control of the DC load in both forward and reverse directions or a single module may be used to provide one-half or one-quarter of the two module control. Normally, the system may have an AC contactor (MA) that removes power from the drive when it is stopped leaving the drive system otherwise completely energized.

The speed of the motor is proportional to the DC voltage applied to its armature. Speed is measured by motor CEMF (Armature voltage feedback with IR compensation). As an optional feature, speed can be measured by a tachometer generator directly connected to the DC motor.

The basic control is manufactured on five (5) removable printed circuit boards. These are the power supply card (PSC) the main control card (MCC) and the auxiliary control card (ACC) the interface card (IFC) and the motor field exciter card (MFE) or the motor field control card (MFC) (optional). Other cards, including a diagnostic card are also available as optional modifications.

The three-phase inputs also supplies power to the Motor Field (MFE or MFC) and to the control power transformer. This transformer is fitted with a 460/230V reconnectable primary winding and two isolated secondary windings: (1) 115V to operate the coil of the MA or MD contactor, and other main control module relays, (2) the second winding is a 50 volt center tapped secondary which provides AC input to the power supply card.

POWER SUPPLY CARD (PSC)

The power supply card rectifies the AC input and provides regulated plus and minus 20 volts for the printed circuit cards. Unregulated plus and minus 30 volts DC is also provided to drive the static logic switches and the 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.

MAIN CONTROL CARD (MCC)

The primary purpose of the main control card is to drive the conversion modules (SCR A and SCR B) as commanded by the speed reference and feedback signals. Connection to the SCR gates is by way of the auxiliary control card (ACC).

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.

A total of twelve (12) potentiometers are provided on this card, ten (10) of which are accessible from the front of the controller. The eleventh potentiometer, the card zero adjustment ***ZERO ADJ***, is preset at the factory and should normally not be disturbed. The twelfth potentiometer is the line impedance compensation adjustment, ***LINE***. The ten accessible 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.

AUXILIARY CONTROL CARD (ACC)

The primary function of this card is to combine phase control signals, leg current signals, and oscillator signals and amplify the resulting pulse trains and direct them to the appropriate SCR gates by way of twelve (12) pulse transformers. One secondary function is to scale the output of three (3) current transformers (CT's) in the three-phase AC power inputs to the conversion modules (SCR A and SCR B).

Another function is to detect circulating overcurrent faults which would not be detected by the shunt in the motor armature loop.

TYPICAL VALUTROL® DRIVE SYSTEM WITH MAIN CONTROL MODULE

© BLOCK DIAGRAM

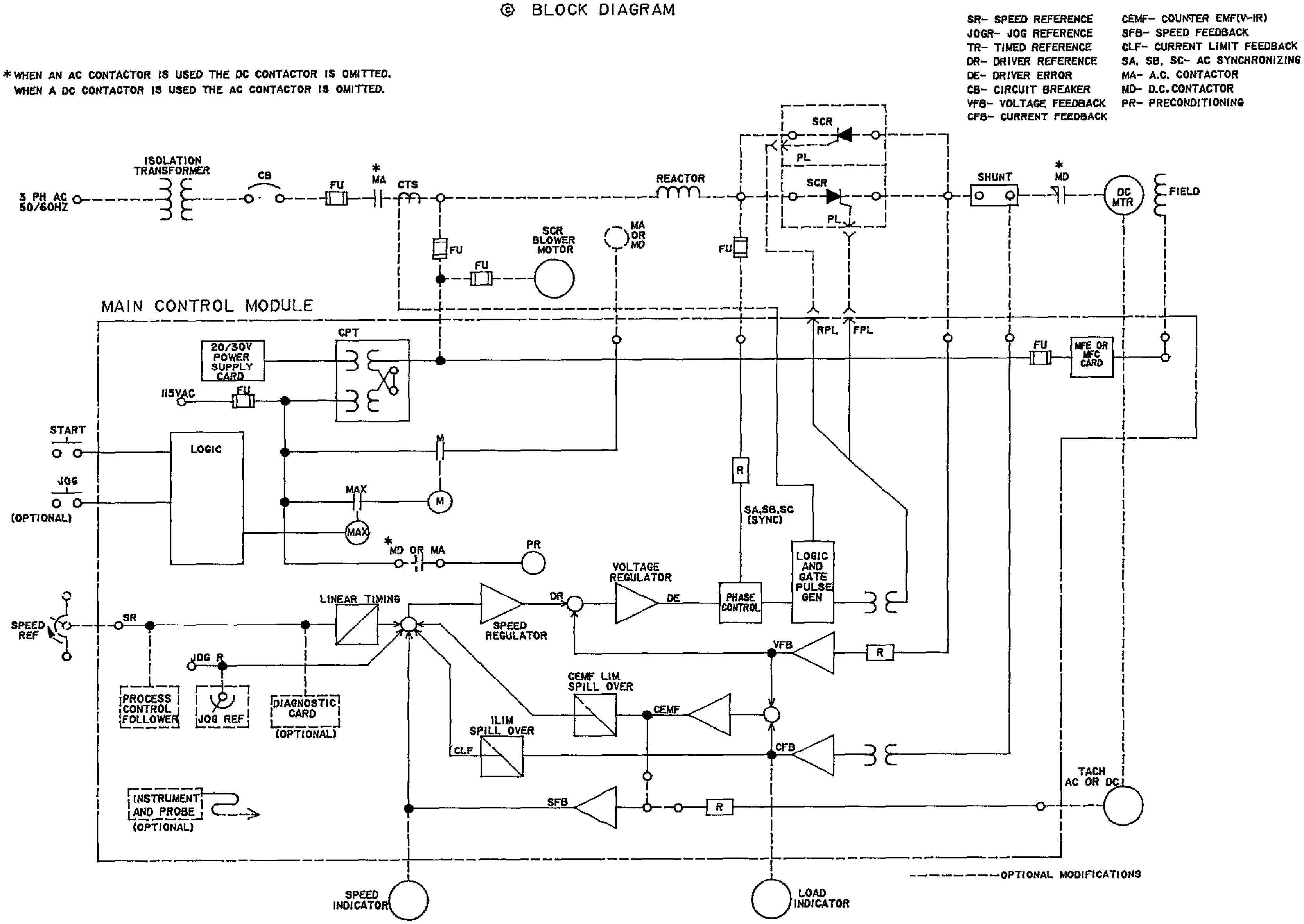
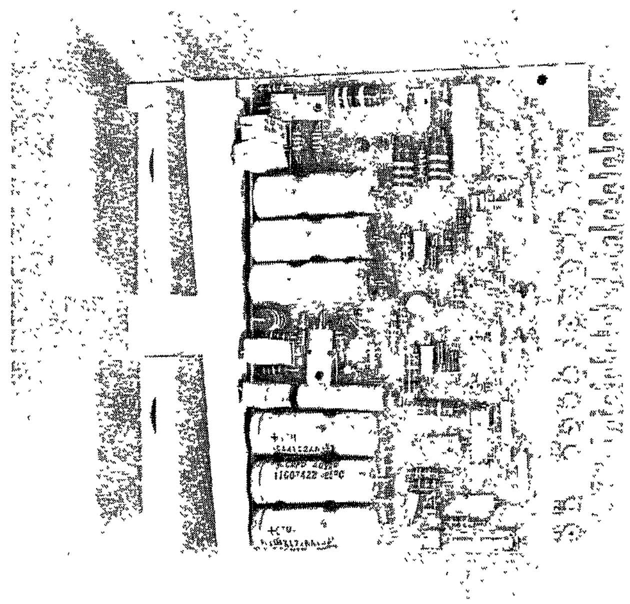


FIG. 1 TYPICAL VALUTROL® DRIVE SYSTEM WITH MAIN CONTROL MODULE BLOCK DIAGRAM



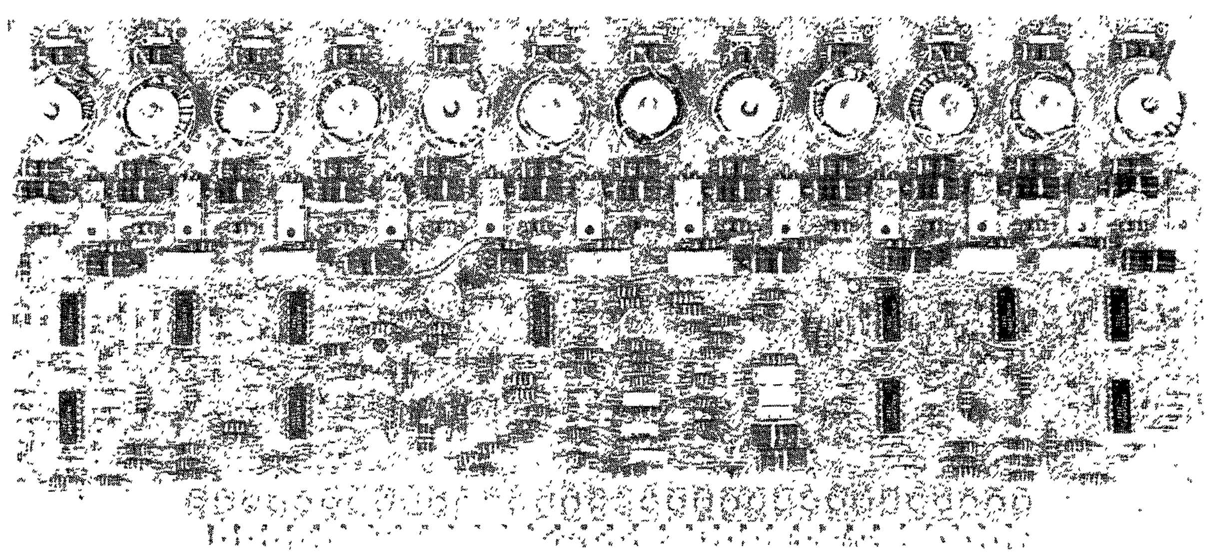
(Photo MG 5236 20)

FIG. 2 POWER SUPPLY CARD

An additional function is to generate a TRIP signal which suppresses SCR firing, executes a system fault, and may be used to operate an optional shunt trip circuit breaker.

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.



(Photo MG 5374 2)

FIG. 3 AUXILIARY CONTROL CARD

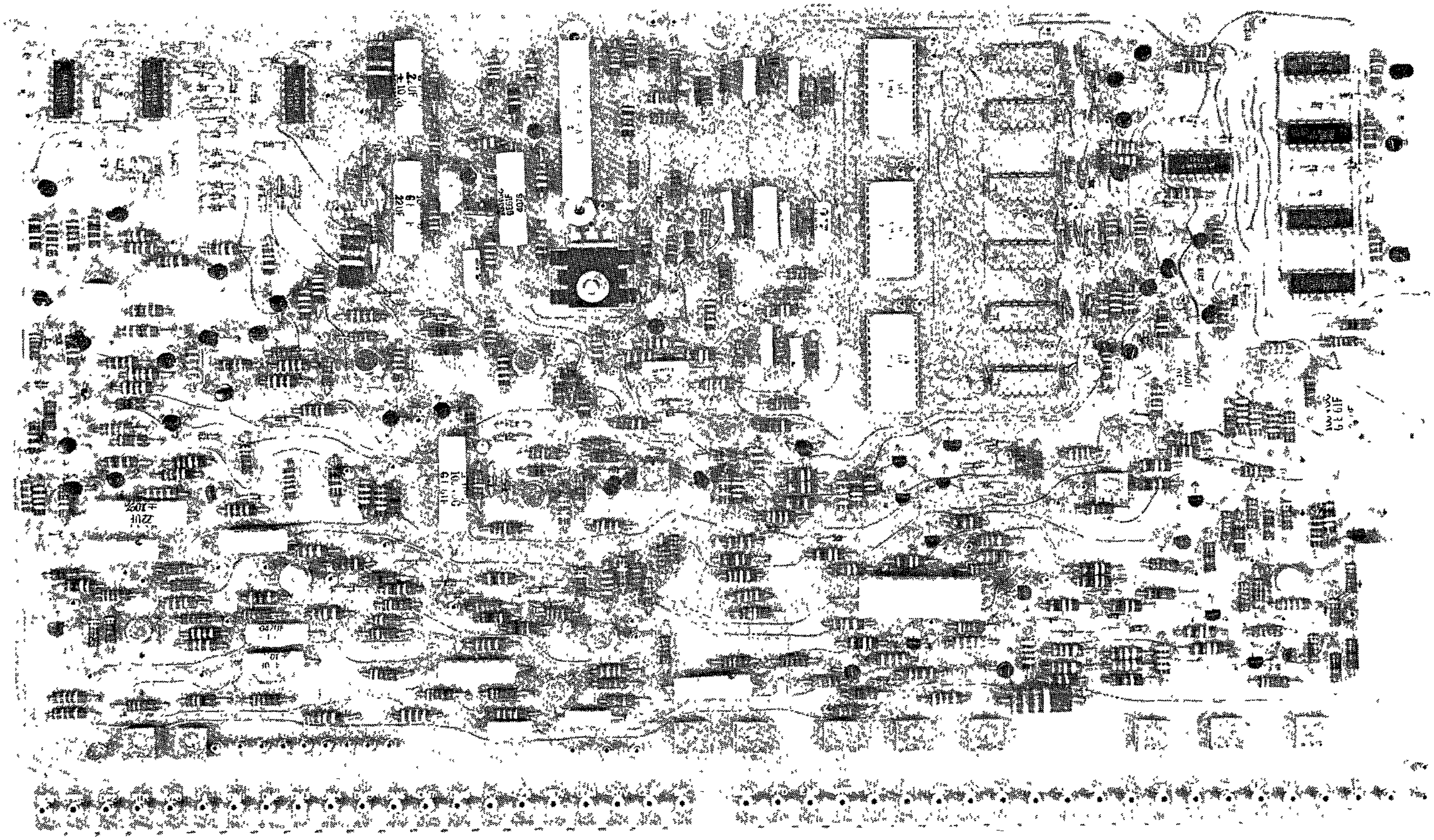


FIG. 4 MAIN CONTROL CARD
(NOTE: TEST POSTS ALONG LARGE EDGE)

MG-5374-1

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 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)

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.

There are (4) potentiometers on this card.

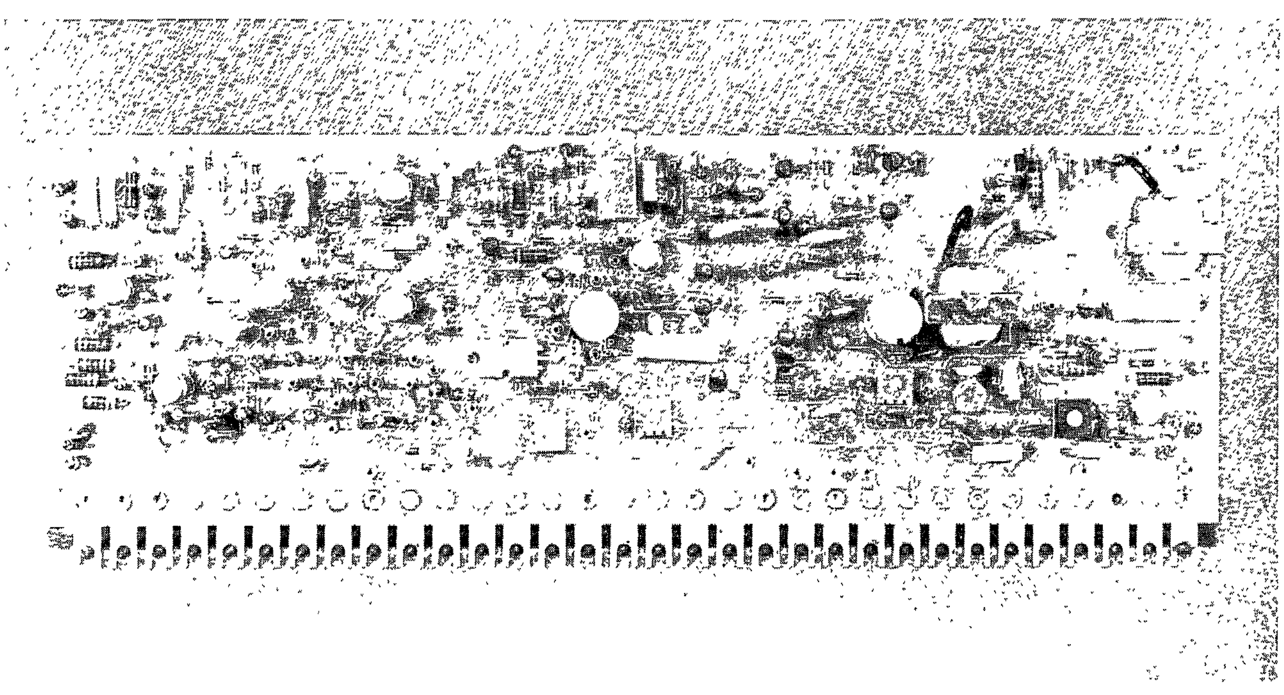
1. The ***IZERO*** is a bias adjustment for the current feedback output and is factory set. This control should not be disturbed.

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

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

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

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

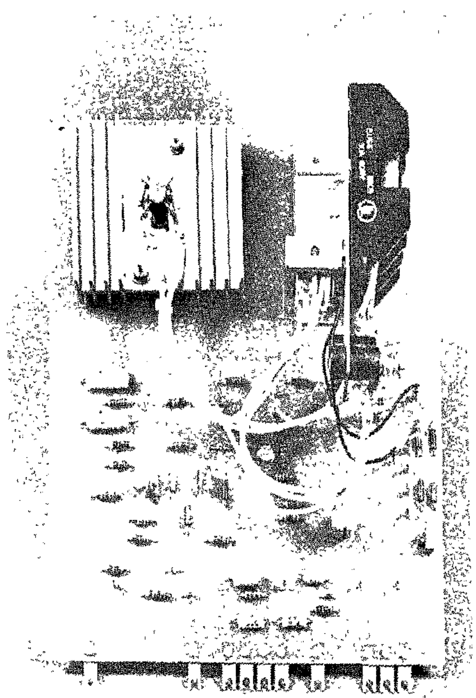


(Photo MG-5236-13)

FIG. 5 INTERFACE CARD

MOTOR FIELD EXCITER CARD (MFE)

This card provides a motor field voltage proportional to the AC line voltage for use with constant torque drives. A field loss circuit is also provided. See GEK-24972 for detailed instructions.



(Photo MG-5274-3)

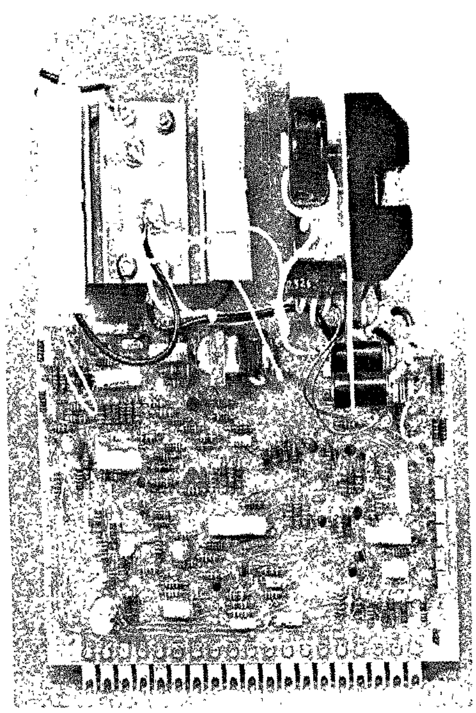
FIG. 6 MOTOR FIELD EXCITER CARD

MOTOR FIELD CONTROL CARD (MFC) (OPTIONAL)

This card provides a current regulated motor field supply for the DC motor. Constant field excitation is supplied in the constant torque range as armature voltage is measured 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 feedback voltage (over speed) or to detect reverse polarity when a DC tachometer is employed. 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, thereb avoiding the possibility of excessive temperature (at stan still) and/or reduced insulation life. See GEK-24971 fo detailed instructions.

In the event it is desirable to provide motor field regulation, tachometer monitor, motor field reversing or special motor field voltages when constant horsepower performance **is not** a requirement, the motor field control card (MFC) can be used by moving the cross over ***(CROSS)*** adjustment to a setting of 5 o'clock.

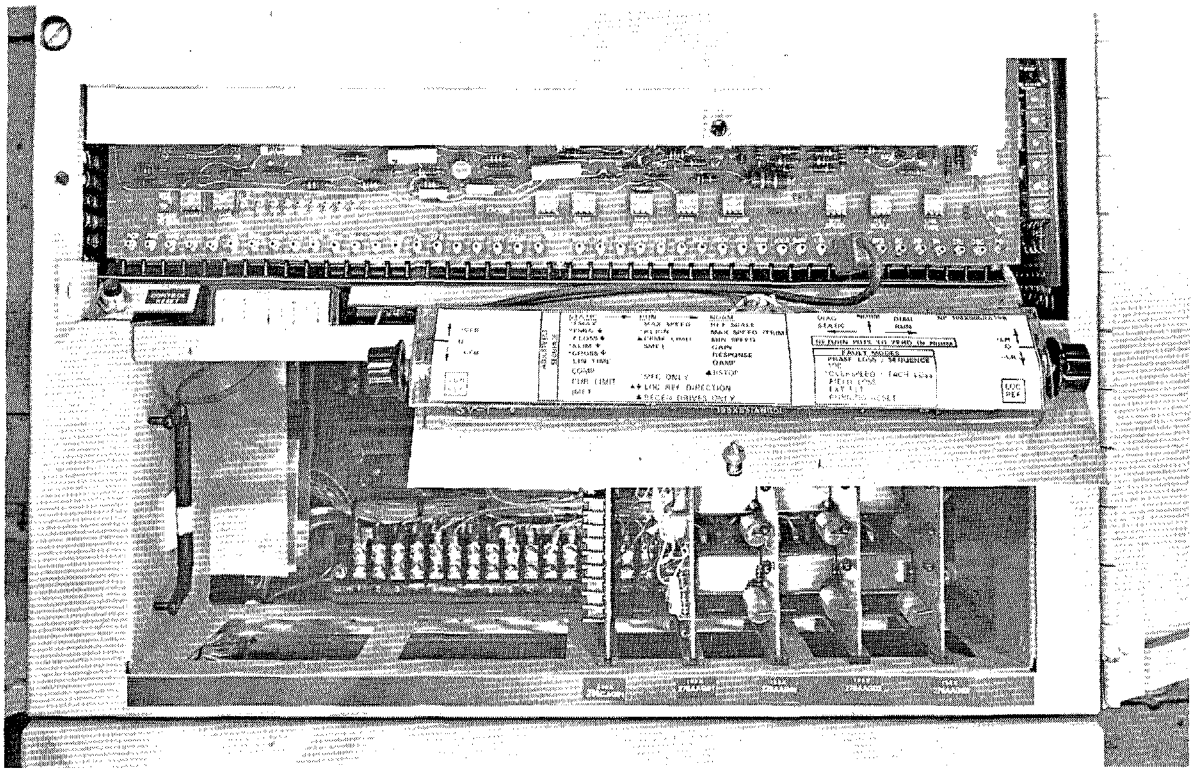


(Photo MG-5236 15)

FIG. 7. MOTOR FIELD CONTROL CARD

DIAGNOSTIC CARD (DGC) (OPTIONAL)

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



(Photo MG-5393-I)

FIG. 8. DIAGNOSTIC CARD AND MODIFICATION RACK

EXCITER AND CONTROL POWER

Three phase power from an externally protected source is supplied to terminal board (TBN). The motor field card and the control transformer are connected to this power source.

SYNCHRONIZING SIGNAL POWER

Three resistance wires which provide line synchronization are connected through terminal board (TBN) to the AC line supplying the conversion module (SCR). Normally, these lines are fused in one of the conversion modules. These fuses also protect metal oxide varistors (MOV's) in the conversion module which protect that unit from excessive transient over voltage conditions. The drive will not operate if a fuse to a synchronizing lead is open.

POWER CONNECTIONS

The DC motor shunt field connections are at points F1 and F2 on terminal board (TBN) located at the top of the main control module.

CONTROL CONNECTIONS

Control connections are made to terminal boards 2TB, TBC and TBN and through plugs RPL and FPL. Signals appearing on these terminal boards and their functions are described in Table 1. Optional connections are made at 3TB and 4TB. Refer to system elementary diagram for details. The SCR firing signals and each conversion module's over temperature thermal switch signal are carried through the plugs.

MODIFICATION RACK (MDR) (OPTIONAL)

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

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

are provided in printed circuit cards in the modification rack located below the main control card.

START-UP

The VALUTROL main control module 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. If the diagnostic option is furnished 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 potentiometer. Return the potentiometer to zero volts.

5. If the diagnostic card option is provided, set the local speed reference ***(LOC REF)*** potentiometer to its center position and switch into the diagnostic run ***(DIAG RUN)*** position. The MA or MD contactor should pick up. Slowly turn the ***LOC REF*** potentiometer away from the control until the motor starts to rotate. If the tachometer feedback option was selected verify that the speed feedback signal appears on the SFB test point, located on the bottom of the main control card (MCC) on the left hand side has electrical polarity opposite to signal LR from ***(LOC REF)***. Check motor rotation. Check tachometer polarity. Turn the ***LOC REF*** potentiometer back to the center position and switch to ***NORMAL***. If the motor rotation was incorrect, remove power and interchange the motor field connections F1 and F2 on TBN terminal board.

6. If no diagnostic card is available set the external speed reference potentiometer to zero volts and press the START pushbutton. The MA or MD contactor should pick up. Slowly turn the speed reference until the motor starts to rotate. Check motor rotation. If incorrect, remove power and interchange the motor field leads F1 and F2 on TBN terminal board.

7. Run the drive from the external speed reference up to top speed. Adjust ***MAX SPEED*** as may be required. DO NOT OVERSPEED.

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

NOTE

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

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

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 GROUND AND ITS METAL PARTS TREATED AS LIVE EQUIPMENT.*** USE OF AN INSTRUMENT HAVING BOTH LEADS ISOLATED FROM THE CASE PERMIT 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.

1. FORWARD & REVERSE FIRING CABLE PLUGS (FPL & RPL)
2. TBN
3. TBC
4. CONTROL POWER TRANSFORMER (CPT)
5. PERMISSIVE RELAY (PR)
6. M CONTACTOR (M)
7. MTB
8. FAN
9. INTERFACE CARD (IFC)
10. POWER SUPPLY CARD (PSC)
11. MA AUXILIARY RELAY (MAX)
12. 2TB
13. FAULT RELAY (FLT)
14. 3TB
15. 4TB
16. MOTOR FIELD CONTROL (MFC) OR MOTOR FIELD EXCITER (MFE)
17. MODIFICATION RACK (MDR)
18. S—22 CARDS
19. MAIN CONTROL CARD (MCC)
20. AUXILIARY CONTROL CARD (ACC)

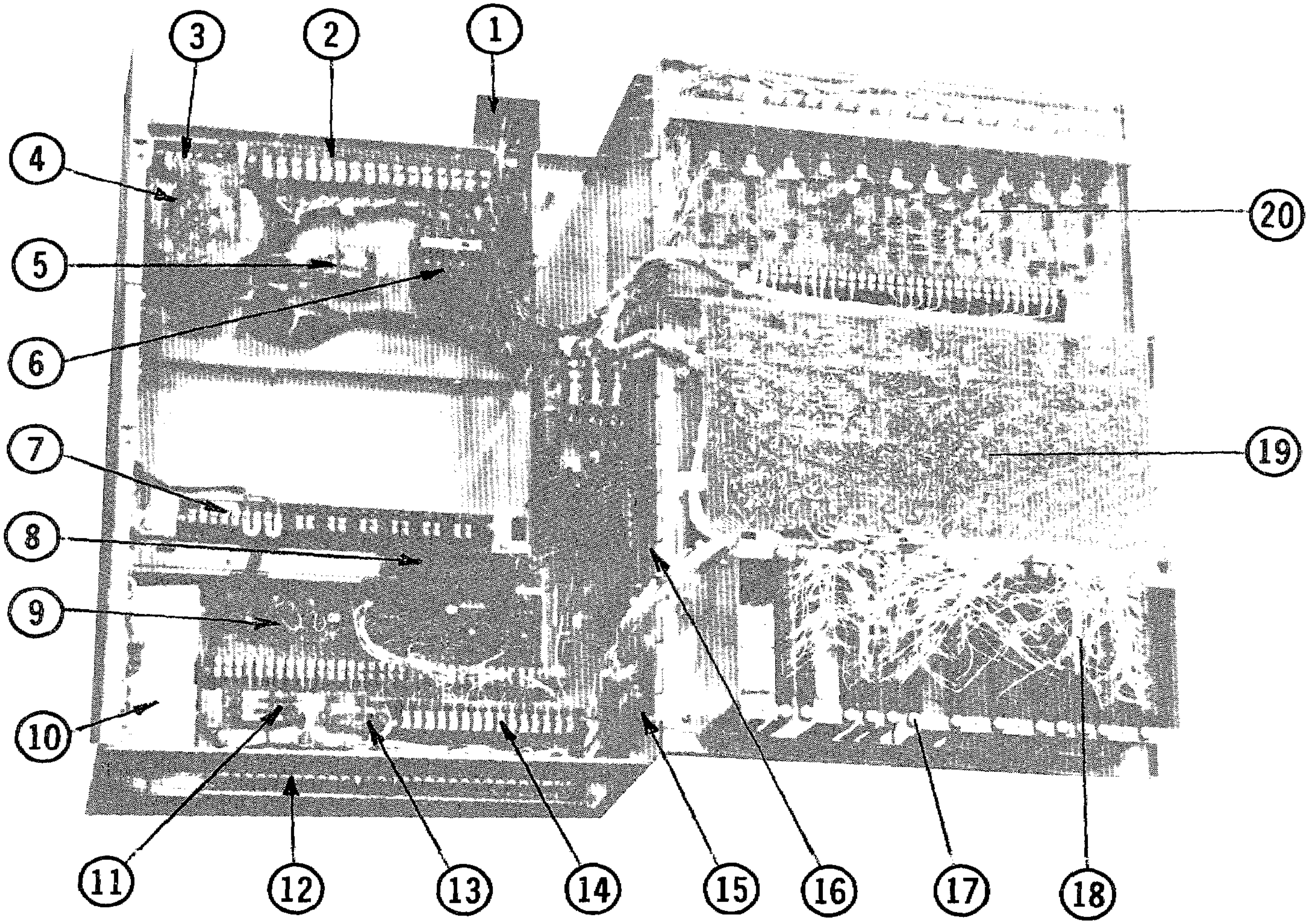


FIG. 9 COMPONENT AND SIGNAL CONNECTION LOCATION

TABLE I 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 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 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, 17 18, 19 24, 25	SP1, SP4 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 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.
15, 16	RPL3, FPL7	Connections to conversion module thermo-switches. When more than one thermo-switch exists, they will be connected in series.

TABLE I 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.
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 MUST BE POSITIVE WHEN SYSTEM REFERENCE IS NEGATIVE AND DA1 IS POSITIVE WITH RESPECT TO DA2.

TBA NO.	NOMENCLATURE	DESCRIPTION
J1 thru J6	J1 thru J6	Current transformer feedback from AC line to ACC for detection of circulating current.

TBC NO.	NOMENCLATURE	DESCRIPTION
1	PS-2X (X2)	Internal 115VAC (grounded to case).
2	PS—3	Internal 115VAC applies through a NO "M" relay contact.
3, 5	M	NC "M" Relay contacts between TBC(3) and TBC(5) signal relay closure.
4	PR	PR Relay coil. Connect TBC(4) to TBC(2), energizes PR Relay making firing circuit operative.

TBN NO.	NOMENCLATURE	DESCRIPTION
K1, K2, K3	EXC—P	3 phase power for motor field (MFE or MFC) and control transformer (CPT).
T11, T12, T13	SYNC SIG	Synchronizing signals from converter power source.
DC1, A2	V FDBK	Voltage Feedback from DC motor armature.
1P, 1N	CURR FDBK	Current Feedback signal from DC line, 100MV shunt
F1, F2	MTR FLD	DC Motor Field connection from (MFE or MFC).

TABLE II FAULT CONDITIONS

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

1. No three phase power.
2. Loss of an incoming phase.
3. Incorrect phase rotation.
4. AC power fuse blown.
5. Control fuse is open.
6. Power supply plus or minus DC fuse is open.

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

8. Motor thermo-switch (OLD). (If connected to fault circuitry).

* 9. Timed overcurrent (TOC) - electronic. (If connected to fault circuitry).

** 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 (OSC) failed - "on."

* 18. Tachometer fault (loss of tachometer signal).

** 19. Overspeed.

20. Trip actuated from ACC (by AC overcurrent or SCR commutation failure).

* 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 the three-phase power and re-apply.

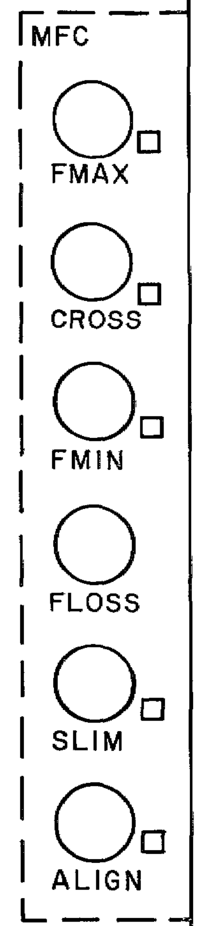
2. Push the RESET button.

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



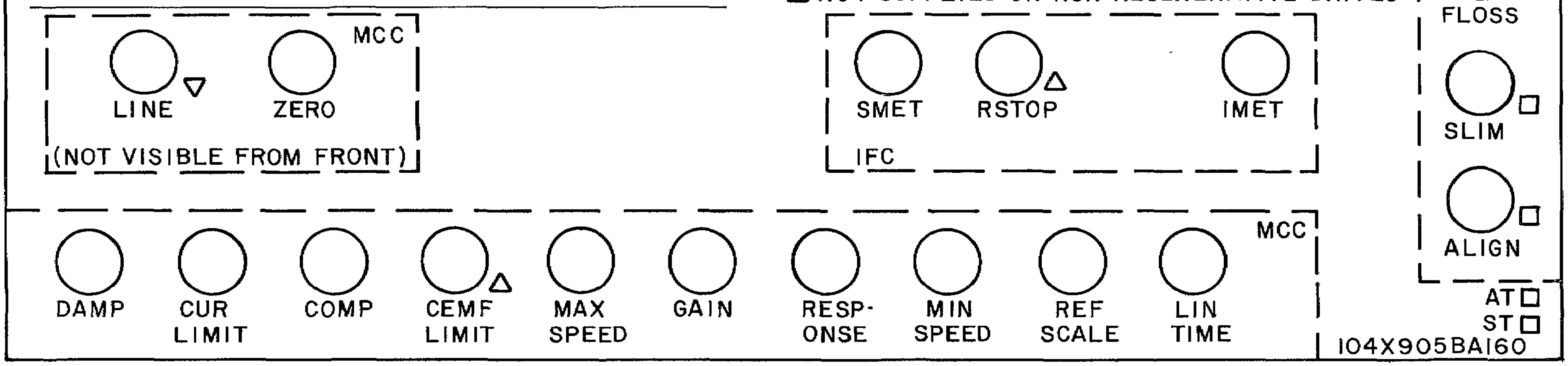


FIG. 10 TEST DATA SHEET

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 II 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 Figure 17.

SWITCH LOGIC

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

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 M relay which picks up the contactor.

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

Releasing preconditioning allows the drive to send firing pulses to the gates of the 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 10 sec. or 2 to 60 sec.)

The speed (or CEMF) feedback from the motor tachometer is scaled with a selectable resistor network on the interface card, and rectified (if required) on the main control card. The output of the speed feedback section is SFB, and will be 10 volts at top speed. ***MAX SPEED*** is adjusted to make the actual top speed correspond to desired top speed. See Figures 18 and 21.

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

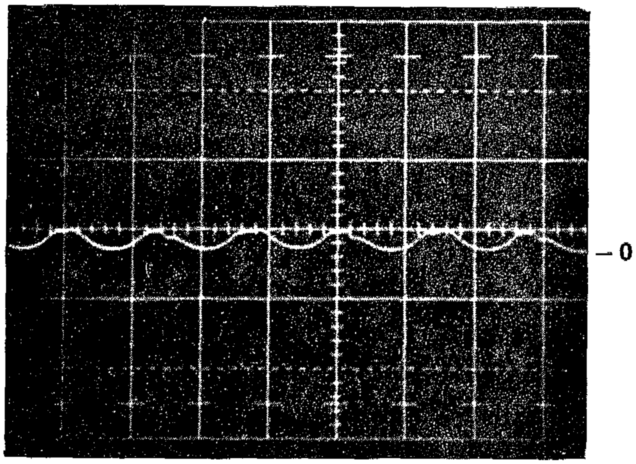
To maintain good load regulation, the error amplifier is fed into the regulator integrator. The output of the integrator is the reference, DR, to the driver. The response of the control below base speed is set with the ***RESPONSE*** adjustment.

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

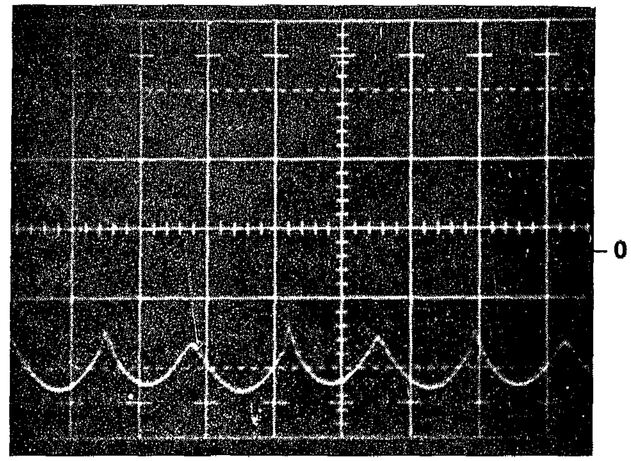
To protect the system, three limit sections are provided; counter—EMF (CEMF) limit and two current limits. The output of the CEMF limit and the primary current limit drive the regulator integrator and will override the error amplifier, if required. The primary current limit is set with the ***CUR LIMIT*** adjustment and the counter EMF limit with the ***CEMF LIMIT*** adjustment. Typically, the primary or regulator current limit is set at 150% of the motor nameplate current of 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 for drives rated 240 volts DC. For drives rated 500 volts DC the CEMF limit is normally 510 volts at no load or 5.60 volts (±10%) at CEMF. The secondary or driver current limit is in the driver section and will be described later. The primary current limit, if used, should not be set higher than the driver current limit. The driver current limit may be inhibited or adjusted.

WAVEFORMS

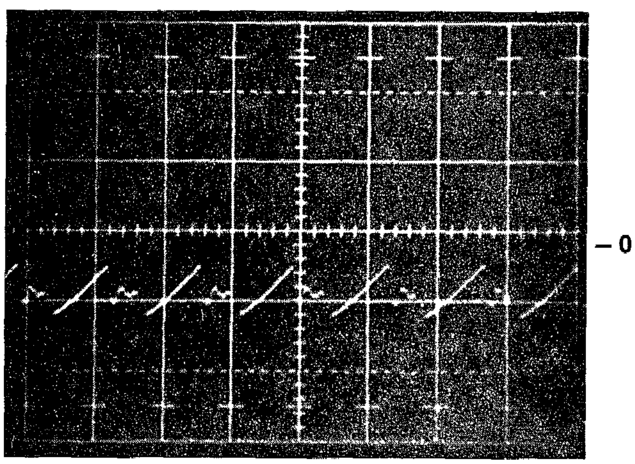
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



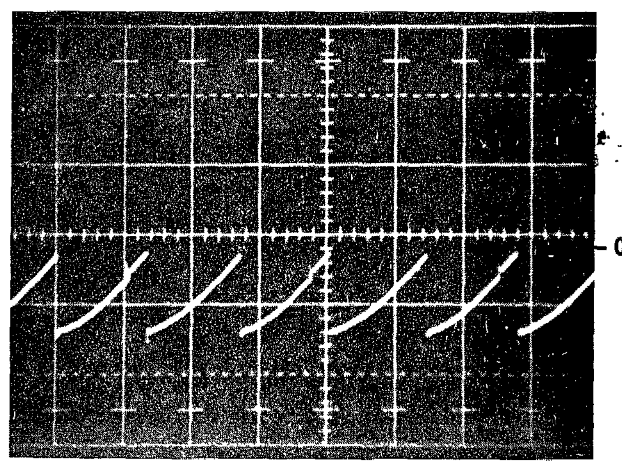
2 msec/div
At low current level 1 volt/division
FIG. 11 CURRENT FEEDBACK (CFB)



2 msec/div
At Continuous current 1 volt/division
FIG. 12 CURRENT FEEDBACK (CFB)



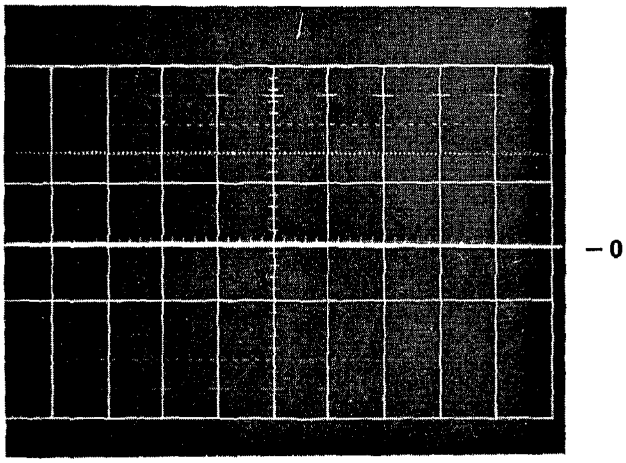
2 msec/div
At low current and 200 volts 5 volts/division
FIG. 13 VOLTAGE FEEDBACK (VFB)



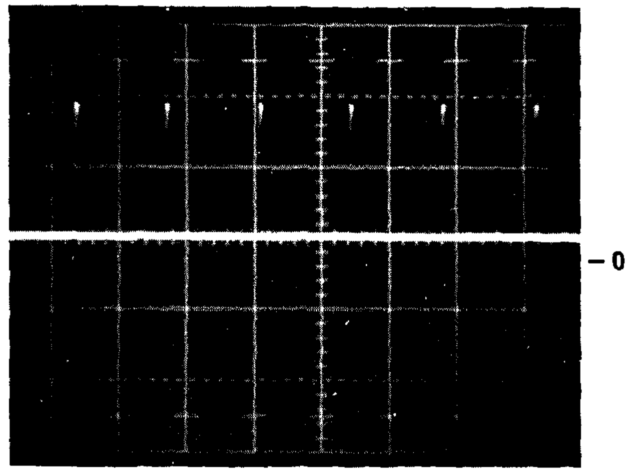
2 msec/div
At continuous current and 200 volts 5 volts/division
FIG. 14 VOLTAGE FEEDBACK (VFB)

WAVEFORMS

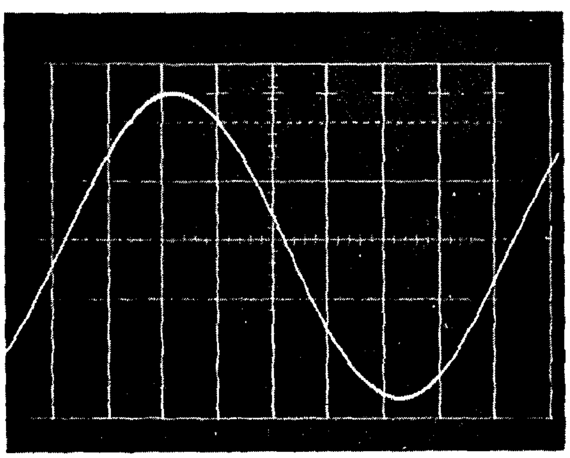
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



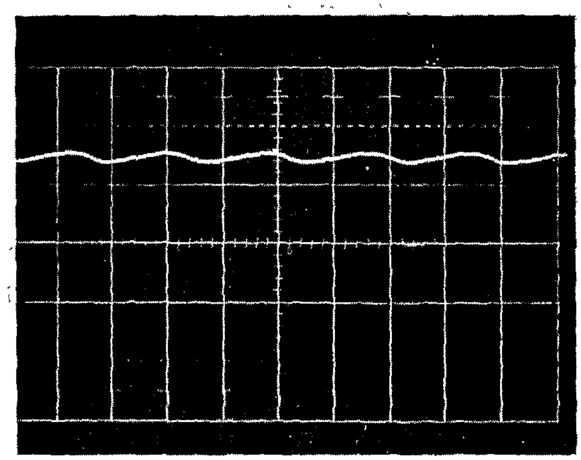
2 msec/div
10 volts/division
FIG. 15 OSCILLATOR (OSC)



2 msec/div
2 volts/division
FIG. 16 INITIAL PULSE (IPU)



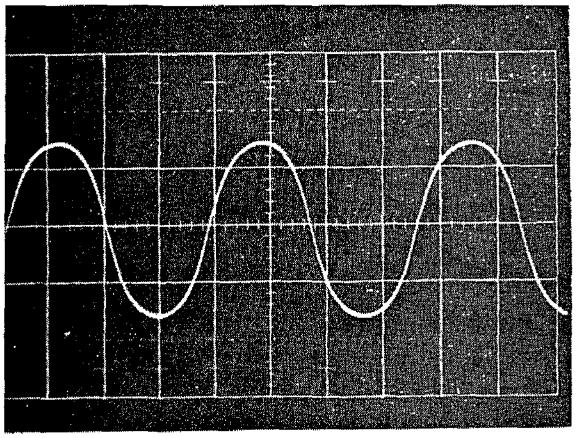
2 msec/div
Typical of SA, SB & SC
SB lags SA by 120°
SC lags SB by 120°
FIG. 17 SYNCHRONIZING SIGNAL (SA)



2 msec/div
With an AC tachometer at 450 RPM
1 volt/division
FIG. 18 SPEED FEEDBACK (SFB)

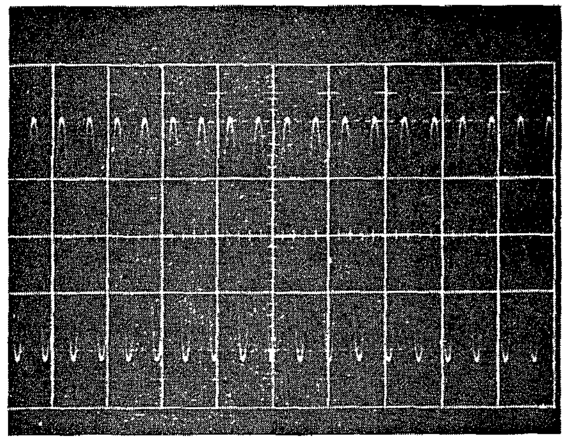
WAVEFORMS

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



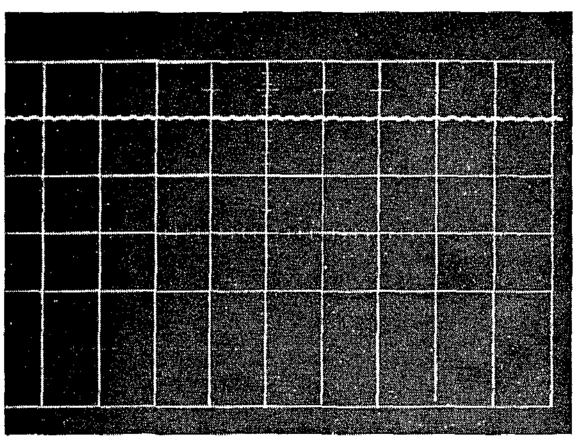
2 msec/div
With an AC Tachometer at 450 RPM
1 volt/division

FIG. 19 TACHOMETER FEEDBACK (TFB)



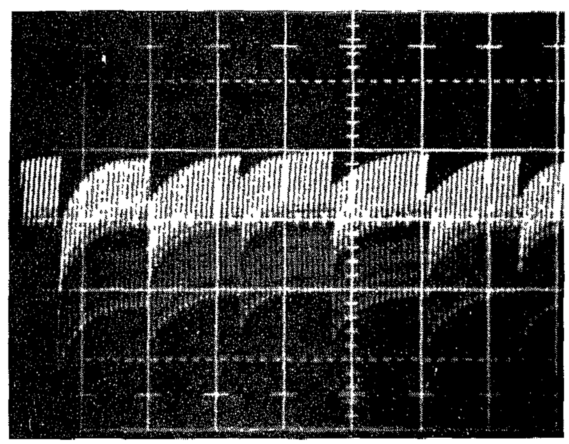
2 msec/div
With an AC Tachometer at 3160 RPM
5 volts/division

FIG. 20 TACHOMETER FEEDBACK (TFB)



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

FIG. 21 SPEED FEEDBACK (SFB)



2 msec/div
AC Coupled
0.1 volt/division

FIG. 22 PULSE OUTPUT (PO)

The main purpose of the secondary, or driver, current limit is to be an operating current limit if the regulator, or primary current limit, is not used and the system is controlled by other signals summed at the driver junction. The driver current limit may be increased by connecting a jumper from DCX to DCY on the main control card which will increase the limit from approximately 130% to 175% of the motor nameplate current. Alternative levels may be established by connecting a resistor between DCL and DCX on the main control card. For normal levels of regulating current limit, either DCX should be jumpered on DCY to increase the driver current limit or it should be inhibited by connecting DCI to COM. For regulating current limit above 150%, a resistor should be connected between DCL and DCX to raise the driver limit above 175% or it should be inhibited with a jumper between DCI and COM.

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, an armature current signal from damping adjustment, ***DAMP***, and the driver current limit output 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 and response and tend to cause over shoot.

The driver provides a signal IPU to the oscillator on the interface card to generate an initial pulse at the exact point in time that an SCR is to be fired. See Fig. 16.

Two driver monitor points are available, PCR and PO. PCR is the phase control reference which causes the output pulse trains to phase shift in time with respect to the AC line. As PCR moves from zero to +6 volts (±10%), the output pulses will shift from full off to full on. PO is used to monitor the pulse outputs to the SCR's. See Fig. 22.

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 contactor. A fault stop opens the contactor and drive coasts to a stop.

Normal stop (disconnect RUN from —30 volts).

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

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

The regenerative stop circuit on the interface card will hold the contactor closed until the CEMF signal is almost zero, corresponding to zero speed. At this time, the preconditioning signal PRE goes to common, removing power from the MAX coil. 100 milliseconds later, MAX drops out removing power from M, 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 II) or CONTROL ON is open.

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

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

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

DIAGNOSTIC STATIC (SWITCH TO LEFT)

LOGIC

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

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

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

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

SIGNAL FLOW

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

The local reference LR is also applied to the input of the last stage of the speed feedback section. The output SFB will be equal to LR in magnitude, but opposite in polarity. The tachometer scaling circuit and its output TFB are unaffected by the local reference and will remain at zero. As the signal from SFB into 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 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 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.

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

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

The gain of the drive is reduced so that the phase control reference PCR is equal to the magnitude of the driver reference DR as long as the current reference is set to zero.

With an oscilloscope, the initial pulse output IPU, and the pulse output PO may be monitored to verify proper operation. See Fig. 16 and 22.

DIAGNOSTIC RUN (SWITCH RIGHT)

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

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

CALIBRATION PROCEDURE

The diagnostic card is used to generate the appropriate test signals and operating modes to calibrate the drive. If a diagnostic card has not been furnished, one may be ordered or the test circuit shown in Figure 23 may be used.

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

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

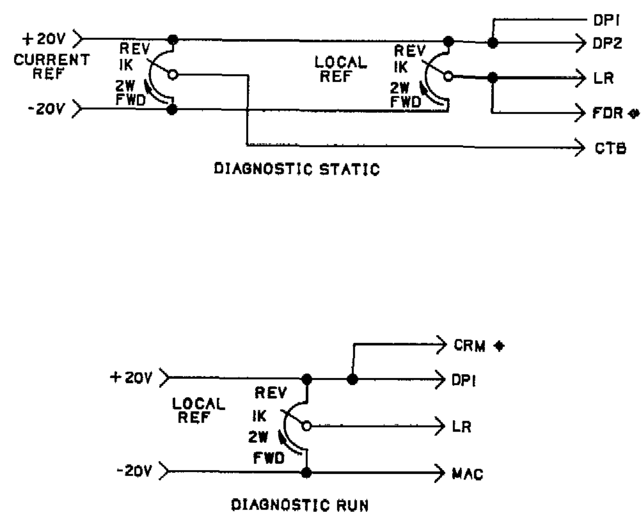


FIG. 23 DIAGNOSTIC TEST CIRCUITS

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 III
Recalibrating Adjustment Sequences

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

*NOTE: A motor field control card may be furnished on base speed drives (constant field) to provide field economy, tach monitor, or 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%.

CALIBRATION WITH MOTOR FIELD CONTROL (MFC)

All readings can have a tolerance of ±10%.

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

LINE (Line Impedance Compensation)

This function is factory set at approximately mid-range (3½% impedance). CW rotation of ***LINE*** pot adjusts for greater line impedance. Range is 2% to 5% with no jumper RLA to PCR. Range is 4% to 10% with jumper RLA to PCR. If impedance is unknown a mid-range setting, no jumper, is suggested.

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 (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 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)

Set ***CROSS*** full CCW. Turn the ***LOC REF*** potentiometer Fwd until LR corresponds to the cross over LR on the test data sheet.

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

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.

COMP (compensation — IR)

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

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

CUR LIMIT (current limit)

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

IMET (load instrument calibration)

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

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

CEMF LIMIT (counter emf limit)

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

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

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

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

SMET (speed instrument calibration)

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

Return the Diagnostic Switch to Normal.

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

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

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

RSTOP (regenerative stop)

With the monitor 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 contactor will open. If the contactor opens before the drive comes down to a stop, **RSTOP** is set too far CW. If the contactor fails to open, **RSTOP** is set too far CCW. Push the RESET button to drop out the contactor prior to removing power. **RSTOP** should be readjusted with power removed.

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 test pin CFB. This is equivalent to rated armature current.
3. Set **COMP** potentiometer by reading at the CEMF test pin a value equal to 0.0312 (240V — motor CEMF) for 240V drives. For 500V drives use .0148 (500V — motor CEMF).

   Typical values of motor counter EMF:

MOTOR HORSEPOWER	MOTOR COUNTER EMF	
	240V	500V
5 to 15	215	455
20 to 40	225	470
50 to 125	230	480
150 to 250	——	490

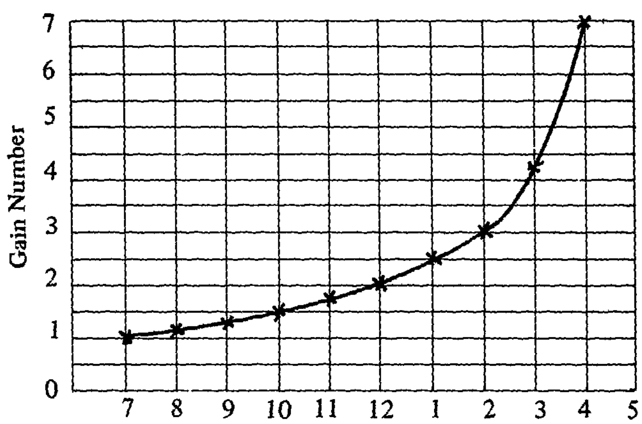
The reading at CEMF test pin is a voltage proportional to motor CEMF.

Example: 20 to 40 HP @ 240V
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. 24).

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



Time

Gain Pot Setting

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

FIG. 24 GAIN ADJUSTMENT

See motor nameplate under — Speed.

Motor Base Speed/Maximum Operating Speed.

Example: 1150/3600RPM

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 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.

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.

LINE (Line Impedance Compensation)

This function is factory set at approximately mid-range (3½% impedance). CW rotation of ***LINE*** pot adjusts for greater line impedance. Range is 2% to 5% with no jumper RLA to PCR. Range is 4% to 10% with jumper RLA to PCR. If impedance is unknown a mid-range setting, no jumper, is suggested.

FLOSS (field loss — fault)

Adjust ***FLOSS*** full CCW and reset.

Monitor FC and move the ***LOC REF*** Rev 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 Fwd or Rev 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 to zero with the ***LOC REF***. 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.

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

MAX SPEED (maximum speed)

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

CEMF LIMIT (counter emf limit)

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

SMET (speed instrument calibration)

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

Return the Diagnostic switch to Normal.

REF SCALE (reference scale)

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

MIN SPEED (minimum speed)

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

RSTOP (regenerative stop)

With the motor operating at some RPM, call for a drive stop by initiating the proper magnetics which will release 2TB-14 from —30 volts. The motor will decelerate to zero speed and the contactor will open. If the contactor opens before the drive comes down to a stop, ***RSTOP*** is set too far CW. If the contactor fails to open, ***RSTOP*** is set too far CCW. Push the RESET button to drop out the contactor 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 test pin CFB. This is equivalent to rated armature current.
3. Set ***COMP*** potentiometer by reading at the CEMF test pin a value equal to 0.0312 (240V — motor CEMF) for 240V drives. For 500V drives use .0148 (500V — motor CEMF).

   Typical values of motor counter EMF:

MOTOR HORSEPOWER	MOTOR COUNTER EMF	
	240V	500V
5 to 15	215	455
20 to 40	225	470
50 to 125	230	480
150 to 250	——	490

The reading at CEMF test pin is a voltage proportional to motor CEMF.

Example: 20 to 40 HP @ 240V

CEMF = 0.0312 (240 — 225)
= 0.468 volts

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

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

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

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

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

7. Reset ***LIN TIME*** to required setting.

TROUBLE SHOOTING

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

RECOMMENDED INSTRUMENTATION

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

Hewlett-Packard or Tektronix (or equivalent). Dual Trace oscilloscope rated for operation from DC to 10 MHZ at 0.01V/CM with deflection factors to provide 0.01 V/CM to 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. 23). This is another powerful tool for quickly locating drive system faults.

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

Detailed adjustments for these two cards are found in GEK-24971 for the MFC card and GEK-24972 for the MFE card.

REMOVAL/REPAIR

PRINTED CIRCUIT CARDS

There should be no need to retune the drive after removal/repair of a conversion module, an SCR or any other removable sub-assembly unless, of course, an adjustment was 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 on terminals TR, RJ, SFB, NDE, CL1, CLJ, and LT2 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 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.

GLOSSARY OF TERMS

	PAGE
ACC — Auxiliary Control Card	4, 6, 15
ALIGN — Tachometer Loss Align Adjustment	(1), 23, 24
*CEMF — Counter EMF	(1), 4, 17, 21, 22, 24, 25, 26
CEMF LIMIT — Counter EMF Limit Adjustment	4, 17, 23, 24, 26
*COM — Regulator Common	13, 21
COMP — IR Compensation Adjustment	4, 21, 22, 23, 24, 25, 26
CPT — Control Power Transformer	14, 17
*CFB — Current Feedback	18, 21, 22, 24, 25, 26
CUR REF — Diagnostic Current Reference Potentiometer	15, 21, 23, 24, 25, 26
CROSS — Crossover Adjustment	(1), 9, 23, 24
CUR LIMIT — Current Limit Adjustment	4, 17, 22, 23, 24, 25, 26
DAMP — Dampening Adjustment	4, 21, 23, 24, 26
Diagnostic — Normal	11, 23, 24, 26
Diagnostic — Run	11, 22, 23, 24, 26
Diagnostic — Static	11, 15, 21, 23, 24, 25
DGC — Diagnostic Card	9, 10, 27
*DM1—DM8 Dummy Input/Output points	27
*DP1—DP2 Diagnostic Switching Signals	22
*DR — Driver Reference	17, 21, 22, 24, 26
*EAO — Error Amplifier Output	17
EST — External Fault Stop	13
FLT — Fault Relay	8, 13, 15, 17
F1—F2 — Motor Field Connections	(1), (2), 14
*FC — Field Current Signal	(1), (2), 23, 24, 25
FDR — Field Diagnostic Reference	(1), 21, 22
FEA — Field Economy Adjust	(1)
FF — Field Fault	(1)
FLOSS — Field Loss Adjustment	(1), (2), 23, 25
FMAX — Motor Field Maximum Adjustment	(1), 23
FMIN — Motor Field Minimum Adjustment	(1), 23
GAIN — Speed Loop Gain Adjustment	4, 17, 23, 24, 25, 26
IFC — Interface Card	4, 8, 14
IMET — Current (Load) Instrument Output and Adjustment	8, 14, 22, 23, 24, 26
IOC — Instantaneous Over Current	15, 25, 26, 27
*IPU — Initial Pulse	19, 21, 22
*JOG — Jog Switch Input	13, 17, 21, 22
*JOGR — Jog Reference	17, 21, 22
LIN TIME — Linear Timing Adjustment	4, 17, 22, 23, 24, 25, 26, 27
*LR — Local Reference from DGC	22, 23
LOC REF — Diagnostic Local Reference Potentiometer	11, 15, 21, 22, 23, 24, 25, 26
LINE — Line Impedance Compensation	4, 23, 25

*TEST Points Located on Door Front (See MCC Illustration, Fig. 4)

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

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

GLOSSARY OF TERMS
(continued)

PAGE

MA — Line Contactor 4, 8, 11, 13
*MAC — MAX Control Signal 17, 21, 22
MAX — Pilot Relay for M 4, 8, 13, 17, 21
MAX SPEED — Adjustment 4, 11, 17, 23, 24, 26
MCC — Main Control Card 4, 7, 11, 27
MD — DC Line Contactor 4, 11
MDR — Modification Rack 10, 13
MFC — Motor Field Control Card .... (1), 4, 9, 14, 17, 21, 22, 23, 27
MFE — Motor Field Exciter Card .... (2), 4, 9, 14, 22, 23, 25, 27
MIN SPEED — Adjustment 4, 14, 23, 24, 26
MOV — Metal Oxide Varistor 10

*OSC — Oscillator 15, 19

*PCR — Phase Control Reference 21, 22, 23, 25
PO — Pulse Outputs 20, 21, 22
PR — Permissive Relay 14
*PRE — Preconditioning 17, 21
PSC — Power Supply Card 4, 6, 27

REF SCALE — Adjustment 4, 17, 22, 23, 24, 26
RESPONSE — Speed Loop Response Adjustment 4, 17, 23, 24, 25, 26, 27
RESET — Pushbutton 11, 13, 15, 21, 22, 23, 24, 25, 26
RSTOP — Regenerative Stop Adjustment 8, 15, 21, 23, 24, 26
*RTR — "Ready to Run" Indicator 15, 17, 23, 25
*RUN — Run Switch Input 13, 17, 21, 22

*SA, SB, SC — Synchronizing Signals 17, 19
*SFB — Speed Feedback .... (1), 17, 19, 20, 21, 22, 23, 24, 26, 27
SLIM — Speed Limit Adjustment .... (1), 23
*SMET — Speed Instrument Output and Adjustment 8, 14, 23, 24, 26
*SMIN — Minimum Speed Reference Adjustment and Input 14
*SR — Speed Reference 11, 14, 17, 21, 22, 26
*SYS — System Fault Trip .... (1), (2), 15
*TA — Tachometer Align Output .... (1), 24
TF — Tach Fault .... (1)
*TFB — Tachometer Feedback Signal 20, 22
TKN — Negative Tachometer Input 14
TKP — Positive Tachometer Input 14
*TR — Timed Reference 17, 21, 22, 24, 26, 27
TRIP — Trip Signal for Optional Circuit Breaker 6
*VFB — Voltage Feedback 18, 21, 23
*WFR — Weak Field Reference .... (1)

(1) Also see Motor Field Control Instructions, GEK-24971
(2) Also see Motor Field Exciter Instructions, GEK-24972
*TEST Points Located on Door Front (See MCC Illustrations, Fig. 4)

HOT LINE TELEPHONE NUMBER

The Contract Warranty for VALUTROL drives is stated in General Electric Apparatus Handbook Section 105, Page 71.

The purpose of the following is to provide specific instructions to the Valutrol—Drive user regarding warranty administration and how to obtain assistance on out-of-warranty failures.

1. In the event of failure or misapplication during "in warranty" refer to the instruction book to identify the defective part or subassembly.

2. When the defective part has been identified (or for assistance in identification)

General Electric Company
Erie, Pennsylvania
814—455—3219
(24 Hour Phone Service)

or

Contact the nearest

General Electric Installation and Service Engineering Office listed in your telephone directory. Before calling, list model numbers of the power unit and DC motor.

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCTS OPERATION
ERIE, PENNSYLVANIA 16531

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GEK-24994 (1/82) 600 (P)