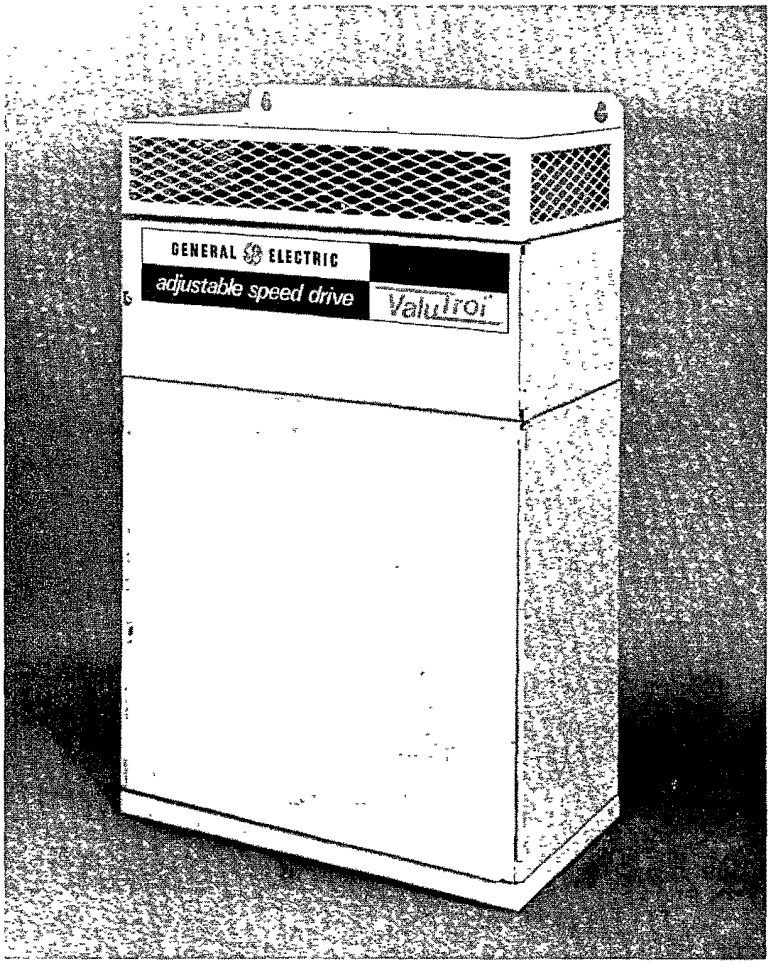
INSTRUCTIONS

GEK-24987B

VALUTROL* INDUSTRIAL DRIVE SYSTEM

FULL WAVE, NON REGENERATIVE

INSTALLATION - OPERATION - MAINTENANCE



(Photo MG-5244-7)

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

GENERAL ELECTRIC

*TRADEMARK OF GENERAL ELECTRIC COMPANY, U.S.A.

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INSTRUCTIONS

VALUTROL DC SCR DRIVES

FULL WAVE, NON-REGENERATIVE

ADD TO PAGE 6 FOLLOWING PARAGRAPH LABELLED "CONNECTIONS."

RECOMMENDED POWER STUD WIRING & TERMINALS

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

CRIMPING TOOLS FOR POWER STUD WIRING TERMINALS

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

RECOMMENDED POWER STUD WIRING AND TERMINALS

230VAC, 240VDC WITHOUT MDM

Drive HP	Stud. Dia. AC	Stud. Dia. DC	Power Wire (a) Qty.	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.	TERMINAL (AMP SOLISTRAND OR AMPower) Crimping Tool
	(c)		(b)						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 SOLISTRAND OR AMPower) AMP Inc. Cat. No.	TERMINAL (AMP SOLISTRAND OR AMPower) Hole Dia.	TERMINAL (AMP SOLISTRAND OR AMPower) 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

						TERMINAL (AMP SOLISTRAND OR AMPower)			
Drive HP	Stud. Dia. AC	DC	Power Wire (a) Qty.	AWG	MCM	GE Cat. No. 104X161AA	AMP Inc. Cat. No.	Hole Dia.	Crimping Tool
	(c)		(b)						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.

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	(c)		(b)						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
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		.50	1		250	--	325703	.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.

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INSTRUCTIONS

GEK-24987

ERRATA SHEET NUMBER 01
AUGUST 12, 1981

VALUTROL INDUSTRIAL DRIVE SYSTEM

Full Wave, Nonregenerative

This Errata Sheet affects instruction book GEK-24987A, dated 2/79. It should be attached to and retained as a part of this publication

This instruction book text should be changed in accordance with information contained in this Errata Sheet.

Page 27
Change MAX SPEED/ALIGN paragraph to read:
MAX SPEED/ALIGN (max speed/tachometer loss align)

Turn MAX SPEED/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.

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LIST OF ILLUSTRATIONS

LIST OF TABLES

*Trademark of General Electric Co., U.S.A.

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 General Electric Company, Speed Variator Products Operation, Erie, Pa. When seeking assistance please use requisition number and model number to identify the equipment. Telephone 814–455-3219.

HANDLING

Wall mounted power units can be transported by lift trucks with the forks completely under the base, 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.

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

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 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 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.

CAUTION

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

NOTE

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

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

CAUTION

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

INSTALLATION

LOCATION

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

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

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

1. Dirt, dust and foreign matter.
2. Vibration and shock.
3. Moisture and vapors.
4. Temperature excursions.

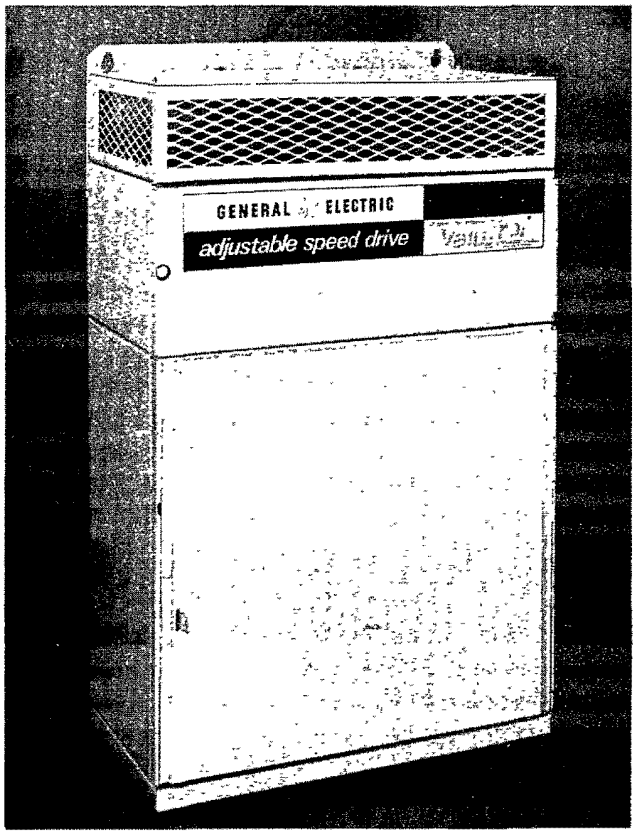
5. Caustic fumes.
6. Power line fluctuations.
7. Electromagnetic interference (noise).

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

A wall mounted power unit enclosure (or floor mounted enclosure) may be placed side by side with another enclosure. Clearance at least equal to the width of the enclosure doors 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.



(Photo MG-5244-6)

FIG. 1. VALUTROL DRIVE POWER UNIT

MOUNTING

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

NOTE

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

AN OPTIONAL MOUNTING ARRANGEMENT IS ALSO AVAILABLE WHICH CONSISTS OF TWO EXTERNAL BRACKETS (ONE AT THE TOP REAR AND ONE AT THE BOTTOM REAR OF THE POWER UNIT ENCLOSURE). EACH BRACKET IS FITTED WITH TWO MOUNTING HOLES FOR EXTERNAL MOUNTING OF THE WALL MOUNTED ENCLOSURE.

CONNECTIONS

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

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

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

NOTE

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

WARNING

ALL MOTOR BASES AND EQUIPMENT ENCLOSURE HOUSINGS SHOULD BE CONNECTED

TO THE FACTORY OR FACILITY EARTH GROUNDING SYSTEM.

NOTE

IT IS RECOMMENDED THAT THE DRIVE SYSTEM COMMON CIRCUIT BE GROUNDED AT ONLY ONE POINT. 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 OR SCR'S OPERATED.

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).

FAN 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 filter, flush only with warm water, dry and recoat lightly with RP super filter coat or equivalent (light oil) or replace with 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.

DC MOTORS ARE NOT DESIGNED FOR FULL FIELD EXCITATION AT STAND STILL FOR EXTENDED PERIODS OF TIME (SEVERAL

HOURS). UNDER THIS CONDITION, POWER SHOULD BE REMOVED, OTHERWISE THE FIELD COILS WILL BE SUBJECTED TO EXCESSIVE TEMPERATURE AND SUBSEQUENT REDUCED INSULATION LIFE.

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

*Trademark of E. I. DuPont Co.

CONTROL DEVICES

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

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

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

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

INSTRUCTION INFORMATION

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

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 Drive 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.

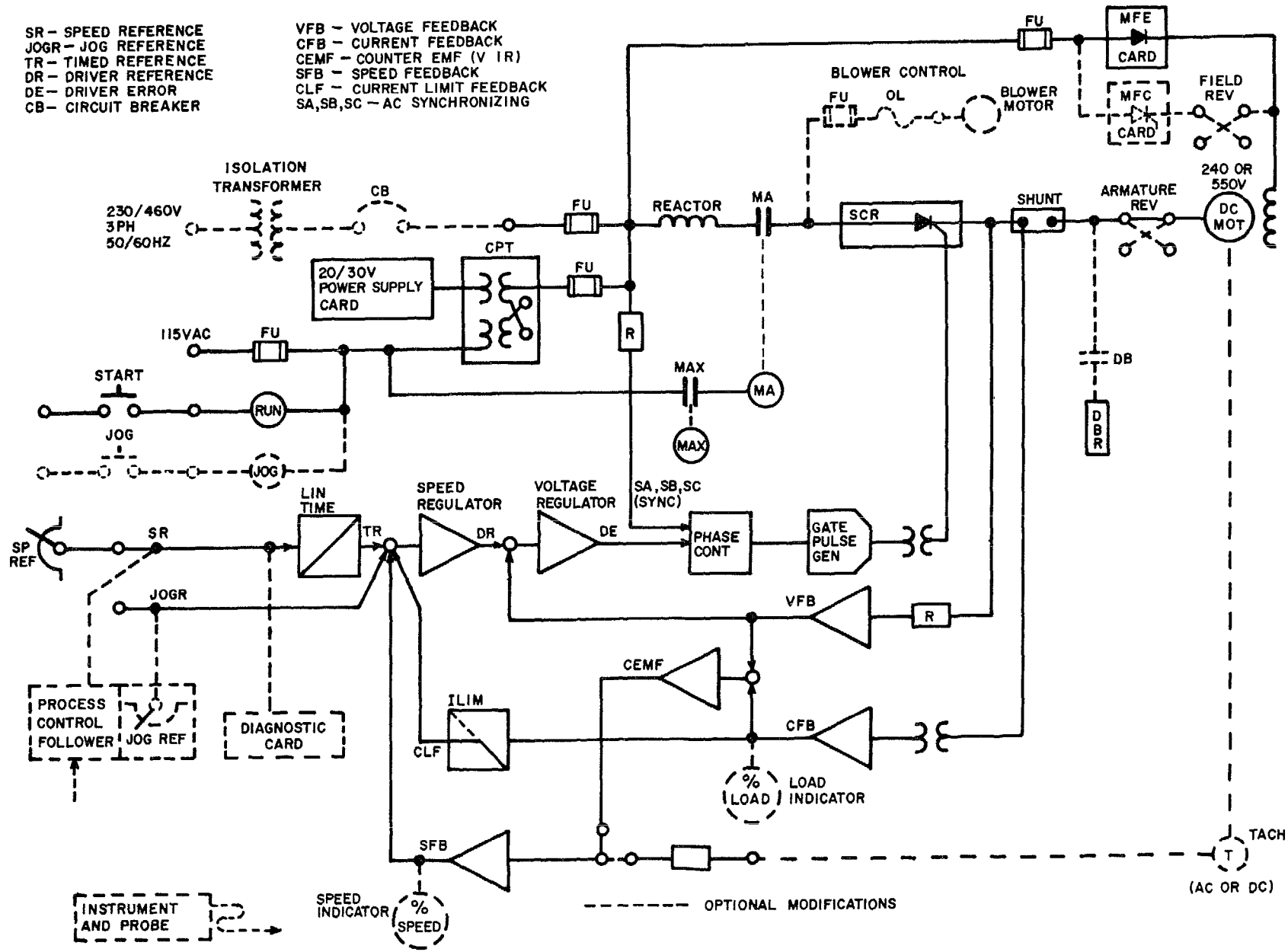


FIG. 2. VALUTROL DRIVE BLOCK DIAGRAM

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.

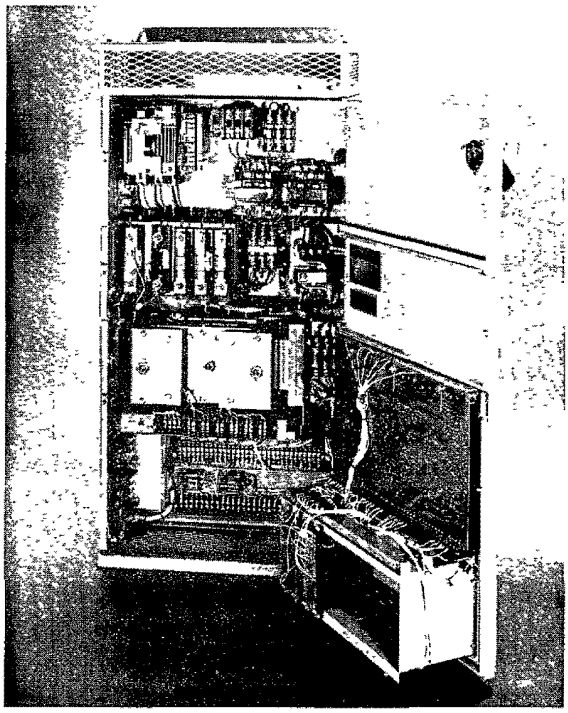
The Elementary diagrams represents (in symbolic form) the fundamental operation and relationship of the electrical parts of a system. These diagrams are drawn in such a manner that the operation of the control system is easily understood. Mechanical relationships of control devices are subordinated to simple presentation of the electrical circuits. Connections made between control devices and power devices within the enclosure are also shown 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. On more complicated systems a separate Interconnection diagram will be furnished, which will show the type and number of connections to be made between major components of the system such as the power unit, motor, operator's station, the plant power source, auxiliary devices and other electrical machines. In some cases the Interconnection information may be presented in tabular form.

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). A fifth card, the diagnostic card is also available as an optional modification.



(Photo MG-5274-4)

FIG. 3. VALUTROL DRIVE POWER UNIT (DOORS OPEN)

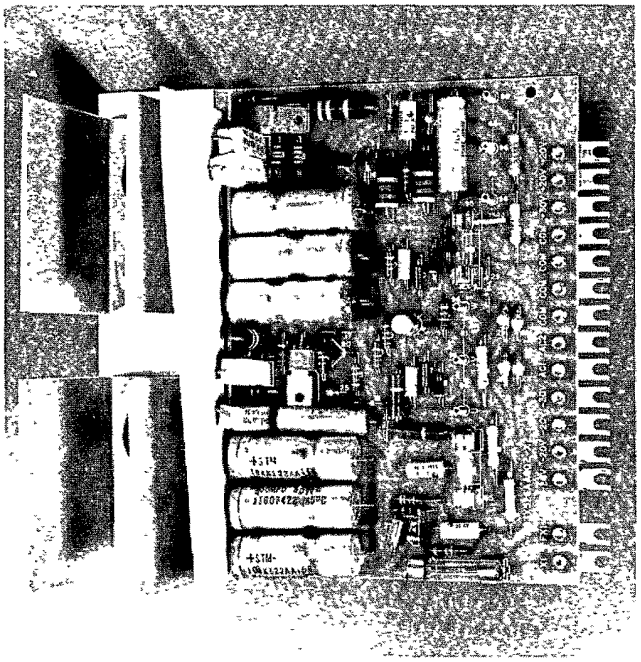
Signal level power for the control is taken from the three phase input through control fuses to the control power transformer. This transformer is fitted with a 460/230V reconnectable primary winding and two isolated secondary windings (1) 115V to operate the coil of the MA contactor, the RUN relay and 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 20 V DC outputs are protected against over voltage conditions caused by a power supply card failure.

MAIN CONTROL CARD (MCC)

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



(Photo MG-5236-20)

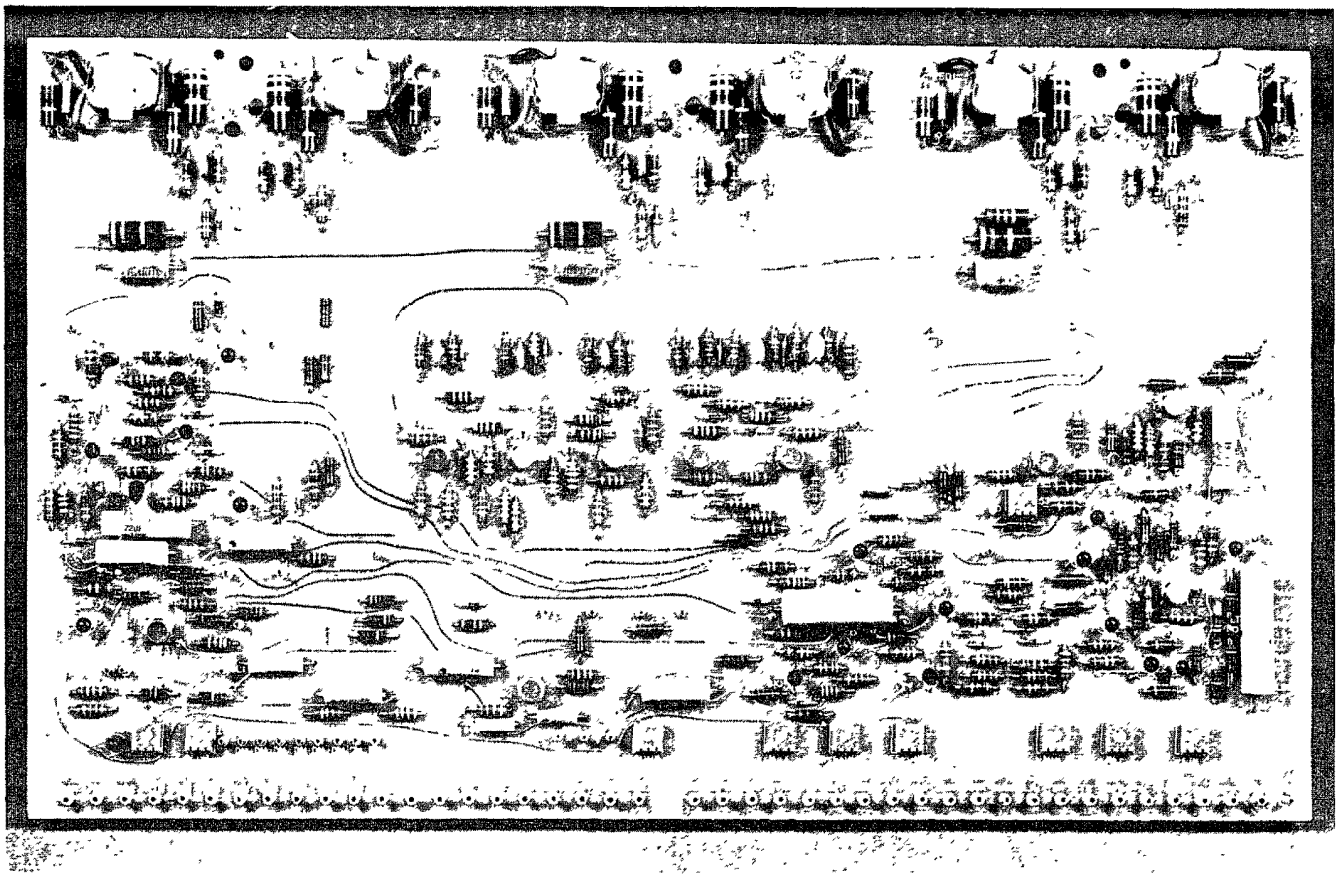
FIG. 4. POWER SUPPLY CARD

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 alligned 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 speed sensitive adjustments in the drive, except the ALIGN adjustment if the MFC card is used.



(Photo MG-5244-8)

FIG. 5. MAIN CONTROL CARD

TEST INSTRUMENT AND PROBE (OPTIONAL)

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

INTERFACE CARD (IFC)

The primary purposes of the interface card are:

1. To provide low level isolated signals corresponding to the three phase AC 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

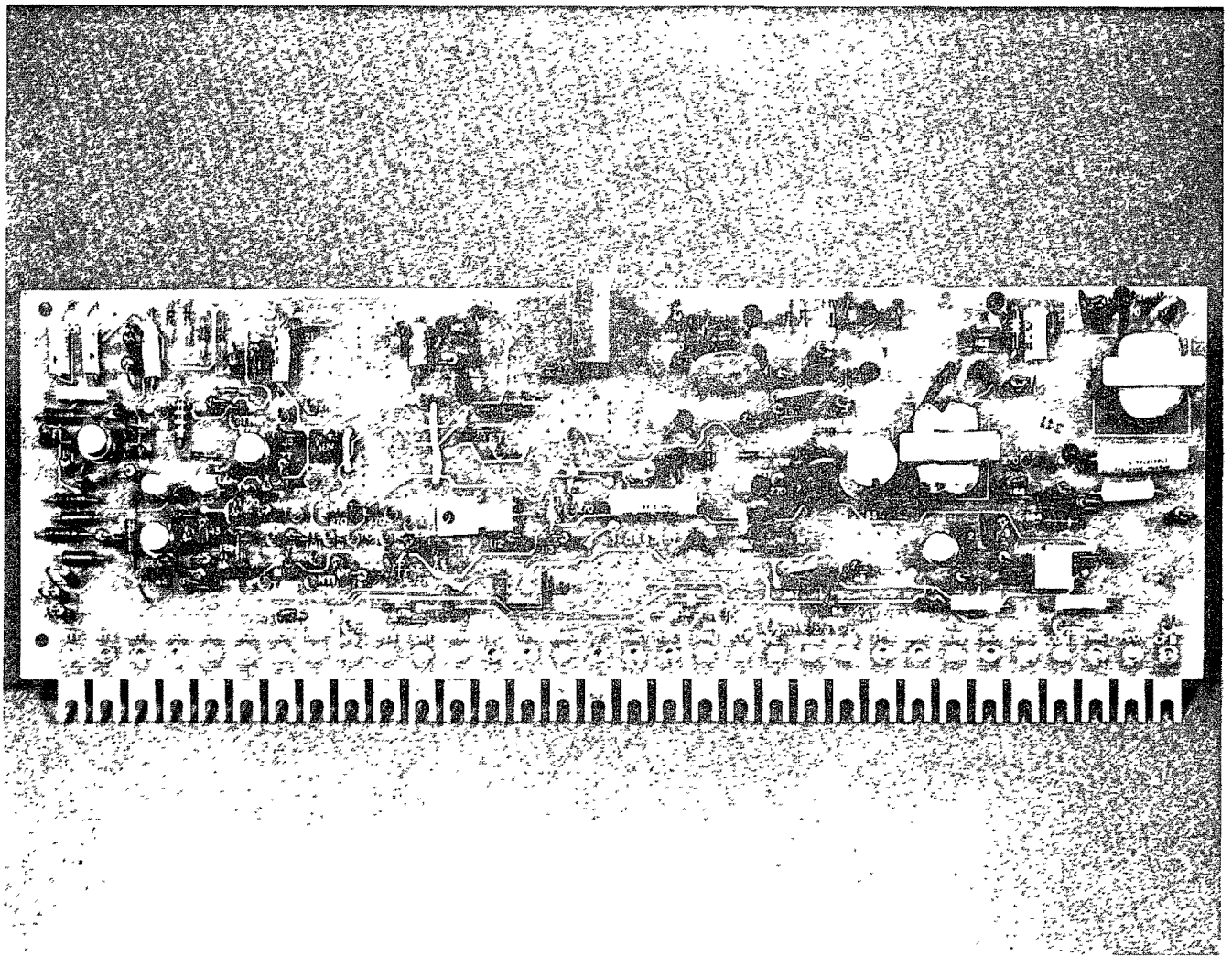
1. A one milliampere signal for the external speed or current indicators (optional).

2. A driver for an external relay with a N/O contact indicating MA closure (MAX).

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).

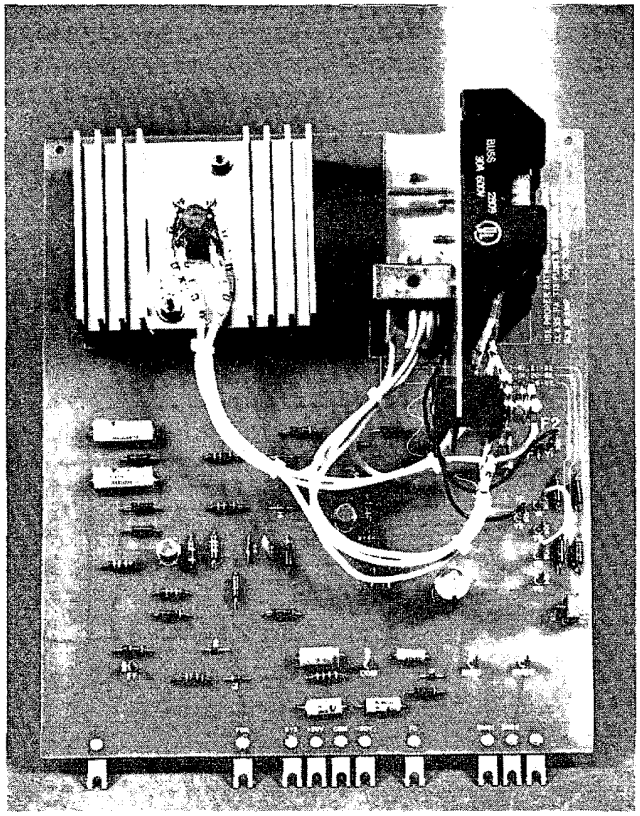


(Photo MG-5244-11)

FIG. 6. INTERFACE CARD

MOTOR FIELD EXCITER CARD (MFE)

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



(Photo MG-5274-3)

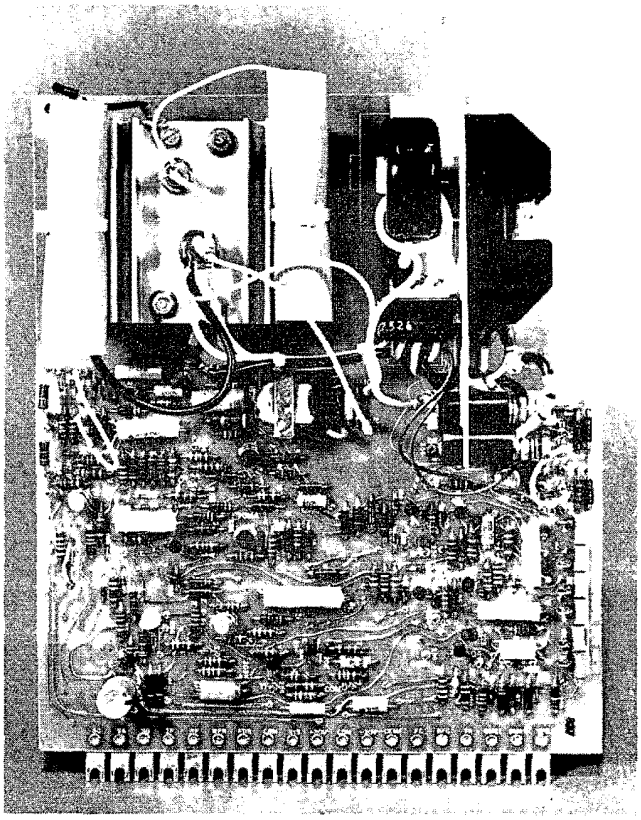
FIG. 7. MOTOR FIELD EXCITER CARD

MOTOR FIELD CONTROL CARD (MFC) (OPTIONAL)

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

Other functions performed by this card include a tachometer monitor circuit to detect the loss of tachometer feedback voltage (over speed) or to detect reverse polarity when a DC tachometer is employed. Loss of motor field is also detected by this card. Any of these faults will shut down the drive. A field economy circuit is also included on this card, which automatically reduces the level of motor field excitation whenever the drive is shut down, thereby avoiding the possibility of excessive temperature (at stand still) and/or reduced insulation life. See GEK-24971 for detailed instructions.

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



(Photo MG-5236-15)

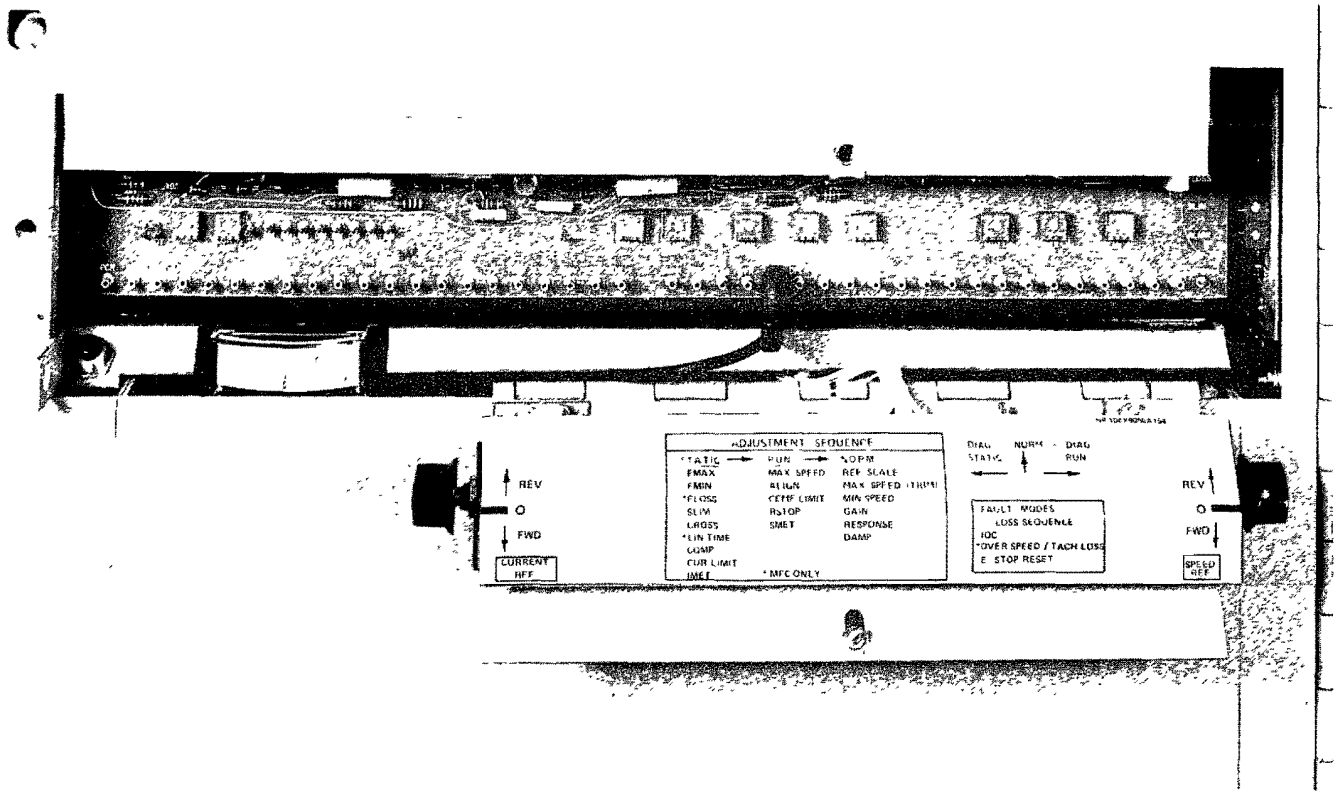
FIG. 8. MOTOR FIELD CONTROL CARD

DIAGNOSTIC CARD (DGC) (OPTIONAL)

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



(Photo MG-5244-13)

FIG. 9. DIAGNOSTIC CARD

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 shunt field connections are at terminals F1 and F2 on the ATB terminal board. The DC armature power connections are DA1 and DA2 on ATB terminal board, or RA1 and RA2 with the MDM.

CONTROL CONNECTIONS

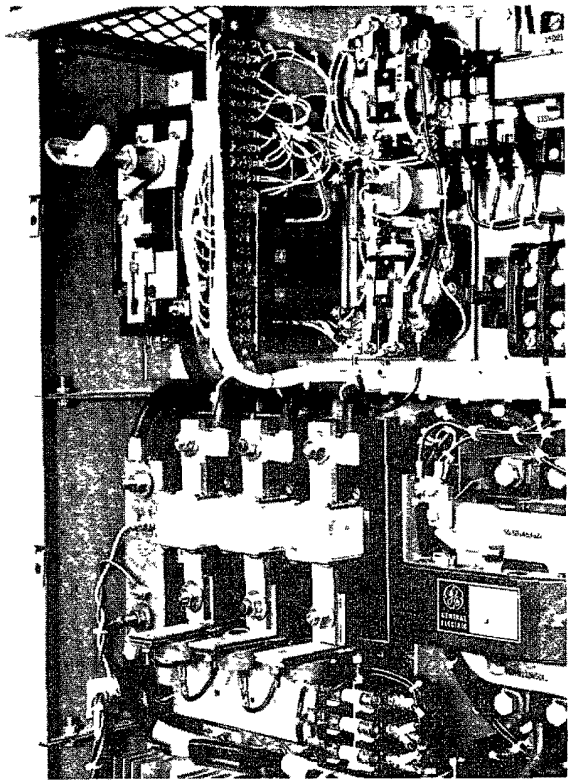
All control connections for a basic drive are located on the 2TB terminal board. The signals appearing on 2TB terminal board and their functions are described in Table III. Refer to system elementary diagram for details.

The JOG and/or Follower Kit are mounted in place of 3TB terminal board. Control connections for additional standard modifications are provided on 4TB terminal board as may be required.

START UP

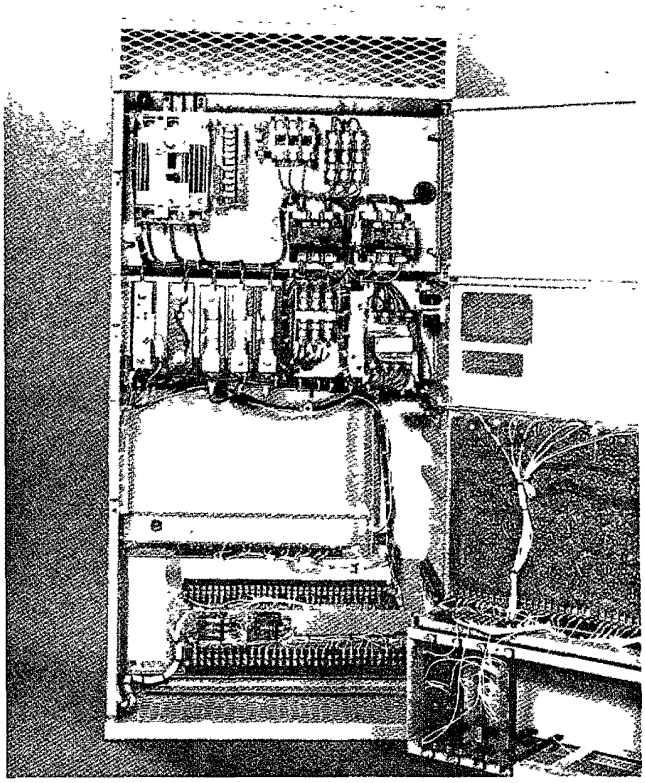
Every Valutrol DC SCR drive has been factory tested and is ready to operate provided the external power and control connections have been properly made and the following step by step procedures are followed:

1. Verify that the terminal board screws are tight.



(Photo MG-5274-7)

FIG. 10. CONTROL FUSES AND MOV'S



(Photo MG-5236-1)

FIG. 11. SIGNAL CONNECTIONS

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.

TABLE III SIGNAL CONNECTIONS

2TB NO.	NOMENCLATURE	DESCRIPTION
1	–30V	Unregulated negative DC voltage used as the return time 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 at the drive coast.
4	OL, THSW	115VAC (FX1) for the STOP/START circuit is applied to 2TB4 through the blower motor overload relay contacts, OL, and the module thermal switch, THSW (when used). If not used, these contacts are replaced by jumpers on terminal board MTB.
5, 6	MAX	A NO, relay contact which actuates when the MA contactor actuates. Pilot duty rating: 0.7 amp holdings, 6 amps 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	FX	The internal 115V AC, fused (1.0A).
11, 12	X2	The internal 115V AC, 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 115V AC).
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 from 2TB(28).
20, 21	+20V, -20V	Regulated power supply outputs.
22	IMET	Output to an optional 1ma load instrument. The instrument is calibrated with the IMET potentiometer on the Interface Card.
23	SMET	Output to a 1ma 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.

TABLE III SIGNAL CONNECTIONS (Continued)

2TB NO.	NOMENCLATURE	DESCRIPTION
28	SR	Speed Reference input.
29, 30	TKP TKN	Input connections for motor mounted tachometer or machine mounted tachometer. NOTE: WITH A DC TACHOMETER, TKP IS POSITIVE FOR FORWARD DIRECTION.
3 17 16	START JOG RUN LATCH	−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). A NO MAX interlock is connected between 2TB(16) & 2TB(15) for holding in the RUN relay while running.
15 7, 18, 19	RUN COIL	With 115V AC applied to 2TB(15) the RUN relay coil is energized. A NO RUN interlock is connected between 2TB(7) and 2TB(18) for latching the RUN relay. A NC APR relay interlock is connected between 2TB(18) and 2TB(19) to provide a start permissive function when the dynamic braking or reversing options are furnished. Refer to the appropriate operator control diagram to see how the interface between external and internal control is accomplished.

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 card.

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

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 FAULT MONITOR SECTION OF THE INTERFACE CARD (IFC) THE "READY TO RUN" INDICATOR ON THE MAIN CONTROL CARD WILL ILLUMINATED. TABLE IV TABULATES THE FAULT CONDITIONS WHICH ARE MONITORED.

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

START

Connect RUN (or JOG) to — 30 volts.

SWITCH LOGIC

RUN or JOG input point on the MCC card will be switched from +30 volts to -30 volts (under purchaser control).

TABLE IV 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. Motor thermo-switch (OL), or module thermo-switch (THSW).

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

** 10. Loss of motor field.

11. External Fault Stop momentarily released from Common.

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

13. System Trip input (SYS) momentarily connected to + 10 volts.

14. RESET button held depressed or RSET input held connected to Common.

15. Diagnostic mode selected with the motor rotating.

16. Oscillator failed "on".

* 17. Tachometer fault (loss of tachometer signal or DC output open).

** 18. Overspeed (or excessive SFB voltage in DIAG. RUN).

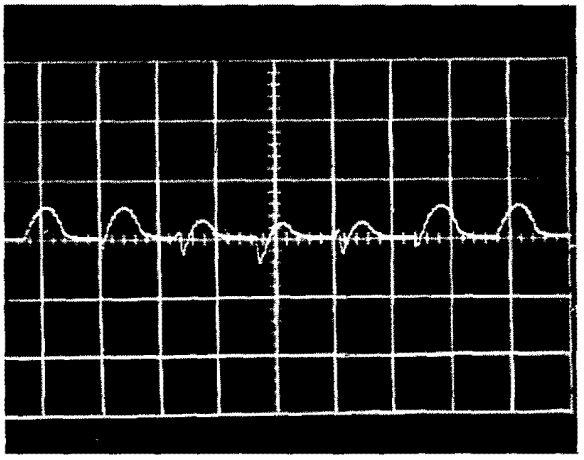
*May not be provided. Refer to instructions on Motor Field Supply and System elementary diagram.
** Can be caused by LOC REF and CUR LIM settings in Static Diagnostic mode.

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

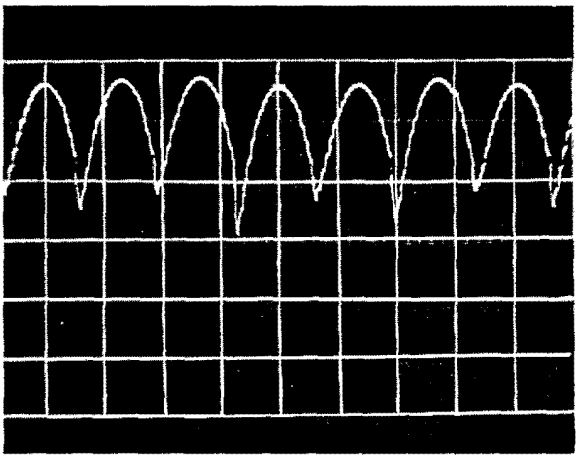
All illustrations were photographed with zero volts on center line at 2 msec per division.



2 msec/div

At low current level 1 volt/division

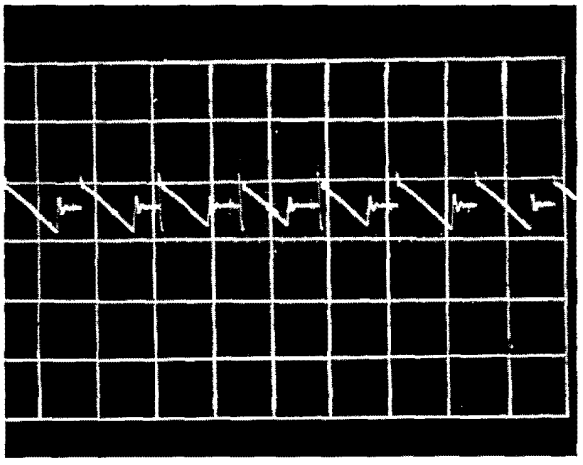
Fig. 12 Current Feedback (CFB) (Inverted)



2 msec/div

At Continuous current 1 volt/division

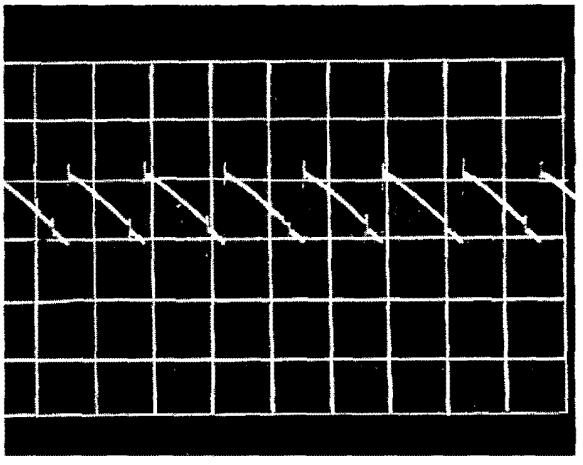
Fig. 13 Current Feedback (CFB) (Inverted)



2 msec/div

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

Fig. 14 Voltage Feedback (VFB) (Inverted)



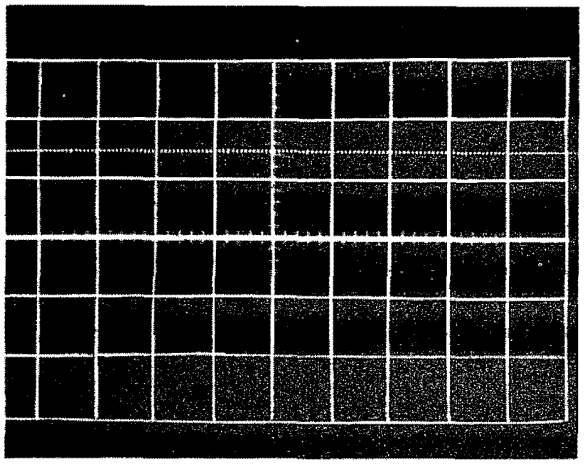
2 msec/div

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

Fig. 15 Voltage Feedback (VFB) (Inverted)

WAVEFORMS

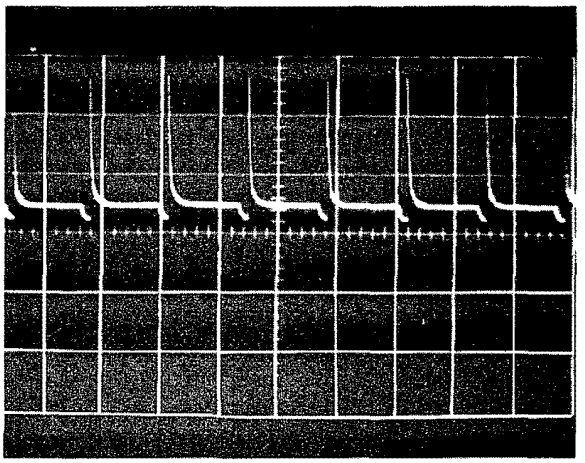
All illustrations were photographed with zero volts on center line at 2 msec per division.



2 msec/div

10 volts/division

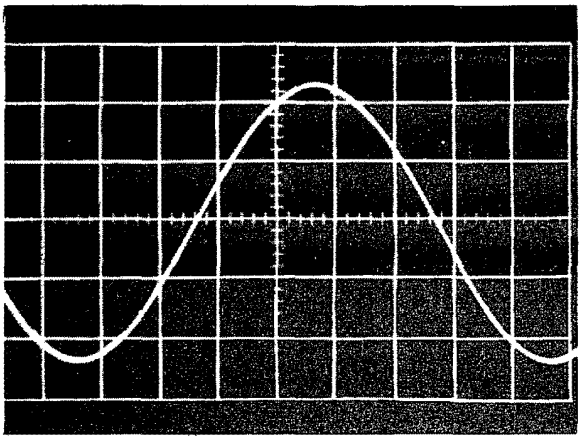
Fig. 16 Oscillator (OSC)



2 msec/div

At 50% output voltage
5 volts/division

Fig. 17 Initial Pulse (IPU)

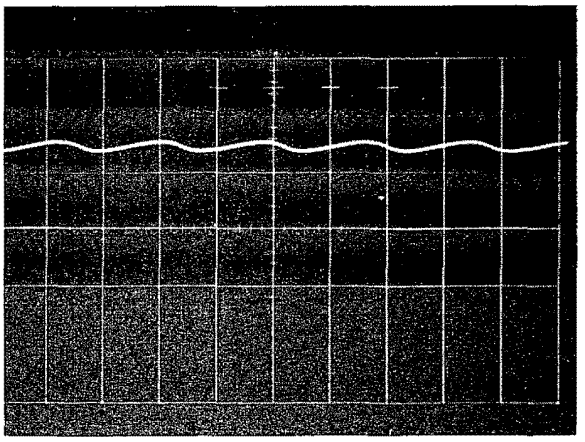


2 msec/div

Typical of SA, SB & SC

SB lags SA by 120°
SC lags SB by 120°
5 volts/division

Fig. 18 Synchronizing Signal (SA)



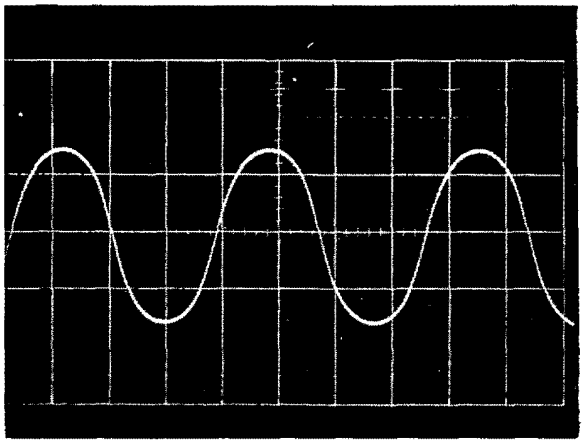
2 msec/div

With an AC tachometer at 450 RPM
1 volt/division

Fig. 19 Speed Feedback (SFB)

WAVEFORMS

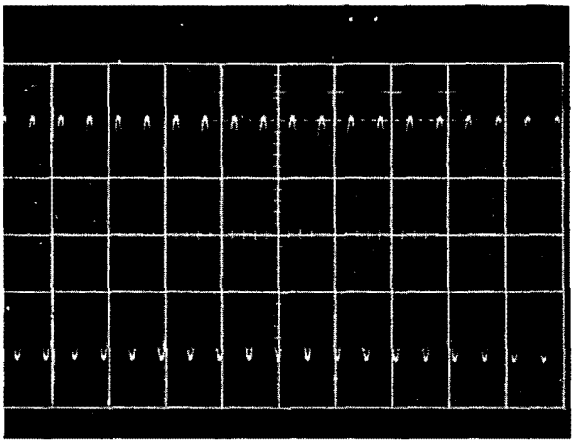
All illustrations were photographed with zero volts on center line at 2 msec per division.



2 msec/div

With an AC Tachometer at 450 RPM
1 volt/division

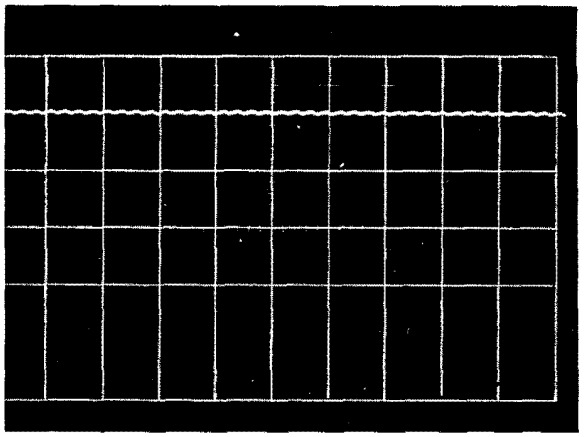
Fig. 20 Tachometer Feedback (TFB)



2 msec/div

With an AC Tachometer at 3160 RPM
5 volts/division

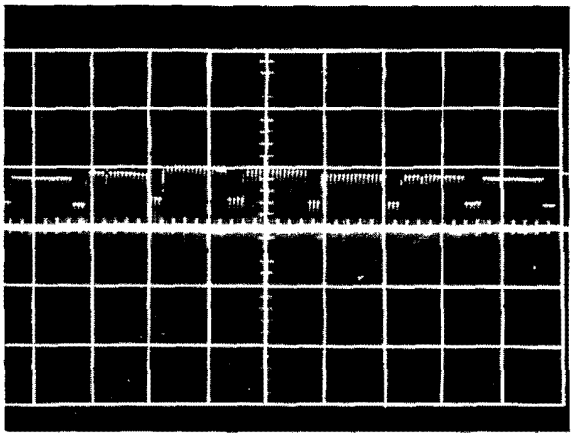
Fig. 21 Tachometer Feedback (TFB)



2 msec/div

With an AC Tachometer at 3160 RPM
5 volts/division

Fig. 22 Speed Feedback (SFB)



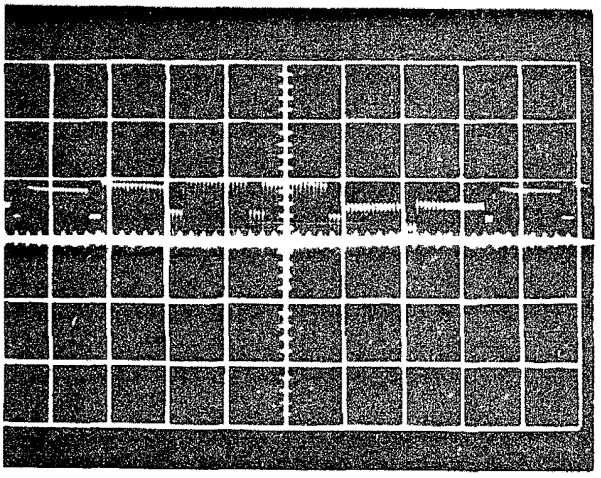
2 msec/div

Normal at 20% output volts.
0.5 volt/division

Fig. 23 Pulse Output (PO)

WAVEFORMS

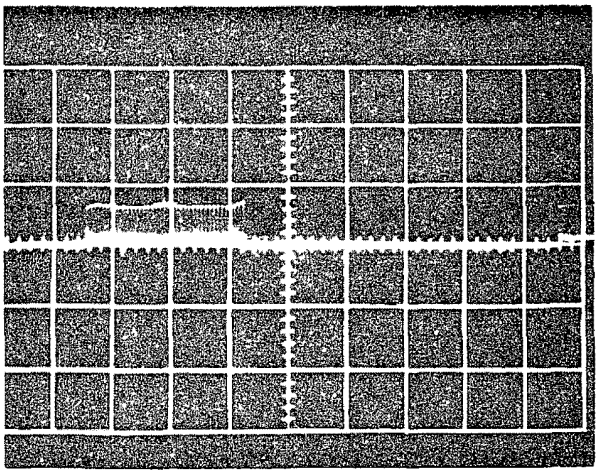
All illustrations were photographed with zero volts on center line at 2 msec per division.



2 msec/div

With one SCR gate lead open, 50% output volts.
0.5 volt/division

Fig. 24 Pulse Output (PO)



2 msec/div

With 50% output voltage continuous current.
Typical of all six signals.
5 volts/division

Fig. 25 Gate to Cathode Firing Signal 1G-1C

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

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.

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

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

SIGNAL FLOW

If 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 proportioned 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 MCC card. (Ranges 0.3 to 7 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 top speed. MAX SPEED is adjusted to make the actual top speed correspond to the desired top speed. (See Fig. 19 and 22)

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 regualting speed. EAO will not be low when the drive speed is chang-

ing. 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 (± 10%) of 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. 17.

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 the speed is increased but the shape and the amplitude should repeat every 60° (2.8 msec). See Fig. 23 & 24.

STOP

There are two 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 antiplugging 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 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 equal to LR in magnitude but opposite in polarity. The tachometer scaling circuit and output TFB are unaffected by the local reference and will reamin 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 Figs. 12 and 13.

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 oscilloscope, the initial pulse output (IPU) and the pulse output (PO) may be monitered to verify proper operation. See Figs. 17, 23 and 24.

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 potentiometer.

CALIBRATION PROCEDURE

The diagnostic card is used to generate the appropriate test signals and operating modes to calibrate the drive. If a diagnostic card has not been furnished, one may be ordered or the test circuit shown in Fig. 26 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. Refer to the system elementary diagram to determine which is provided.

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).

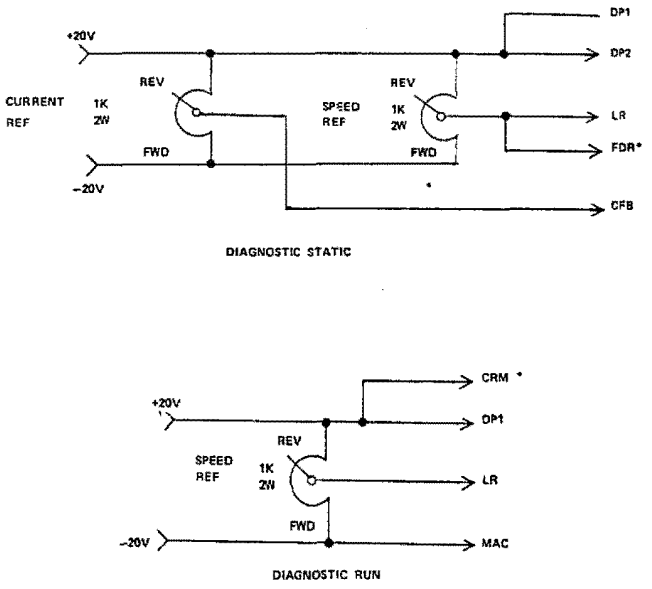


FIG. 26. DIAGNOSTIC TEST CIRCUITS

For Example:

For 460V AC/550V DC drives
Armature volts = 97.8 x VFB (5.62)

For 230V AC/240V DC drives
Armature volts = 43.1 x VFB (5.56)

CALIBRATION WITH MOTOR FIELD CONTROL (MFC)

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

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

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

FMAX (maximum field)

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

FMIN (minimum field — limit)

Set LOC REF potentiometer —6 volts at LR. Adjust FMIN until FC corresponds to minimum 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.

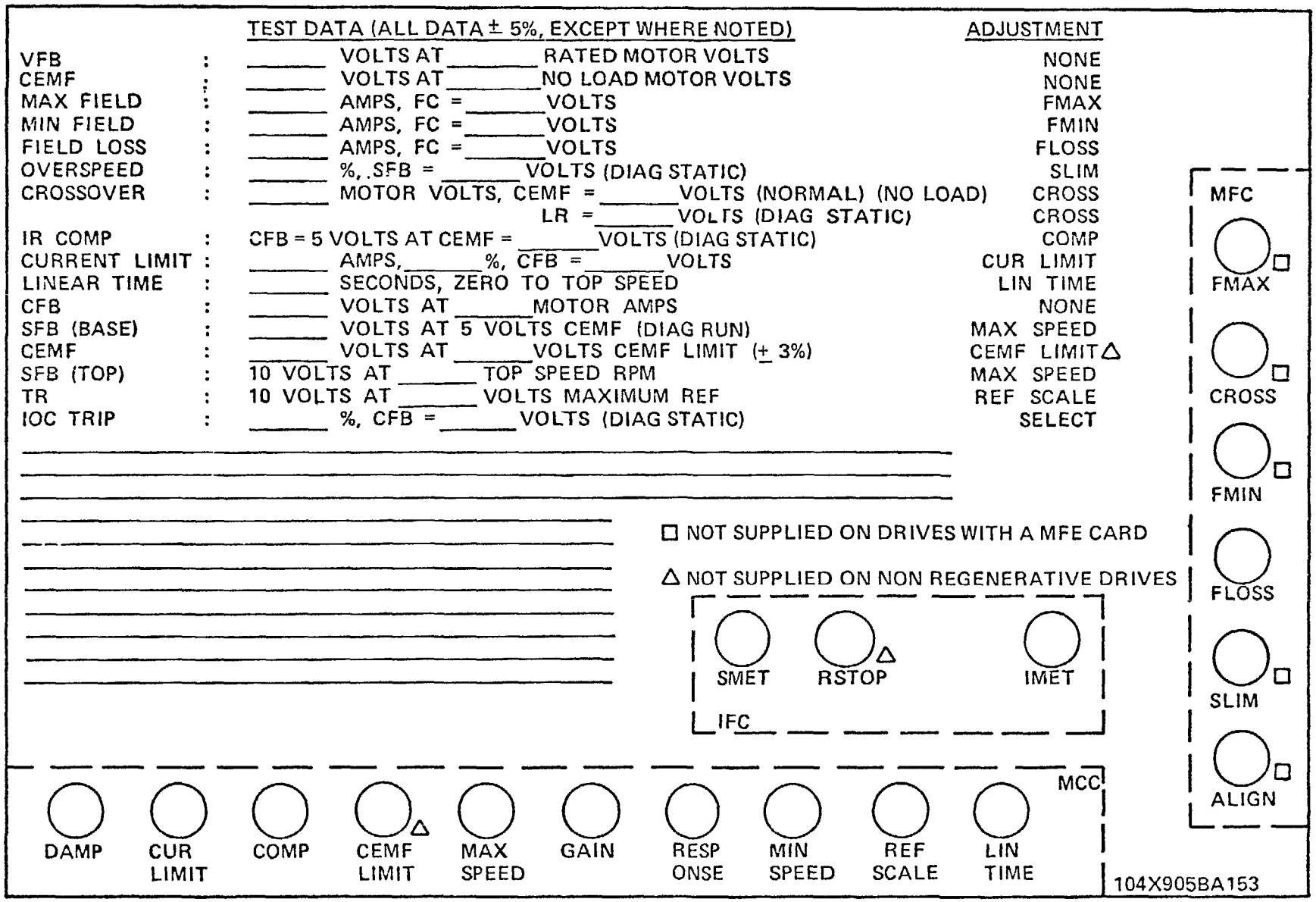


FIG. 27. TYPICAL TEST DATA SHEET

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 volts). 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 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 minimum speed requirements.

GAIN, RESPONSE, DAMP (stability adjustments)

The GAIN adjustment 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). Adjustment 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 re-check 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 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).

TROUBLE SHOOTING

Although many of the problems which may arise can be effectively located with a multi-meter, an oscilloscope is a very powerful trouble shooting tool. 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. A line synchronizing mode is needed.

PROCEDURES

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

Included in this procedure is the use of the built-in Diagnostic Card (DGC) (or Test Circuit Fig. 26). This is anothe powerful tool for quickly locating drive system.

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

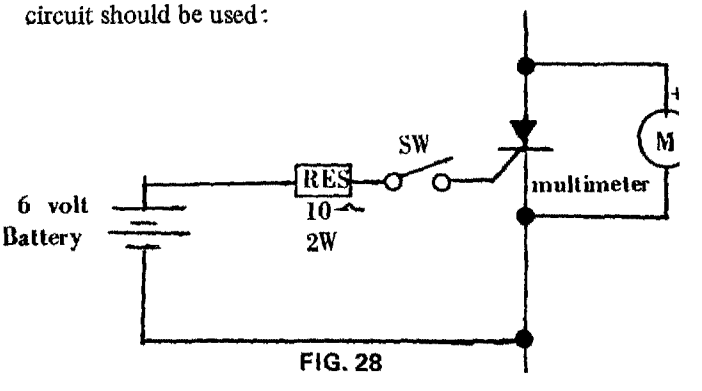


FIG. 28

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 but will remain 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.

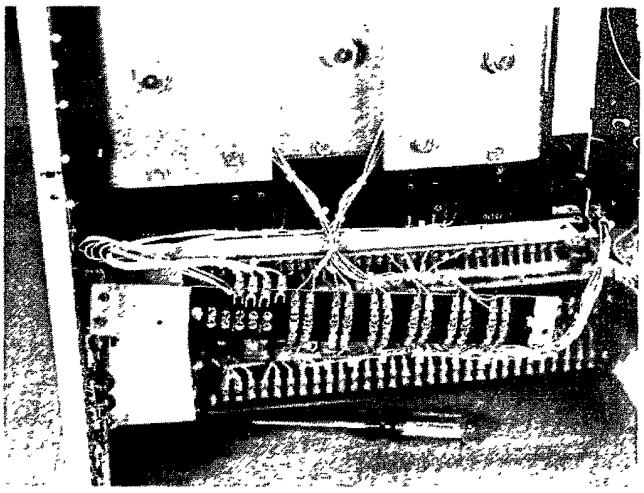
5. Certain SCR problems will only occur after the cell temperature is increased. A recheck of resistances while the SCR module is still hot may indicate a faulty device. Likewise, a "weak" or "leaky" cell may cause its temperature to be excessive during operation. After a shutdown, ***with power disconnected***, 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:

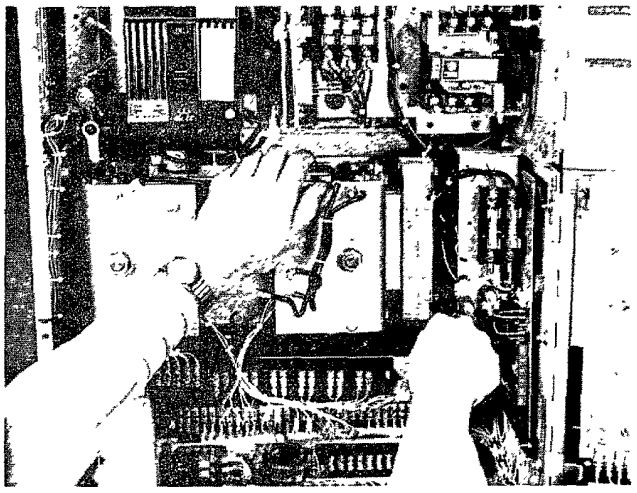
Disconnect the three AC input power and DC output leads as shown.



(Photo MG-5236-7)

FIG. 29 REMOVAL OF GATE LEADS

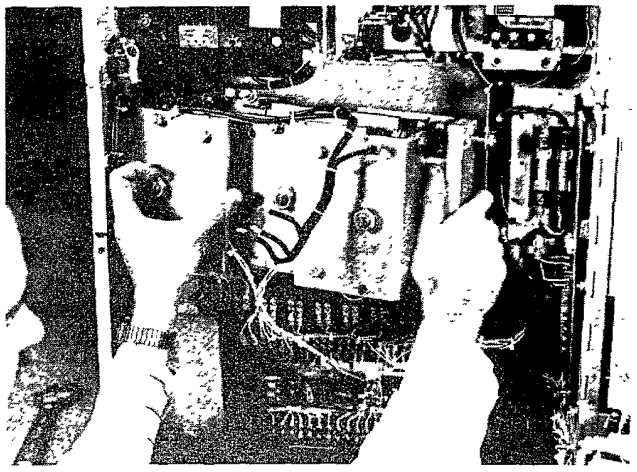
Disconnect the 6 pairs of SCR gate and cathode leads from the terminal board. If markings are not legible, remark prior to removal.



(Photo MG-5236-10)

FIG. 30 REMOVAL OF SLOTTED SPACER

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



(Photo MG-5236-22)

FIG. 31 REMOVAL OF CONVERSION MODULE

Slide module to the right and pull out.

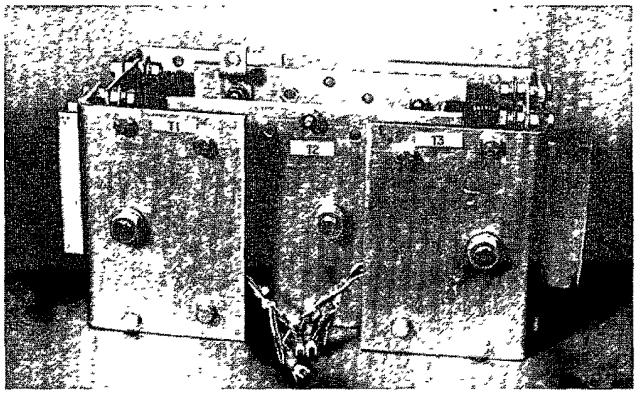
SCR REPLACEMENT

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

STUD MOUNT SCR'S

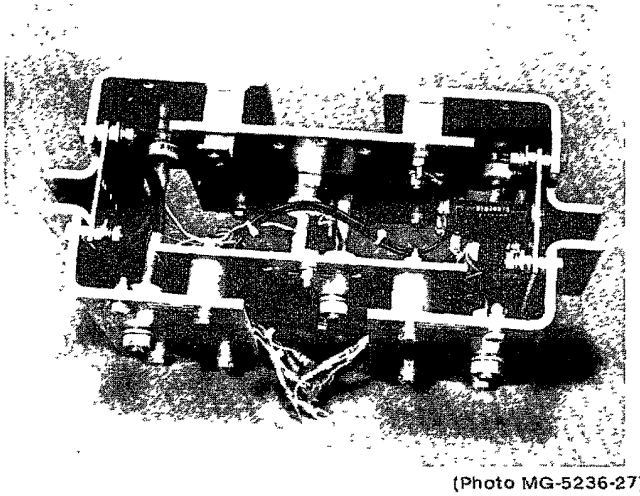
Clean all surfaces of old lubricant and stray dust. Apply a thin film of General Electric G322L VERSILUBE*, lubricant and tighten with a torque wrench to the following specifications:

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



(Photo MG-5236-26)

FIG. 32. STUD MOUNT HEAT SINK (FRONT VIEW)



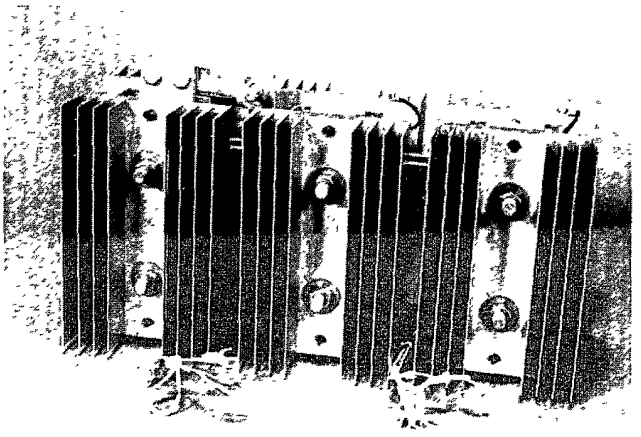
(Photo MG-5236-27)

FIG. 33. STUD MOUNT HEAT SINK (TOP VIEW)

PRESS PAK SCR'S

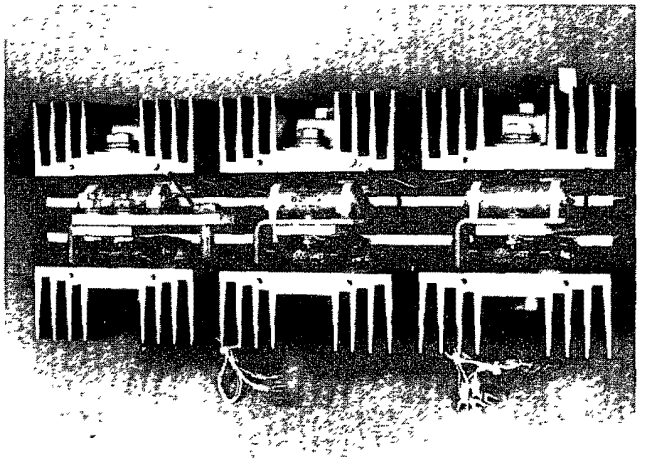
Clean both surfaces of old lubricant and dust. Apply a thin film of General Electric G322L VERSILUBE lubricant. Line up the assembly and evenly tighten the nuts finger tight. Tighten the nuts, one at a time, alternating between nuts according to the following specifications.

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



(Photo MG-5236-24)

FIG. 34. PRESS PAK SCR HEAT SINK (FRONT VIEW)



(Photo MG-5236-18)

FIG. 35. PRESS-PAK SCR HEAT SINK (TOP VIEW)

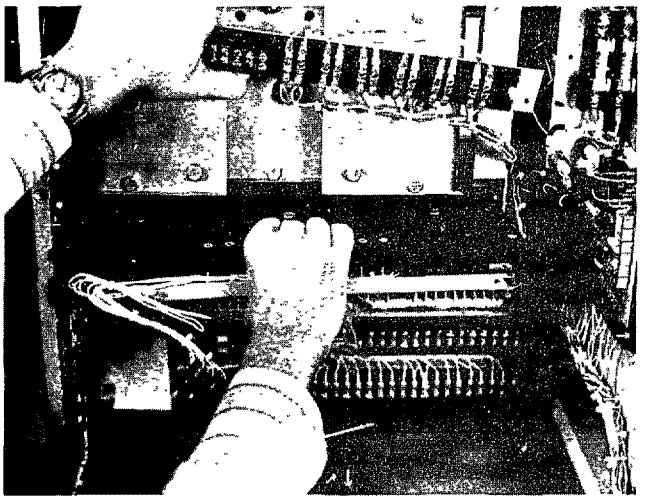
FANS (if supplied)

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.

MOV'S

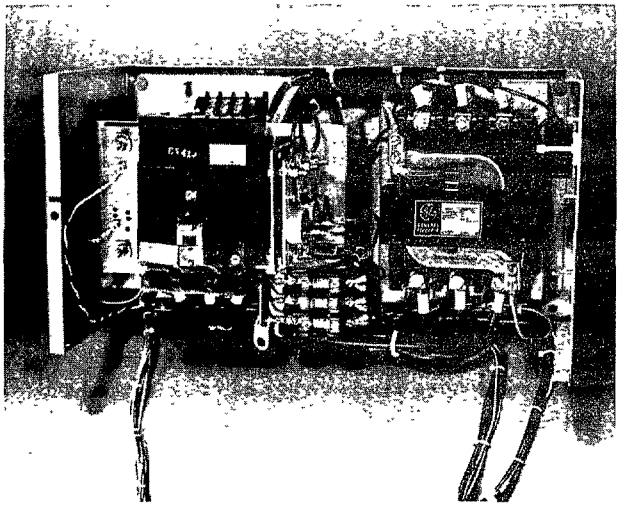
The drives have the MOV assembly screwed to the bottom of the fuse bracket with two screws. Remove these screws and the assembly to gain access to the MOV's.

*Registered Trademark of General Electric Company, U.S.A.



(Photo MG-5236-23)

FIG. 36. REMOVAL OF FANS



(Photo MG-5236-25)

FIG. 37. REMOVAL OF MOV'S (100-125 HP ONLY)

PRINTED CIRCUIT CARDS

NOTE

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

1. ADD STAB ON JUMPERS TO THE REPLACEMENT CARD JUST LIKE THE JUMPERS ON THE CARD THAT WAS REPLACED OR AS LISTED ON THE SYSTEM ELEMENTARY DIAGRAM "PROGRAMMING" TABLE.

2. ADD STAB ON RESISTORS AND CAPACITORS TO THE REPLACEMENT CARD JUST LIKE THE COMPONENTS ON THE CARD THAT WAS REPLACED OR AS SHOWN WITH VALUES ON THE SYSTEM ELEMENTARY MAIN CONTROL CARD (MCC) AT STAB ON TERMINALS TL, RJ, SFB, NDE, CL1 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 TO THE POSITION AS WAS SET TO THE 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.

HOT LINE TELEPHONE NUMBER

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

The purpose of the following is to provide specific instructions to the Valutrol drive user regarding warranty administration and how to obtain assistance on out or 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 model and serial numbers of the power unit and the dc motor.

GLOSSARY OF TERMS

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

GLOSSARY OF TERMS (Continued)

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

GENERAL ELECTRIC COMPANY
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GENERAL ELECTRIC

GEK-24987B (6/82) 1M (P)