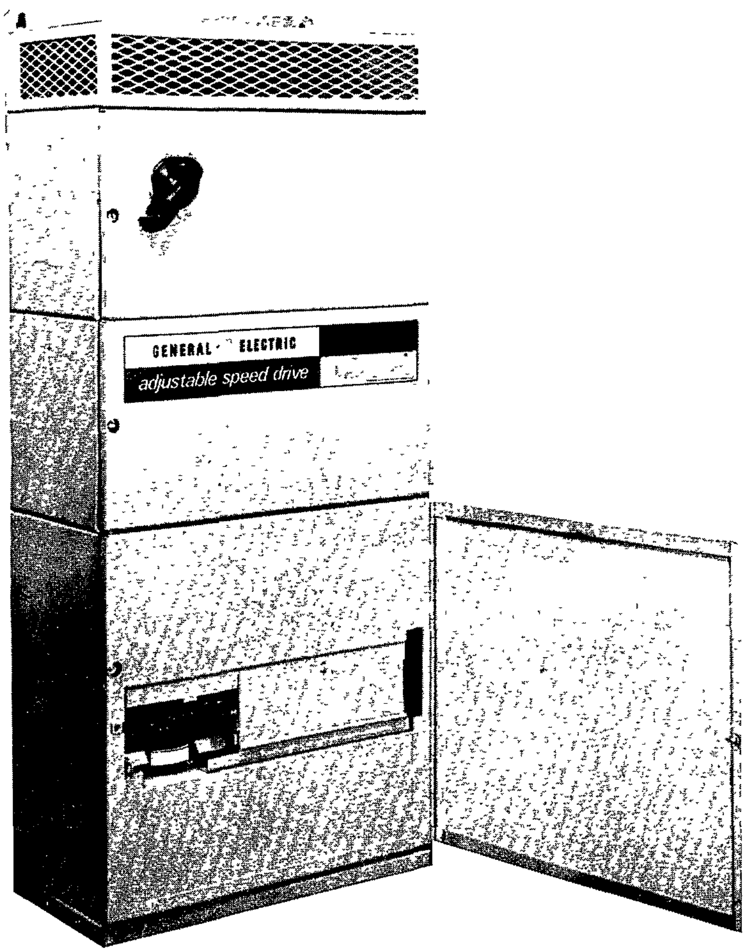
INSTRUCTIONS

GP ValuTrol* DC SCR DRIVES

FULL WAVE, NON REGENERATIVE

INSTALLATION – OPERATION – MAINTENANCE



(Photo MG-5274-5)

GENERAL ELECTRIC

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

ELEMENTARY DIAGRAMS

CARD DIAGRAMS

LIST OF TABLES

INTRODUCTION

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

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

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

RECEIVING, HANDLING AND STORAGE

RECEIVING

The equipment should be placed under adequate cover immediately upon receipt as packing cases are not suitable for out-door or unprotected storage. Each shipment should be carefully examined upon arrival and checked with the packing list. Any shortage or damage should be reported promptly to the carrier. If required, assistance may be requested from the General Electric Company, Speed Variator Products Operation, Erie, Pa. When seeking assistance please use drive serial 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, care being taken that the unit does not tip.

STORAGE

If the equipment is not to be installed immediately, it should be stored in a clean, dry location at ambient temperatures from $-20^{\circ}C$ ($-4^{\circ}F$) to $+55^{\circ}C$ ($131^{\circ}F$). 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 $15^{\circ}C$ ($27^{\circ}F$) 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.

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 $-20^{\circ}C$ ($-4^{\circ}F$) are likely to be present then auxiliary heat should be added in each enclosure to maintain temperature at or above $-20^{\circ}C$. For assistance in heater size selection, contact the General Electric Company.

When a drive that has been in operation is shut down for either a short or extended period of time, it is recommended the environmental conditions be maintained the same as when in operation. Power unit ventilation or heating and air

TABLE I

Relationships 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

conditioning (if used) should be left on during the downtime to prevent large changes in temperature and possible moisture condensation.

SAFETY FOR PERSONNEL AND EQUIPMENT

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

WARNING

DENOTES OPERATING PROCEDURES AND PRACTICES THAT MAY RESULT IN PERSONAL INJURY OR LOSS OF LIFE IF NOT CORRECTLY FOLLOWED.

COLOR – BLACK OR WHITE LETTERING ON RED FIELD.

CAUTION

DENOTES OPERATING PROCEDURES AND PRACTICES THAT, IF NOT STRICTLY OBSERVED, MAY RESULT IN DAMAGE TO, OR DESTRUCTION OF, THE EQUIPMENT.

COLOR – BLACK LETTERING ON AMBER FIELD.

NOTE

DENOTES AN OPERATING PROCEDURE OR CONDITION WHICH SHOULD BE HIGHLIGHTED.

COLOR – BLACK LETTERING ON WHITE FIELD.

WARNING

IMPROPER LIFTING PRACTICES CAN CAUSE SERIOUS OR FATAL INJURY.

LIFT ONLY WITH ADEQUATE EQUIPMENT AND TRAINED PERSONNEL.

WARNING: HIGH VOLTAGE

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC VOLTAGE SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGE TO GROUND WILL BE PRESENT AT MANY POINTS. WHEN INSTRUMENTS SUCH AS OSCILLOSCOPES ARE USED TO WORK ON LIVE EQUIPMENT, GREAT CAUTION MUST BE USED. 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.

WARNING

DO NOT SERVICE THE EQUIPMENT WHILE POWER IS APPLIED.

NOTE

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

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

CAUTION

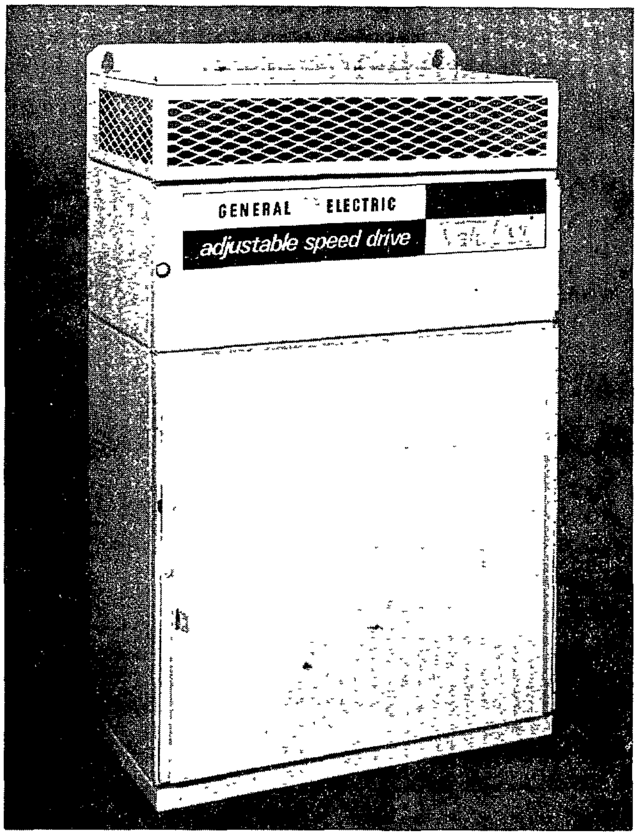
DO NOT REMOVE INPUT POWER FROM THE DRIVE UNTIL IT HAS FULLY EXECUTED A STOP SEQUENCE, AS THIS CAN DAMAGE THE DRIVE SYSTEM.

INSTALLATION

LOCATION

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

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



(Photo MG-5244-6)

FIG. 1 VALUTROL –GP 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 (NEMA 12) should be positioned to permit heat radiation from all surfaces except the bottom; otherwise, the enclosure (NEMA 1) 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

EXPLOSIONS OR FIRES MIGHT RESULT FROM MOUNTING DRIVE POWER UNITS IN HAZARDOUS AREAS SUCH AS LOCATIONS WHERE INFLAMMABLE OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT. DRIVE POWER UNITS SHOULD BE INSTALLED AWAY FROM HAZARDOUS AREAS, EVEN IF USED WITH DC MOTORS SUITABLE FOR USE IN SUCH LOCATIONS.

MOUNTING

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

NOTE

EXTERNAL MOUNTING FLANGES ARE PROVIDED, ONE AT THE TOP REAR AND ONE AT THE BOTTOM REAR OF THE WALL MOUNTED POWER UNIT ENCLOSURE. EACH BRACKET IS FITTED WITH TWO MOUNTING HOLES FOR EXTERNAL MOUNTING OF THE WALL MOUNTED ENCLOSURE.

CONNECTIONS

All internal electrical connections between components in DC–SCR drive power units are made at the 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. See Pages 78–82 for wire/cable size.

If additional relays, contactors, solenoids, brakes, etc., 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 coil is recommended.

NOTE

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

WARNING

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

NOTE

IT IS RECOMMENDED THAT THE DRIVE SYS-

TEM COMMON CIRCUIT BE GROUNDED AT ONLY ONE POINT. IF THE DRIVE REFERENCE IS SUPPLIED BY A PROCESS INSTRUMENT WITH GROUNDED COMMON, THE DRIVE COMMON SHOULD NOT BE GROUNDED.

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

CAUTION

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

CAUTION

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

NOTE

CONNECTION OF EXTERNAL CIRCUITS OTHER THAN SHOWN ON THE ELEMENTARY DIAGRAM, SUCH AS AMMETERS ON THE SHUNT OR VOLTMETERS ON THE TACHOMETER MAY DEGRADE THE PERFORMANCE OF THE DRIVE SYSTEM.

CAUTION

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

Before power is applied to the drive system, checks should be made to see that all internal connections are tight, and that all open relays and contactors operate freely by hand. Check that the equipment is clean and that no metal chips are present.

MAINTENANCE

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

FANS AND FILTERS

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

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

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

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

To clean metal filters, flush only with warm water, dry and recoat lightly with RP super filter coat or equivalent (light oil) or replace the filter.

Be sure to install filters with air flow direction as indicated on the filter.

DC MOTORS

Maintenance instructions covering brushes, commutator and lubrication are in GEH–2304 or GEH–3967 which is found elsewhere in the instruction book.

CAUTION

IT SHOULD BE NOTED THAT WHEN THE DRIVE SYSTEM IS SHUT DOWN AND POWER IS NOT REMOVED FROM THE POWER UNIT THE MOTOR FIELD WILL CONTINUE TO BE EXCITED EVEN AT STAND STILL.

ALTHOUGH DC MOTORS ARE DESIGNED FOR FULL FIELD EXCITATION AT STAND STILL FOR PERIODS OF TIME (SEVERAL HOURS), UNDER THIS CONDITION, POWER SHOULD BE REMOVED, OTHERWISE THE FIELD COILS WILL BE SUBJECTED TO EXCESSIVE TEMPERATURE AND SIGNIFICANTLY REDUCED INSULATION LIFE.

AN ALTERNATE TO THIS PROCEDURE IS TO EMPLOY A FIELD ECONOMY CIRCUIT WHICH AUTOMATICALLY REDUCES THE LEVEL OF

EXCITATION WHENEVER THE DRIVE IS SHUT DOWN. SEE MOTOR FIELD CONTROL CARD (MFC).

PRINTED CIRCUIT CARDS

Printed circuit cards normally do not require maintenance except to keep them clean and tightly secured to their respective terminal boards. 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 follows:

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

CAUTION

SOLVENT CAN HARM NON-METAL COMPONENTS.

2. Oily Dirt – Use dry or barely moist (with solvent) non-linting cloth. Repeat until cloth remains clean. All SCR's 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.

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

*Trademark of E. I. DuPont Co.

THE FOLLOWING INFORMATION IS OF PARTICULAR IMPORTANCE.

TYPES OF DIAGRAMS

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

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

The Elementary diagrams represent (in symbolic form) the fundamental operation and relationship of the electrical parts of a system. These diagrams are drawn in such a manner that the operation of the control system is easily understood. Mechanical relationships of control devices are subordinated to simple presentation of the electrical circuits. Connections made between control devices and power devices within the enclosure are also shown on 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. Adjustments are CAPITALIZED and UNDERLINED in this instruction book. Example: FMAX (maximum motor field adjustment). Signals and test points are CAPITALIZED only, example: CFB (Current Feed Back).

In many cases the Elementary diagram will be combined with the Interconnection diagram, which will show the type and number of connections to be made between major components of the system such as the power unit, motor, operator's station, the plant power source, auxiliary devices and other electrical machines.

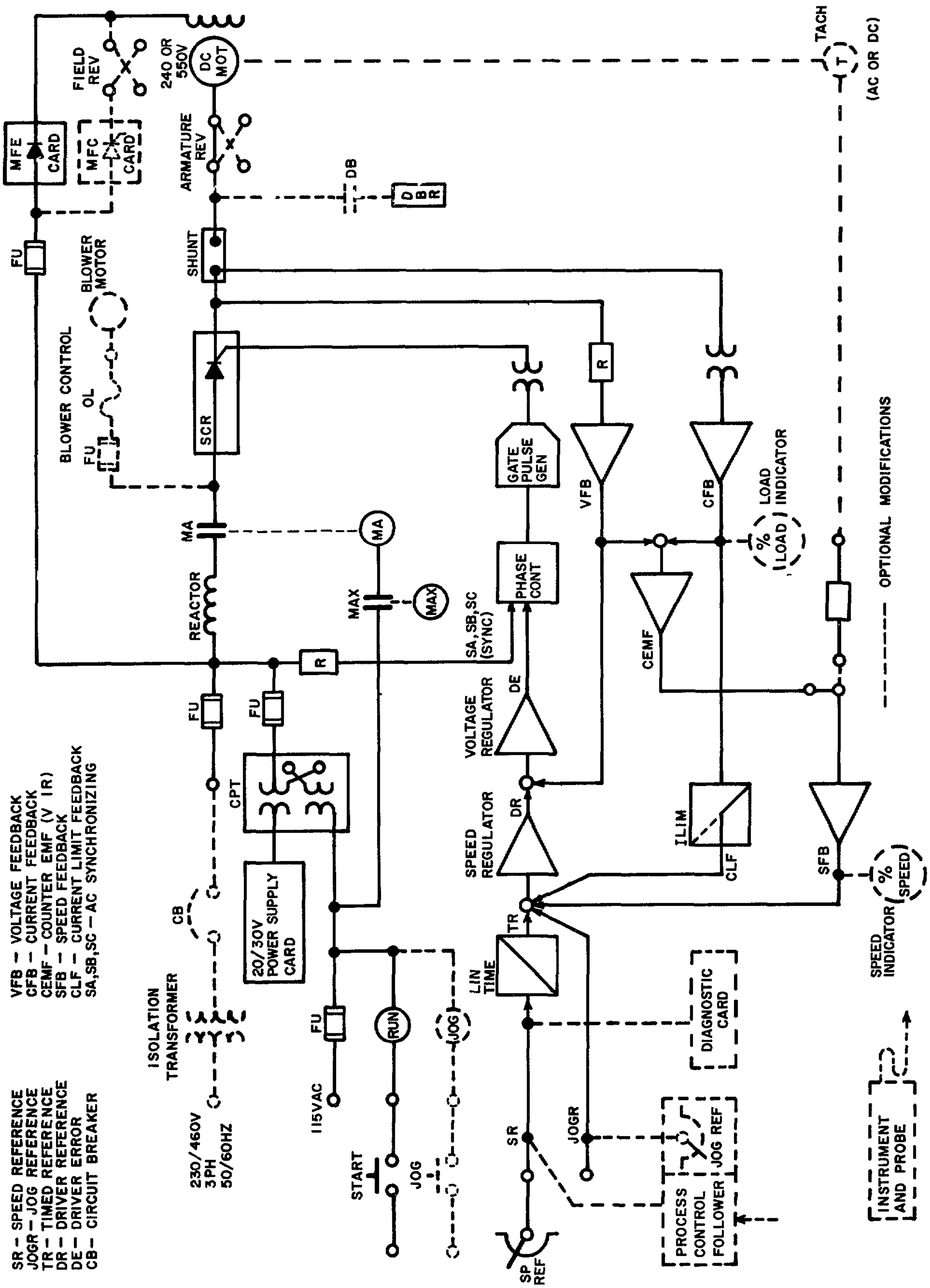


FIG. 2 VALUTROL BLOCK DIAGRAM

INSTRUCTION INFORMATION

The instruction folder furnished with the equipment includes detailed instructions and diagrams applicable to the basic drive system and the various options and modifications.

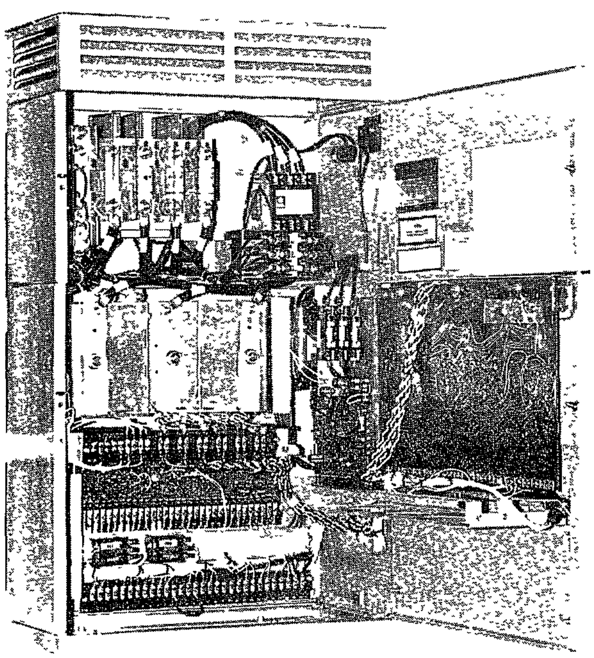
In addition to this general information the folder includes instructions for the motor(s) and other components furnished. Start-up and troubleshooting guides are included. All instructions and the accompanying diagrams should be consulted before applying power to the system.

GENERAL DESCRIPTION

The basic elements of the Valutrol , full wave, non-regenerative DC SCR drive are shown in the simplified block diagram, Fig. 2, Valutrol Block Diagram.

Three phase AC power enters through the fuses and is fed through the line reactor, line contactor (MA) and enters the power conversion module (SCR) where it is converted to DC adjustable voltage. DC power is fed through a shunt to the DC motor armature.

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.



(Photo SV-4951-1)

FIG. 3 VALUTROL – POWER UNIT (DOORS OPEN)

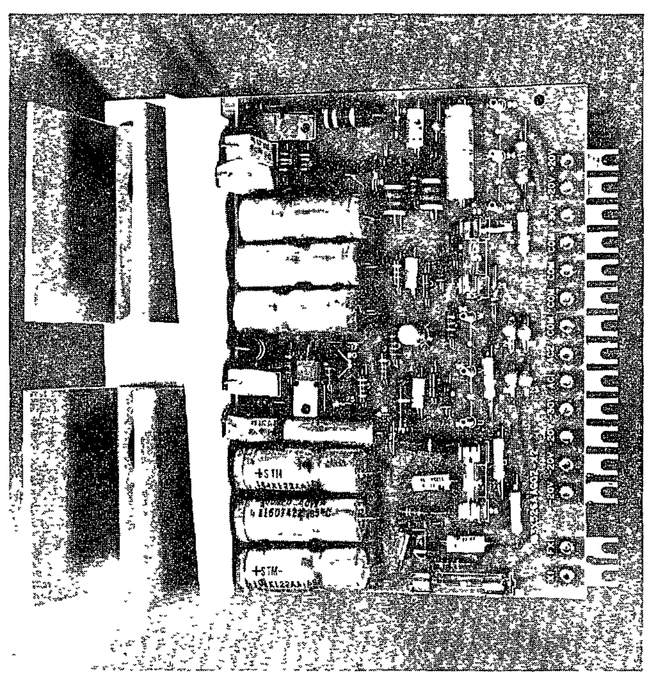
The remainder of the control is manufactured on four (4) removable printed circuit boards. These are the power supply card (PSC) the main control card (MCC) the interface card (IFC) and the motor field exciter card (MFE) or the motor field control card (MFC) (optional). Additional cards are available for optional modifications, such as:

Diagnostic card
Field reversing card
Anti plug card
Process Control Follower/Jog Reference card
Timed Overcurrent card

Signal level power for the control is taken from the three phase input through control fuses 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 contactor, the RUN relay and the conversion module cooling fans (if required); (2) the second winding is a 50 volt center tapped secondary which provides the AC input to the power supply card.

POWER SUPPLY CARD (PSC)

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



(Photo MG-5236-20)

FIG. 4 POWER SUPPLY CARD

MAIN CONTROL CARD (MCC)

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

This card also performs several additional functions such as linear timing of the reference; current limit, "READY TO RUN" indicator; and various scaling and trimming adjustments.

A total of ten (10) potentiometers are provided on this card, nine (9) of which are accessible from the front of the controller. The tenth potentiometer is the card zero adjustment ZERO ADJ, which is preset at the factory and should not be disturbed. All adjustments have been pre aligned prior to shipment. These nine potentiometers are

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

When the drive is first placed into operation the actual top speed may be different from what is required. By adjusting the MAX SPEED potentiometer, the proper top speed can be set without disturbing any other adjustments in the drive, except the ALIGN speed sensitive adjustment if the MFC card is used.

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.

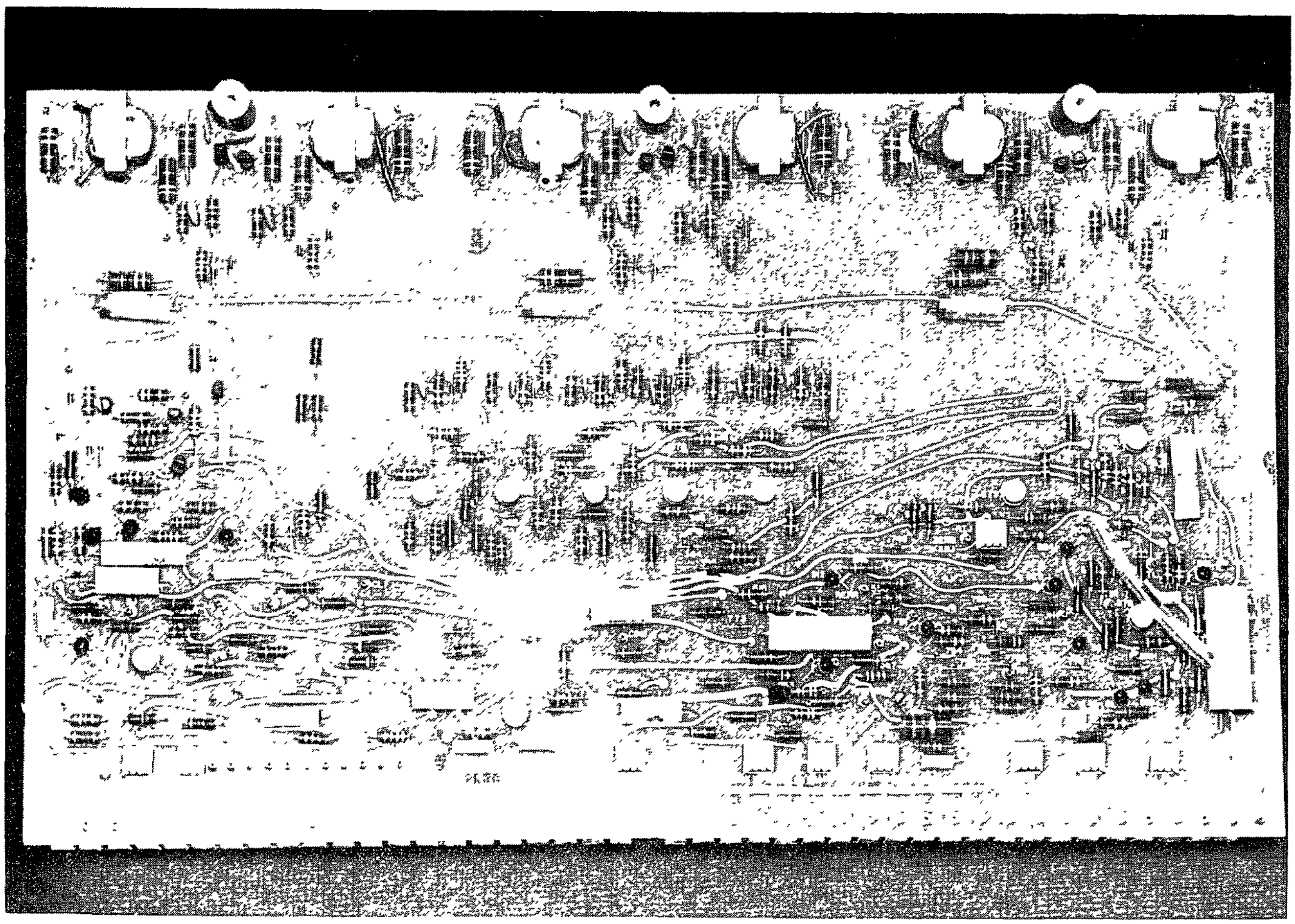


FIG. 5 MAIN CONTROL CARD

(Photo SV-4951-002)

INTERFACE CARD (IFC)

The primary purposes of the interface card are:

1. To provide low level isolated signals corresponding to the three phase AC line voltage, DC armature voltage, armature current and tachometer feedback (if used).
2. To control the start, stop and synchronizing signals of the drive while monitoring the system for abnormal operating conditions.

OTHER OUTPUTS PROVIDE

1. A one milliampere signal for the external speed and current indicators (optional).
2. A driver for the external MAX relay with a N/O contact indicating MA closure.

There are two (2) potentiometers on this card:

1. IMET is the calibration adjustment for the current indicator. (Optional)
2. SMET is the calibration adjustment for the speed indicator. (Optional).

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.

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

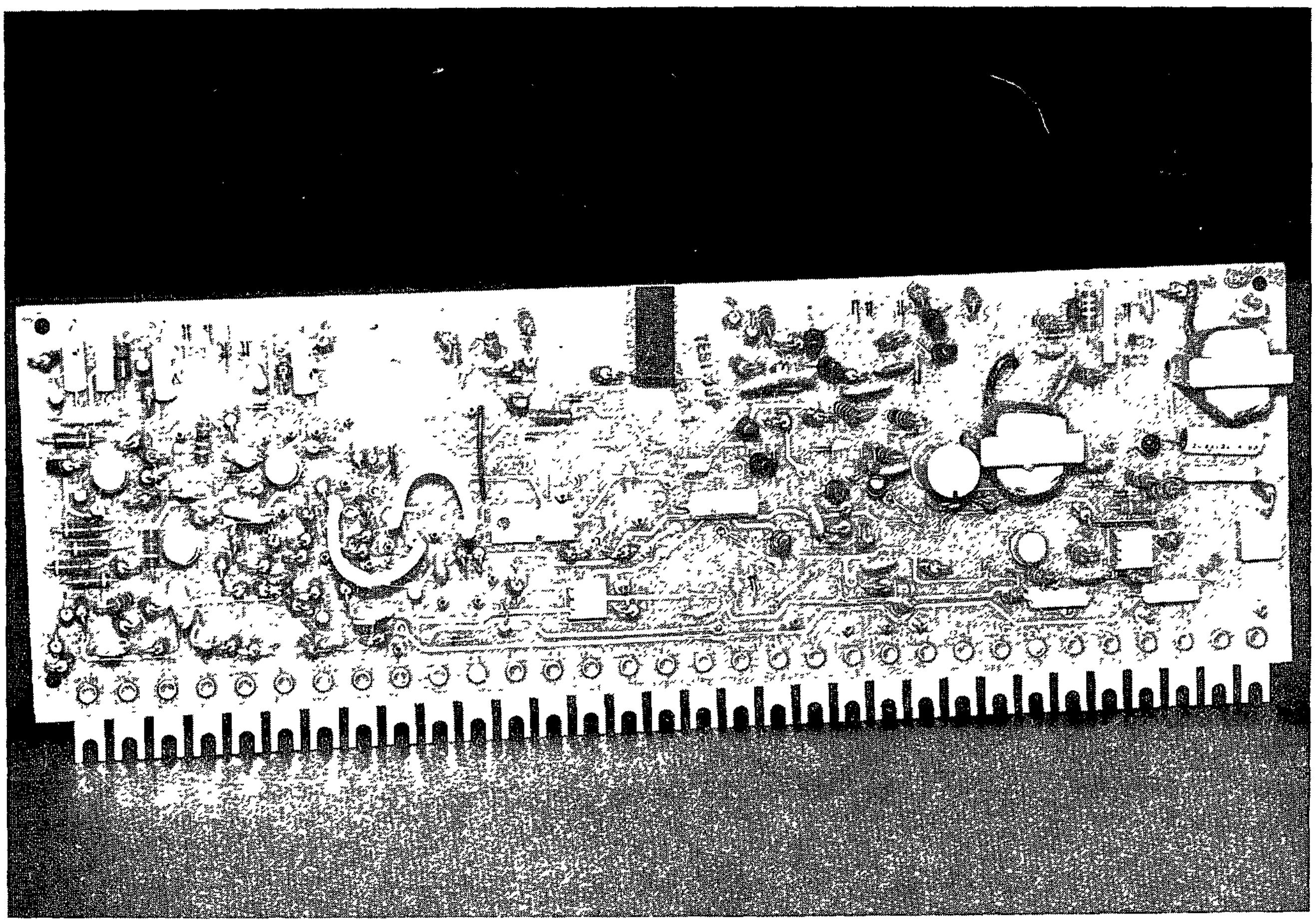
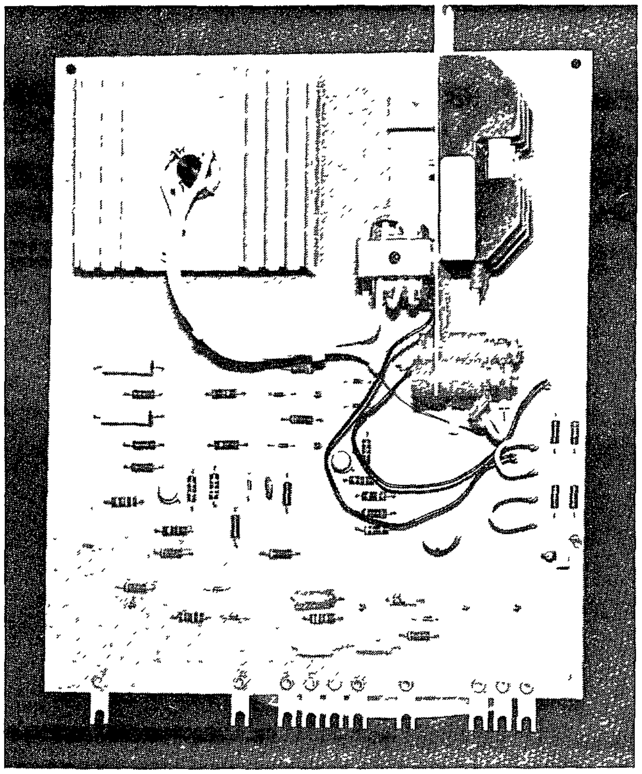


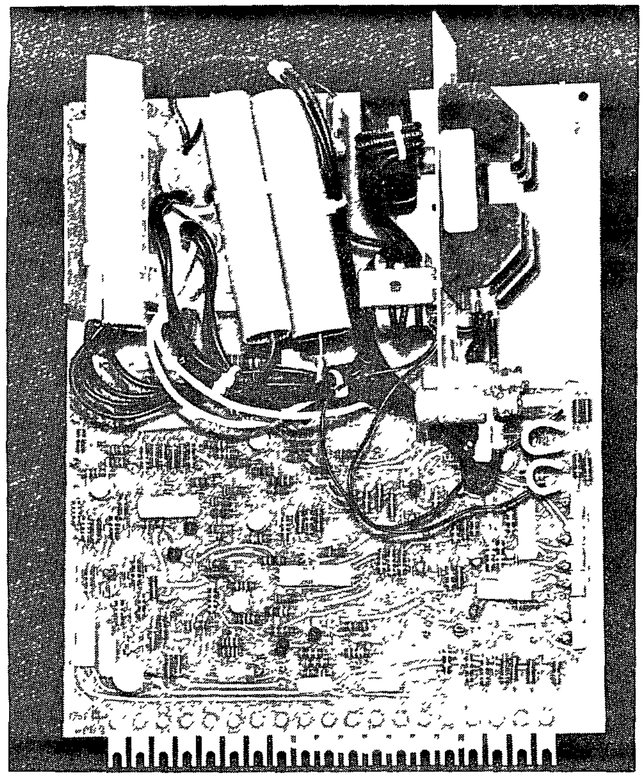
Photo SV-4951-003)

FIG. 6 INTERFACE CARD



(Photo SV-4951-004)

FIG. 7 MOTOR FIELD EXCITER CARD



(Photo SV-4951-005)

FIG. 8 MOTOR FIELD CONTROL CARD

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 monitor circuit to detect the loss of tachometer feedback voltage, over speed and loss of motor field. Any of these faults will shut down the drive. A field economy circuit 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.

DIAGNOSTIC CARD (DGC) (OPTIONAL)

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

CONTROL FUSES, MOV'S

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

POWER CONNECTIONS

The power connections are the three phase input at L1, L2, and L3 on the line fuses. An optional circuit breaker can be added ahead of the fuses as shown on the block diagram, Fig. 2. The line fuses remain in the circuit even though an optional circuit breaker is selected.

The DC motor armature and shunt field connection are as follows:

Arm: DA1, DA2 in the ACM (basic)
RA1, RA2 in the MDM (optional)

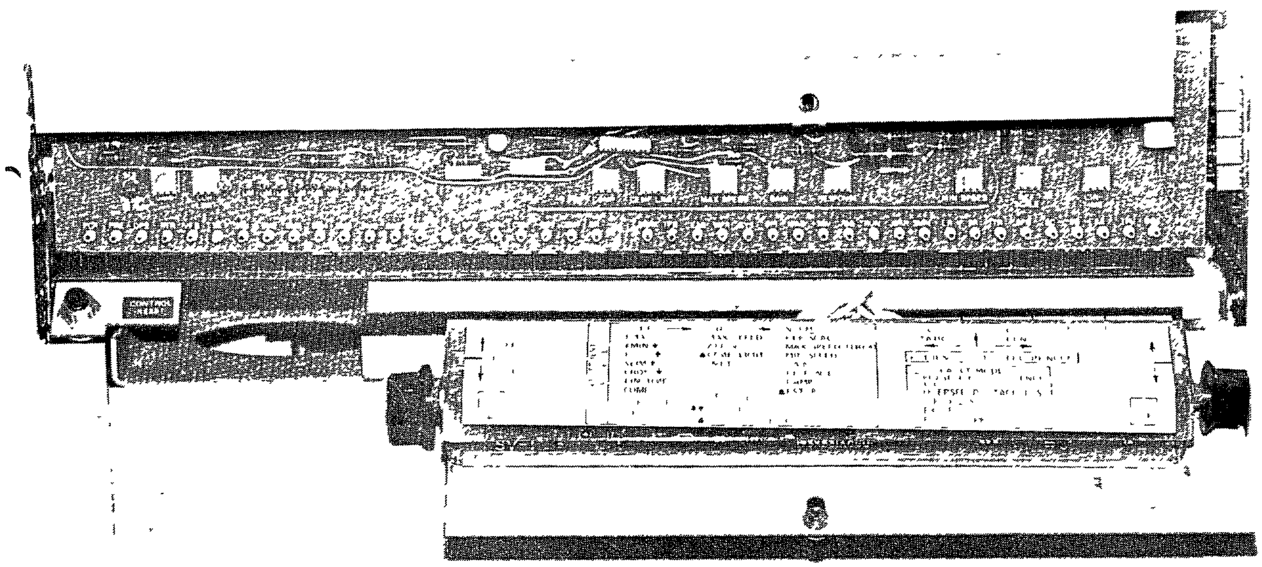
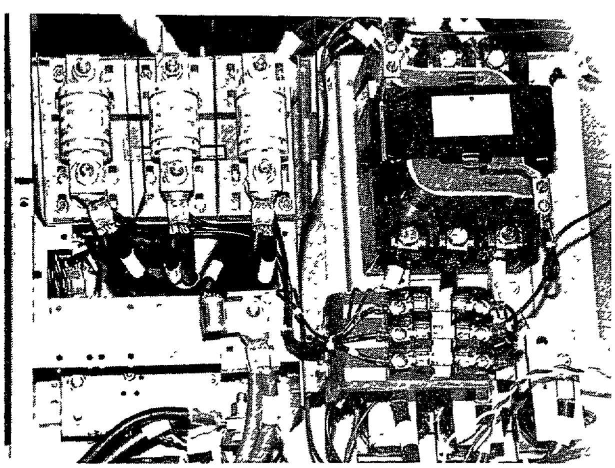


FIG. 9 DIAGNOSTIC CARD (Photo SV-4951-006)



(Photo SV-4951-007)

FIG. 10 CONTROL FUSES AND MOV'S

Field: F1, F2 in the ACM (basic)
RF1, RF2 in the MDM (optional)

CONTROL CONNECTIONS

All control connections for a basic drive are located on the 2TB terminal board. The signals appearing on 2TB terminal board and their functions are described in Table III. Refer to system elementary diagram for details.

The JOG and/or Process Follower Kit are mounted to the right of the RUN relay. Control connections for the reversing modification are provided on 4TB terminal board.

CONTROLLED SPEED RANGE: 20:1

SPEED VERSUS TORQUE

Typical data for speed versus torque:

MOTOR ENCLOSURE	Percent Rated Speed			
	100-60	50	40	5
	Percent Continuous Torque (Or Rated Amperes)			
DPFG	100	94	87	45
TENV or TEFC	100	95	92	77

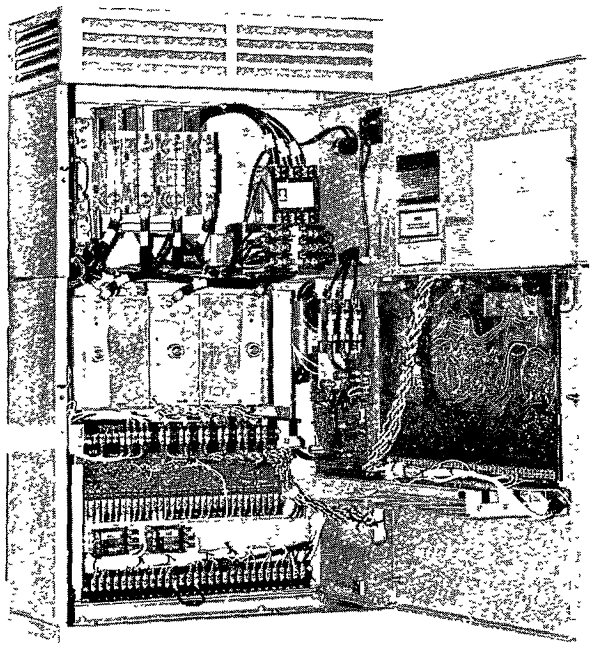


FIG. 11 SIGNAL CONNECTIONS (Photo SV-4951-1)

SPECIFICATIONS FOR BASIC DRIVES

POWER RATINGS – 3 Phase 50/60 Hertz

HP	KVA	AC LINE AMPS		DC OUTPUT AMPS			
		230VAC	460VAC	240VDC	150VDC	550VDC	300VDC
5	9	19	8.2	20	10	8 5	10
7½	12	26	11.3	29	10	12 2	10
10	15	34	14 4	38	10	16	10
15	21	49	22	55	10	24	10
20	27	68	27	72	10	31	10
25	33	77	33	89	10	38	10
30	39	91	40	106	10	46	10
40	51	119	52	140	10	61	10
50	63	146	63	173	10	75	10
60	74	173	76	206	10	90	10
75	91	214	93	255	10	111	10
100	120	284	124	341	10	148	10
125	147		154		10	185	10
150	175		184		10	222	10
200	229		244		10	294	10
250	285		300		10	362	10

SERVICE CONDITIONS

- Rated Voltage –230VAC (–5, + 10%)
  –460VAC (–5, + 10%)
- Frequency –60 Hertz ± 1 Hertz
  –50 Hertz ± 1 Hertz
- Ambient Temperature 0° to 40°C (32° to 104°F)
- Altitude Sea Level to 3300 feet
- Load Inertia Not more than motor inertia when referred to motor shaft. For motor WK^2 refer to motor dimension sheet

TABLE III SIGNAL CONNECTIONS

2TB NO.	NOMENCLATURE	DESCRIPTION
1	–30V	Unregulated negative DC voltage used as the return line for the CONTROL ON function and the static switches RUN and JOG, and possible modifications.
2	CONTROL ON	2TB(2) is normally jumpered to 2TB(1). IF CONTROL ON is not connected to –30V the drive will not start. If CONTROL ON is opened with the drive operating the MA contactor will open and the drive will coast.
4	OL 115VAC CONTROL POWER	115VAC (FX1) for the START/STOP circuit is applied to 2TB(4) through the blower motor overload relay contacts (OL). If not used, these contacts are replaced by jumpers on terminal board (MTB).
5, 6	MAX	A N.O. relay contact which actuates when the MA contactor actuates. Pilot duty rating: 0.7 ampere holding 6 ampere inrush at 115VAC with 0.8 power factor load.
8, 27	COM	Signal Common. All signals are measured with respect to common, unless otherwise noted.
9	EST	External Stop input. If EST is momentarily disconnected from common, the MA contactor will open and the motor will coast. The drive may not be restarted until the reset line is momentarily connected to COMMON, 2TB(12). If not used, 2TB(9) is jumpered to 2TB(8).
10	FX1	The internal 115VAC, fused (1.0A).
11, 12	X2	The internal 115VAC, grounded to case.
13	JOG COIL	If the independent JOG option is furnished the JOG relay coil is wired between 2TB(13) and 2TB(12) (grounded side of 115VAC).
14	RUN	When –30V is applied to 2TB(14) the MAX relay and the MA contactor will pick up. The drive will run from the speed reference SR, applied to 2TB(28).
20, 21	+20V, –20V	Regulator power supply outputs.
22	IMET	Output to an optional 1 ma load instrument. The instrument is calibrated with the IMET potentiometer on the Interface Card.
23	SMET	Output to an optional 1 ma rectifier type 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.

TABLE III SIGNAL CONNECTIONS (Continued)

2TB NO.	NOMENCLATURE	DESCRIPTION
29, 30	TKP TKN	Input connections for motor mounted tachometer or machine mounted tachometer. **NOTE:** WITH A DC TACHOMETER, TKP IS POSITIVE FOR FORWARD DIRECTION.
3 17	START JOG	–30 volts applied when RUN picks up. When –30 volts is applied to 2TB(17) the MAX relay and the MA contactor will pick up. The drive will run from the JOG reference applied at 2TB(25).
16	RUN LATCH	A N.O. MAX interlock is connected between 2TB(16) 2TB(15) for holding in the RUN relay while running.
15 7, 18, 19	RUN COIL	With 115 V AC applied to 2TB(15) the RUN relay coil is energized. A N.O. RUN interlock is connected between 2TB(7) and 2TB(18) for latching the RUN relay. A N.C. APR relay interlock is connected between 2TB(18) and 2TB(19), when the dynamic braking or reversing options are furnished to provide a start permissive function. Refer to the appropriate operator control diagram to see how the interface between external and internal control is accomplished.

SPEED VERSUS TORQUE (continued from page 14)

NOTE

THE VALUES TABULATED REPRESENT AN AVERAGE FOR 5 TO 250 HP MOTORS. IF CONTINUOUS TORQUE GREATER THAN THAT LISTED IN THE TABLE IS REQUIRED SUPPLEMENTARY VENTILATION OR A DERATED MOTOR MAY BE REQUIRED. REFER TO THE COMPANY FOR SPECIFIC DATA OR RECOMMENDATION.

NOTE

DRIVE WILL GENERALLY OPERATE SATISFACTORILY WITHOUT LOAD COUPLED TO THE MOTOR BECAUSE MOTOR LOSSES APPROXIMATE 5% CURRENT.

OVERLOAD CAPACITY – 150% of rated current for one minute.

SPEED REGULATION

- Operating Deviation/Service Deviation
- Basic – 5%/15% of Base Speed
- Improved – See Modifications

MINIMUM SPEED ADJUSTMENT – 0 to 30% Rated Speed.

MAXIMUM SPEED ADJUSTMENT – 50 to 100% Rated Speed.

MINIMUM LOAD – 5% Rated power unit current.

PROTECTION

- Short Circuit Protection
  Current limiting type fuses provide short circuit protection for the power unit and purchaser's wiring in the event of rectifier failure or control short circuits.
- Electronic, Instantaneous Over-Current Protection
  An internal circuit providing DC fault current protection for the motor and power unit.
  Standard – 400% of rated current.
  Adjustable by Jumper – 300% or 500% of rated current.

- **Transient overvoltage protection by metal oxide varistors (MOV)**
- Overload Protection
  150% of rated current for one minute.
  Motor mounted Thermal Switch and/or Electronic Timed over current circuit. (Optional)
- Phase Sequence Protection
  Initiates the fault function. The "Ready to Run" light will not turn on for incorrect phase sequence.
- Loss of Phase Protection
  The "Ready to Run" light turns off and a controlled drive system shut down occurs due to the loss of one or more phases.
- Electronic Motor Field Loss Protection
  Adjustable on both the MFE and MFC card.

DC MOTOR VOLTAGES

230VAC Input – 240VDC Armature, 150VDC Field
460VAC Input – 550VDC Armature, 300VDC Field

CONTROL POWER (Push buttons)

Fused 115VAC Isolated

ACCELERATION/DECELERATION CONTROL

Linear Time Rate, Single Adjustment
0.3 to 60 second range
Current Limit Adjustment
20 to 150% of rated current.

JOG AT MINIMUM SPEED

Adjustable – 0 to 30% speed with RUN/JOG Selector Switch.

INPUT SIGNAL REQUIREMENTS **–5V to –20V DC at 1.3MA (with 1% or less ripple)**

- Voltage Follower – Signal greater than 20VDC requires dropping resistor.
  Maximum level not to exceed 250VDC.
- Instrument Follower – Modification provides for 0-5, 1-5, 4-20, and 10-50 milliamp signals.

SERVICE FACTOR – 1.0

EFFICIENCY

AC to DC at Rated Output
Power Unit – Approximately 97%
Drive – 80 to 85% depending on rating selected.

POWER FACTOR – At Rated Output 77 to 88% depending on voltage selected.

POWER UNIT ENCLOSURE –

Standard – Nema 1, Ventilated
Optional – Nema 12, See Modifications.

STABILITY ADJUSTMENTS (Card Mounted)

Gain, Response, Damping and IR Compensation.

EXTERNAL POTENTIOMETERS

Speed Adjust – 2.5K, 2W
Current Limit Adjust –1K, 2W (optional)

MODIFICATIONS

DYNAMIC BRAKING

Drive system shall be capable of braking a load (whose inertia equals that of the motor, referred to the motor shaft) at an initial current of 150% of rated armature current from full speed to standstill, three times in rapid succession with the dynamic braking resistor initially at ambient temperature.

REVERSING (SELECTIVE ROTATION)

Selective Rotation is provided by magnetic contactors. Armature reversing is provided on Valutrol Drives from 5 to 30 HP at 230VAC; 5 to 60 HP at 460VAC. Above these ratings, motor field contactors are employed to perform the selective rotation function.

IMPROVED SPEED REGULATION

Speed regulation of the basic voltage regulated drive with IR drop compensation is 5% "operating" and 15% "service" deviation. By the addition of a type AN, AC tachometer for a speed feedback signal, speed regulation can be improved to 1% "operating" and 2% "service" deviation.

CONSTANT HORSEPOWER SPEED RANGE

All Valutrol Drives include a constant voltage exciter (MFE) with field loss protection. If operation above base speed (motor field weakening range) is required, a motor field control (MFC) will be provided. See General Description.

The MFC function includes:

- **Motor Field Programming**
- **Motor Field Current Regulation**

- Tachometer Monitor
- Max Field, Min Field and Field Loss Adjustments.
- Motor Field Economy – Designed to reduce motor field excitation at standstill.

NOTE

A TACHOMETER GENERATOR IS REQUIRED WHEN THE CONSTANT HORSEPOWER SPEED RANGE IS SELECTED, EITHER FACTORY INSTALLED OR IN "KIT" FORM.

AC LINE CIRCUIT BREAKER/SWITCH

An AC line disconnect switch with external operating handle mechanically interlocked with the enclosure door may be ordered for all drive ratings. Enclosure will be increased on basic drives only. Note that the modification compartment added will accommodate any or all control modifications offered. The AC line fuses are always retained.

BLOWER MOTOR CONTROL

All motor ventilation blowers operate from the main AC line contactor and require the addition of fuses and a thermal overload relay. These components are mounted in the modification compartment.

POWER UNIT ENCLOSURES

NEMA 1 ventilated wall mounted enclosures are standard up to 40 HP at 230VAC and 100 HP at 460VAC.

NEMA 1 ventilated floor mounted enclosures are standard 50 HP and above at 230VAC and 125 HP and above at 460VAC. NEMA 1 ventilated floor mounted enclosures are available as a modification 40 HP and below at 230VAC and 100 HP and below at 460VAC.

NEMA 12 enclosure. The normal wall mounted enclosure will be mounted in a large NEMA 12 enclosure with adequate surface area to dissipate power unit watts to a 40°C (104°F) ambient temperature. This arrangement is available up to 60 HP at 460VAC.

ISOLATION TRANSFORMERS

Isolation transformers are available for all Valutrol GP ratings in NEMA 1 enclosures for separate mounting by the purchaser. All transformers are furnished with 1-5% full rated tap above and 1-5% full rated tap below rated primary voltage, UL listed and labeled as follows:

Primary Voltage	230V–	460V–	575V–
Secondary Voltages	230V–Y 460V–Y	230V–Y 460V–Y	230V–Y 460V–Y

TEST INSTRUMENT

A test instrument and probe is available for mounting in the main control module allowing direct reading of test points on the main control card.

DIAGNOSTIC PANEL

Most "set up" adjustments are made in factory test; however the diagnostic panel is highly recommended option for pre-start up check and maintenance during the life of the equipment.

Panel provides a "mode" selector (normal, diagnostic static and diagnostic run) with speed and current reference potentiometers.

SPEED INDICATOR – 3½" Instrument

Scale: 0-100% speed (Does not require a tachometer generator).

LOAD INDICATOR – 3½" Instrument

Scale: 0-150% load
(Red lined, 100-150%)

VOLTAGE FOLLOWER – NOTE: A Manual/Auto selector switch may be required.

INSTRUMENT FOLLOWER – NOTE: A Manual/Auto selector switch may be required.

PRESET JOG SPEED

Provides a separate preset jog speed (without timing) and includes a jog potentiometer and relay.

REMOTE CURRENT LIMIT

Provides a separate potentiometer and knob in an operator's station for remote current limit (torque) adjustment.

INTERCONNECTION

GENERAL

All internal electrical connections between devices in the power unit have been made by General Electric Company. Check for proper jumper connections on terminal boards 2TB, according to the operator control circuit amployocl.

INTERCONNECTION OF DRIVE COMPONENTS

Electrical connections are required between the power unit and motor and between the power unit and operator's

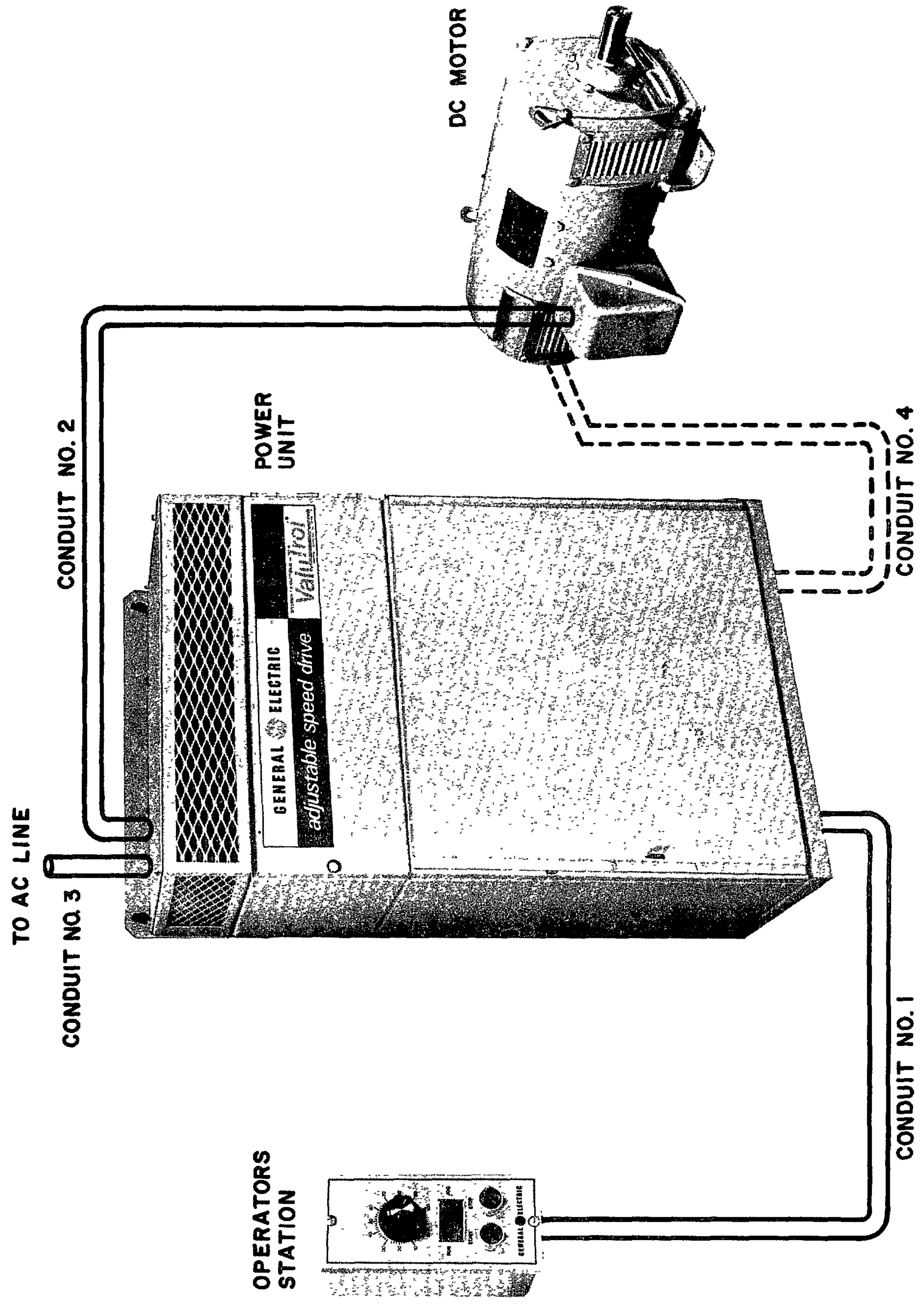


FIG. 12 INTERCONNECTIONS

TABLE IV INTERCONNECTION CHART

CONDUIT OR ROUTE NUMBER	DESCRIPTION	WIRE NO.	CONNECTION POINTS FROM POWER UNIT		CONNECTION POINTS TO	REMARKS
			ACM	MDM		
3	3 PHASE AC LINE SUPPLY	L1 L2 L3	FU1(L1) FU2(L2) FU3(L3)	CB(L1) CB(L2) CB(L3)	AC PHASE 1 AC PHASE 2 AC PHASE 3	REQUIRED PHASE SEQUENCE IS L1-L2-L3
			ACM	MDM		
2	ADJUSTABLE DC VOLTAGE OUTPUT	A1 A2	DA1 DA2	RA1 RA2	DC MOTOR A1 DC MOTOR A2	INSULATE ALL MOTOR CONNECTIONS WITH PVC TAPE.
	DC MOTOR SERIES FLD NORMALLY NOT USED. TAPE EACH TERMINAL IN MOTOR CON-DUIT BOX.	S1 S2			DC MOTOR S1 DC MOTOR S2	THE SERIES FLD MAY BE WIRED AT THE MOTOR CON–DUIT BOX FOR NON–REVERSING DRIVES ONLY BY CONNECT–ING S1 TO A2 AND BRING S2 BACK TO DA2 IN THE POWER UNIT.
	DC MOTOR THERMAL SW	4 P1	2TB(4) 1PB(1) (OPERATORS) STATION)		DC MOTOR P2 DC MOTOR P1	
			ACM	MDM		
	DC MOTOR SHUNT FIELD	F1 F2	ATB(F1) ATB(F2)	FTB(RF1) FTB(RF2)	DC MOTOR F1 DC MOTOR F2	
4	TACHOMETER (WHEN USED)	29 30	2TB(29) 2TB(30)		TACHOMETER FEEDBACK	+ IF DC TACH –IF DC TACH
1	OPERATION STATION		REFER TO FIG. 13A, AND FIG. 13B OPERATOR STATION INTERCONNECTION INFORMATION			

station as shown in Fig. 12. This illustration shows the conduit runs or routes required for these interconnections. Table IV shows the number of wires required for each conduit run as shown in Fig. 12. Wire sizes for interconnections should be selected in accordance with the ampere requirements shown on page 16 and in accordance with local and national electrical codes. Install conduit runs 1 thru 3 in accordance with this tabulation.

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 process instrument with grounded common, the drive common should not be connected to ground except through the process instrument.

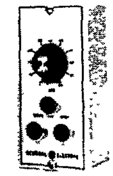
If the secondary of the isolation transformer (optional) must be grounded, it is recommended that high resistance grounding be used for grounding the transformer neutral. It is recommended that the power unit, operator's station and DC motor enclosures be grounded in accordance with NEC or local code requirements.

AC POWER CONNECTION

1. Make certain that the input voltage and frequency of the available power supply agree with the rating on the power unit nameplate located on the inside of the power unit enclosure. If an isolation transformer is to be used, refer to step 4.
2. Electrical codes generally require the use of a fused disconnecting switch or circuit breaker in the AC power line, ahead of the power unit and transformer (if used). This disconnecting device also provides a convenient method for removing field excitation from the DC motor when the drive is not in use, and allows complete removal of power for routine maintenance and inspection. The disconnecting switch and fuse (or circuit breaker) should be selected in accordance with the National Electrical Code and/or local code requirements based on the power input data on the Valutrol Drive nameplate. These data are sum-

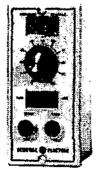
A. STANDARD STATION

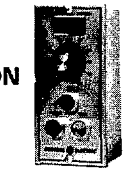
B. PUSHBUTTON JOG STATION



WIRE NO.	POWER UNIT	CONNECTION POINTS A. STANDARD STATION W. O. DB W. O. JOG	A. STANDARD STATION W. O. DB	A. STANDARD STATION W. DB	B. P.B. JOG STATION W. O. DB	B. P.B. JOG STATION W. DB
3	2TB(3)		1SW(5)	1SW(5)		
7	2TB(7)		1SW(2)	1SW(2)		
14	2TB(14)		1SW(4)	1SW(4)		
15	2TB(15)	2PB(3)	2PB(3)	2PB(3)	2PB(3)	2PB(3)
16	2TB(16)		1SW(1)	1SW(1)		
17	2TB(17)		1SW(6)	1SW(6)		
18	2TB(18)	1PB(2), 2PB(1)	1PB(2), 2PB(1)	1PB(2)	1PB(2), 2PB(1), 3TB(1)	1PB(2)
19	2TB(19)			2PB(1), 1SW(3)		2PB(1),3PB(1)
21	2TB(21)	TB(3)	TB(3)	TB(3)	TB(3)	TB(3)
26	2TB(26)	TB(1)	TB(1)	TB(1)	TB(1)	TB(1)
28	2TB(28)	TB(2)	TB(2)	TB(2)	TB(2)	TB(2)
P1	THSW(P1)	1PB(1)	1PB(1)	1PB(1)	1PB(1)	1PB(1)
13	2TB(13)				3PB(3)	3PB(3)
2TB JUMPERS		(3) to (14)	(25) to (26)	(25) to (26)	(3) to (14)	(3) to (14)
		(7) to (16)			(7) to (16)	(7) to (16)
CIRCUIT		FIG. 13E	FIG. 13E	FIG. 32	FIG. 13E	FIG. 32

FIG. 13A INTERCONNECTION OF OPERATOR'S STATION

C. STANDARD REVERSING STATION 

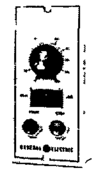
D. PUSHBUTTON JOG REVERSING STATION 

WIRE NO.	CONNECTION POINTS		
	POWER UNIT	REVERSING STATION	
		C. STANDARD	D. P.B. JOG
3	2TB(3)	1SW(5)	
7	2TB(7)	1SW(2)	
14	2TB(14)	1SW(4)	
15	2TB(15)	2PB(3)	2PB(3)
16	2TB(16)	1SW(1)	
17	2TB(17)	1SW(6)	
18	2TB(18)	1PB(2)	1PB(2)
19	2TB(19)	2PB(1), 1SW(3)	2PB(1), 3PB(1)
21	2TB(21)	TB(3)	TB(3)
26	2TB(26)	TB(1)	TB(1)
28	2TB(28)	TB(2)	TB(2)
P1	THSW(P1)	1PB(1)	1PB(1)
10	2TB (10)	2SW(2)	2SW(2)
13	2TB(13)		3PB(3)
41	4TB(1)	2SW(1)	2SW(1)
42	4TB(2)	2SW(6)*	2SW(6)*
43	4TB(3)	2SW(3)	2SW(3)
44	4TB(4)	2SW(4)*	2SW(4)*
45	4TB(5)	2SW(5)*	2SW(5)*
2TB JUMPERS		(25) to (26)	(7) to (16) (3) to (14)
CIRCUIT		FIG. 32	FIG. 32

*NOT REQUIRED WITH ARMATURE REVERSING.

FIG. 13B INTERCONNECTION OF OPERATOR'S STATION (REVERSING)

E. AUTO/MANUAL STATION



	CONNECTION POINTS			
		E. AUTO/MANUAL STATION		
WIRE NO.	POWER UNIT	PROCESS CONTROLLER	VOLTAGE FOLLOWER	MAN. OVERRIDE
15	2TB(15)	2PB(3)	2PB(3)	2PB(3)
18	2TB(18)	1PB(2)	1PB(2)	1PB(2)
19	2TB(19)	2PB(1)	1PB(1)	2PB(1)
P1	THSW(1)	1PB(1)	1PB(1)	1PB(1)
MR1	PCF(MR1)	TB(3)		
21	2TB(21)		2TB(3)	1SW(1), (4)
26	2TB(26)	TB(1)	TB(1)	TB(1)
28	2TB(28)	1SW(2), (5)	1SW(2), (5)	TB(2)
ASR	PCF(ASR)	1SW(3), (6)		
		TB(2), 1SW(1) (4)	TB(2), 1SW(1) (4)	TB(3), 1SW(2) (4)
PCP	PCF(PCP)	EXT		
PSW	PCF(PSW)	EXT		
27	2TB(27)		EXT	EXT
	EXT		1SW(3) (6)	1SW(3) (6)
2TB JUMPERS		(3) to (14) (7) to (16)	(3) to (14) (7) to (16)	(3) to (14) (7) to (16)
CIRCUIT		FIG. 34	FIG. 36	FIG. 36

EXT – EXTERNAL SIGNAL SOURCE OR SERIES RESISTOR. IF DYNAMIC BRAKING IS NOT USED JUMPER 2TB(18) TO 2TB(19).

FIG. 13C INTERCONNECTION OF OPERATOR'S STATION

F. REMOTE CURRENT LIMIT ADJUST STATION

WIRE NO.	CONNECTION POINTS	
	FROM POWER UNIT	TO OPERATOR'S STATION
20	2TB(20)	TB(4)
27	2TB(27)	TB(1)
24	2TB(24)	TB(2)

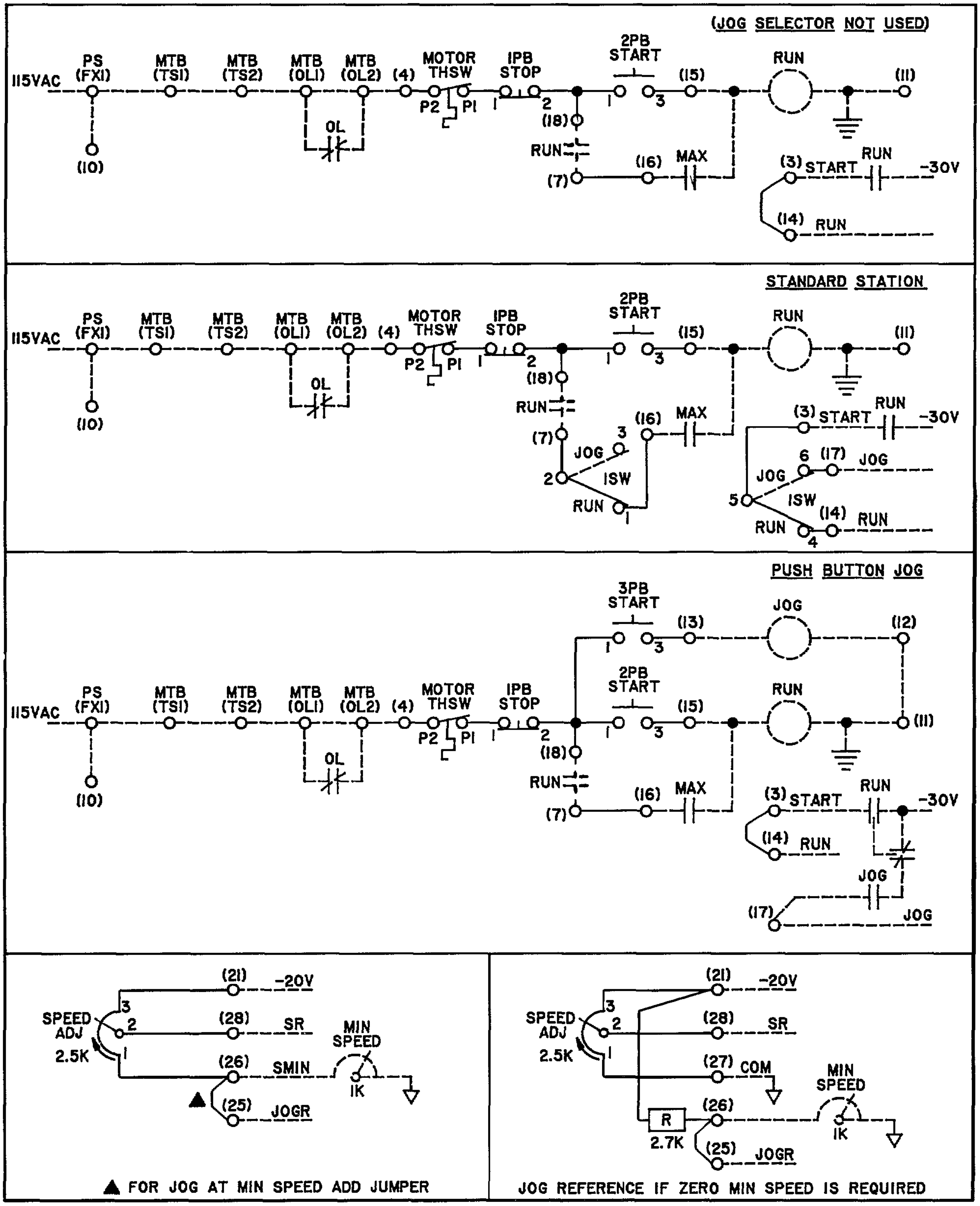
G. SPEED INDICATOR

WIRE NO.	CONNECTION POINTS	
	FROM POWER UNIT	TO OPERATOR'S STATION
23	2TB(23)	INST (1)
27	2TB(27)	INST (2)

H. LOAD INDICATOR

WIRE NO.	CONNECTION POINTS	
	FROM POWER UNIT	TO OPERATOR'S STATION
22	2TB(22)	INST (–)
27	2TB(27)	INST (+)

FIG. 13D INTERCONNECTION OF OPERATOR'S STATION



TERMINAL BOARD POINTS ( ) ARE ALL ON 2TB.

---------- INTERNAL WIRING

FIG.13E CONTROL CIRCUITS WITHOUT DYNAMIC BRAKING OR REVERSING

marized on page 16 to aid in the selection of disconnecting devices, fuses and wire sizes. The circuit breakeroption provides disconnect of all power to the power unit, motor and operator's station.

3. AC power connections from any external disconnecting device to the power unit may now be made in accordance with conduit run 3 as shown in Table IV.
4. If the available power supply is other than that shown on the power unit data nameplate it will be necessary to use a line transformer between the disconnecting device and the power unit. This transformer will be separately mounted by the purchaser. The appendix provides complete information on isolation transformers for use with Valutrol Drives, including required KVA catalog numbers, weights and dimensions.

FINAL CHECK

After all electrical connections have been made, complete the installation as follows:

1. Recheck all connections using the interconnection chart Table IV. Recheck the transformer connections (if used) and connections to the disconnecting device (if used).
2. Re-assemble the operator' station. Carefully dress the interconnecting wire into the back of the station so that the device assembly may be installed. Keep the wires away from sharp edges and do not force the device assembly into place. Replace the station cover.
3. Recheck the motor connections, carefully tape and insert them in the conduit box. Replace the conduit box cover.
4. Install protective fuses in the AC disconnect (if used).

START UP

Every Valutrol DC SCR drive has been factory tested and 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 –20 volts with the external speed adjust potentiometer turned fully clockwise. Return the potentiometer to zero (fully CCW).
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 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 a positive speed feedback signal appears on the SFB test point, located on the bottom of the main control card (MCC) on the left hand side. Check motor rotation. Check tachometer polarity. With a DC tachometer TKP (2TB-29) is positive for forward rotation. 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 (or RF1) and F2 (or RF2) on ATB terminal board.**
6. If no diagnostic card is available set the external speed reference potentiometer to zero (full CCW) and press the START pushbutton. The MA contactor should pick up. Slowly turn the speed reference CW until the motor starts to rotate. Check motor rotation. If incorrect, remove power and interchange the motor field leads F1 and F2 (or RF1 and RF2) on ATB terminal board
7. Run the drive from the external speed reference up to top speed. Adjust MAX SPEED as may be required.
8. **Close and secure the front door of the power unit.**

SEQUENCE OF OPERATION

POWER APPLIED

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

The power supply card (PSC) is energized and the DC outputs (±20 volts) are applied through their fuses to the rest of the cards. All readings carry a tolerance of ±10% when read on the built in instrument.

The motor field supply is energized. Refer to the motor field supply instructions for details.

TABLE V FAULT CONDITIONS

A fault has occured if the READY TO RUN light is off. The conditions that can initiate a fault are as follows:

	1.	No three phase power to the Fuses (or optional Circuit Breaker)
	2.	Circuit breaker is open, or AC power fuse blown.
	3.	Control fuse is open.
	4.	Power supply plus or minus DC fuse is open.
	5.	Loss of an incoming phase.
	6.	Incorrect phase rotation.
**	7.	Instantaneous overcurrent (IOC) level exceeded.
	8.	Timed over current (TOC) – electronic.
**	9.	Loss of motor field.
	10.	External Fault Stop momentarily released from Common.
*	11.	Other special functions to System Trip (SYS) or External Fault Stop inputs.
	12.	System Trip input (SYS) momentarily connected to +10 volts.
	13.	RESET button held depressed or RSET input held connected to Common.
	14.	Diagnostic mode selected with the motor rotating.
	15.	Oscillator failed "on".
*	16.	Tachometer fault (loss of tachometer signal), DC output open, or incorrect <u>ALIGN</u> adjustment.
**	17.	Overspeed

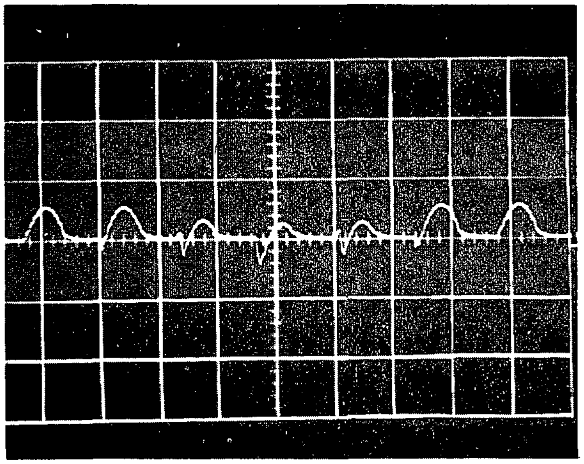
* May not be provided. Refer to instructions on Motor Field Supply and System elementary diagram.
** Can be caused by <u>LOC REF</u> and <u>CUR LIM</u> settings in Static Diagnostic mode.

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.

WAVEFORMS

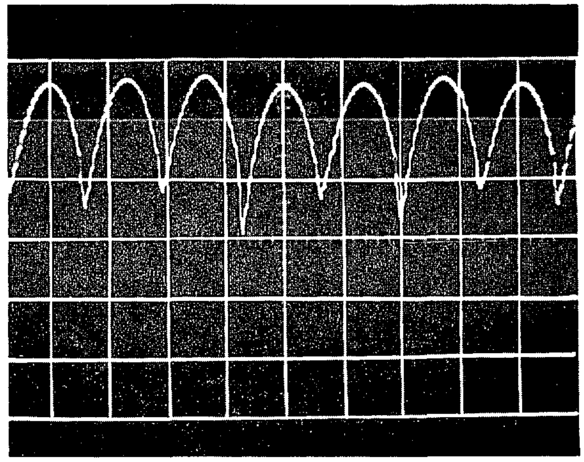
All illustrations were photographed zero volts on center line at 2 msec per division



2 msec/div

At low current level (1 volt/division)

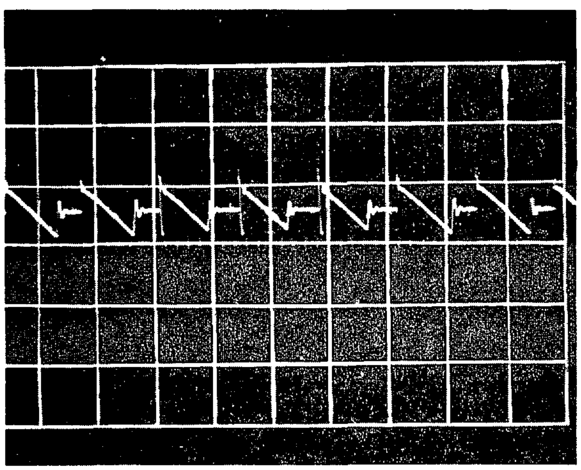
Figure 14. Current Feedback (CFB) (Inverted)



2 msec/div

At Continuous current (1 volt/division)

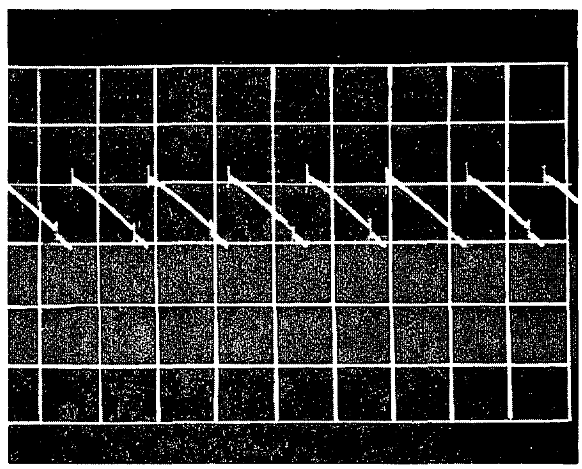
Figure 15. Current Feedback (CFB) (Inverted)



2 msec/div

At low current and 50% output (5 volts/division)

Figure 16. Voltage Feedback (VFB) (Inverted)



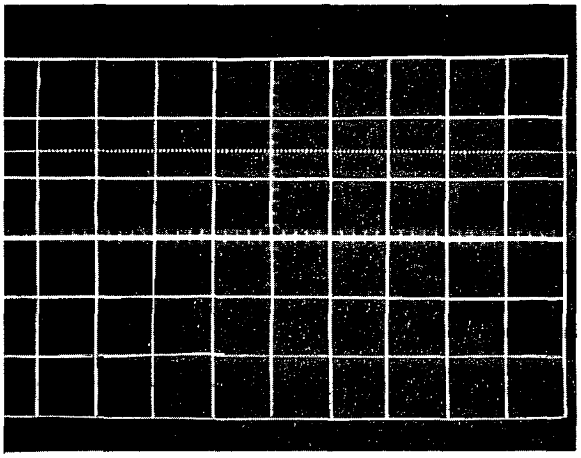
2 msec/div

At continuous current and 50% output volts) (5 volts/division)

Figure 17. Voltage Feedback (VFB) (Inverted)

WAVEFORMS

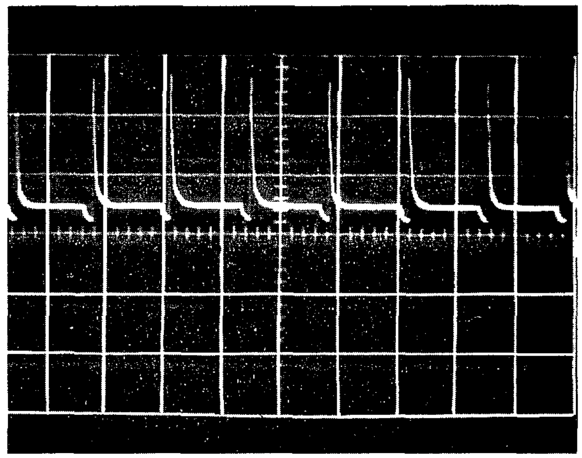
All illustrations were photographed zero volts on center line at 2 msec per division



2 msec/div

(10 volts/division)

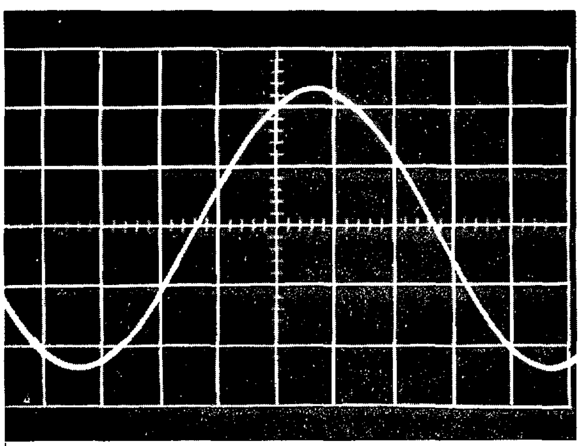
Figure 18. Oscillator (OSC)



2 msec/div

At 50% output voltage (5% volts/division)

Figure 19. Initial Pulse (IPU)



2 msec/div

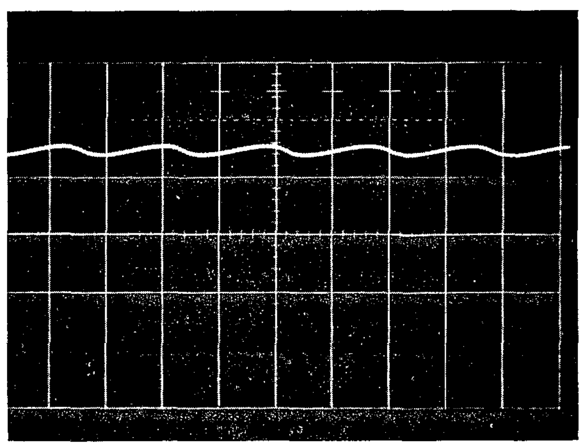
Typical of SA, SB & SC

SB lags SA by 120°

SC lags SB by 120°

(5 volts/division)

Figure 20. Synchronizing Signal (SA)



2 msec/div

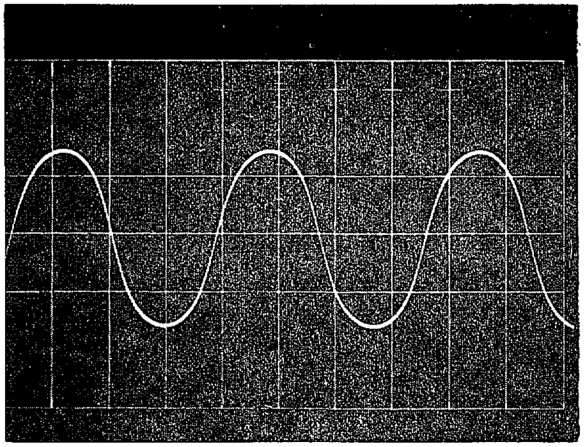
With an AC tachometer at 450 RPM

(1 volt/division)

Figure 21. Speed Feedback (SFB)

WAVEFORMS

All illustrations were photographed zero volts on center line at 2 msec per division

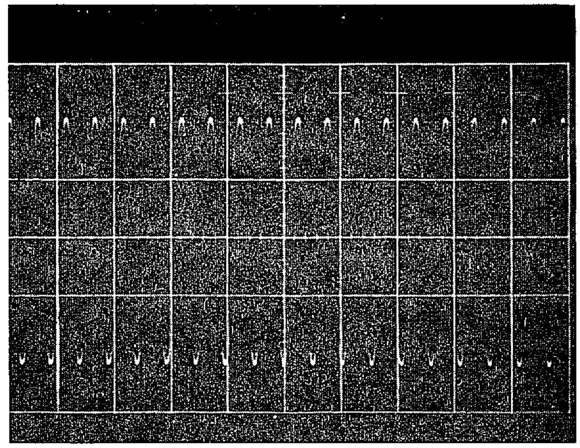


2 msec/div

With an AC Tachometer at 450 RPM

(1 volt/division)

Figure 22. Tachometer Feedback (TFB)

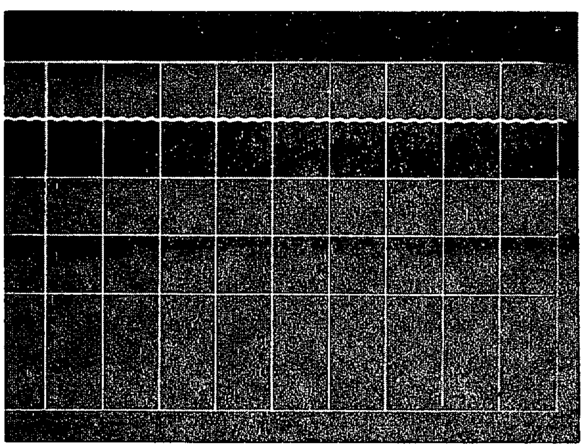


2 msec/div

With an AC Tachometer at 3160 RPM

(5 volts/division)

Figure 23. Tachometer Feedback (TFB)

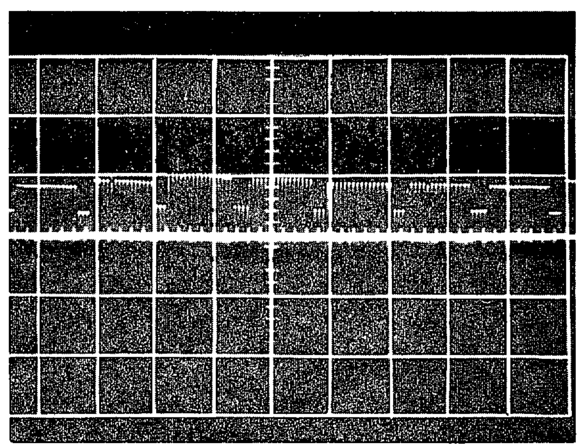


2 msec/div

With an AC Tachometer at 3160 RPM

(5 volts/division)

Figure 24. Speed Feedback (SFB)



2 msec/div

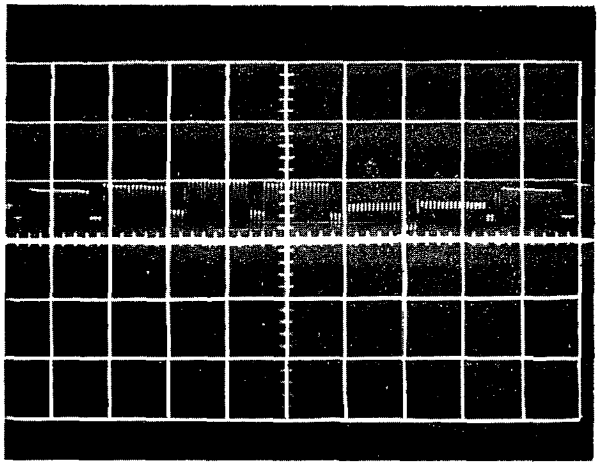
Normal at 20% output volts.

(0.5 volts/division)

Figure 25. Pulse Output (PO)

WAVEFORMS

All illustrations were photographed zero volts on center line at 2 msec per division

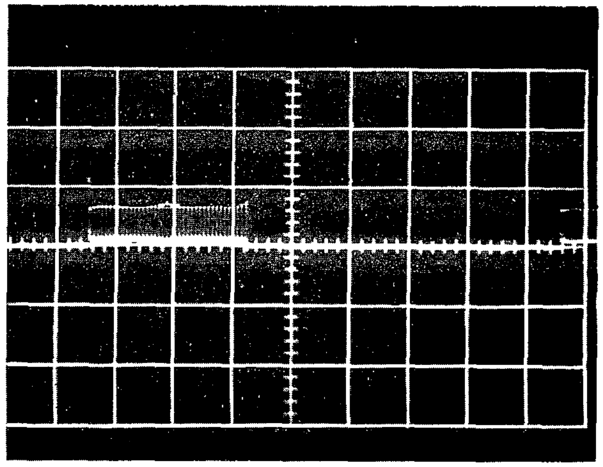


2 msec/div.

With one SCR gate lead open, 50% output volts.

(0.5 volts/division)

Figure 26. Pulse Output (PO)



2 msec/div

Gate to Cathode Firing Signal 1G-1C, with 50% output voltage continuous current. Typical of all six signals.

(5 volts/division)

FIG. 27

Gate to Cathode Firing Signal (1G–1C)

NOTE

IF THE MOTOR FIELD REVERSING OPTION IS PROVIDED, THE MOTOR FIELD WILL NOT BE ENERGIZED UNTIL THE DRIVE IS STARTED.

IF NO FAULTS HAVE BEEN DETECTED BY THE MONITOR SECTION OF THE INTERFACE CARD (IFC) THE "READY TO RUN" INDICATOR ON THE MAIN CONTROL CARD WILL ILLUMINATE. TABLE V TABULATES THE FAULT CONDITIONS WHICH ARE MONITORED.

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

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

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

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

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

START

The RUN relay will pick up when the start pushbutton is pushed.

SWITCH LOGIC

The RUN (or JOG) input point on the main control card (MCC) will be switched from +30 volts to –30 volts.

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

SIGNAL FLOW

If the 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 0.3 to 60 seconds with the LIN TIME adjustment. See jumper table for the MCC card. (Ranges 0.3 to 6 sec. or 2 to 60 sec.)

The external tachometer signal (if used) or the internal CEMF signal must be selected by two (2) jumpers on the interface card (IFC) to provide a speed feedback signal (TFB) to the speed feedback section on the main control card (MCC) where the signal is rectified (if required). 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 the desired top speed. (See Fig. 21 and 24)

The timed reference TR, or the JOG reference, JOGR, and the speed feedback, SFB are summed by the regulator error amplifier. The error amplifier output EAO will be at low voltage (nearly zero) when the drive is regulating speed. EAO will not be low when the drive speed is changing. The gain of the error amplifier is set with the GAIN adjustment. The GAIN 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) card.

To maintain good speed regulation the error amplifier output (EAO) is fed into the 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 the MFC card is used, the response is desensitized when the drive is operating in the weak field mode (constant horsepower). DO NOT ADJUST RESPONSE DURING THIS MODE OF OPERATION.

To protect the system a current limit section is provided. The limit section output, CLF, drives the regulator integrator and will override the error amplifier. The current limit is set with the CUR LIMIT adjustment. Typically current limit is set at 150% of the motor nameplate or 3.75 volts current feedback, CFB.

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

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

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

Two driver monitor points are available, PCR and PO. PCR is the phase control reference which causes the output pulse trains to phase shift in time with respect to the AC line. As the driver error voltage, DE, changes from zero to −12 volts, the phase control reference, PCR, changes from −4 volts to +4 volts and the output pulses will shift from full off to full on. PO is used to monitor the pulse outputs to the SCR's. The PO signal will vary as speed is increased, but the shape and amplitude should repeat every 60° (2.8 msec) See Fig. 25 and 26.

STOP

There are two stop sequences; normal stop and fault stop.

In either case preconditioning will be applied to phase back and lock out the SCR firing pulses such that the load current is reduced to zero prior to opening the MA contactor.

The motor will coast to a stop or stop by dynamic braking if the DB option is provided.

If the motor stops by dynamic braking, the drive cannot be restarted until the motor speed has decreased to a low speed level at which time the anti-plugging relay, APR, drops out.

DIAGNOSTIC STATIC (SWITCH TO LEFT)

LOGIC

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

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

The local reference LOC REF potentiometer is connected into the input of the linear time section and into the speed feedback section. The local reference is also connected to the field diagnostic reference FDR. Refer to motor field control (MFC) 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 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 applied to the input of the last stage of the speed feedback section. The output SFB will be equal to LR in magnitude but opposite in polarity. The tachometer scaling circuit and its output TFB are unaffected by the local reference and will remain at zero. As the signal from SFB into the regulator amplifier is inhibited, the primary purpose of exercising SFB is to check the SFB functions of the MFC card (if used).

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

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

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

The gain of the drive is reduced so that the driver error (DE) is equal to the magnitude of the driver reference (DR) as long as the current reference is set to zero.

With an osilloscope, the initial pulse output (IPU) and the pulse output (PO) may be monitored to verify proper operation. See Figs. 19, 25 and 26.

DIAGNOSTIC RUN (SWITCH TO THE RIGHT)

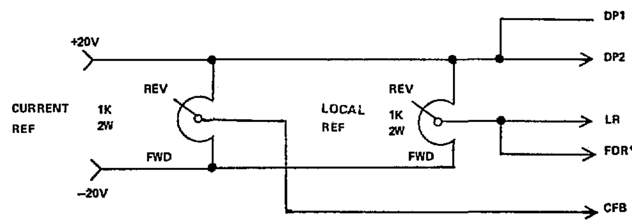
In diagnostic run, the local reference LR and the diagnostic switch are substituted for the SR reference and the RUN switch input just as in diagnostic static. The drive then runs normally with one important exception: system feedback is normal but the signal from system feedback to the regulator error 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 regulated drive from the LOC REF potentio– meter.

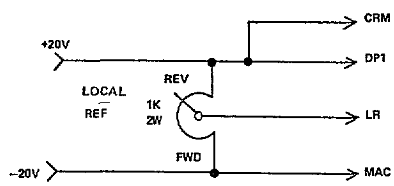
CALIBRATION PROCEDURE

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 Fig. 28 may be used.

To avoid confusion and possible interaction, the adjustments should be made in the following sequence. Two sequences are listed, (1) when a motor field exciter (MFE) is provided and (2) when a motor field control (MFC) is furnished.



DIAGNOSTIC STATIC



DIAGNOSTIC RUN

Make all connections and set the potentiometers to center (zero) position prior to applying input power. To exit from the DIAGNOSTIC RUN mode, turn the SPEED REF potentiometer to center. Then remove input power after the motor has stopped.

*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.

Figure 28. Diagnostic Test Circuits

All of the high voltage inputs to the controller have been scaled down with the scale factors shown on the test data sheet (located on the inside door of the power unit).

For Example:

For 460VAC/550VDC drives
VFB = 5.62r@550VDC (Armature Volts)
For 230VAC/240VDC drives
VFB = 5.56r@240VDC (Armature Volts)

CALIBRATION WITH MOTOR FIELD CONTROL (MFC)

Refer to motor field control instructions GEK-24971 for details of operation.

All readings have a tolerance of ±10% when read on the test instrument.

Select DIAGNOSTIC STATIC and set the CUR REF and LOC REF to the center positions.

FMAX (maximum field)

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

TABLE II

Recalibrating Adjustment Sequences

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

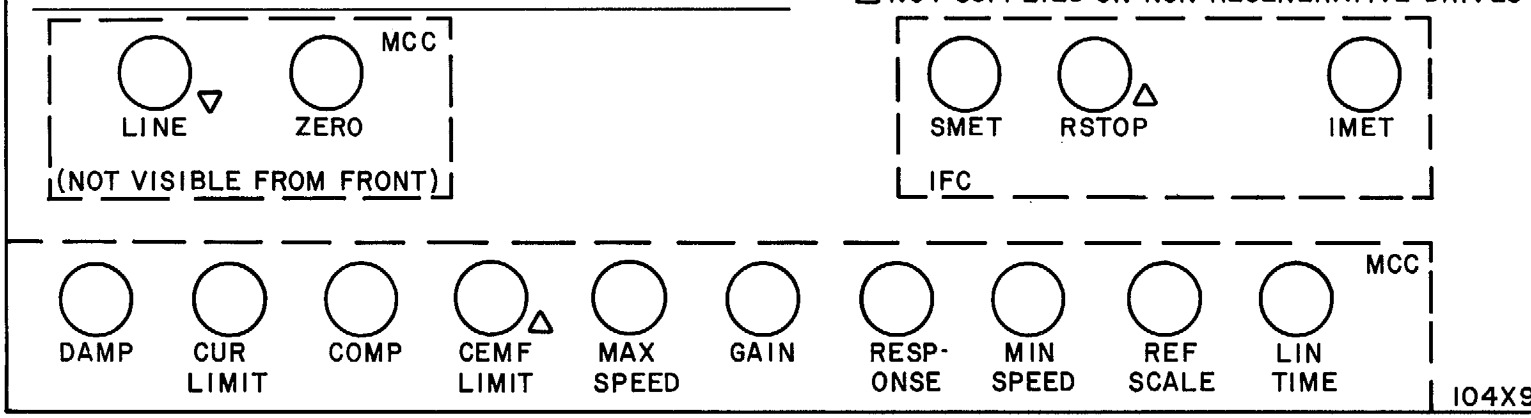
*Some drives may be provided with a motor field control card (MFC) and not have any constant HP range. On such drives set CROSS full CW and FMIN per Test Data Sheet or at 80% of rated field current.

Drives with a motor field exciter (MFE) do not have CROSS, FMIN, SLIM and ALIGN adjustments.

NOTE: A MOTOR FIELD CONTROL CARD (MFC) MAY BE FURNISHED ON BASE SPEED DRIVES (CONSTANT FIELD) TO PROVIDE FIELD ECONOMY, TACHOMETER MONITOR OR FIELD CURRENT REGULATION FUNCTIONS.

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

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



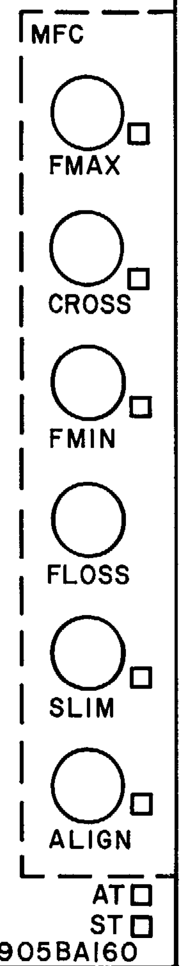


Figure 28A. Typical Test Data Sheet

FMIN (minimum field – limit)

Set LOC REF potentiometer for –6 volts at LR. Adjust FMIN until FC corresponds to minimum field FC on the test data sheet.

COMP (compensation – IR)

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

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

On a speed regulated drive, COMP may be retrimmed for stabilizing the drive when operating above base speed.

On a voltage (CEMF) regulated drive, COMP should be set for zero speed regulation at a specific speed (typically 50%) when the load changes from minimum to maximum. If the speed decreases with increasing load the COMP potentiometer should be turned further clockwise. Always re-check the MAX SPEED adjustment after making a COMP adjustment.

CUR LIMIT (current limit)

Set LOC REF for 10 volts at DR. 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 starts to decrease.

IMET (load instrument calibration)

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

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. Normally set at 75% of the FMIN setting.

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. Normally set with 11.5 volts (115%) at SFB.

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 –10 volts with the LOC REF potentiometer. Flip the diagnostic switch to NORMAL, then back to STATIC and measure the time for TR to ramp from 0 to –10 volts. Adjust LIN TIME as required.

Set the LOC REF to the center position; reset the drive and switch to DIAGNOSTIC RUN to operate the drive as a voltage regulator.

MAX SPEED/ALIGN (max speed/tachometer loss align)

Turn MAX SPEED full CCW. 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, switch to NORMAL 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 the 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.

MIN SPEED (minimum speed)

Reduce the system reference to zero and start the drive. Adjust MIN SPEED, as required, to meet system mimimum speed requirements.

GAIN, RESPONSE, DAMP (stability adjustments)

The GAIN adjustments affects the stability over the entire speed range. This potentiometer will normally be set between 9 and 12 o'clock.

The RESPONSE adjustment affects stability in the constant torque region (below base speed). Adjustments should not be made when operating above base speed. The potentiometer will normally be set between 10 and 1 o'clock.

The DAMP adjustment primarily affects the region around cross over between the constant torque and constant horsepower regions. Normally damping is not required and the potentiometer is set fully counter clockwise (7 o'clock).

CALIBRATION WITH MOTOR FIELD EXCITER (MFE)

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

SELECT DIAGNOSTIC STATIC and set CUR REF and LOC REF to the center positions.

FLOSS (field loss – fault)

Adjust FLOSS full CCW and reset the drive.

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. Normally set at 50% of rated motor field current.

COMP (compensation – IR)

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

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

On a voltage (CEMF) regulated drive, COMP should be set for zero speed regulation at a specific speed (typically 50%) when the load changes from minimum to maximum. If the speed decreases with increasing load the COMP adjustment should be turned further clockwise. Always recheck the MAX SPEED potentiometer after making a COMP adjustment.

CUR LIMIT (current limit)

Set the LOC REF for 10 volts at DR. 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 starts to decrease.

IMET (load instrument calibration)

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

LIN TIME (linear time)

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

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%).

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, switch to NORMAL to initiate a shut down. Remove power, adjust SMET and repeat.

Return the DIAGNOSTIC SWITCH TO NORMAL.

REF SCALE (reference scale)

Turn the REF SCALE potentiometer 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 zero and start the drive. Adjust MIN SPEED as required to meet system minimum speed requirements.

GAIN, RESPONSE, DAMP (stability adjustments)

The GAIN potentiometer is normally set fully counter clockwise (7 o'clock).

The RESPONSE potentiometer is adjusted for stable operation normally in the range of 10 to 1 o'clock.

Normally damping is not required and therefore DAMP should be set fully counter clockwise (7 o'clock).

MODIFICATIONS AND OPTIONS

The modification module, MDM, mounted on top of the basic power unit is required for any of the following modifications.

Dynamic braking
Reversing with dynamic braking
AC line circuit breaker
Blower motor control

Other modifications and/or options are available as Kits which may either be factory assembled and wired or installed in the main controller by the user. The modification Kits are provided with mounting hardware and cut to length wire harness with marked terminals when required, for easy installation. The power unit modification Kits are:

Diagnostic panel
Test instrument and probe
Process Control follower (with independent jog reference)
Jog by pushbutton (with independent jog reference)
Timed overcurrent protection

Modifications and/or options that affect devices and wiring external to the power unit include:

Auto/Manual operation
Remote current limit
Speed indicator
Load indicator
Tachometer (for improved speed regulation)

DYNAMIC BRAKING

The dynamic braking resistor(s) are mounted on the back panel in the MDM, (modification module) and selected to produce a dynamic braking current of 125 to 150% of rated armature current at rated armature voltage.

The dynamic braking resistor(s) will be connected across the motor armature by closing in the DB contactor which, depending on horsepower, may have one, two, or three contactor poles.

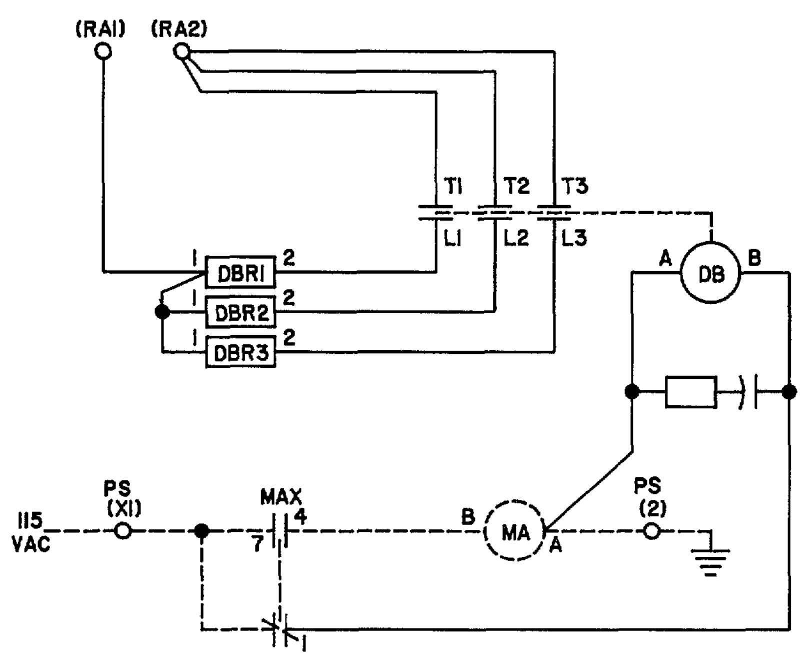


FIG.29 DYNAMIC BRAKING RESISTOR CONNECTIONS

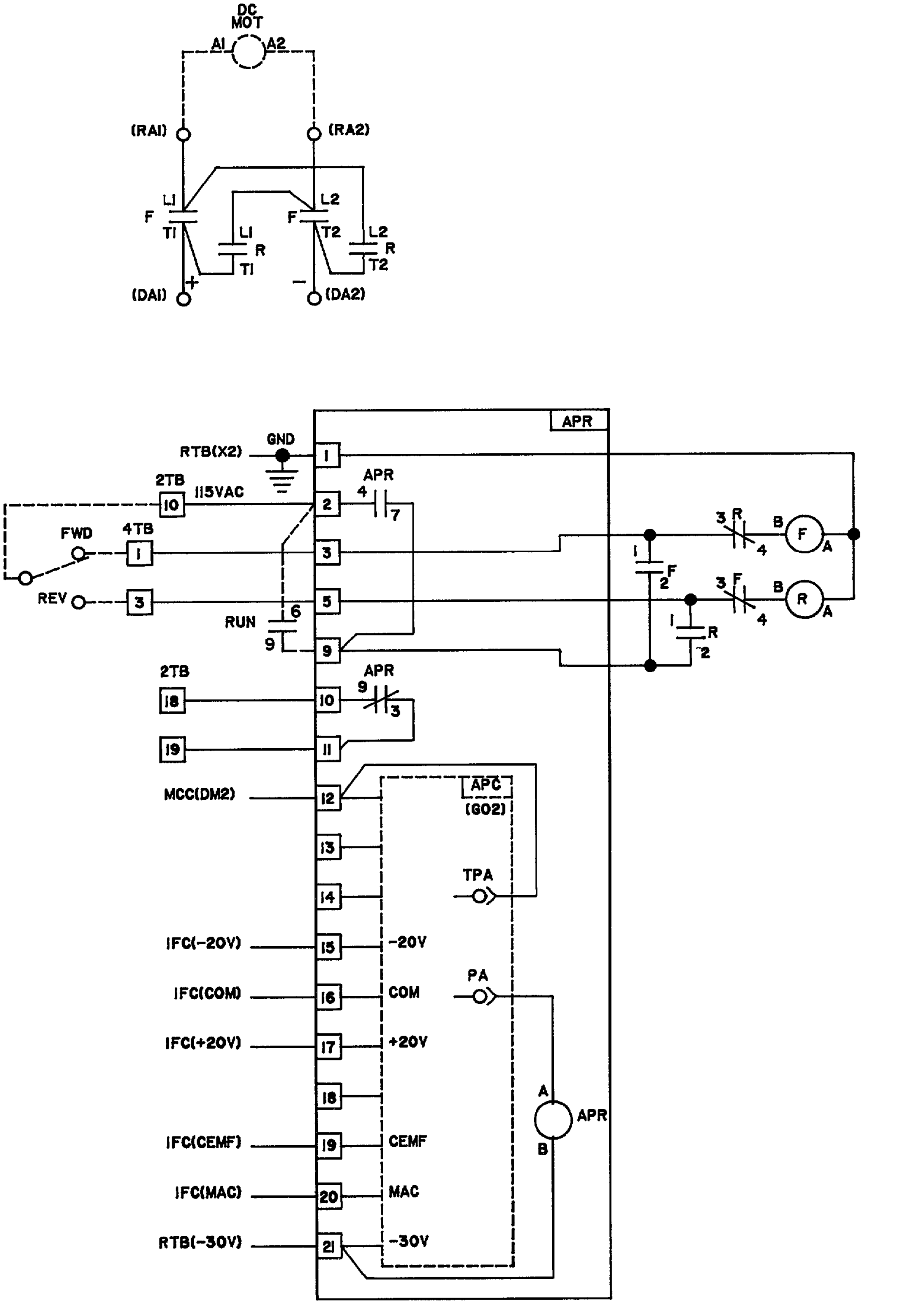


FIGURE 30. ARMATURE REVERSING

A normally closed interlock on the MAX relay is used to energize the DB contactor in order to initiate the dynamic braking function.

On all drives with dynamic braking a NC (normally closed) interlock on the APR (anti plug) relay is used to prevent restarting until the motor speed is reduced to a low level. This is a protective feature to avoid damaging the DB contactor poles by repeated interruption of high levels of dynamic braking current.

Refer to the armature reversing section for the operation and wiring of the APR relay panel.

REVERSING

Reversing is only available with dynamic braking. If a coast stop is more desirable, the wiring to the DB resistor(s) or the DB contactor coil may be disconnected.

Reversing is performed either by armature reversing contactors or by field reversing contactors:

Armature Reversing	5 to 30 HP at 240V DC 5 to 60 HP at 550V DC
Field Reversing	40 to 100 HP at 240V DC 75 to 250 HP at 550V DC

Field reversing is performed by using an MFC card instead of the MFE card such that the field current can be reduced to a low level prior to operating the field reversing contactors.

ARMATURE REVERSING

The armature reversing circuitry is wired as indicated in Fig. 30. The FOR/REV selector switch is wired from the operator's station to 2TB(10), 4TB(1) and 4TB(3) as shown. The anti-plugging relay (APR) picks up when the drive is started to latch in the selected forward (F) or reverse (R) contactor. If the For-Rev selector switch is operated the contactors will not reverse until the STOP button is operated and the motor speed is reduced to a low level at which time the APR relay drops out.

The APR relay is controlled by a printed circuit card (APC) mounted on the APR panel terminal board. When the START pushbutton is depressed the MAC signal switches from zero to –20V to normally pick up the MAX relay, but is now also used to pick up the APR relay. As the motor speed is increased the CEMF signal goes from

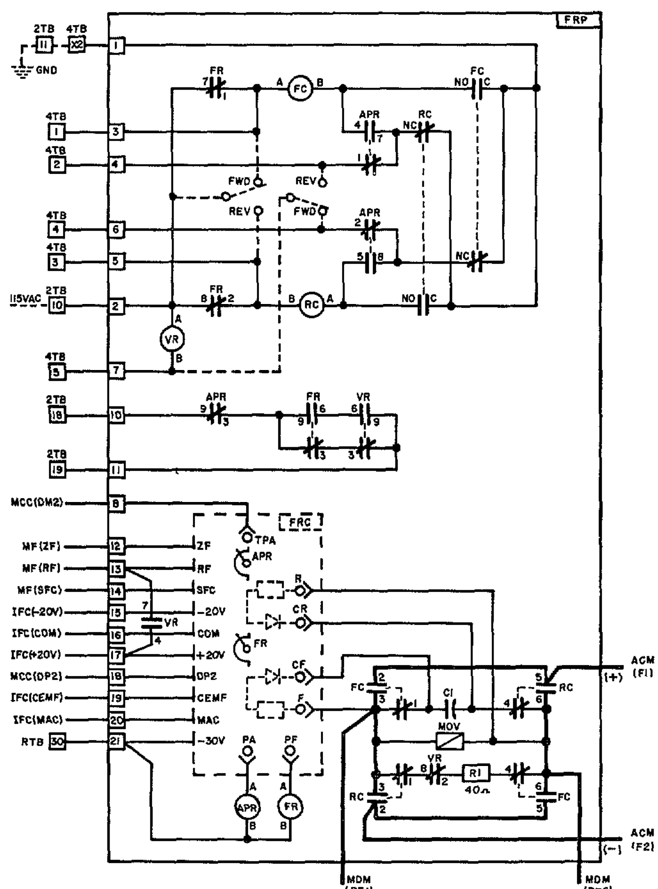


Figure 31. Field Reversing Panel

zero to approximately –5 volts at rated armature voltage to latch in APR relay. With MAC returned to zero (STOP) APR will drop out as the CEMF voltage is reduced to a level corresponding to approximately 10% of rated armature voltage. The drop out level is adjustable by the APR potentiometer on the APC card from 8% to 40%. Normally the APR potentiometer should be set fully CCW for an 8% drop out level.

NOTE

DO NOT SET THE APR POTENTIOMETER PAST MID-POSITION.

FIELD REVERSING

The field reversing circuitry is shown in Fig. 31 and Fig. 32. The FOR/REV selector switch is wired from the operators station to 2TB(10) and 4TB(1) through 4TB(5) as illustrated.

Field excitation is applied when START (or JOG) is initiated. At this time the APR relay picks up, making the selected forward, FC, or reverse, RC, contactor pick up. At the same time the VR relay drops out to disconnect the RF point from +20 volts, which makes the field current go to the level set by the FMAX potentiometer on the MFC card. As field current is applied, the FR relay drops out to latch in the selected contactor.

If the STOP button is depressed, the motor will stop by dynamic braking. The APR relay drops out at a low motor speed as the CEMF signal drops below a preset level.

NOTE:

REFER TO THE ARMATURE REVERSING SECTION FOR A DESCRIPTION OF THE APR RELAY OPERATION.

At this time the MFC card is programmed into its FIELD ECONOMY mode; i.e. the field current is reduced to about 70% of normal while the motor is at standstill.

Now if the FOR/REV selector switch is operated, the VR relay picks up; +20V is applied to RF and the field is programmed off. The voltage at SFC is proportional to field current and when a low level is reached the FR relay picks up and the field contactor drops out.

As the contacts open the stored energy in the field inductance causes arcing between the contact tips for a few milliseconds until a pre-charged capacitor C1, is applied across the output terminals. The capacitor will shunt the current away from the contact tips to extinguish the arcing almost instantly. The field current will quickly reverse the capacitor charge, but the voltage will be clipped by the metal oxide varistor MOV, which now quickly dissipates the remaining inductive field energy.

The level at which the FR relay picks up to initiate switching is adjustable by the FR potentiometer on the FRC card. Generally the potentiometer is turned fully CCW for a minimum switching level.

The circuitry is arranged to permit a direct speed reversal without a distinct stop. With the motor running at preset speed, operate the FOR/REV selector switch. Then momentarily depress the STOP pushbutton to initiate dynamic braking and immediately push and hold the START button until motor accelerates in the opposite direction. In this operating mode the reversing time may be reduced by increasing the level at which the APR and FR relays operate. By turning the APR potentiometer CW the APR relay will drop out at a higher speed to initiate field turn off earlier in the dynamic braking (DB) cycle. By turning the FR potentiometer CW the contactor switching will be initiated at a higher level of field current. As the field is reversed while the motor is still rotating the motor terminal voltage (CEMF) reverses and when the MA contactor picks up and output power is reapplied the motor will regenerate to zero speed and continue accelerating to the preset speed in the opposite direction. If any appreciable arcing occurs during the switching of the field contactor, the FR potentiometers must be turned CCW.

NOTE

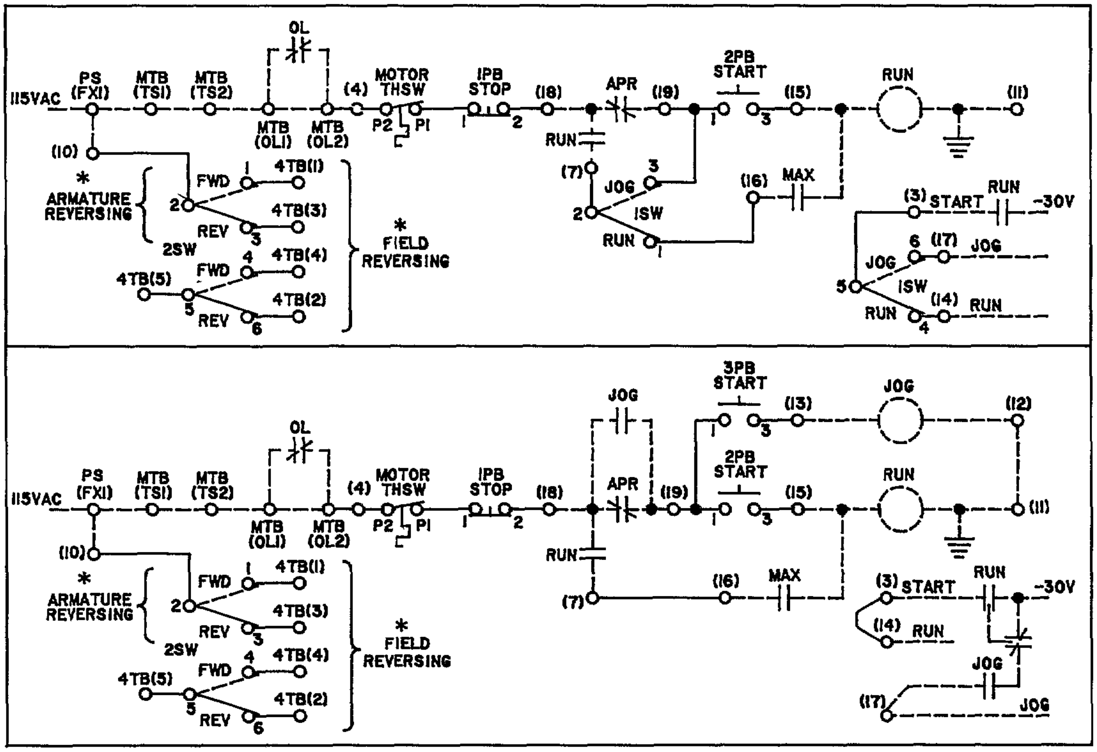
IF THE START PUSHBUTTON IS NOT OPERATED IN THE ABOVE SEQUENCE THE STOPPING TIME WILL INCREASE SINCE DYNAMIC BRAKING TORQUE IS LOST AS THE FIELD CURRENT IS PROGRAMMED TO ZERO.

Fig. 31 shows a wire connection from FRC (TPA) to FRP(8) to MCC (DM2). Normally a jumper on the main control card (MCC) connects MCC (FEA) to MCC (DM2) in order to delay FIELD ECONOMY until dynamic braking is completed. By removing the (FEA)-(DM2) jumper the dynamic braking torque will be reduced to produce a "softer" deceleration.

AC LINE CIRCUIT BREAKER/SWITCH

The molded case switch (or circuit breaker) provides a manual AC line disconnect with provision for padlocking of the external operating handle.

For 40HP and less at 230V and 100HP and less at 460V, a circuit breaker with a magnetic trip mechanism is provided. For higher horsepower ratings a molded case switch without any trip mechanism is used.



*-IF USED ( ) 2TB POINT UNLESS MARKED OTHERWISE

FIG.32 CONTROL CIRCUITS WITH DYNAMIC BRAKING AND/OR REVERSING

BLOWER MOTOR CONTROL

The blower motor control consists of a thermal overload relay with three heating elements and three fuses for protection of the blower motor for the DC motor. The blower motor is controlled through the main AC contactor, MA, and thus starts and stops with the DC drive motor.

The three wires from the blower motor connect to the overload relay except for 40 HP, 240VDC and 75/100 HP, 550VDC where connections are made to the fuse block. The overload relay interlock (OL) is wired to MTB (OL1) and MTB (OL2) and is normally wired in series with the stop circuit.

DIAGNOSTIC PANEL

The diagnostic panel greatly simplifies check out and trouble shooting of a drive system. In particular when the system uses the motor field control card (MFC) for operation above base speed it is highly recommended.

The check out procedure using the diagnostic panel is described on page 36, in the Calibration Procedure in this instruction book.

NOTE:

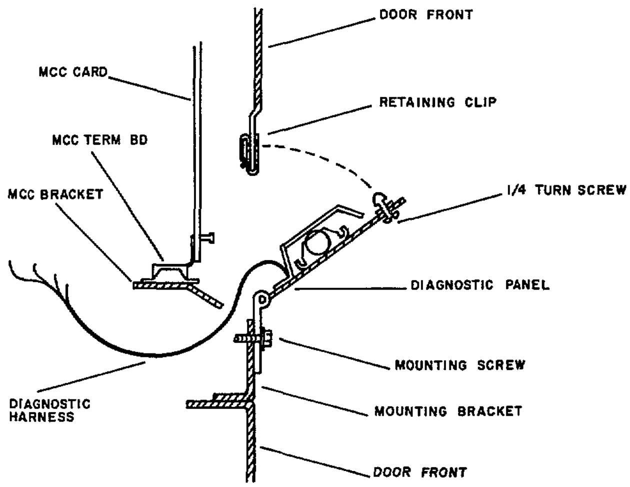
AFTER MAKING A DIAGNOSTIC CHECK ALWAYS RETURN THE SELECTOR SWITCH TO NORMAL AND THE REFERENCE POTENTIOMETERS TO THEIR CENTER POSITIONS.

CAUTION

IF THE DIAGNOSTIC SWITCH IS SET TO DIAG RUN AND THE DIAGNOSTIC LOC REF POTENTIOMETER IS TURNED TO FWD, THE DRIVE WILL START RUNNING WHEN THE AC POWER IS APPLIED.

In case the diagnostic panel is not available a diagnostic test can still be made by wiring up either a Diagnostic Static or Diagnostic Run circuit as shown in Fig. 28. In all cases observe the caution statement above.

Following the mounting procedures when installing the panel. See Fig. 33.



MOUNTING INSTRUCTIONS

1. Remove the retaining clip from the diagnostic panel and attach it over the hole in the offset door flange.
2. Mount the panel loosely to the mounting bracket using the two flat washers and self tapping screws.
3. Align the panel and fasten the 1/4 turn screw to the retaining clip.
4. Tighten the mounting screws.
5. Pass the diagnostic harness underneath the main control card (MCC) bracket and connect the labeled wires to the corresponding MCC terminal board points DP1, DP2, MAC, LR and the RTB terminal board points RSET, COM, +20V, –20V, FDR, CRM and CFB.

Figure 33. Diagnostic Panel

TEST INSTRUMENT

The instrument with its probe is used to measure any of the DC signals on the test row along the front (bottom) of the main control card (MCC). Used with the diagnostic panel, the instrument provides a convenient way of recalibration or verification of most of the preset adjustments.

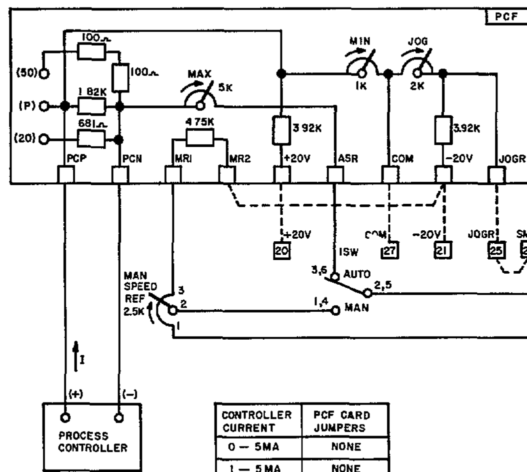
The test probe has two connection points for a full scale reading of either 4 volts or 20 volts.

Mount the instrument by first removing the two mounting screws and placing it through the slot in the left hand side of the door front. Place the instrument against the bottom side of the main control card (MCC) bracket and line the mounting holes up with the two holes in the bracket. Insert the screws from the top of the bracket and tighten. Then connect the common lead attached to the negative instrument terminal to the main control card terminal board marked COM.

PROCESS CONTROL FOLLOWER

The process control follower assembly is located in the main control module to the right of the RUN relay and above 2TB. It consists of a terminal board mounted printed circuit card on a bracket which mounts to the two studs located in the relay bracket.

Set up procedure: Wire the process controller, the manual speed potentiometer and the MAN/AUTO selector switch as shown in Fig. 34.



CONTROLLER CURRENT	PCF CARD JUMPERS
0 – 5MA	NONE
1 – 5MA	NONE
4–20 MA	(P) — (20)
10–50 MA	(P) — (50)

1. Dashed lines indicate factory made connections if the Kit is ordered factory mounted.
2. Remove jumpers (SRH)-(COM) and (JH)-(COM) on the main control card (MCC)
3. For jogging at MIN SPEED remove wire PCF (JOGR)-2TB(25).

   For independent jog reference remove jumper 2TB(25)-2TB(26).
4. Due to the low current level it is recommended to parallel the two Form C contacts of the AUTO/MAN selector switch, by connecting points 1 and 4, 2 and 5 and 3 and 6.

Figure 34. Process Control Follower

1. In the MAN mode with the speed potentiometer fully CW sets the REF SCALE potentiometer for –10V at test post TR. Set the MAX SPEED potentiometer. (Refer to the start up section of this instruction book).
2. In AUTO mode with minimum controller output, set the MIN process control follower (PCF) potentiometer for zero (or minimum) speed.

With maximum controller output set the MAX (PCF) potentiometer for maximum speed (−10V at test post TR). Set the JOG (PCF) potentiometer (if used).

JOG BY PUSHBUTTON/INDEPENDENT JOG REFERENCE (including the process controller follower circuitry).

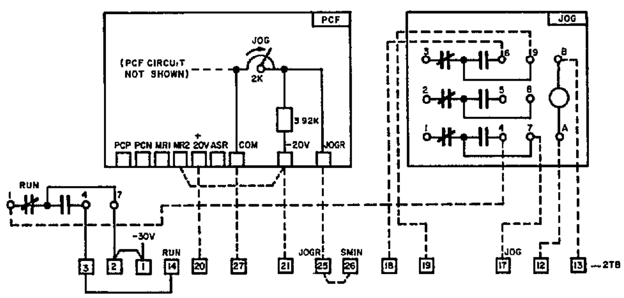
The JOG kit is the same as the Process Control Follower Kit with a JOG relay mounted to the right of the PCF card. The assembly mounts to the two studs in the relay bracket to the right of the RUN relay.

The JOG Relay and the JOG reference are wired to 2TB as shown in dashed lines in Fig. 35. (Unless ordered "factory mounted" these connections must be made by the purchaser using the wire harness attached to the assembly).

NOTE:

ONE WIRE CONNECTS FROM JOG(4) TO RUN(1) WITH FAST-ON CONNECTIONS. THE RUN(1) TERMINAL IS THE BOTTOM CONNECTOR IN THE FRONT ROW WHEN LOOKING AT THE RUN RELAY.

As the JOG relay picks up by pushing the JOG button, −30V is applied through the NC RUN and the NO JOG interlocks to 2TB(17) which is connected to the JOG switch point on the main control card (MCC). The drive will now run from the JOG reference applied to 2TB(25) which connects to JOGR on the main control card (MCC).



1. Dashed lines indicate factory made connections if the Kit is ordered "factory mounted"
2. Refer to the previous section for a description of the PROCESS CONTROL FOLLOWER (if used).
3. Remove the jumper between 2TB(25) and 2TB(26) for independent jog reference.

Figure 35. Jog Kit

TIMED OVERCURRENT CARD (TOC)

The TOC card provides overcurrent protection by initiating a drive shutdown if the motor armature current exceeds rated level for an extended period of time.

This function is particularly advantageous on unattended drives where the nature of the process is such that motor stalling or prolonged overload is possible.

The circuit consists of an integrator (timer) and a switching stage. When the current feedback exceeds 120% (3 volts) timing is initiated. When the output of the timing stage reaches 10 volts the output of the switching stage goes positive to initiate a system fault trip.

At 150% current the nominal trip time is 95 seconds and at 200% current the time is 36 seconds.

The card mounts by its terminal board connector points SYS, +20V, COM and −20V to the corresponding points on the bottom row of the MF terminal board. A wire is run from the stab-on connector, IABS to the corresponding connector IABS on the interface card (IFC).

Refer to the TOC instruction book for additional information. See GEK-45119.

AUTO/MANUAL CONTROL

The AUTO/MANUAL control station enables the use of two reference sources for the regulator.

In MANUAL the motor speed is set by the speed adjust potentiometer on the operator station.

In AUTO the reference signal is usually applied from the Process Control Follower or from an external reference like a tachometer to operate as a voltage follower.

The control circuit connection shows the two basic voltage follower schemes. See Fig. 36. Note that with manual override in AUTO the voltage source has to supply approximately 10 ma at top speed while the direct method requires about 1.3 ma.

If the follower voltage (Vx) exceeds 20 volts, external resistors and/or rheostats must be provided. In this case the

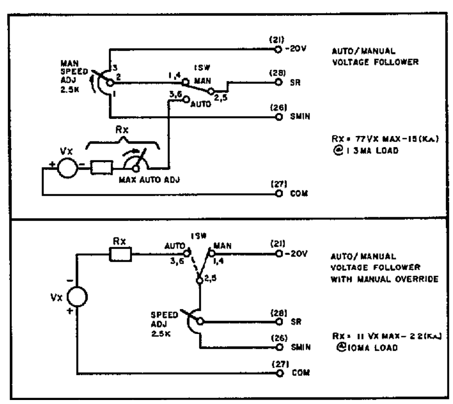


Figure 36. Auto/Manual Control

REF SCALE and MAX SPEED potentiometers must be set in the MANUAL mode. Then the external resistors must be selected (or rheostat adjusted) for the desirable maximum AUTO speed. (The 5K MAX potentiometer on the Process Control Follower Card may be used for trimming the speed in AUTO provided the 1.82K resistor connected between PCP and PCN is removed).

If the follower voltage (Vx) is less than 20 volts, it may be applied directly between 2TB(28) and 2TB(27) when in the AUTO mode. Now the maximum manual speed reference voltage must be reduced to equal the follower voltage by adding a resistance (Rx) between –20V (2TB(21) and the speed potentiometer when in the MANUAL mode. In this case the REF SCALE potentiometer must be adjusted in the AUTO mode. Then the Rx resistor must be selected or trimmed in the MANUAL mode.

A standard 15 point, 20 amp terminal board can be mounted to existing studs located along the bottom of the right hand side wall in the modification control module (MCM). This terminal board 4TB is only supplied for a reversing drive, but may be added and used for mounting external resistors or for spare connection points.

NOTE:

IF THE FOLLOWER VOLTAGE SIGNAL IS GROUNDED, THE SYSTEM COMMON OF THE VALUTROL DRIVE MUST BE LEFT UNGROUNDED.

REMOTE CURRENT LIMIT

The external current limit potentiometer enables the operator to vary the maximum torque delivered by the motor to the driven machine.

In general the current limit is controllable below the specified 20% depending on the motor and load characteristics.

The CURRENT LIMIT potentiometer should be connected as shown in Fig. 37. A jumper is required on the main control card (MCC) between connectors (ILA) and (DM1).

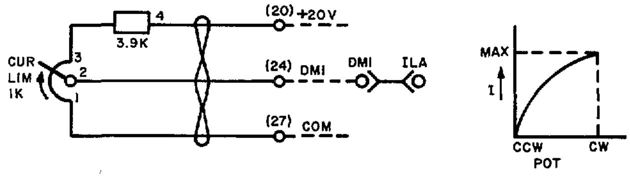


Figure 37. Remote Current Limit

With the external current limit potentiometer turned fully CW the maximum current limit should be set with the internal CUR LIMIT potentiometer. Maximum current limit must not exceed 150% (approximately 3.75 volts at ILA).

A minimum current limit setting can be made by adding a 1K rehostat connected potentiometer (or a resistor) between terminal (1) of the external CURRENT LIMIT potentiometer and common 2TB(27). (If not connected to the external speed potentiometer, the MIN SPEED potentiometer may be used as a minimum current limit adjustment).

NOTE:

THE CURRENT LIMIT IS NON-LINEAR WITH RESPECT TO THE POTENTIOMETER SCALE. WITH 150% MAXIMUM AND ZERO MINIMUM, 100% CURRENT LIMIT IS OBTAINED WITH THE POTENTIOMETER TURNED TO ITS CENTER POSITION.

SPEED INDICATOR

The speed indicating instrument connects between 2TB(27) and 2TB(23) as indicated in Fig. 38. The instrument has a 1 milliampere rectifier type movement resulting in non-linearity below 10% speed.

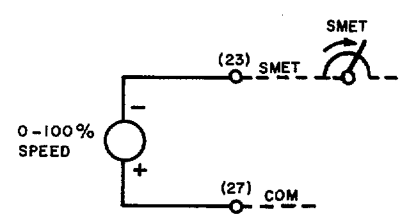


Figure 38. Speed Indication

For optimum accuracy from 10% to 100% speed, adjust the SMET potentiometer on the interface card (IFC) for a 100% reading when the drive is running at maximum speed.

Then with the drive running at 10% speed, use a screw driver to set the mechanical zero adjustment on the instrument for a 10% reading. (Repeat and re-adjust SMET at maximum speed if necessary).

LOAD INDICATOR

The load indicating instrument connects between 2TB(27) and 2TB(22) with the positive terminal to 2TB(27) as illustrated in Fig. 39.

The instrument is calibrated with the IMET potentiometer on the interface card (IFC) for a 100% reading at rated current (Calibration can also be made in DIAG STATIC for a 100% reading with −2.5V at the CFB test post).

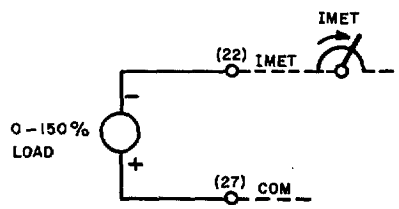


Figure 39. Load Indication

TACHOMETER

Speed regulation of a basic drive can be improved by adding a tachometer to the system for speed feedback.

On dripproof fully guarded (DPFG) motors a type 5AN, AC tachometer Kit can be added; however, the regulator will operate from any machine mounted AC or DC tachometer.

The tachometer leads connect to 2TB(29) and 2TB(30). A 56K ohm resistor is also connected between these two points. If a DC tachometer is used this resistor should be removed.

On the interface card (IFC) remove the jumpers between connectors NT-CEMF and CC-COM. Reconnect the jumpers from NT to NT1, NT2 or NT3 and from PT to PT1, PT2 or PT3 according to the maximum tachometer voltage listed in the programming table in this instruction book. **(Page 57)**

On the main control card (MCC) the AT1-AT2 jumper must be connected.

After converting from CEMF to tachometer regulation the MAX SPEED potentiometer must be readjusted. Likewise the RESPONSE potentiometer may require retuning.

TROUBLESHOOTING

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

RECOMMENDED INSTRUMENTATION

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

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

PROCEDURES

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

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

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.

HOW TO TEST AN SCR

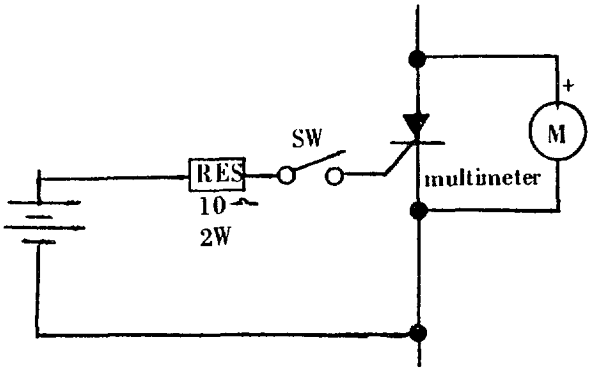
WARNING

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

1. Disconnect the AC power and make sure the loop contactor (MA) is open.
2. Using a multi-meter selected to read ohms on the 1K scale, check the forward and reverse resistance of each individual SCR cell. This is done by reading across power terminals T1 and DA1, T2 and DA1, T3 and DA1. See conversion unit elementary diagram. Good or faulty SCR's will give the following typical readings:

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

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



The multimeter is selected to read ohms on the 1K scale, and is connected to read the forward resistance of the SCR. When switch SW is closed, the forward resistance of a good SCR will change from a high value (100K to infinity) to a low value (1 to 10K). When the switch is opened a good SCR will revert to its high forward resistance or blocking state, if the holding current (multi-meter battery) source is momentarily removed. A faulty SCR will not switch remaining in either an open or a conducting state.

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

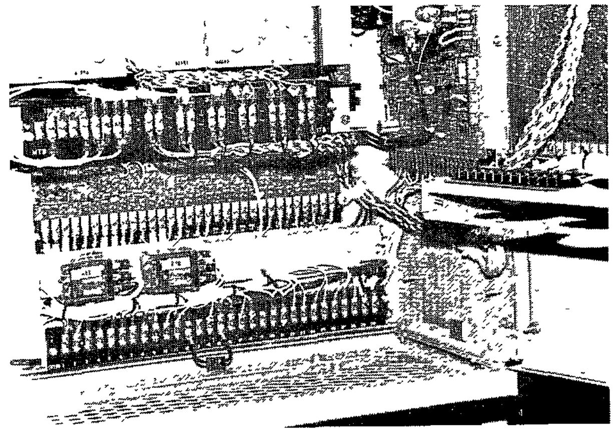
5. Certain SCR problems will only occur after the cell temperature is increased. A re-check of cell resistance while the SCR is still hot may locate a faulty device. Likewise, a "weak" or "leaky" cell may cause its temperature to increase excessively during operation after a shut-down, with power disconnected. Check if one of the SCR cells and associated heatsink has reached a considerably higher temperature than the other devices.

REMOVAL/REPAIR

CONVERSION MODULE

The conversion module is best removed as follows:

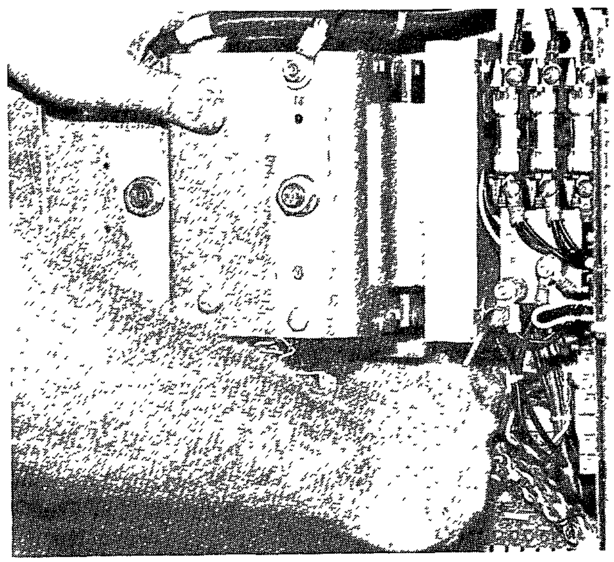
Disconnect the three AC input power and DC output leads as shown.



(Photo SV-4951-008)

Figure 40. Removal of Gate Leads

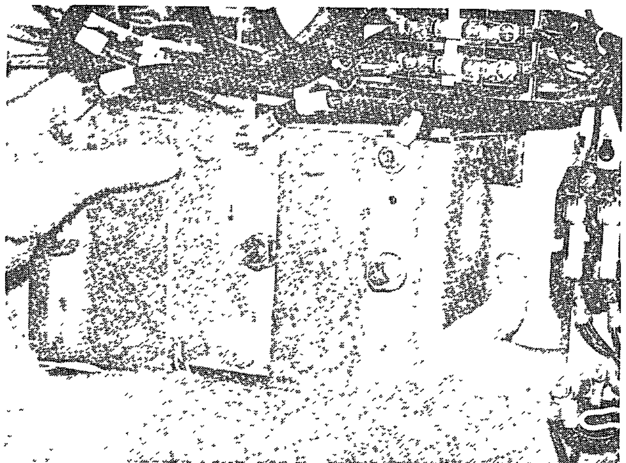
Disconnect the SCR gate leads from the terminal. If markings are not legible, remark prior to removal.



(Photo SV-4951-009)

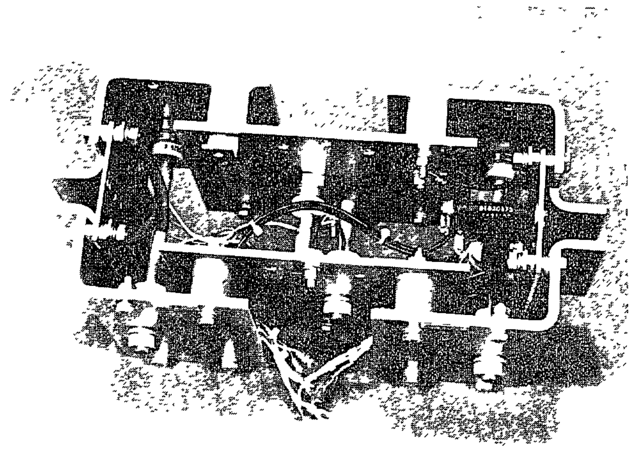
Figure 41. Removal of Slotted Spacer

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



(Photo SV-4951-010)

Figure 42. Removal of Conversion Module



(Photo MG-5236-27)

Figure 44. Stud Mount Heat Sink (Top View)

Slide module to the right and pull out.

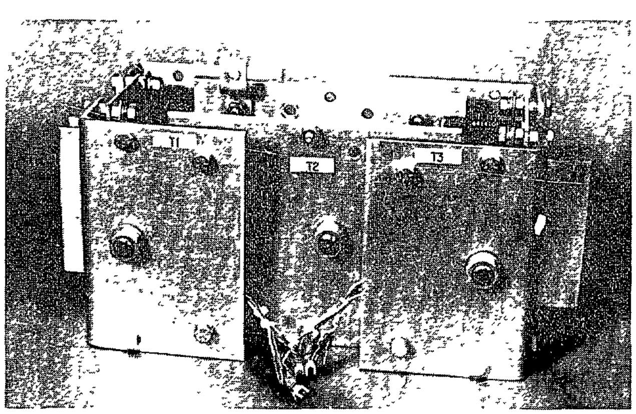
SCR REPLACEMENT

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

STUD MOUNT SCR'S

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

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



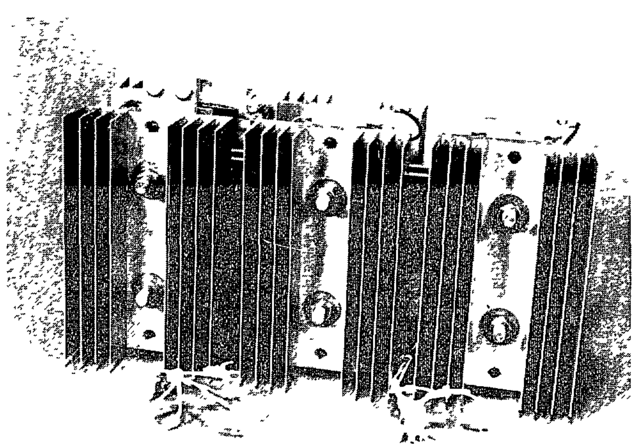
(Photo MG-5236-26)

Figure 43. Stud Mount Heat Sink (Front View)

PRESS PAK SCR'S

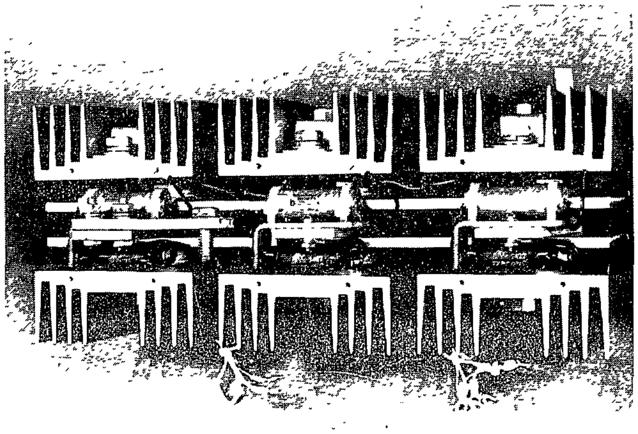
Clean both surfaces of old lubricant and dust. Apply a thin film of General Electric G322L, VERSILUBE. Line up the assembly and evenly tighten the nuts finger tight. Tighten the nuts, one at a time, alternating between nuts according to the following specifications.

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



(Photo MG-5236-24)

Figure 45. Press Pak Heat Sink (Front View)

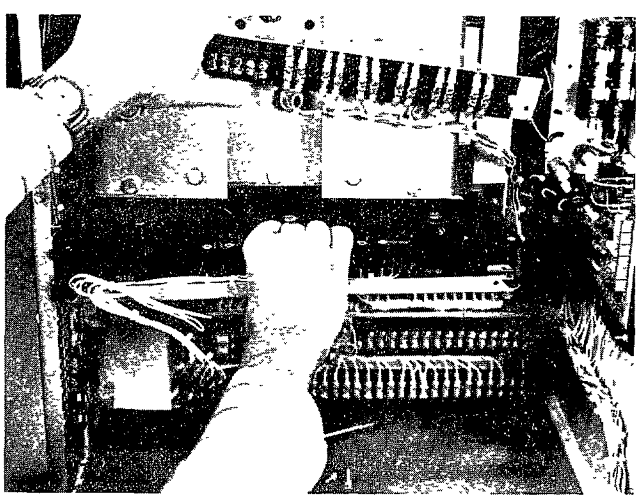


(Photo MG-5236-18)

Figure 46. Press Pak Heat Sink (Top View)

FANS (if supplied)

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

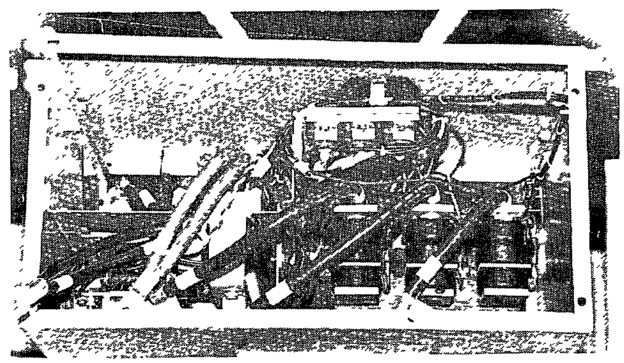


(Photo MG-5236-23)

Figure 47. Removal of Fans

MOV'S

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



(Photo SV-1951-011)

Figure 48. Removal of MOV's (100-125HP Only)

NON STANDARD POWER UNIT/MOTOR/ LOAD COMBINATIONS

A GP Valutrol power unit can be used with other than the standard listed DC motors, but some considerations should be made to assure proper operation.

INERTIA

If the resulting rotating energy is much higher than in a standard system, the resulting duty on the DB resistors could be excessive. The internal DB resistors may have to be replaced by externally mounted resistors with higher heat dissipating capability.

SHUNT FIELD VOLTAGE

Standard field voltages are 300V at 460 VAC and 150V at 230 VAC. In a 460 VAC system, a 240V shunt field motor can be used provided the adjustable field supply, MFC, is used.

At 230 VAC, a 240V field must be reconnectable for 120V and used with the MFC card.

ARMATURE VOLTAGE

A 500V rather than 550V motor can be used. However, when operating a rated load, both the ac input current and dc output current will be 10% higher. At certain HP levels, it may be necessary to use the next highest HP power unit.

PRINTED CIRCUIT CARDS

NOTE

THERE SHOULD B 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 DISTRUBED. 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 AT STAB-ON TERMINALS TL, RJ, SFB, NDE, CLI AND CLJ OR ON THE DM1, DM2 ETC. TERMINALS ON ANY OTHER PRINTED CIRCUIT CARD.

3. SET THE POTENTIOMETERS ON THE REPLACEMENT PRINTED CIRCUIT CARD THAT WAS REPLACED OR TO 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.

5. FOR FAST TIMING (0.3 TO 7 SECONDS) CALL HOT LINE TELEPHONE NUMBER.

6. WHEN REPLACING THE ***MCC***, DUE TO COMPONENT BUILD-UP OF TOLERANCES, IT MAY BE NECESSARY TO ADJUST ***ZERO ADJUST*** IN ORDER TO GET ***OV*** OUT OF THE MOTOR ARMATURE FOR ***OV*** IN.

POWER UNITS

Dimensions

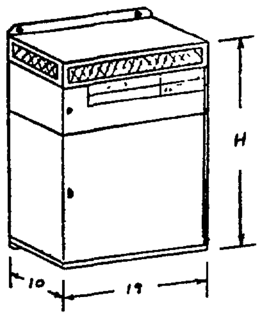


Fig. 1
Wall Mounted

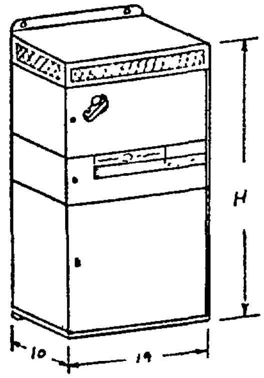


Fig. 2
Wall Mounted

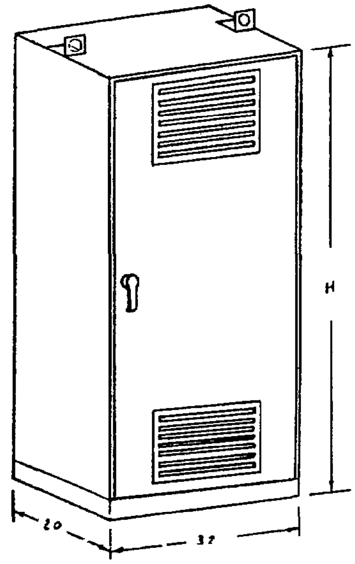
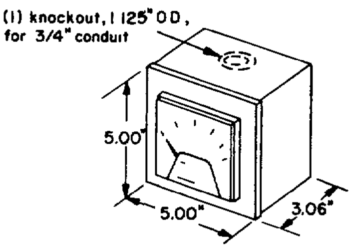


Fig. 3
Floor Mounted

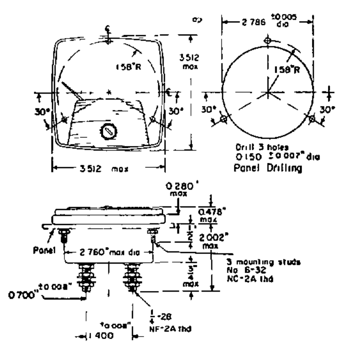
POWER UNIT								
HP		BASIC			MODIFIED[1]			
230 VAC	460 VAC	Fig. No.	Approx. Net Wt. in Lbs.	"H" Dimensions in Inches	Fig. No.	Approx. Net Wt. in Lbs.	"H" Dimensions in Inches
5-15	5-40	1	135	30	2	175	40
20-40	50-100	1	155	33	2	195	43
50-100	125-250	3	545	76	3	545	76

[1] Modification compartment required for wall mounted enclosures when any (or all) of the following modifications are selected: 1) circuit breaker, 2) reversing, 3) dynamic braking, 4) blower motor control.

OPERATOR'S CONTROL

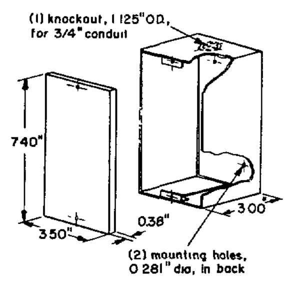


Speed indicator enclosure dimensions (Shown with meter installed)



3½-inch Type DO-9 meter

Load or speed indicator meter dimensions



Operator's station dimensic

For Estimating Only Unless Endorsed For Constructi

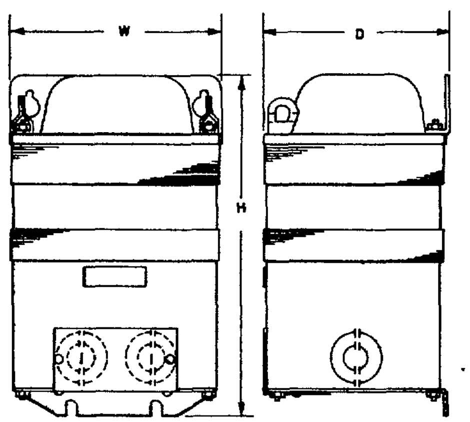
Figure 49. Power Unit Outline Dimensions

ISOLATION TRANSFORMERS Three Phase 60 Hertz

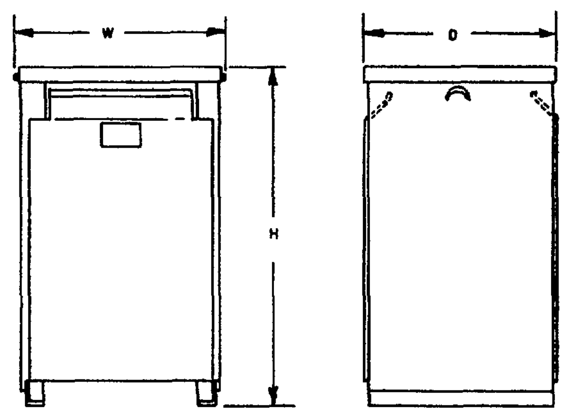
+5 AND −5% FULL RATED TAPS ON PRIMARY. UL LISTED AND LABELED

Model Type	HP	230 VΔ Primary		460 VΔ Primary		575 VΔ Primary		Approx Net Wt in Lbs
		230Y Volt Secondary	460Y Volt Secondary	230Y Volt Secondary	460Y Volt Secondary	230Y Volt Secondary	460Y Volt Secondary	
ENCLOSED FOR SEPARATE MOUNTING								
ML	2	9T21B3001G29	9T21B3001G28	9T21B3001G23	9T21B3001G22	9T21B3001G27	9T21B3001G26	70
	3	9T21B3002G29	9T21B3002G28	9T21B3002G23	9T21B3002G22	9T21B3002G27	9T21B3002G26	110
	5	9T21B3003G29	9T21B3003G28	9T21B3003G23	9T21B3003G22	9T21B3003G27	9T21B3003G26	150
	7.5	9T21B3004G29	9T21B3004G28	9T21B3004G23	9T21B3004G22	9T21B3004G27	9T21B3004G26	280
	10	9T21B3005G29	9T21B3005G28	9T21B3005G23	9T21B3005G22	9T21B3005G27	9T21B3005G26	270
QL	15	9T23B4001G29	9T23B4001G28	9T23B4001G23	9T23B4001G22	9T23B4001G27	9T23B4001G26	305
	20	9T23B4002G29	9T23B4002G28	9T23B4002G23	9T23B4002G22	9T23B4002G27	9T23B4002G26	305
	25	9T23B4003G29	9T23B4003G28	9T23B4003G23	9T23B4003G22	9T23B4003G27	9T23B4003G26	395
	30	9T23B4004G29	9T23B4004G28	9T23B4004G23	9T23B4004G22	9T23B4004G27	9T23B4004G26	405
	40	9T23B4005G29	9T23B4005G28	9T23B4005G23	9T23B4005G22	9T23B4005G27	9T23B4005G26	415
	50	9T23B4006G29	9T23B4006G28	9T23B4006G23	9T23B4006G22	9T23B4006G27	9T23B4006G26	630
	60	9T23B4007G29	9T23B4007G28	9T23B4007G23	9T23B4007G22	9T23B4007G27	9T23B4007G26	640
	75	9T23B4008G29	9T23B4008G28	9T23B4008G23	9T23B4008G22	9T23B4008G27	9T23B4008G26	750
	100	9T23B4009G29	9T23B4009G28	9T23B4009G23	9T23B4009G22	9T23B4009G27	9T23B4009G26	920
	125	9T23B4010G29	9T23B4010G28	9T23B4010G23	9T23B4010G22	9T23B4010G27	9T23B4010G26	945
	150	9T23B4011G29	9T23B4011G28	9T23B4011G23	9T23B4011G22	9T23B4011G27	9T23B4011G26	1185
	200	9T23B4012G29	9T23B4012G28	9T23B4012G23	9T23B4012G22	9T23B4012G27	9T23B4012G26	1225
	250	9T23B4013G29	9T23B4013G28	9T23B4013G23	9T23B4013G22	9T23B4013G27	9T23B4013G26	1750

DIMENSIONS (For Estimating Only)



Type ML Enclosed



Type QL Enclosed

Enclosed

Model Type	HP	Approximate Dimensions (in inches)		
		Height	Width	Depth
ML	2	23 5/16	7 1/4	6 1/8
	3	25 5/16	9 1/8	7 3/4
	5	28 15/16	9 1/8	7 3/4
	7.5	31 3/16	11 5/8	9 13/16
	10	31 3/16	11 5/8	9 13/16
QL	15	31 1/4	24	16 1/4
	20	31 1/4	24	16 1/4
	25	32 1/4	24	17 3/4
	30	32 1/4	24	17 3/4
	40	32 1/4	24	17 3/4
	50	35 3/4	32	21 3/4
	60	35 3/4	32	21 3/4
	75	40	32	21 3/4
	100	46	35	23 3/4
	125	46	35	23 3/4
	150	48	38 1/2	25
	200	48	38 1/2	25
	250	51 3/4	42 1/2	30 1/4

Figure 50. Isolation Transformer Dimensions

OPERATORS STATIONS AND MODIFICATION KITS

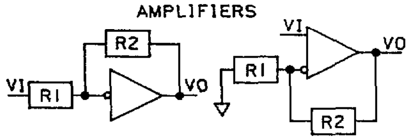
NAME	CATALOG NUMBER
TEST INSTRUMENT	6VMK10
DIAGNOSTIC PANEL	6VD10
STANDARD STATION	6VOC10
PB JOG STATION	6VOC30
STANDARD REVERSING STATION	6VOC20
PB JOG REV REVERSING STATION	6VOC40
AUTO/MANUAL STATION	6VOC50
REMOTE CURRENT LIMIT STATION	6VCLP10
PB JOG RELAY KIT	6VJ10
PROCESS INSTRUMENT FOLLOWER KIT	6VP10
SPEED INDICATOR	6VSI10
LOAD INDICATOR	6VLI10
TIMED OVERCURRENT CARD	6VTOC

HARDWARE ABBREVIATIONS

MCC	MAIN CONTROL CARD
IFC	INTERFACE CARD
PSC	POWER SUPPLY CARD
SCR	THYRISTOR ASSEMBLY
DGC	DIAGNOSTIC CARD
MFC	MOTOR FIELD CONTROL
MFE	MOTOR FIELD EXCITER
MDM	MODIFICATION MODULE
FRP	FIELD REVERSING PANEL
APR	ANTI PLUG PANEL

SYMBOLS

AMPLIFIERS



$VO = \frac{-R2}{R1} VI$ $\qquad$ $VO = \left(1 + \frac{R2}{R1}\right) VI$

CASE GROUND


POTENTIOMETER ARROWS ON THE CARD ELEMENTARY DIAGRAMS INDICATE THE WIPER DIRECTION AS THE POTENTIOMETER SHAFT IS ROTATED CLOCKWISE TO INCREASE FUNCTION.

–STAB ON TERMINAL

–TERMINAL AT 2TB

✦ -TEST POINT ON DOOR FRONT

∞ - *SHIELDED OR TWISTED PAIR*

MODIFICATIONS ,

MODIFICATIONS AND OPTIONS ARE INDICATED BY THE DASHED LINES. REFER TO THE RESPECTIVE SECTIONS IN THE INSTRUCTION BOOK FOR DETAILED CIRCUITS AND DESCRIPTIONS.

SIGNAL DEFINITIONS

✦CEMF	COUNTER EMF
✦CFB	CURRENT FEEDBACK
CRM	CROSSOVER MODIFY
DFP	DELAYED FIRING POWER
✦DR	DRIVER REFERENCE
✦EAO	ERROR AMP OUTPUT
EST	EXTERNAL FLT STOP INPUT
FALT	FAULT
✦FC	FIELD CURRENT
FDR	FIELD DIAGNOSTIC REFERENCE
FEA	FIELD ECONOMY ADJUST
FF	FIELD FAULT
IABS	MOTOR CURRENT ABSOLUTE
ILA	CURRENT LIMIT ADJUST
IMET	CURRENT SIGNAL FOR METER
✦IPU	INITIAL PULSE
✦LR	LOCAL REF FROM DGC
✦JOG	JOG SWITCH INPUT
✦JOGR	JOG REFERENCE INPUT
✦MAC	MAX CONTROL SIGNAL
MSW	MODE SWITCH
✦OSC	OSCILLATOR
✦PCR	PHASE CONTROL REF
✦PRE	DRIVE PRECONDITION
ØSEQ	PHASE SEQUENCE
RERR	REGULATOR ERROR
RIJ	INTEGRATOR SUMMING JUNCTION
RJ	REGULATOR SUMMING JUNCTION
RRA	REGULATOR RESPONSE ADJUST
RSET	RESET
✦RTR	READY-TO-RUN
✦RUN	RUN SWITCH INPUT
✦SA-C	PHASE SYN OUTPUT
✦SFB	SYSTEM FEEDBACK
SMET	SPEED SIGNAL FOR METER
✦SR	SYSTEM REFERENCE INPUT
✦SYS	SYSTEM FAULT TRIP
✦TA	OUTPUT FOR TACH TRIP ADJUST
TF	TACH FAULT
✦TFB	TACHOMETER FEEDBACK
✦TR	TIMED REFERENCE
✦VFB	VOLTAGE FEEDBACK
✦WFR	WEAK FIELD REFERENCE

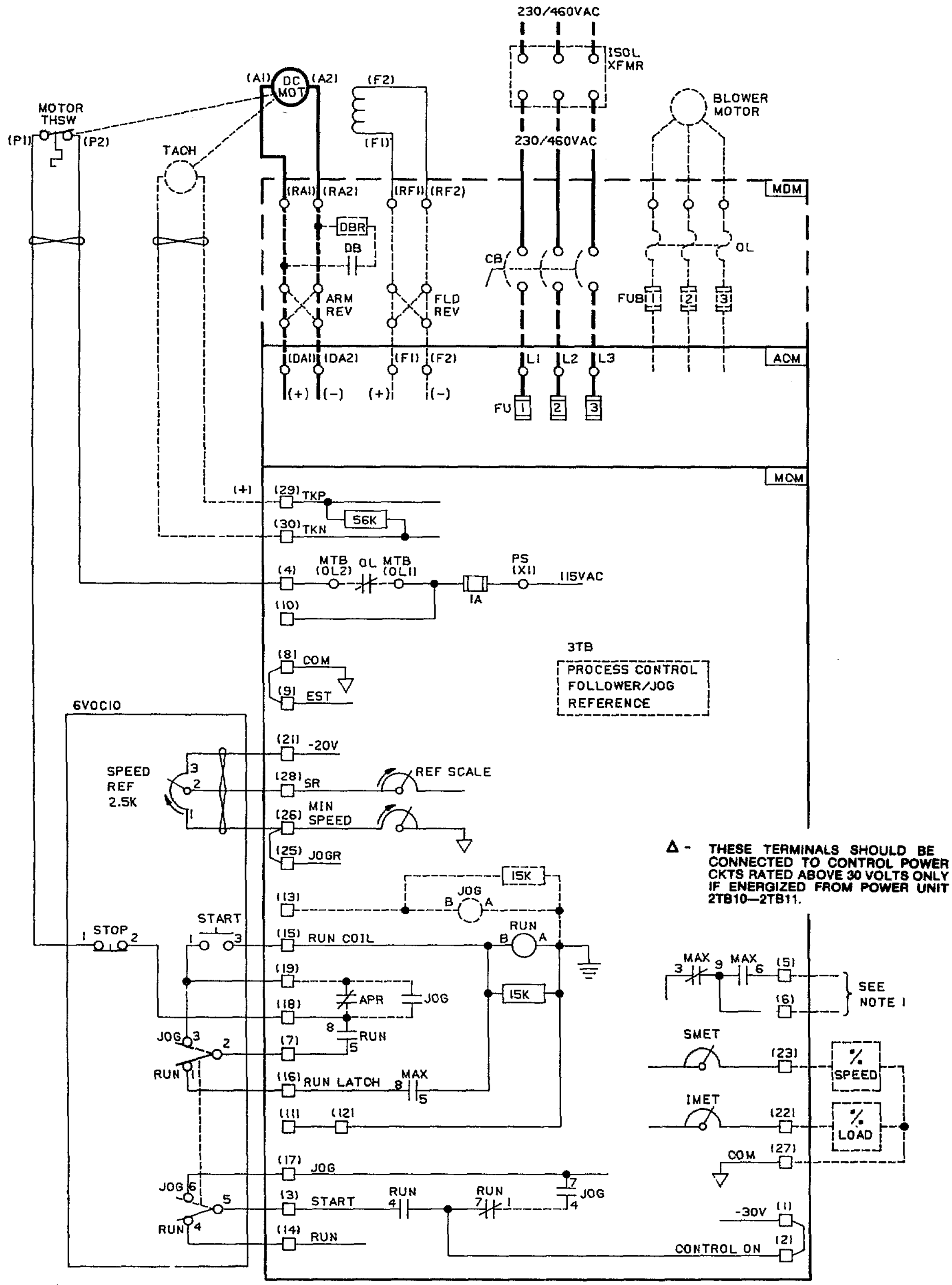
TABLE I PROGRAMMING

FUNCTION	USE	LOC	JUMPERS
60HZ		MFC	ZA-ZB, (IF USED)
50HZ			(NONE)
IOC-400%	X		(NONE)
-500%		IFC	I-IHI
-300%		IFC	I-ILO
SR5-9V			(NONE)
9-20V	X	MCC	SRH-COM
JOGR 10V			(NONE)
20V	X	MCC	JH-COM
LT.3-7SEC			(NONE)✦ ✦
2-60SEC	X	MCC	332Ω FROM LTI TO COM
VREG	X	IFC	NT-CEMF, CC-COM
DC TACH			ATI-AT2
AC TACH	X	MCC	ATI-AT2
TACH FILT		IFC	TC-TC
TACH VOLTS 24-64VDC		IFC	NT-NTI, PT-PTI
27-71VAC		IFC	NT-NTI, PT-PTI
60-160VDC		IFC	NT-NT2, PT-PT2
66-177VAC		IFC	NT-NT2, PT-PT2
110-300VDC		IFC	NT-NT3, PT-PT3
120-330VAC		IFC	NT-NT3, PT-PT3
G1,3,4 G2,5,6 MAX AMPS			MFC OR MFE
.8		MF	NONE
1.3		MF	YB-YD
2.4		MF	YA-YB
4.0		MF	YA-YB, YC-YD
7.0		MF	YA-YC
13		MF	YA-YC, YB-YD
L/R <.25S		MFC	QA-QB
INH RUN		DGC	DI-D2 (IF USED)
COMP POS		MCC	CF-CFP,CPN-COM
NEG	X	MCC	CF-CFN,CFP-COM

X -INDICATE JUMPER CONNECTIONS SUPPLIED FOR A BASIC DRIVE SYSTEM.

✦ ✦)FOR 193X530AA MCC CARDS:
LIN TIME .3-7SEC: LTI-LT2
2-60 SEC: NO JUMPER USED

ELEMENTARY DIAGRAM



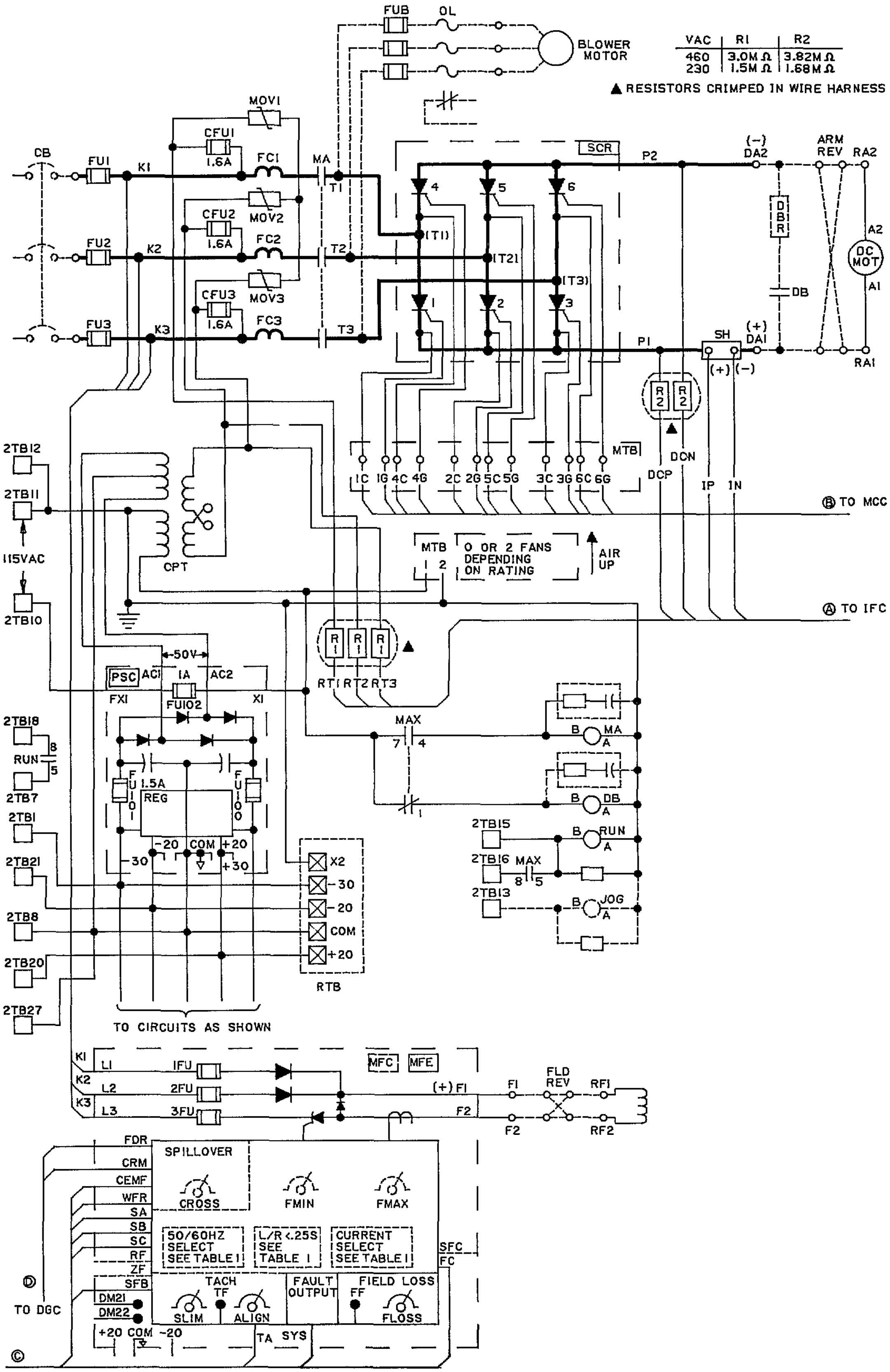
NOTE 1. MAXIMUM PERMISSABLE VOLTAGE:

115 VOLTS IF CONNECTED TO THE INTERNAL 115 VAC SUPPLY

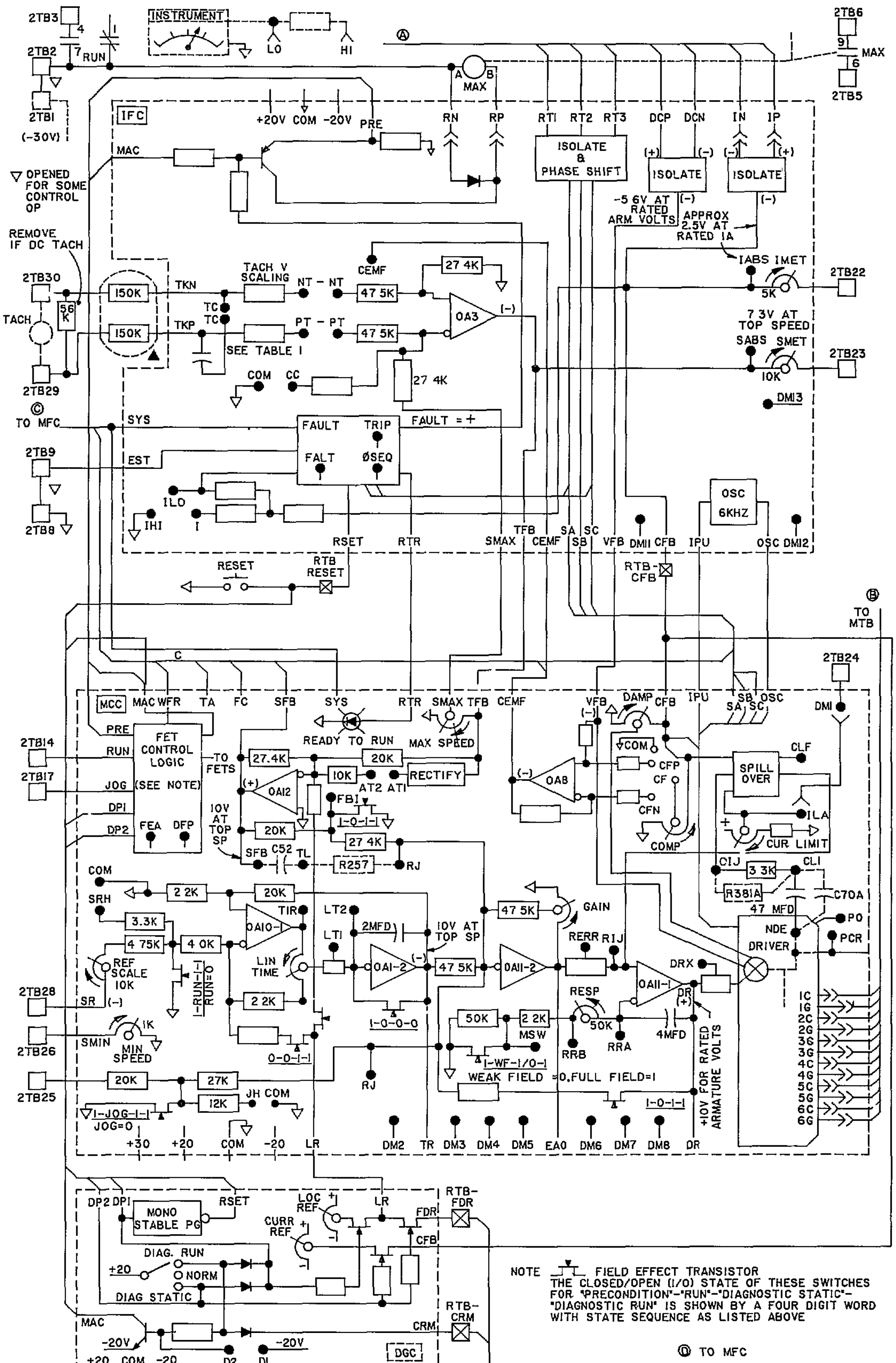
30 VOLTS IF CONNECTED TO AN EXTERNAL CONTROL CIRCUIT

NOTE 2. CUSTOMER TO CONNECT TO PROVIDE OVERLOAD PROTECTION AND TO PREVENT STARTING OF MOTOR UPON DEVICE RESETTING.

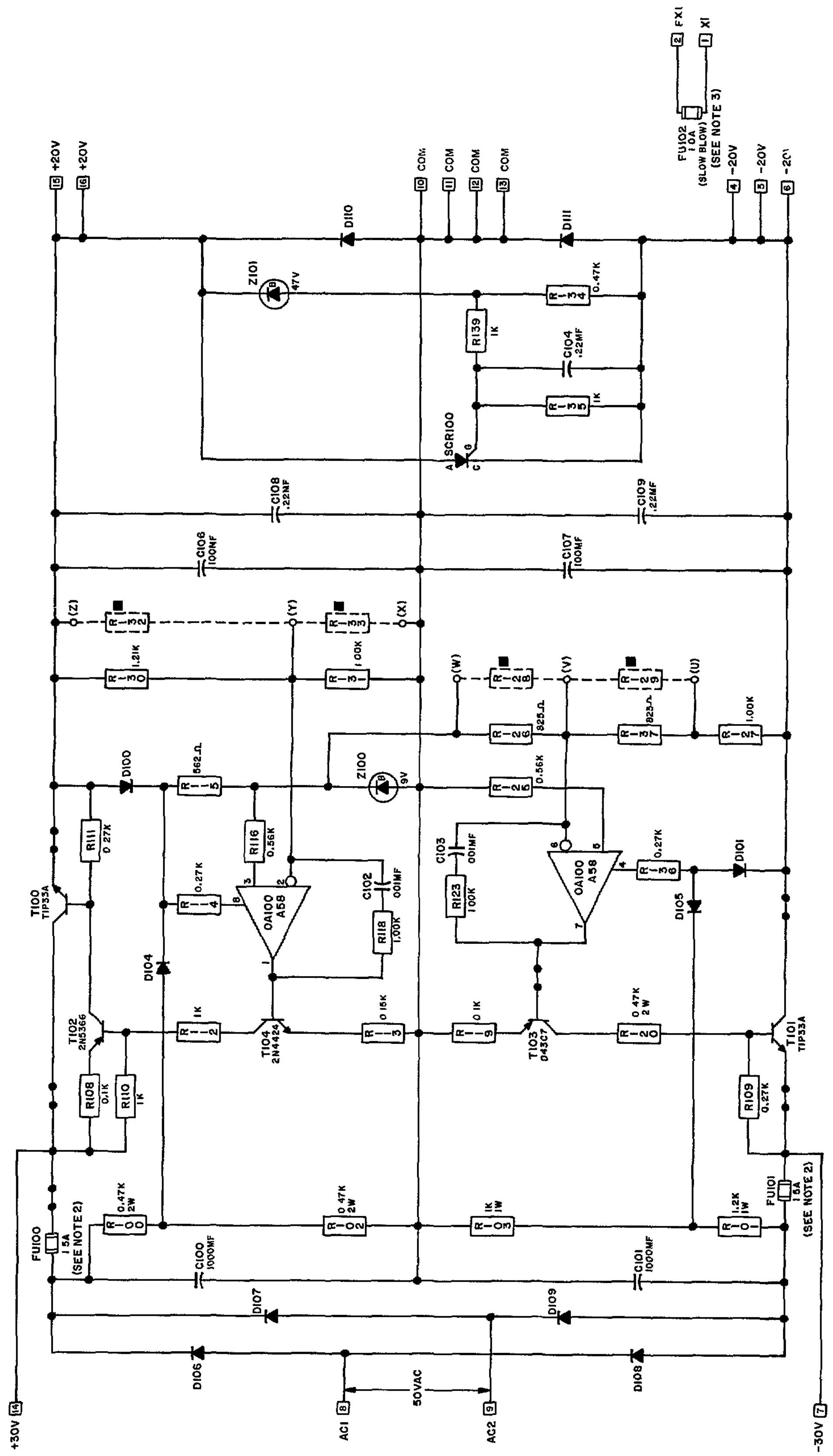
ELEMENTARY DIAGRAM



ELEMENTARY DIAGRAM



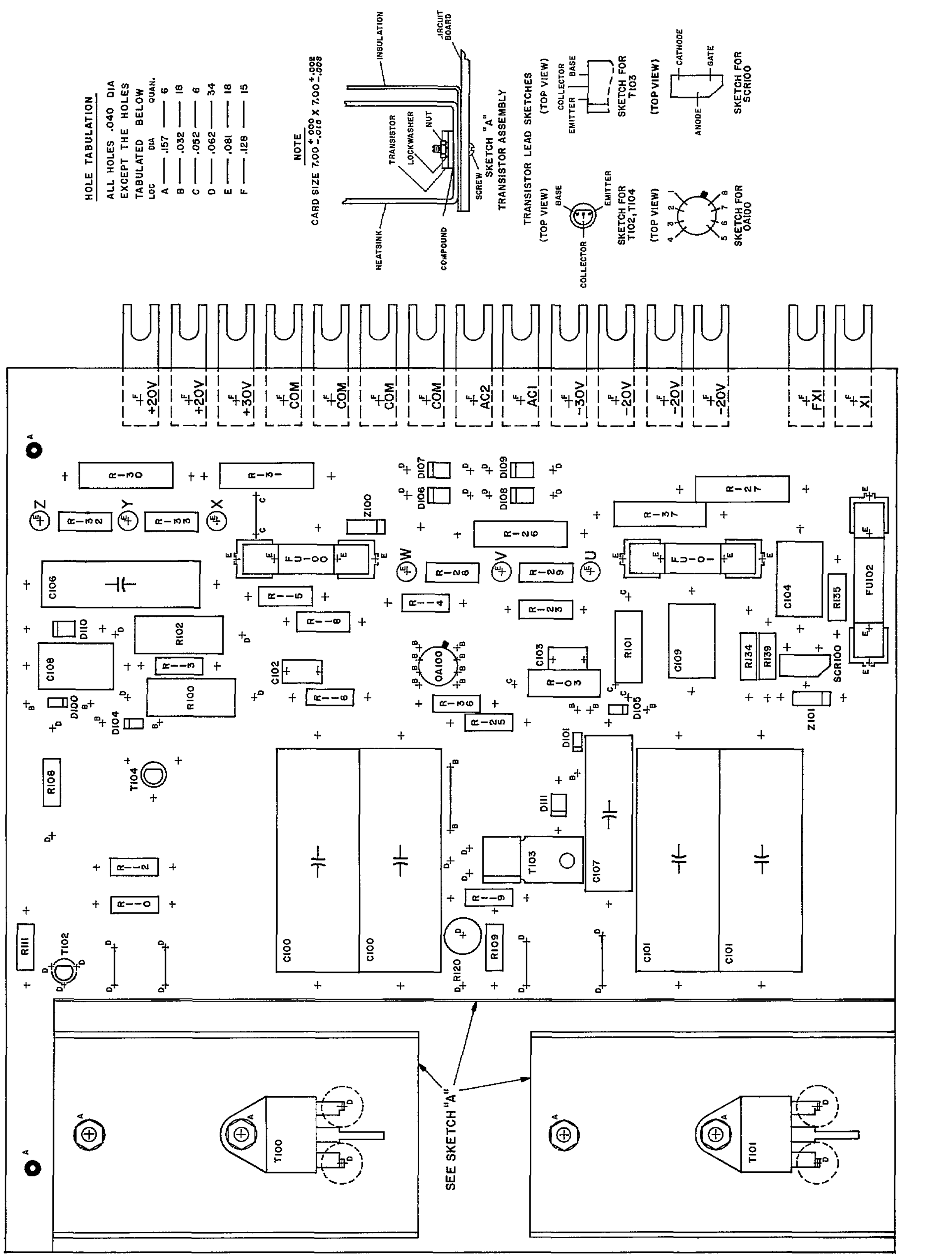
ELEMENTARY DIAGRAM



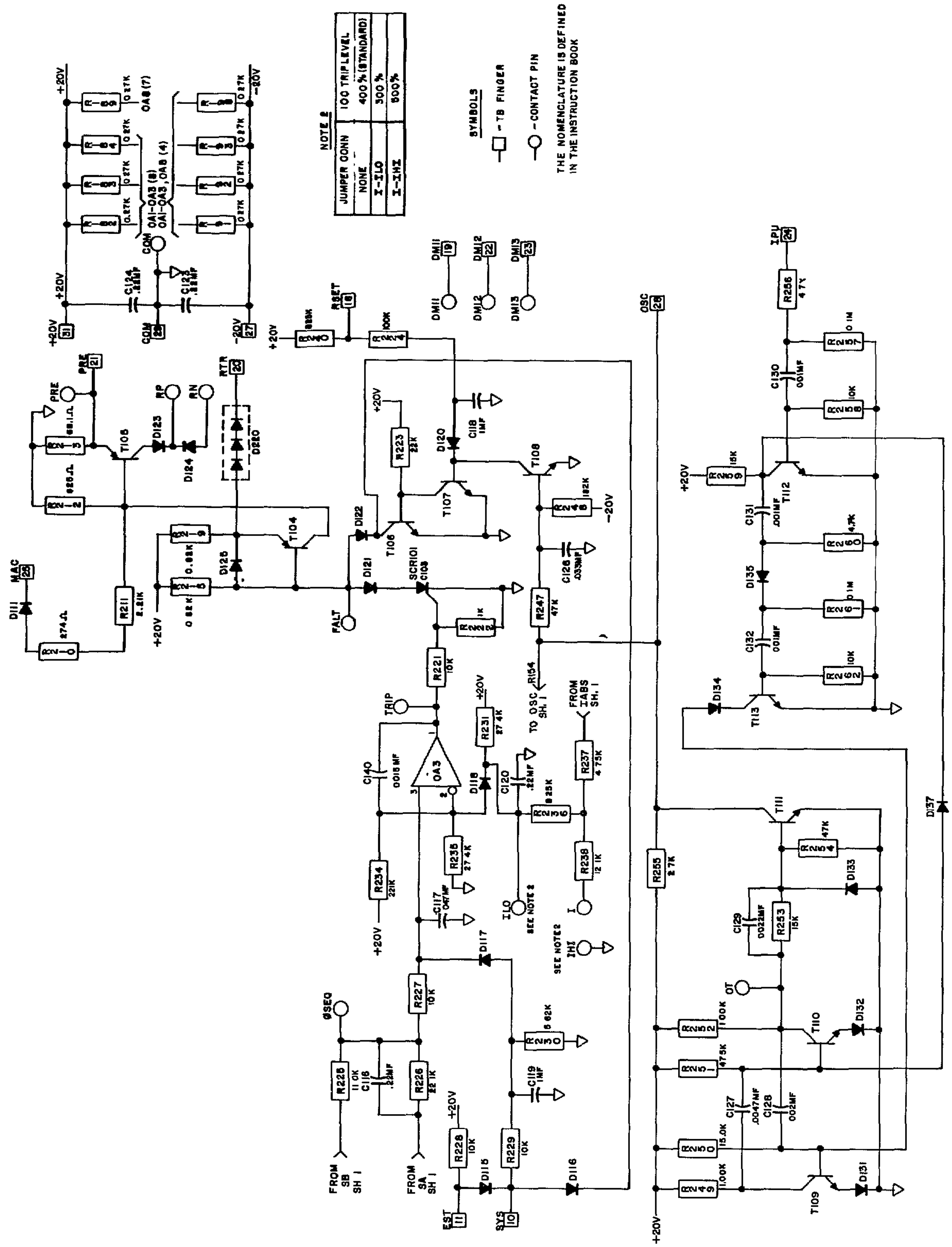
POWER SUPPLY CARD

NOTES

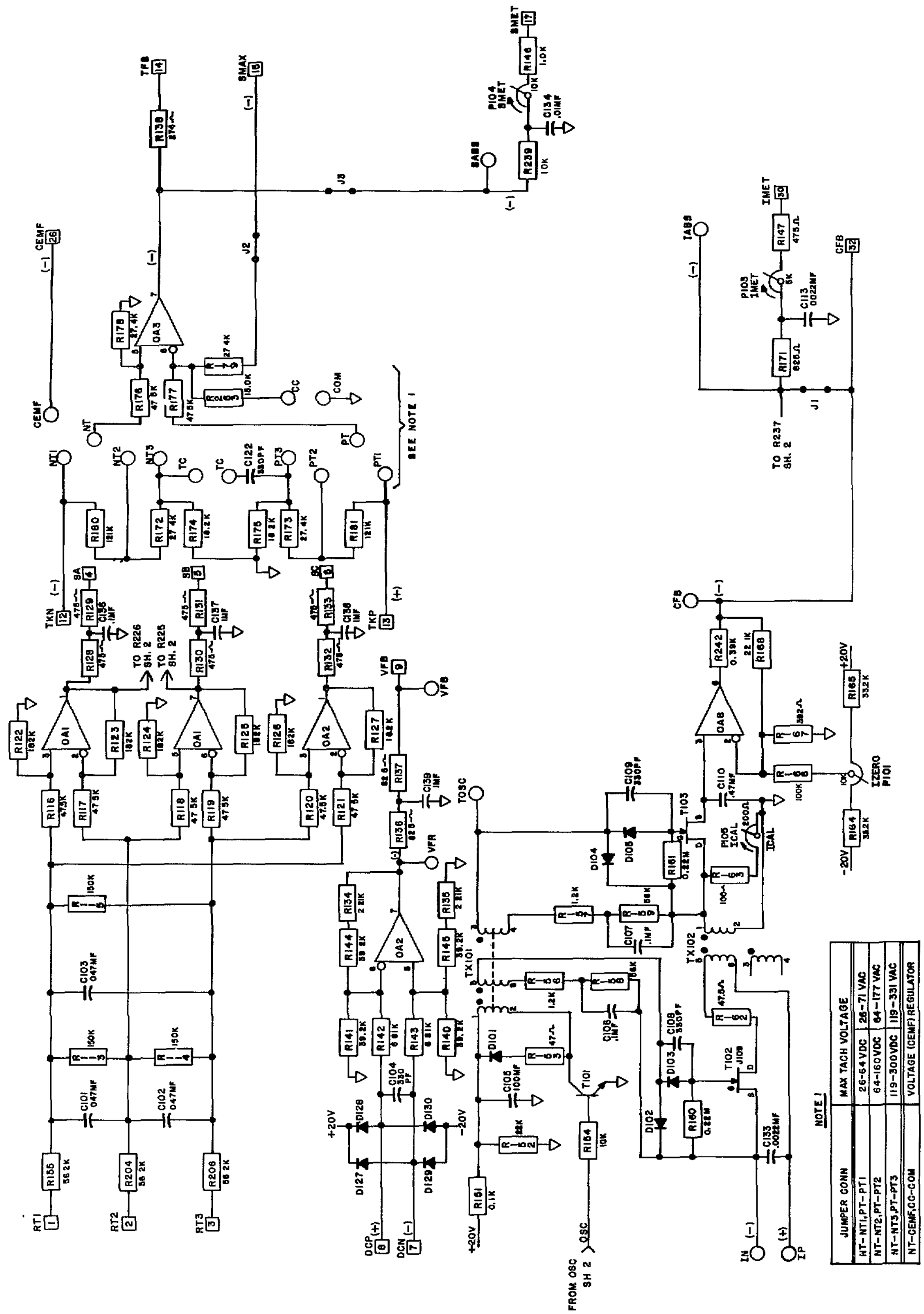
1. ■ – RESISTOR SELECTION IN TEST.
2. FUSES ARE INSTRUMENT TYPE, LITTLE FUSE 36101 5, OR EQUIVALENT.
3. LITTLE FUSE 313001, OR EQUIVALENT



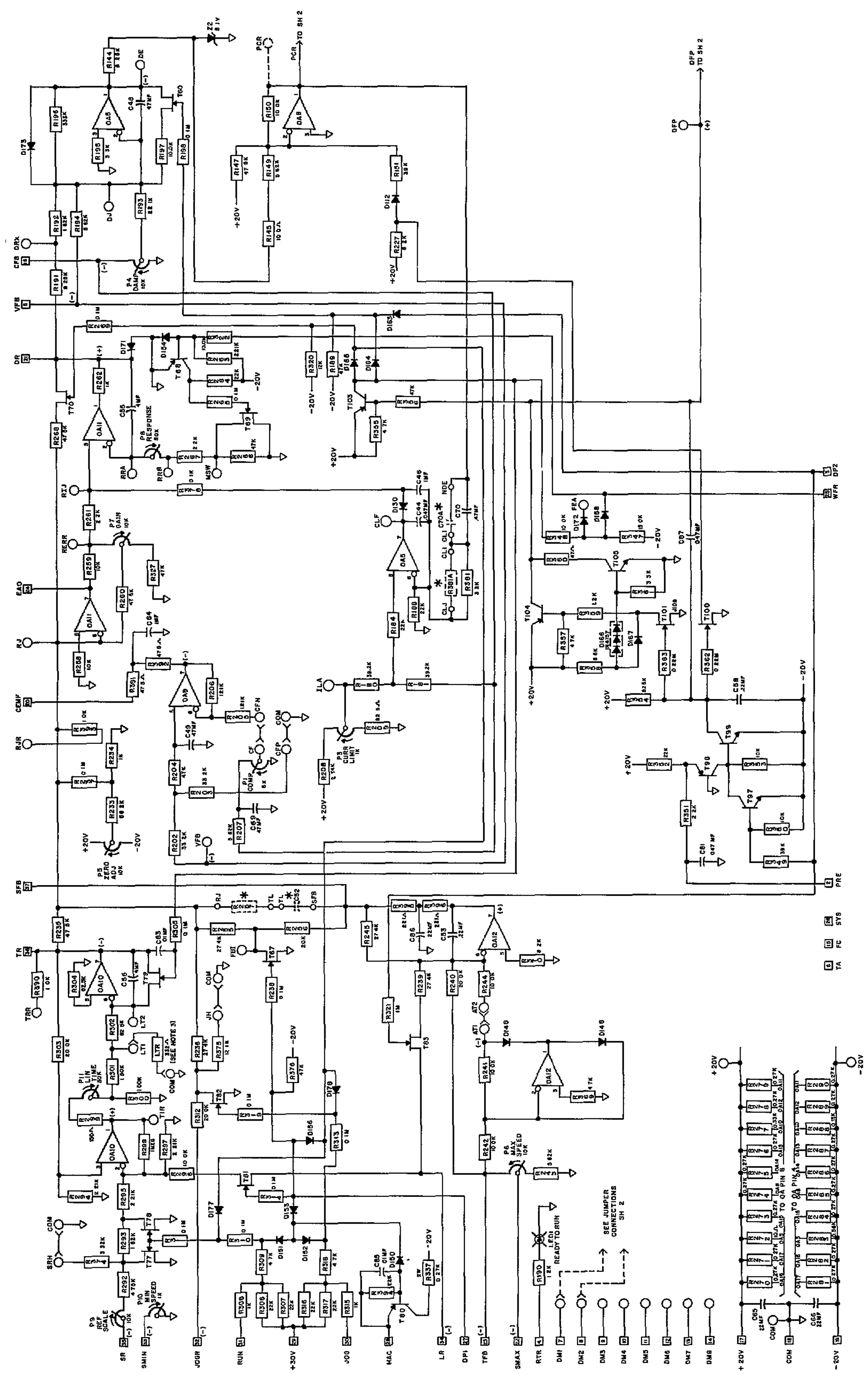
POWER SUPPLY CARD



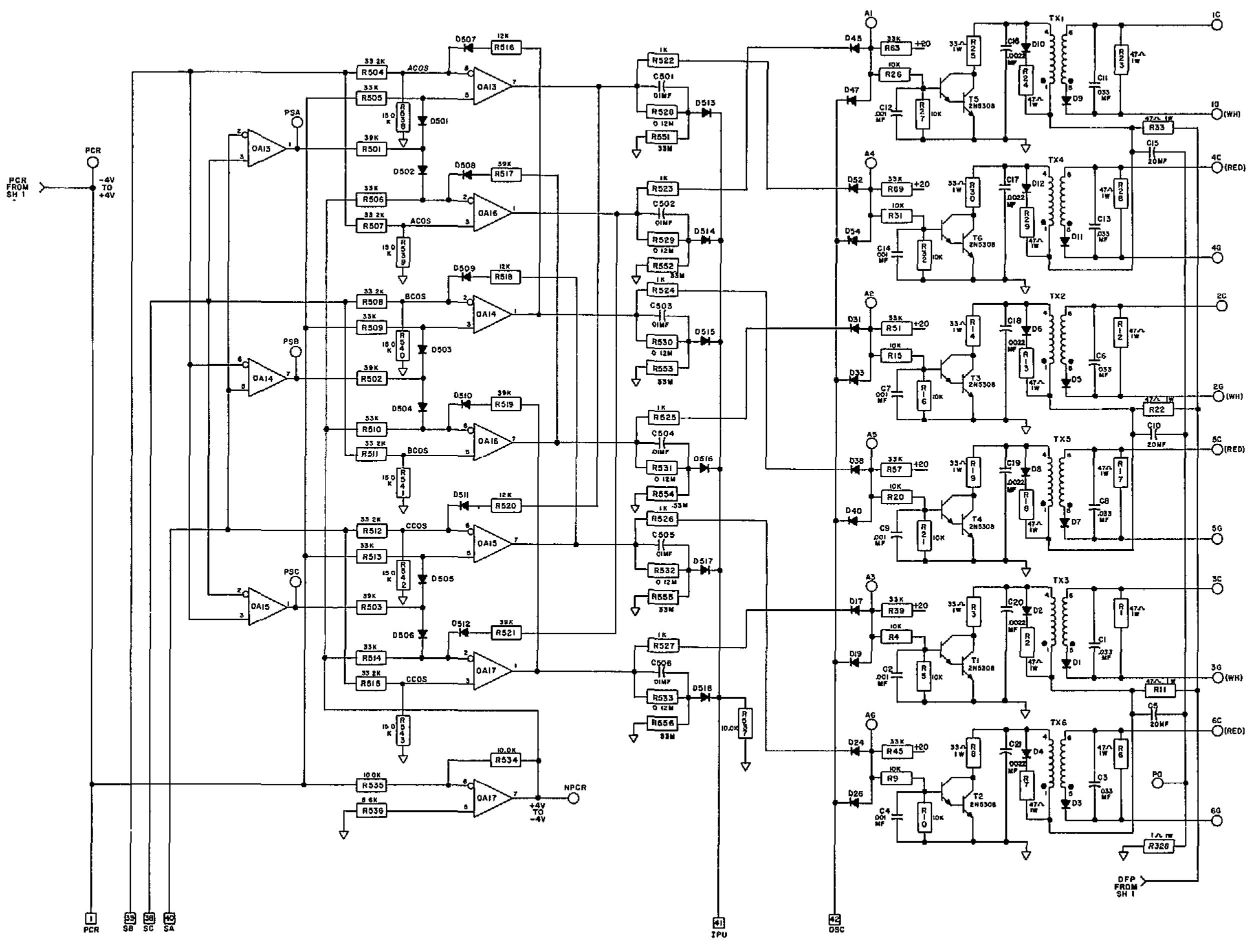
INTERFACE CARD



INTERFACE CARD



MAIN CONTROL CARD



SYMBOLS

* – COMPONENTS SELECTED IN TEST (IF REQUIRED)

– T B FINGER

– CONTACT PIN (FOR JUMPER CONNECTIONS AND/OR TEST POINTS)

– COMPONENTS SHOWN DOTTED ARE FURNISHED ONLY WHEN REQUIRED C52 AND R257 WILL PROVIDE A TACHOMETER RATE NETWORK C70A AND R381A WILL CONTROL THE RATE OF RISE OF CURRENT

REFER TO THE INSTRUCTION BOOK FOR ADDITIONAL INFORMATION

EXCEPT AS NOTED ALL NPN TRANSISTORS ARE 2N4424 AND ALL PNP TRANSISTORS ARE 2N5366

JUMPER CONNECTIONS

1 THIS CARD IS SUPPLIED WITH THE JUMPERS INDICATED BELOW OTHER JUMPER ARRANGEMENTS MAY BE MADE AS REQUIRED

SRH — COM JH — COM – (-10 TO -20V MAX REF)

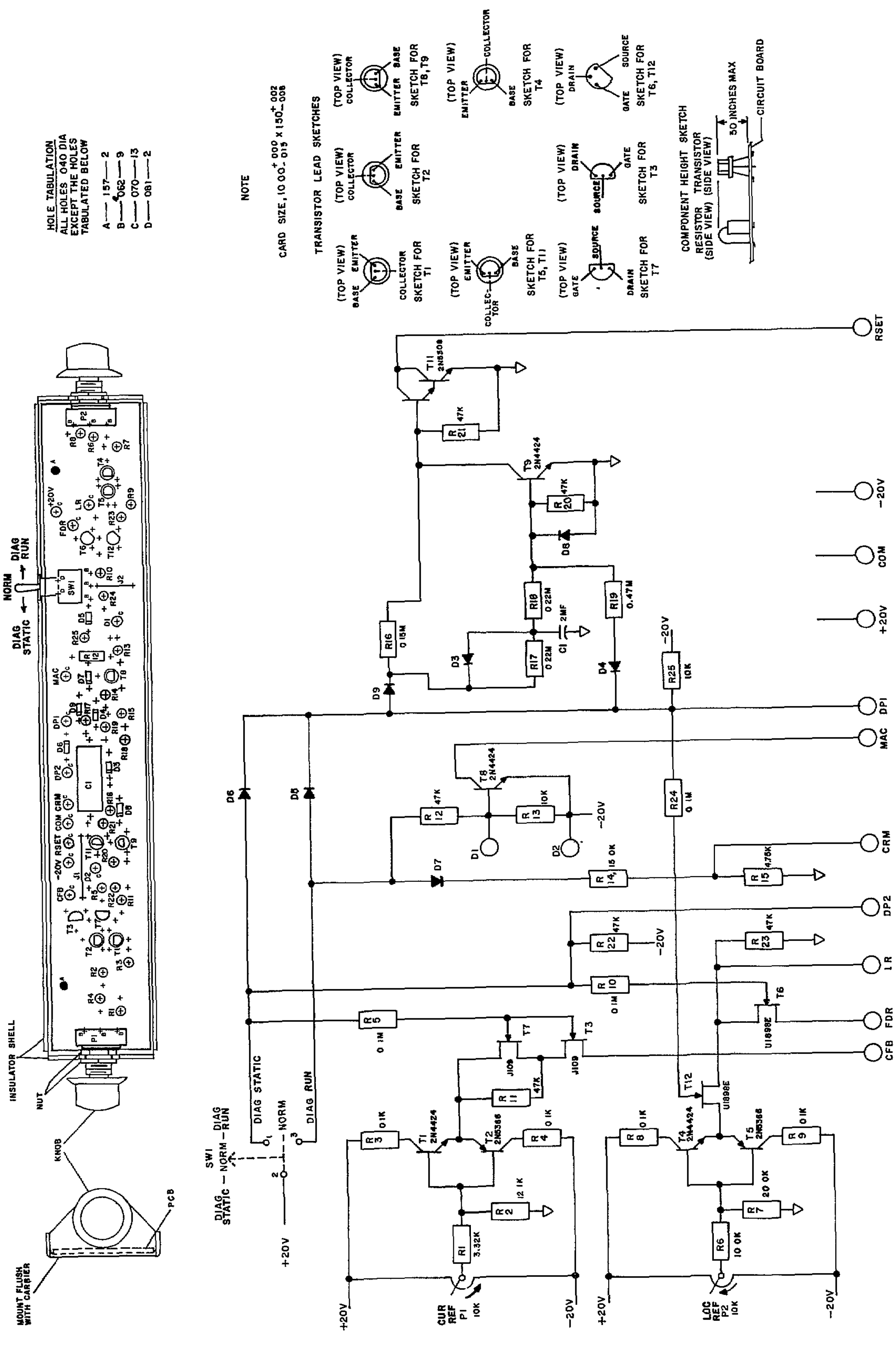
AT1 — AT2 – (RECTIFIED TACH FEEDBACK)
CF — CFN, CFP — COM – (NEG IR COMPENSATION)

2 DM1-ILA – ADD JUMPER FOR REMOTE CURRENT LIMIT

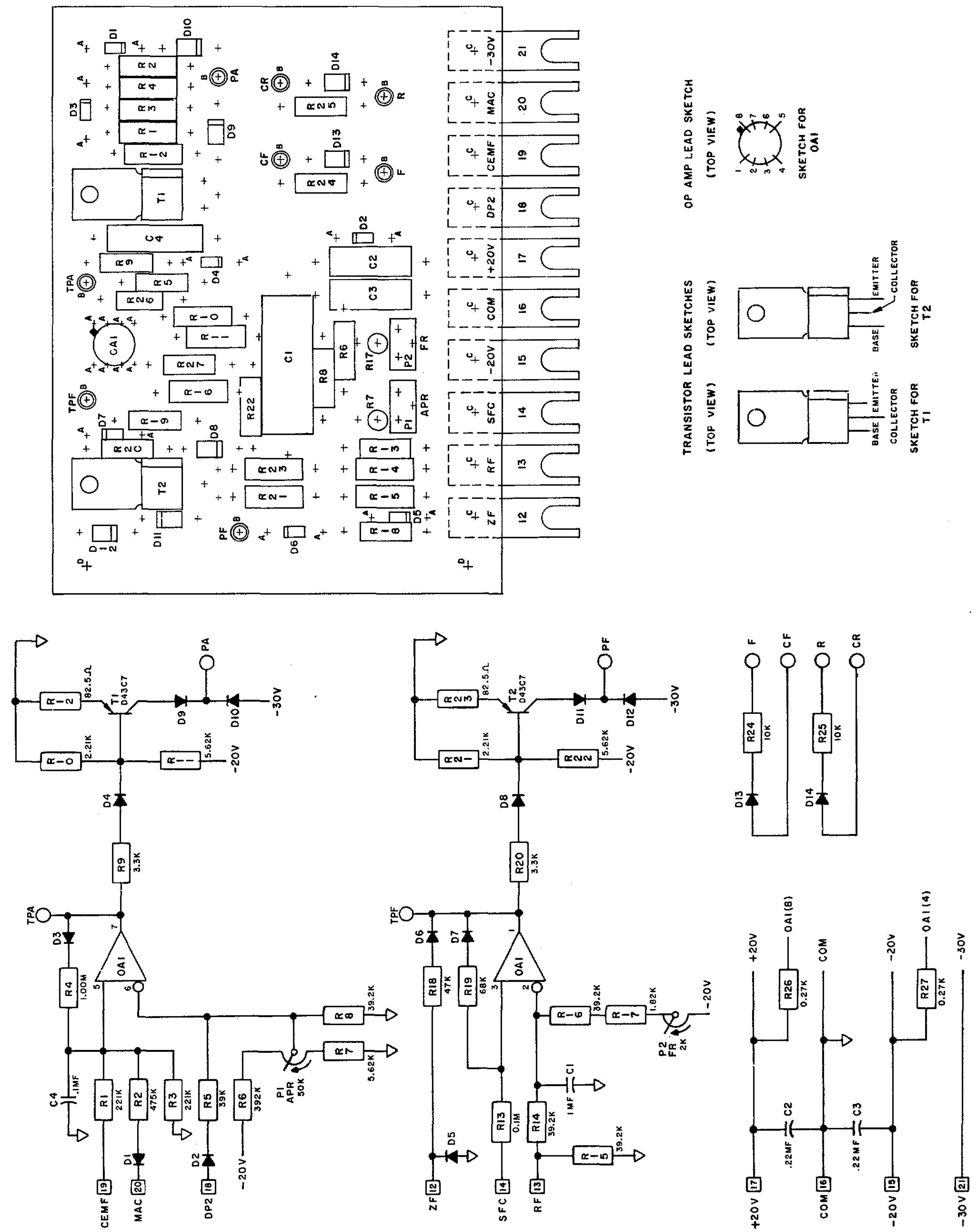
DM2-FEA – ADD JUMPER FOR DELAYED FIELD ECONOMY

3 332-Ω RESISTOR LTR FROM LT1 TO COM FOR 2-60 SEC LINEAR TIME RANGE

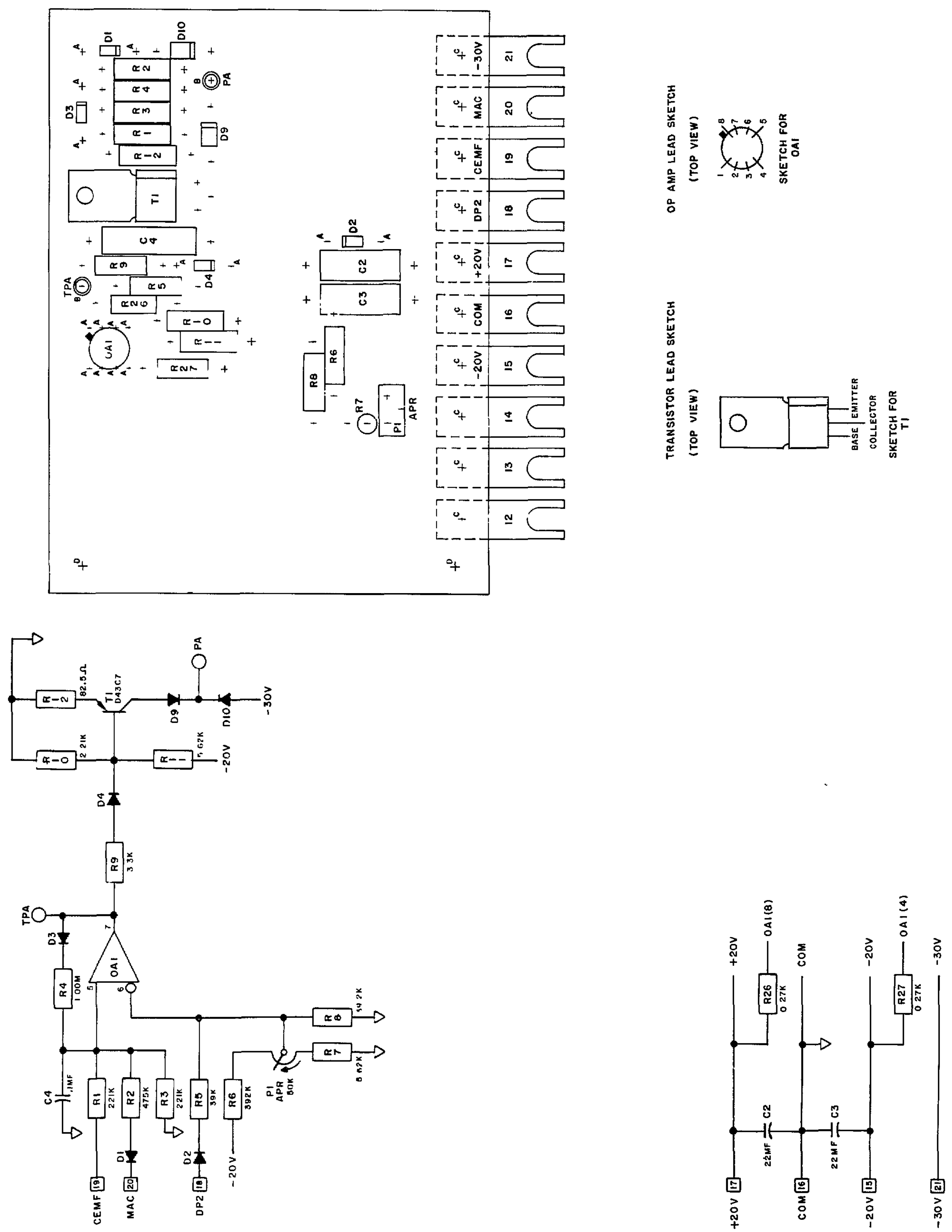
MAIN CONTROL CARD



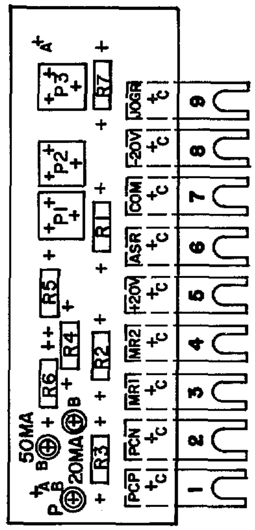
DIAGNOSTIC CARD

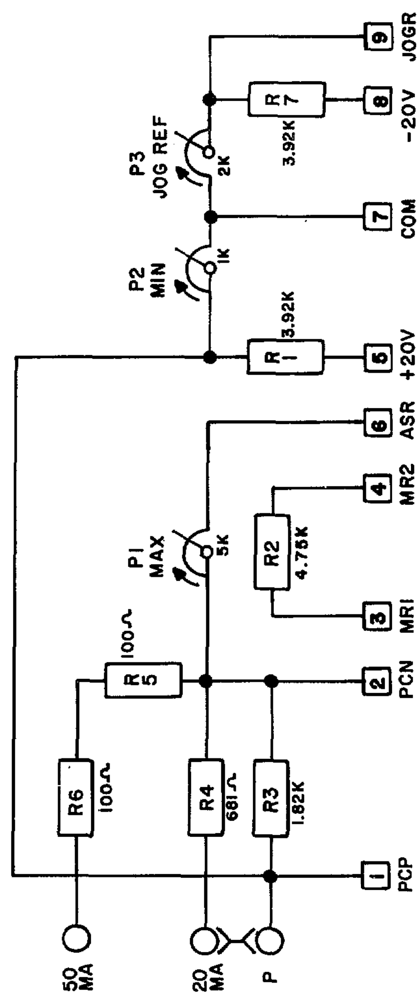


FIELD REVERSING/ANTI-PLUGGING CARD

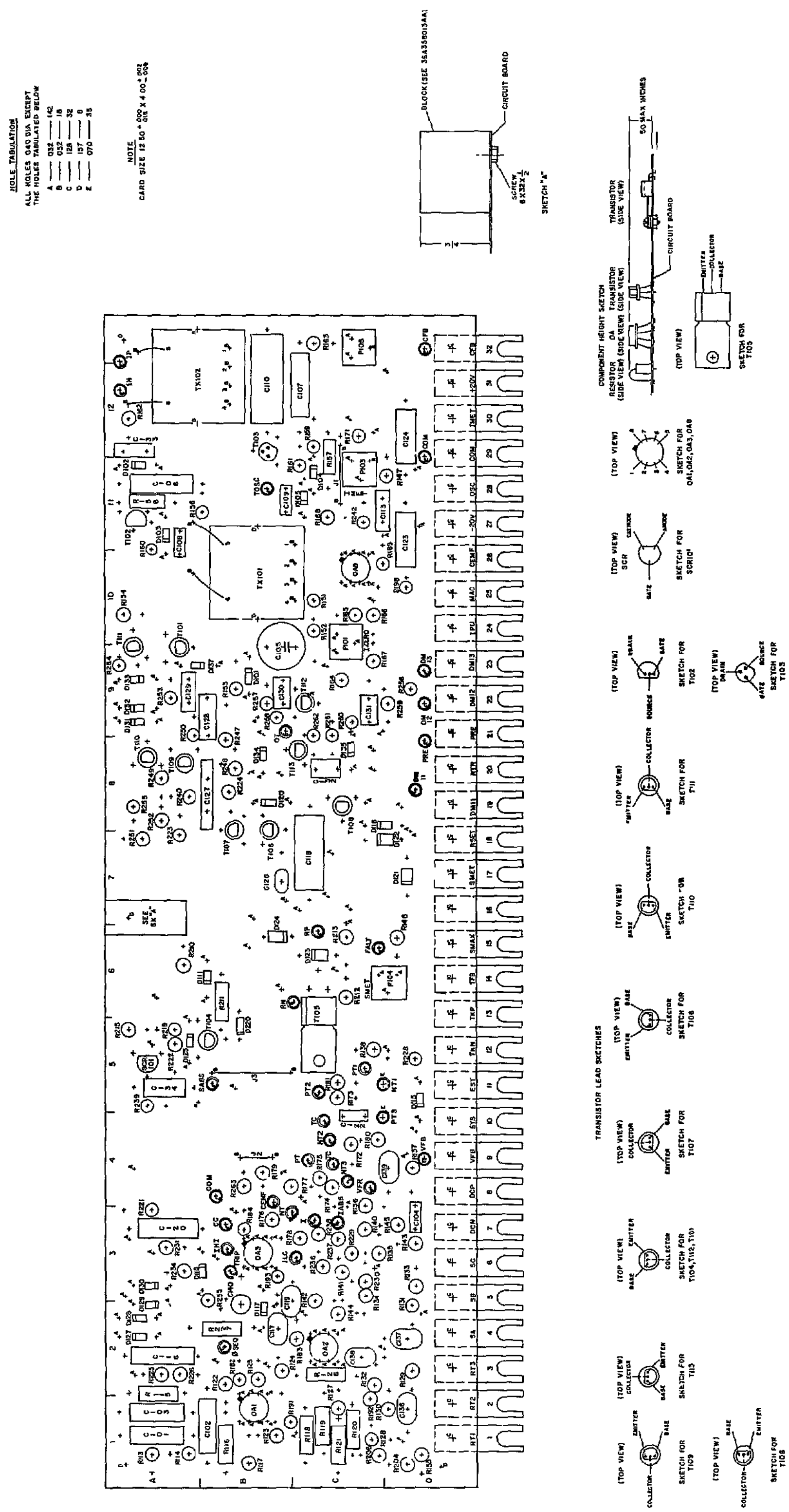


ANTI-PLUGGING CARD

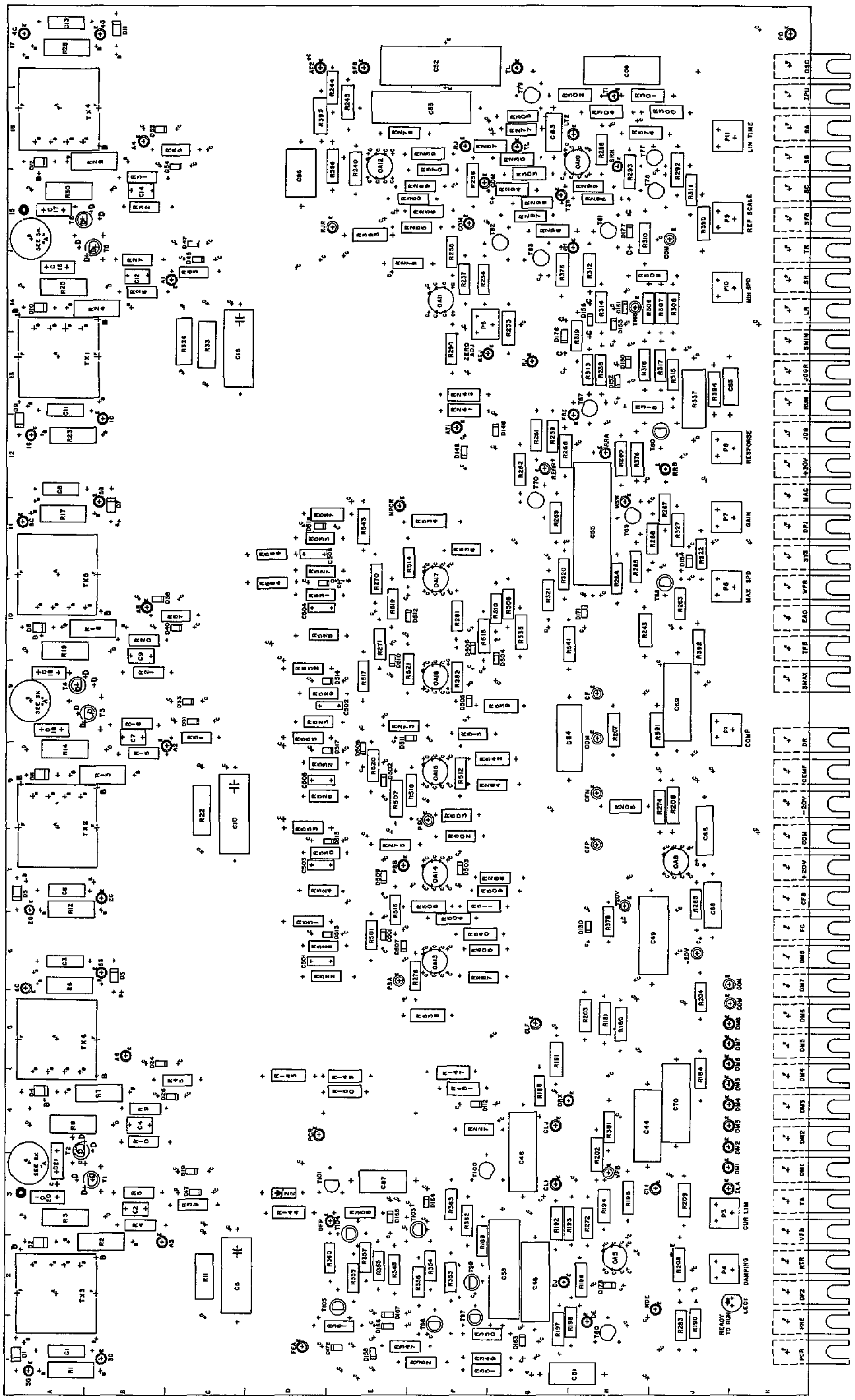


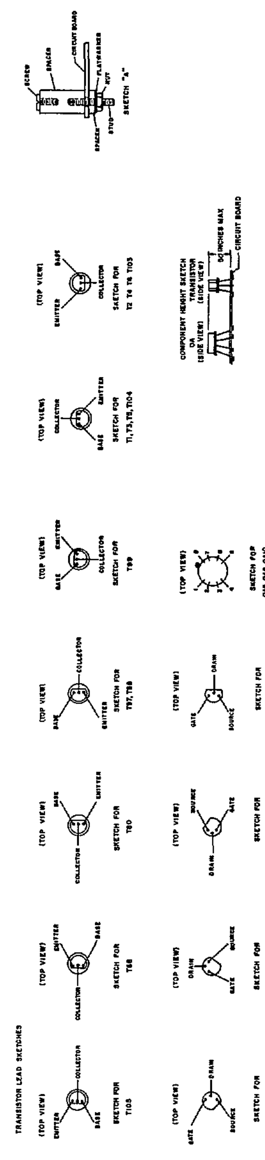


PROCESS CONTROL FOLLOWER/JOG REF CARD



INTERFACE CARD





MAIN CONTROL CARD

SPARE AND RENEWAL PARTS

PRINTED CIRCUIT CARDS

NAME	CATALOG NUMBER	DESCRIPTION
MCC	193X530BBG01	MAIN CONTROL CARD
IFC	193X528ABG01	INTERFACE CARD
PSC	193X526AAG01	POWER SUPPLY CARD
MFE	193X525ABG01	MOTOR FIELD EXCITER CARD
MFC (2)	193X532ACG04	MOTOR FIELD CONTROL CARD
DGC (1)	193X531ABG01	DIAGNOSTIC CARD
FRC (2)	193X533ABG01	FIELD REVERSING CARD
APC (2)	193X533ABG02	ANTI-PLUGGING CARD (DB AND/OR ARM. REVERSING)
PCF (2)	193X535AAG01	PROCESS CONTROL CARD/JOG REFERENCE
TOC (1)	193X536AAG01	TIMED OVERCURRENT CARD (OVERLOAD PROTECTION)

1 –OPTIONAL CARD
2 –USED WITH MODIFICATION ONLY

SUB-ASSEMBLY AND COMPONENTS (NOT HP RELATED)

PART NAME	CATALOG NUMBER	DESCRIPTION
REPAIR KIT	193X432AAG01	JUMPERS & TERMINATIONS
RELAY – MAX	104X166AA055	24VDC COIL
RELAY - RUN, JOG, VR, VRX	104X166AA049	115VAC COIL
RELAY – APR, FR	104X166AA051	24VDC COIL
CONTACTOR – FC, RC	104X131AB014	FIELD REVERSING
FIELD REV. PANEL – FRP	36C774119ABGO1	
ANTI PLUG PANEL – APR	36C774121AAG01	
TRANSFORMER – CONTROL	104X156CA006	350VA
TRANSFORMER – CONTROL	104X156CA008	100VA
FUSE – CONTROL, 230VAC	104X109AD038	QTY 3, 3.2A
FUSE – CONTROL, 460VAC	104X109AD073	QTY 3, 1.6A
FUSE – POWER SUPPLY CARD	104X109AD026	QTY 2, 1.5ADC
FUSE – POWER SUPPLY CARD	104X109AD075	QTY 1,1.0AAC
FUSE – MFE/MFC CARD	104X109AD076	QTY 3, 15A, 600V
FUSE – BLOWER CONTROL	*104X109AD083 (Preferred)	QTY 3, 3A, 5A, 10A
METAL OXIDE VARISTOR	104X125AD015	MOV – QTY 3 230VAC
METAL OXIDE VARISTOR	104X125AD014	MOV – QTY 3, 460VAC
RC SUPPRESSOR	104X122CA002	115VAC COIL SUPPRESSION
FAN	104X215CA003	
DB CONTACTOR	104X105CA064	
OL RELAY	104X130AA019	BLOWER CONTROL
RC SNUBBER RESISTOR	104X123DA012	40 OHMS, 20 WATT
RC SNUBBER CAPACITOR	104X122AA318	0.2 MFD 1000V

*104X109AD076 (Acceptable Substitute)

SPARE AND RENEWAL PARTS

DRIVE HORSEPOWER RATING, 230VAC/240VDC NEMA 1 FOR DRIVES WITH MODEL NUMBER ENDING WITH - - - - -A1

PART NAME CATALOG NUMBER	5	7½	10	15	20	25	30	40	50	60	75	100
AC POWER FUSE, QTY 3 104X109AF - - - - -	005	005	007	007	010	010	010	012	012	015	015	022
MA CONTACTOR 104X150CA - - - - -	016	016	017	017	018	018	018	019	019	020	020	020
POWER CONV. MODULE 36D877201 - - - - -	DBG01	DBG01	DBG01	DBG01	DBG01	DBG02	DBG02	CBG01	CBG02	CBG02	CBG03	CBG03
SCR CELL, QTY 6 36B605201 - - - - -	ABG02	ABG02	ABG02	ABG02	ABG02	ACG02	ACG02	AAG08	AAG04	AAG04	AAG02	AAG02
CIRCUIT BREAKER 104X202RA - - - - -	G04	G04	G05	G07	G07	G07	G09	G09	G09			
CIRCUIT BREAKER 104X203EA - - - - -										G03	G03	
CIRCUIT BREAKER 104X204EA - - - - -												G03
ARM. REV. CONTACTOR 104X105YA - - - - -	G02	G02	G02	G01	G01	G01	G01					
DB RESISTOR, QTY ( ) 104X136AD - - - - -	(1) 016	(1) 003	(2) 016	(2) 003								
DB RESISTOR, QTY ( ) 104X135AA - - - - -					(3) 011	(3) 011	(3) 043	(3) 042	(3) 009	(3) 031	(3) 031	(3) 046

SPARE AND RENEWAL PARTS

DRIVE HORSEPOWER RATING, 460VAC/550VDC NEMA 1 FOR DRIVES WITH MODEL NUMBERS ENDING WITH A1

PART NAME CATALOG NUMBER	5	7.5	10	15	20	25	30	40	50	60	75	100	125	150	200	250
AC POWER FUSES QTY 3 104X109AR - - - - -	026	005	005	005	007	007	007	007	010	010	010	012	012	017	022	022
MA CONTACTOR 104X150CA - - - - -	016	016	016	016	016	017	017	017	018	018	018	019	019	020	020	020
POWER CONV. MODULE 36D877201 - - - - -	DBG03	DBG03	DBG03	DBG03	DBG03	DBG03	DBG03	DBG03	DBG04	DBG04	CBG04	CBG04	CBG05	CBG05	CBG06	CBG06
SCR CELL, QTY 6 **36B605201 - - - - -**	**ABG01**	**ABG01**	**ABG01**	**ABG01**	**ABG01**	**ABG01**	**ABG01**	**ABG01**	**ACG01**	**ACG01**	**AAG07**	**AAG07**	**AAG03**	**AAG03**	**AAG01**	**AAG01**
CIRCUIT BREAKER **104X202RA - - - - -**	G03	G03	G04	G04	G05	G05	G05	G07	G07	G07	G09	G09				
CIRCUIT BREAKER 104X203EA - - - - -													G03	G03		
CIRCUIT BREAKER 104X204EA - - - - -															G03	G03
ARM. REV. CONTACTOR 104X105YA - - - - -	G02	G02	G02	G02	G02	G02	G02	G01	G01	G01						
DB RESISTOR QTY ( ) 104X136AA - - - - -	(1) 008	(1) 007	(2) 008	(2) 007												
DB RESISTOR QTY ( ) 104X135AA - - - - -					(1) 045	(1) 047	(2) 041	(3) 041	(3) 041	(3) 012	(3) 047	(3) 047	(6) 012	(6) 012	(6) 047	(6) 044

SPARE AND RENEWAL PARTS

DRIVE HORSEPOWER RATING, 230VAC/240VDC NEMA 1 FOR DRIVES WITH MODEL NUMBERS ENDING WITH A2

PART NAME CATALOG NUMBER	5	7½	10	15	20	25	30	40	50	60	75	100
AC POWER FUSE, QTY 3 104X109AG------	005	005	007	007	009	009	015	015	015	021	021	025
MA CONTACTOR 104X105CB------	001	001	002	003	004	005	006	009	010			
MA CONTACTOR 104X150XE------										G03	G03	G03
POWER CONV. MODULE 36D877201-----	DCG05	DCG01	DCG01	DCG01	DCG01	DCG02	DCG02	CBG01	CBG02	CBG02	CBG03	CBG03
SCR CELL QTY 6 36B605201-----	ABG03	ABG02	ABG02	ABG02	ABG02	ACG02	ACG02	AAG08	AAG04	AAG04	AAG02	AAG02
CIRCUIT BREAKER 104X202EA-----	G04	G04	G05	G07	G07	G07	G09	G09				
MOLDED CASE SWITCH 104X203EA-----									G05	G05		
MOLDED CASE SWITCH 104X204EA-----											G05	G05
ARM. REV. CONTACTOR 104X105YA-----	G02	G02	G02	G01	G01	G01	G01					
DB RESISTOR, QTY ( ) 104X136AD-----	(1) 016	(1) 003	(2) 016	(2) 003								
DB RESISTOR, QTY ( ) 104X135AA-----					(3) 011	(3) 011	(3) 043	(3) 042	(3) 009	(3) 031	(3) 031	(3) 046

SPARE AND RENEWAL PARTS

DRIVE HORSEPOWER RATING, 460VAC/550VDC NEMA 1 FOR DRIVES WITH MODEL NUMBERS ENDING WITH - - - - - A2

PART NAME CATALOG NUMBER	5	7.5	10	15	20	25	30	40	50	60	75	100	125	150	200	250
AC POWER FUSES QTY 3 104X109AG - - - - -	003	003	003	005	007	007	007	007	009	009	015	015	015	021	021	025
MA CONTACTOR 104X105CB - - - - -	001	001	001	001	001	002	002	004	004	005	006	010	010			
MA CONTACTOR 104X150XE - - - - -														G03	G03	G03
POWER CONV. MODULE 36D877201 - - - - -	DCGO3	DCGO3	DCGO3	DCGO3	DCG03	DCG03	DCG03	DCG03	DCG04	DCG04	CBG04	CBG04	CBG05	CBG05	CBG06	CBG06
SCR CELL QTY 6 36B605201 - - - - -	ABGO1	ABGO1	ABGO1	ABGO1	ABG01	ABG01	ABG01	ABG01	ACG01	ACG01	AAG07	AAG07	AAG03	AAG03	AAG01	AAG01
CIRCUIT BREAKER 104X202EA - - - - -	G03	G03	G04	G04	G05	G05	G05	G07	G07	G07	G09	G09				
MOLDED CASE SWITCH 104X203EA - - - - -													G05	G05		
MOLDED CASE SWITCH 104X204EA - - - - -															G05	G05
ARM. REV. CONTACTOR 104X105YA - - - - -	G02	G02	G02	G02	G02	G02	G02	G01	G01	G01						
DB RESISTOR QTY ( ) 104X136AA - - - - -	(1) 008	(1) 007	(2) 008	(2) 007												
DB RESISTOR QTY ( ) 104X135AA - - - - -					(1) 045	(1) 047	(2) 041	(3) 041	(3) 041	(3) 012	(3) 047	(3) 047	(6) 012	(6) 012	(6) 047	(6) 044

RECOMMENDED POWER STUD WIRING & TERMINALS

CRIMPING TOOLS FOR POWER STUD WIRING TERMINALS

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

RECOMMENDED POWER STUD WIRING AND TERMINALS
230VAC, 240VDC WITHOUT MDM

Drive HP	Stud. Dia. AC (c)	Stud. Dia. DC	Power Wire (a) Qty. (b)	Power Wire (a) AWG	Power Wire (a) MCM	TERMINAL (AMP SOLISTRAND OR AMPower) GE Cat. No. 104X161AA	TERMINAL (AMP SOLISTRAND OR AMPower) AMP Inc. Cat. No.	TERMINAL (AMP SOLISTRAND OR AMPower) Hole Dia.	Crimping Tool (See tooling sheet)
1-3	#10		1	14		005	34123	#10	Item 1
		.25	1	14		006	34124	.25	Item 1
5	.25		1	14		006	34124	.25	Item 1
		.25	1	12		009	33458	.25	Item 2
7.5	.25		1	10		009	33458	.25	Item 2
		.25	1	10		009	33458	.25	Item 2
10	.25		1	8		012	33461	.25	Item 3
		.25	1	8		012	33461	.25	Item 3
15	.25		1	6		015	33465	.25	Item 3
		.25	1	4		017	33469	.25	Item 3
20	.25		1	4		017	33469	.25	Item 3
		.25	1	3		057	320383	.25	Item 3
25	.25		1	3		057	320383	.25	Item 3
		.25	1	1		021	36917	.38	Item 4
30	.25		1	1		021	36917	.38	Item 4
		.25	1	1/0		021	36917	.38	Item 4
40	.25		1	2/0		023	36923	.38	Item 5
		.25	1	3/0		025	36927	.38	Item 6
50	.25		1	3/0		025	36927	.38	Item 6
		.25	1		250	--	325703	.38	Item 8
60	.38		1		250	--	325705	.50	Item 8
		.38	1		300	--	325805	.50	Item 9
75	.38		1		300	--	325805	.50	Item 9
		.38	2	2/0		023	36923	.38	Item 5
100	.38		2	3/0		025	36927	.38	Item 6
		.38	2	4/0		068	321878	.38	Item 7

NOTES:

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

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

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

RECOMMENDED POWER STUD WIRING AND TERMINALS
460VAC, 550VDC WITHOUT MDM

Drive HP	Stud. Dia. AC (c)	Stud. Dia. DC	Power Wire (a) Qty. (b)	Power Wire (a) AWG	Power Wire (a) MCM	TERMINAL (AMP SOLISTRAND OR AMPower) GE Cat. No. 104X161AA	TERMINAL AMP Inc. Cat. No.	TERMINAL Hole Dia.	Crimping Tool See tooling sheet
1-3	#10		1	14		005	34123	#10	Item 1
		.25	1	14		006	34124	.25	Item 1
5	#10		1	14		005	34123	#10	Item 1
		.25	1	14		006	34124	.25	Item 1
7.5	#10		1	14		005	34123	#10	Item 1
		.25	1	14		006	34124	.25	Item 1
10	#10		1	14		005	34123	#10	Item 1
		.25	1	14		006	34124	.25	Item 1
15	.25		1	12		009	33458	.25	Item 2
		.25	1	10		009	33458	.25	Item 2
20	.25		1	10		009	33458	.25	Item 2
		.25	1	8		012	33461	.25	Item 3
25	.25		1	8		012	33461	.25	Item 3
		.25	1	6		015	33465	.25	Item 3
30	.25		1	6		015	33465	.25	Item 3
		.25	1	6		015	33465	.25	Item 3
40	.25		1	6		015	33465	.25	Item 3
		.25	1	4		017	33469	.25	Item 3
50	.25		1	4		017	33469	.25	Item 3
		.25	1	3		057	320383	.25	Item 3
60	.25		1	3		057	320383	.25	Item 3
		.25	1	1		021	36917	.38	Item 4
75	.25		1	1		021	36917	.38	Item 4
		.25	1	1/0		021	36917	.38	Item 4
100	.25		1	2/0		023	36923	.38	Item 5
		.25	1	3/0		025	36927	.38	Item 6
125	.25		1	4/0		068	321878	.38	Item 7
		.25	1		250	--	325703	.38	Item 8
150	.38		1		250	--	325705	.50	Item 8
		.38	2	1/0		021	36917	.38	Item 4
200	.38		2	2/0		023	36923	.38	Item 5
		.38	2	3/0		025	36927	.38	Item 6
250	.38		2	3/0		025	36927	.38	Item 6
		.38	2		250	--	325705	.50	Item 8

NOTES:

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

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

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

RECOMMENDED POWER STUD WIRING AND TERMINALS
230VAC, 240VDC WITH MDM

Drive HP	Stud. Dia. AC (c)	Stud. Dia. DC	Power Wire (a) Qty. (b)	Power Wire (a) AWG	Power Wire (a) MCM	TERMINAL (AMP SOLISTRAND OR AMPower) GE Cat. No. 104X161AA	TERMINAL AMP Inc. Cat. No.	TERMINAL Hole Dia.	Crimping Tool See tooling sheet
1-3	#10		1	14		005	34123	#10	Item 1
		#10	1	14		005	34123	#10	Item 1
5	.25		1	14		006	34124	.25	Item 1
		#10	1	12		009	33458	.25	Item 2
7.5	.25		1	10		009	33458	.25	Item 2
		#10	1	10		009	33458	.25	Item 2
10	.25		1	8		012	33461	.25	Item 3
		#10	1	8		012	33461	.25	Item 3
15	.25		1	6		015	33465	.25	Item 3
		.38	1	4		018	33471	.38	Item 3
20	.25		1	4		017	33469	.25	Item 3
		.38	1	3		019	35184	.38	Item 3
25	.25		1	3		057	320383	.25	Item 3
		.38	1	1		021	36917	.38	Item 4
30	.25		1	1		021	36917	.38	Item 4
		.38	1	1/0		021	36917	.38	Item 4
40	.25		1	2/0		023	36923	.38	Item 5
		.38	1	3/0		025	36927	.38	Item 6
50	.25		1	3/0		025	36927	.38	Item 6
		.50	1		250	--	325705	.50	Item 8
60	.38		1		250	--	325705	.50	Item 8
		.50	1		300	--	325805	.50	Item 9
75	.38		1		300	--	325805	.50	Item 9
		.50	2	2/0		024	36925	.50	Item 5
100	.38		2	3/0		025	36927	.38	Item 6
		.50	2	4/0		--	321880	.50	Item 7

NOTES:

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

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

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

RECOMMENDED POWER STUD WIRING AND TERMINALS

460VAC, 550VDC WITH MDM

						TERMINAL (AMP SOLISTRAND OR AMPower)			
Drive HP	Stud. Dia. AC (c)	Stud. Dia. DC	Power Wire (a) Qty. (b)	Power Wire (a) AWG	Power Wire (a) MCM	GE Cat. No. 104X161AA	AMP Inc. Cat. No.	Hole Dia.	Crimping Tool See tooling sheet
1-3	#10		1	14		005	34123	#10	Item 1
		#10	1	14		005	34123	#10	Item 1
5	#10		1	14		005	34123	#10	Item 1
		#10	1	14		005	34123	#10	Item 1
7.5	#10		1	14		005	34123	#10	Item 1
		#10	1	14		005	34123	#10	Item 1
10	#10		1	14		005	34123	#10	Item 1
		#10	1	14		005	34123	#10	Item 1
15	.25		1	12		009	33458	.25	Item 2
		#10	1	10		009	33458	.25	Item 2
20	.25		1	10		009	33458	.25	Item 2
		#10	1	8		012	33461	.25	Item 3
25	.25		1	8		012	33461	.25	Item 3
		#10	1	6		015	33465	.25	Item 3
30	.25		1	6		015	33465	.25	Item 3
		#10	1	6		015	33465	.25	Item 3
40	.25		1	6		015	33465	.25	Item 3
		.38	1	4		018	33471	.38	Item 3
50	.25		1	4		017	33469	.25	Item 3
		.38	1	3		019	35184	.38	Item 3
60	.25		1	3		057	320383	.25	Item 3
		.38	1	1		021	36917	.38	Item 4
75	.25		1	1		021	36917	.38	Item 4
		.38	1	1/0		021	36917	.38	Item 4
100	.25		1	2/0		023	36923	.38	Item 5
		.38	1	3/0		025	36927	.38	Item 6
125	.25		1	4/0		068	321878	.38	Item 7
		.50	1		250	--	325705	.50	Item 8
150	.38		1		250	--	325705	.50	Item 8
		.50	2	2/0		024	36925	.50	Item 5
200	.38		2	2/0		023	36923	.38	Item 5
		.50	2	3/0		026	36929	.50	Item 6
250	.38		2	3/0		025	36927	.38	Item 6
		.50	2		250	--	325705	.50	Item 8

NOTES:

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

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

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

HOT LINE TELEPHONE NUMBER

The Contract Warranty for Valutrol* -GP drives is stated in the General Electric Apparatus Handbook Section 105, Page 71.

The purpose of the following is to provide specific instructions to the Valutrol* -GP 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) call:

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 the model and serial numbers of the power unit, motor, operators station, or any modification kits.

GLOSSARY OF TERMS

Term	Page
ACM – Auxiliary Control Module	58
ALIGN – Tachometer Loss Align Adjustment	12, 30, 36, 39
APC – Anti-plugging Card	11
APR – Anti-plugging Relay	35, 43
ASR – PCF Output	
* CEMF – Counter EMF	10, 11, 15, 57, 72
* COM – Regulator Common	15, 17, 72
COMP – IR Compensation Adjustment	12, 35, 36, 39, 40
CPT – Control Power Transformer	10, 11
* CFB – Current Feedback	10, 15, 31, 35, 57, 72
CUR REF – Diagnostic Current Reference Potentiometer	35
CROSS – Crossover Adjustment	14, 39
CUR LIMIT – Current Limit Adjustment	12, 35, 39, 40
DA1 – Positive Armature Connection (ACM)	14, 22
DA2 – Negative Armature Connection (ACM)	14, 22
DAMP – Dampening Adjustment	12, 35, 40
DB – Dynamic Braking Contactor	35
Diagnostic – Normal	29, 36
Diagnostic – Run	36
Diagnostic – Static	35
DGC – Diagnostic Card	11, 14, 15
* DM1-DM8 Dummy Input/Output points	15, 48, 72
* DP1-DP2 Diagnostic Switching signals	15, 36, 72
* DR – Driver Reference	10, 15, 36, 57, 72
* EAO – Error Amplifier Output	15, 35, 57, 72
EST – External Fault Stop	17, 57
F – Forward Armature Reversing Contactor	43
F1-F2 – Motor Field Connections	15, 29
* FC – Field Current	15, 57, 72
FC – Forward Field Reversing Contactor	15, 57, 72
FDR – Field Diagnostic Reference	35, 57
FEA – Field Economy Adjust	44, 57
FF – Field Fault	57
FLOSS – Field Loss Adjustment	39, 40
FMAX – Motor Field Maximum Adjustment	36
FMIN – Motor Field Minimum Adjustment	36, 39
FRC – Field Reversing Card	11, 44
GAIN – Speed Loop Gain Adjustment	12, 35, 40
IABS – Current Signal	45, 57
IFC – Interface Card	11, 13, 34
ILA – Current Limit Reference	48, 57
IMET – Current (Load) Instrument **Output** and Adjustment	13, 17, 36, 39, 40, 48, 49, 57
* IPU – Initial Pulse	15, 31, 35, 36, 57, 72
* JOG – Jog Switch Input	15, 18, 57, 72

* Test Points Located on Door Front (See MCC Illustration, Fig. 5 and Fig. 9).

GLOSSARY OF TERMS (Continued)

		Page
*	JOGR–Jog Reference	15, 35, 57, 72
	L1, L2, L3–AC Power Connections	14
	LIN TIME–Linear Timing Adjustment	12, 34, 35, 39, 40
*	LR–Local Reference From DGC	15, 35, 36, 57, 72
	LOC REF– Diagnostic Local Reference Potentiometer	29, 35
	MA–Line Contactor	11, 13, 34
	MAC–MAX Control Signal	15, 17, 34, 43, 57, 72
	MCC–Main Control Card	11, 12
	MCM–Main Control Module	58
	MDM–Modification Module	14, 15, 41, 58
	MAX–Pilot Relay for MA	11, 17
	MAX SPEED–Adjustment	12, 29, 35, 39, 40
	MCC–Main Control Card	12
	MDM–Modification Module	41
	MFC–Motor Field Control Card	11, 13, 19
	MFE–Motor Field Exciter Card	11, 13
	MIN SPEED–Adjustment	12, 39, 40
	MOTOR THSW–Motor Thermal Switch	17, 19, 28, 45, 58
	MOV–Metal Oxide Varistor	14, 19
	MSW–Mode Switch Test Point	57
	OL–Blower Control Overload Relay	17, 28, 45, 58
*	OSC–Oscillator	15, 31, 57, 72
	P1–Motor Thermal Switch Output	22
	P2–Motor Thermal Switch Output	22
	PCF–Process Control Follower/Jog Reference Card	11
	PCP, PCN–Process Control Follower Input Signal	46
*	PCR–Phase Control Reference	15, 35, 57, 72
*	PO–Pulse Outputs	15, 33, 34, 35, 36
*	PRE–Preconditioning	15, 34, 57, 72
	PSC–Power Supply Card	11
	R–Reversing Armature Reversing Contactor	43
	RA1, RA2–Armature Connections (MDM)	14, 22
	RC–Reverse Field Reversing Contactor	44
	REF SCALE–Adjustment	12, 34, 35, 39, 40
	RESPONSE–Speed Loop Response Adjustment	12, 35, 40
	RESET–Pushbutton	30
	RF–Reduced Field Signal	15, 29
	RF1, RF2–Field Connections (MDM)	15, 29
*	RTR–"Ready to Run" Indicator Signal	15, 19, 30, 57, 72
*	RUN–Run Switch Input	15, 17, 34, 72
	SCR–Power Conversion Module	11
*	SA, SB, SC–Synchronizing Signals	10, 15, 32, 34, 72
*	SFB–Speed Feedback	10, 29, 32, 33, 34, 35, 36, 57
	SH–Current Shunt	59
	SLIM–Overspeed Trip Adjustment	36, 39

* Test Points Located on Door Front (See MCC Illustrations, Fig. 5 and Fig. 9).

GLOSSARY OF TERMS (Continued)

*	SMAX–Maximum Speed Adjustment and Output	15, 72
	SMET–Speed Instrument Output and Adjustment	13, 17, 39, 40, 48, 57
*	SMIN–Minimum Speed Reference Adjustment and Input	15, 17, 72
*	SR–Speed Reference	10, 15, 17, 29, 34, 57, 72
*	SYS–System Fault Trip	15, 30, 57, 72
*	TA–Tachometer Align Output	15, 57, 72
*	TFB–Tachometer Feedback Signal	15, 33, 35, 57, 72
	THSW–Drive Thermal Switch	28, 45, 58, 59
	TKN–Negative Tachometer Input	18
	TKP–Positive Tachometer Input	18
	TOC–Timed Overcurrent Card	11, 30, 47
*	TR–Timed Reference	10, 15, 34, 35, 57, 72
*	VFB–Voltage Feedback	10, 15, 31, 35, 57, 72
*	WFR–Weak Field Reference	15, 57, 72
	ZF–Zero Field Signal	59

* Test Points Located on Door Front (See MCC Illustration, Fig. 5 and Fig. 9).

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