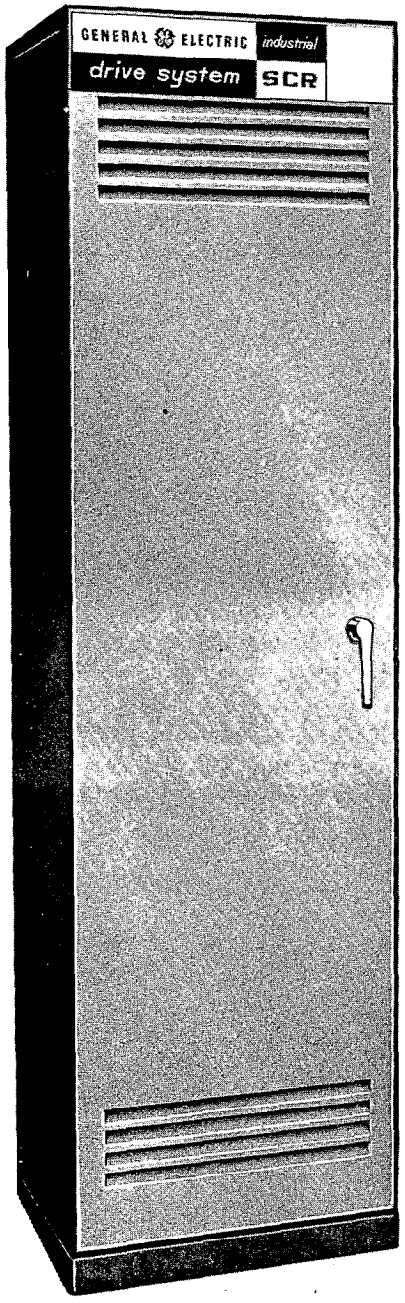
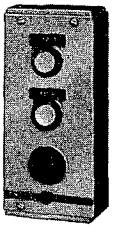
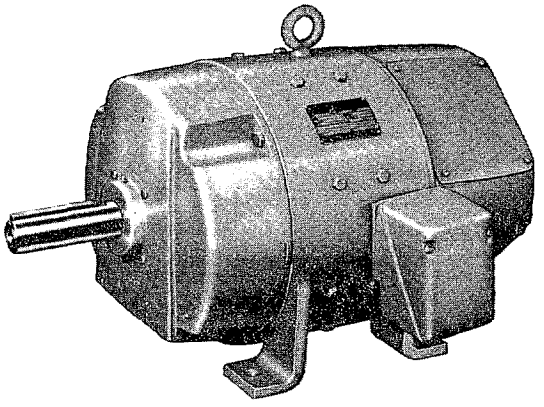
INSTRUCTIONS

GEK-11017A

SILCON VI*
INDUSTRIAL DRIVE SYSTEMS
GENERAL
INSTALLATION - OPERATION - TROUBLE SHOOTING







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 the General Electric Company.

GENERAL ELECTRIC

*Trademark of the General Electric Co.

TABLE OF CONTENTS

WARNING

HIGH VOLTAGE. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. WHETHER THE AC VOLTAGE SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS WITHIN THE SCR DRIVE. EXTREME CARE MUST BE EXERCISED IN THE SELECTION AND USE OF TEST INSTRUMENTS.

OPERATORS SHOULD NOT STAND ON GROUNDED SURFACES OR BE IN CONTACT WITH GROUND WHEN APPLYING TEST INSTRUMENTS TO TEST POINTS. TEST INSTRUMENTS SHOULD NOT HAVE CHASSIS GROUNDED WHILE TESTS ARE BEING MADE. THUS THEIR CHASSIS WILL BE AT A HIGH VOLTAGE WITH RESPECT TO GROUND DURING TESTING. EXTREME CARE SHOULD BE TAKEN WHILE ATTEMPTING TO ADJUST, TROUBLESHOOT OR MAINTAIN ANY DRIVE SYSTEM DESCRIBED HEREIN.

SILCON VI*

INDUSTRIAL DRIVE SYSTEMS

INTRODUCTION

This instruction book contains helpful suggestions for placing Silcon VI drive equipment in service. It contains general information about Silcon VI drive operation and maintenance.

When more specific information is required, those sections applicable will be cross referenced.

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

RECEIVING, HANDLING AND STORAGE

RECEIVING

The equipment must be placed under adequate cover immediately upon receipt as packing cases are **not** suitable for out-of-doors 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 and to the nearest office of the General Electric Company.

HANDLING

The power units can be transported by lift trucks with the forks completely under the base, care being taken that the unit does not tip. All floor mounted power units have lifting lugs located on top of the enclosure at each end, so that they may be readily handled by a crane.

Where the power unit consists of two enclosures bolted together, a lifting beam is provided to prevent buckling during handling.

STORAGE

If the equipment is not being installed immediately, it should be stored in a clean, dry location. Precautions should be taken to prevent moisture from accumulating in the equipment. The entrance of moisture, dust, or dirt during storage or installation is detrimental to the equipment insulation.

DESCRIPTION

The Silcon VI drive is a DC adjustable speed drive which utilized silicon controlled rectifiers for AC to DC voltage conversion.

Controlled DC voltage is supplied to the DC drive motor. This drive motor is available with a variety of speed ranges and enclosures.

The drive speed may be adjusted over a wide speed range by controlling the armature voltage and the motor field current.

A Silcon VI drive consists of the following equipment:

1. **The Silcon VI Drive Power Unit**

   This contains the SCR conversion assembly covered by instruction books GEK 11014A, GEK 11015A, and GEK 11016A, a regulator and the associated power and control components.

2. **The Drive Motor**

   The drive motor is an adjustable speed DC motor. It is covered by instruction book GEH 2304, unless otherwise noted.

3. **The Operator's Control Station**

   The station contains the speed setting potentiometer and the necessary operating pushbuttons.

   The station may vary in complexity from a simple three unit pushbutton unit to a floor mounted operator's console with all the controls for a complex coordinated system.

* Trademark of General Electric Company

VENTILATION ASSEMBLY –Used in higher horsepower ratings, provides filtered air (positive pressure) to all components. Extra quality features include easily removed, metallic, washable filter and Heavy-duty industrial 3-phase, ball bearing motor.

AC LINE BREAKER – An optional device providing a-c line disconnection and short circuit protection.

STATIC EXCITER – Includes isolating transformer with 115V tap for control power and a full-wave bridge rectifier.

DC POWER CONTROL – Heavy duty magnetic control including line contactor, thermal overload relay, run relay and other devices as required.

CONVERSION MODULE – A single drawout assembly of 6 SCR units (individually removable) in a full 6-way bridge. SCR protective devices and feedback circuits are an integral part of the assembly.

SCR DRIVER MODULE – All drawout printed circuit construction includes silicon semiconductor gate pulse generators (firing circuits), power supply, amplifier and drive monitor. Monitor provides indicating lights for IOC trip, incorrect phase sequence and overtemperature.

DRIVE REGULATOR – Provides timed acceleration and deceleration, comparison of reference and feedback, stabilization and other functions as required by the application.

ENCLOSING CASE–Gasketed removable door, rugged, lockable handle, heavy sheet, metal, reduced floor area (25 x 20 inches for 150 hp @ 550V DC). Covered conduit entrance top and bottom.

TYPES OF DIAGRAMS

There are different types of control diagrams created 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), connection, and interconnection.

The **elementary diagram** 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 is easily understood. Mechanical relationships of control devices are subordinated to the most simple presentation of the electrical circuits.

The **connection diagram** is one which shows the relative physical position of the devices on the control panel as well as other electrical components located within the same enclosure. Actual wire connections made between control devices and power devices within the enclosure, as well as outgoing terminal points, are shown on this type diagram.

The **interconnection diagram** indicates the type and number of connections to be made between major components of the system (power unit, motor and operator's station), the plant power source, auxiliary devices, and other electrical machines. On less involved units, the connection and interconnection diagrams are usually combined.

INSTALLATION

LOCATION

Silcon VI drive power units are suitable for most factory areas where other industrial equipment is installed. They should be installed in a well ventilated area not subject to ambient temperatures above 40° C (104° F). Locations subject to steam vapors or excessive moisture, oil vapors, chemical fumes, excessive dirt, dust or lint should be avoided.

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.

A **floor mounted power unit** enclosure may be placed, end to end or back to back with another enclosure, or may be placed with its ends or back against a wall. Sufficient clearance should be allowed in front of the enclosure so that the door may be fully opened for easy access. This front clearance should be equal to the width of the enclosure for single door enclosures or one-half the width of the enclosure for double door enclosures.

A **wall mounted power unit** enclosure may be placed side by side with another enclosure, or may be placed so that only its front is accessible. Clearance equal to the width of the enclosure should be allowed in front so that the door may be fully opened for easy access.

AIR SUPPLY

Power units in ratings 5 through 20 hp at 240V DC and 5 through 40 hp at 500V DC, are normally enclosed in convection cooled cases.

Air enters into the power unit through dripproof louvers near the bottom of the door(s) and exits through dripproof louvers near the top of the door(s). Power units rated 25 hp and above at 240V DC, 50 hp and above at 500V DC, are force cooled. Air is drawn into the intake chamber of the power unit through dripproof louvers near the top of the right hand door. A fan, which is located inside the intake air chamber, blows the air into the power unit proper across the cooling fins of the SCR conversion module(s). The air is expelled through dripproof louvers near the bottom of the door(s). This force cooling method provides positive case pressurization to prevent entry of dirt and dust into the power unit. All doors are completely gasketed.

Force cooled power units are furnished with filters. Filters must be changed or cleaned whenever they become dirty, since a dirty filter will restrict air flow, resulting in overheating of the power unit. If the power unit is located in an area where the air is clean, the filters may be omitted.

MOUNTING

All floor mounted power units are in enclosures having sturdy fabricated bases. These units may be mounted on any firm, reasonably flat and level floor or foundation. Holes are provided in the enclosure base for bolting down each unit. For best appearance, it may be necessary to shim one front corner of the base in order to have the doors line up perfectly.

Wall mounted enclosures may be mounted on any firm, reasonable flat, vertical surface. Larger units are provided with mounting ears, while smaller units have mounting holes in the back panel of the enclosure.

CONNECTIONS

All internal electrical connections between components in Silcon VI drive power units are made at the General Electric factory.

When installing the equipment, **all connections should be checked for tightness. Connections may become loose during shipping or storage.**

A diagram showing the connections between the power unit and related components is furnished with each equipment. All terminals to which external connections are to be made are numbered on the equipment as indicated on the connection diagram. Conduit entrance can be made through the top, ends or bottom of the power unit enclosure. Recommended entry for power and control leads is through the base or the top near the left end of the enclosure. A conduit entry hole is located in the base near the left end. Entrance of conduit through other than the left end of the base or top may be blocked by base mounted components or the top mounted blower.

Make certain the input voltage, frequency and phase of the power supply agree with the power unit nameplate on the control panel inside the enclosure. It is necessary on three phase power units to connect the AC supply in the correct phase sequence for proper operation. Refer to instructions in the SCR conversion assembly instruction book GEK 11014A.

If a separate AC line breaker, switch and/or fuse is used, the device and fuse selection should be in accordance with National Electric Code and/or local requirements based on power unit input data. Codes generally require the use of a fused disconnecting switch or circuit breaker.

Connect the DC motor, tachometer generator (if furnished), and all operator's control station components in accordance with the connection or interconnection diagrams. The power unit enclosure and operator's station enclosures should be grounded.

CAUTION

DO NOT GROUND ANY POWER OR CONTROL CIRCUITS OF THE SILCON VI DRIVE UNLESS NOTED ON THE DIAGRAMS. NATIONAL ELECTRICAL CODE AND SOUND LOCAL PRACTICES SHOULD BE CONSULTED FOR FURTHER REQUIREMENTS.

The following table of AC input currents for several voltages is given for standard equipments to aid in the selection of breakers, switches, fuses and wire sizes (for 50 and 60 cycles only).

For power units supplying a single DC motor, the two armature leads carry load currents approximately as shown in the following table of DC output currents

	AC INPUT AMPS				DC OUTPUT AMPS	
DC HP	230V	460V	575V	PH	240V	500V
5	18	9	7.5	3	19	9
7½	25	12.5	10		28	13
10	33	16.5	13		37	17
15	48	24	19		54	26
20	62	31	26		72	34
25	76	38	30		88	42
30	90	45	36		105	50
40	118	59	48		140	66
50	148	74	59		174	83
60	174	87	70		206	100
75	212	106	86		256	121
100	282	141	114		340	161
125	354	177	146		427	203
150	426	213	170		510	245
200	566	283	228		680	326
250	705	353	284		850	405
300	—	423	340		—	510
400	—	563	455		—	680
500	—	703	565		—	850

INITIAL DRIVE CHECK-OUT

Before power is turned on the following steps should be taken:

1. Visually inspect panel for loose wiring.
2. Manually operate all contactors, breakers (if provided), and relays.

WARNING

HIGH VOLTAGE. ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. DC POWER CIRCUITS INCLUDING ARMATURE FEEDBACK CIRCUITS, MOTOR BRUSHES, AND COMMUTATOR MAY BE AT A HIGH VOLTAGE WITH RESPECT TO GROUND, EVEN THOUGH ARMATURE LOOP CONTACTOR IS OPENED.
AC VOLTAGE SUPPLY TO POWER UNIT MUST BE DISCONNECTED PRIOR TO THE INSPECTION AND ADJUSTMENT OF POWER UNIT COMPONENTS, MOTOR BRUSHES OR COMMUTATOR.

With power the following checks should be made:

1. Check transformer voltages to see that they agree with elementary diagram values.
2. Check exciter output voltages:
   Points M5 to M6 should read 115V AC

Points 31 to 32 should read 240V DC (with point 31 positive with respect to point 32)

The drive may be checked out before connecting the motor armature leads. This may be accomplished by connecting a resistor across the output terminals of the SCR conversion assembly. This resistor need only load the SCR conversion assembly about 2% of rated amps at rated output voltage to enable drive to run over most of its DC voltage range. For voltage regulators, the output voltage of the SCR conversion assembly should not exceed the armature loop IR drop before the armature loop contactor is closed. For speed regulators, the SCR conversion assembly output voltage should be essentially zero before the armature loop contactor is closed.

Refer to the instructions on selection and use of oscilloscope contained in the trouble shooting section of the SCR conversion module instruction book GEK 11015A for operation and adjustments within the SCR conversion. Conversion assembly refers to the following instruction books:

1. SCR Conversion Assembly GEK 11014A
2. SCR Conversion Module GEK 11015A
3. Driver Module GEK 11016A

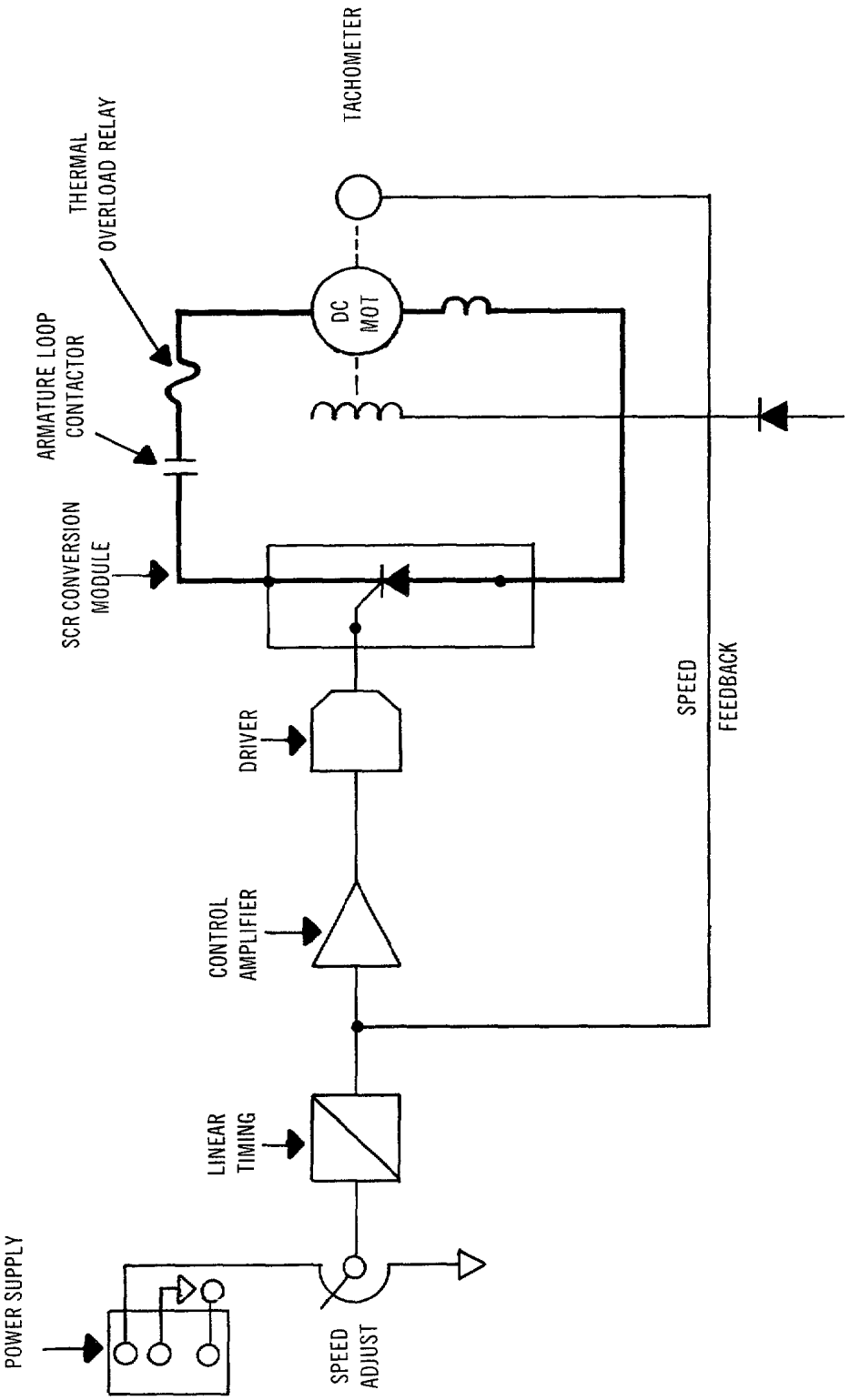

TACHOMETER
THERMAL OVERLOAD RELAY
ARMATURE LOOP CONTACTOR
SCR CONVERSION MODULE
DC MOT
DRIVER
CONTROL AMPLIFIER
LINEAR TIMING
POWER SUPPLY
SPEED ADJUST
SPEED FEEDBACK

FIGURE 1

PRINCIPLES OF OPERATION

OVERALL SYSTEM

Figure 1 (Page 8) shows a functional block diagram of a basic SCR speed variator. The desired preset speed is set by the speed adjustment potentiometer, which is supplied from the regulator power supply. The timing circuit applies a linearly increasing reference signal to the control amplifier during acceleration.

A tachometer is used for feedback. This speed feedback signal is compared with the reference signal from the timing circuit at the input to control amplifier. The output of this amplifier controls the driver which in turn controls the firing of the SCR module. The output of the SCR conversion module supplies controlled voltage to the DC motor armature. Motor starting and stopping is accomplished by means of a DC armature loop contactor. Thermal protection of the DC motor is provided by means of a thermal overload relay in the armature circuit.

OPERATING RANGE

The controlled speed range by armature voltage is nominally 20 to 1. It is mainly established by the performance specification of the regulator used, because in general, the percent minimum speed setting should not be less than the expected percent speed regulation in order to avoid stalling. The SCR conversion module is capable of controlling the armature voltage down to zero. A minimum current of 5% of rating should be applied in order to maintain continuous regulation during slow speed transient conditions (on drives not equipped with back to back SCR conversion assemblies).

Constant horsepower speed range is available by motor field control. For 500 volts DC motors, the maximum additional range is 1.5 to 1. For 240 volts DC motors, the maximum additional range is determined by the selected motor rating and may be as high as 4 to 1 on standard motors.

OVERLOAD RATING

The normal service factor of these drives is 1.0 however, following operation at rated load (not exceeding rated load for at least fifteen minutes) standard power units are capable of operation at 150% rated load for periods not exceeding 60 seconds.

For any horsepower rating, the power unit, including the SCR conversion assembly and transformers (if used), is rated for continuous operation at no more than rated load if the short time overload ability is to be retained.

MAINTENANCE

Maintenance of this equipment is primarily a matter of routine inspection of the power unit and the inspection and lubrication of the DC motor. The equipment should be kept as clean as possible by brushing or blowing out dust and dirt. Prompt attention to minor problems found during regulator inspections can promote a long life that is uninterrupted by costly shutdowns.

SCR CONVERSION ASSEMBLY

Keep the SCR's and cooling fins free from dirt, oil or grease, since an accumulation of dirt may cause overheating. Check for loose power or control connections to the conversion module and to the driver module.

REGULATOR

The regulator consists of printed circuit cards which normally require no maintenance except to keep them free from dirt and tightly plugged into their receptacles. Refer to the regulator instructions which may be found elsewhere in the instruction folder for specific card maintenance instructions.

CONTROL DEVICES

Inspect all relays and contactors at regulator 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 sandpaper 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.

FANS AND FILTERS

On force ventilated Silcon VI drives, the power unit contains a fan and air filter in the intake plenum chamber near the top of the enclosure.

Inspect the fan at regular intervals to see that it is

operating properly. Check for excessive noise or vibration, fan blades loose or striking the housing, and for overheating of the motors. Keep the fan blades clean.

The fan motor furnished will be three-phase and has ball bearings. These motors have a large supply of long-life grease which makes re-lubrication unnecessary for 10 years of normal service. If the fan motor will not operate, replace with a motor of the same model shown.

DC MOTOR

Maintenance instructions covering brushes, commutator and lubrication are in GEH-2304, which may be found elsewhere in the instruction folder.

TROUBLE SHOOTING

When incorrect operation is first noticed, it is often possible to greatly reduce the overall servicing time by studying all the symptoms. The trouble can often be isolated by observing or inspecting the suspected component, or by the process of elimination, if the circuit functions are clearly understood. In some cases, however, a systematic check of the entire system may be required.

REGULATOR

Trouble shooting notes for the regulator functional building blocks may be found in the regulator instructions elsewhere in the instruction folder.

CONTROL DEVICES

A general procedure for control trouble shooting is all that can be given, due to the wide variety of control that may be supplied with a particular unit. The following approach can be recommended to locate the trouble in most control circuits:

1. Make sure there are no open control fuses or open thermal overload relay interlock. Wait for the thermal overload relays to cool, then reset all overload relays.
2. Refer to elementary diagram and its operating notes and determine an area or areas in which the fault may be located.
3. Make a visual check of the suspected areas for broken wiring or loose connections; also look for damaged contactors and relays as indicated by burned or welded tips. Each contactor and relay should be inspected for proper mechanical operation.
4. Ring out the circuitry in the suspected area, opening connections as necessary to isolate series circuits that may be checked in their entirety. Contactors and relays should be operated manually where necessary to establish continuity through the selected and now isolated series circuits.

After establishing continuity or finding the fault in the circuitry, make sure that all connections removed for purposes of circuit isolation are reconnected.

A. Problem

Drive will not start

Drive stops and will not restart

Check:

1. Control voltage to the command pushbuttons.
2. For tripping of the fault relay in the driver module. Tripping may be due to:
   a. Loss of phase or incorrect phase sequence.
   b. Heat sink overtemperature.
   c. Instantaneous overcurrent.
   d. Blown fuse. (If drive is furnished with fuse detection provision).

   Each of the above faults is indicated by its light on the monitor card. This card is mounted on the driver regulator module. Before resetting drive, check and correct cause of fault stop.trip.

Causes

a. Loss of Phase

Self-explanatory

b. Heat Sink Overtemperature may be due to any of the following:

1. Drive is under horsepower.
2. Dirty filters.
3. Blown fuses in fan motor circuit on force cooled drives.

c. Instantaneous Overcurrent may be due to a **locked** driven machine. If not, assume that trip was caused by a transient. Reset and restart drive. If drive stops again check for loss of motor field and for armature short circuit.

If no fault is revealed go to trouble shooting section of GEK 11014A.

d. Blown Fuse

See instruction book GEK 11015A.

3. For tripping of the overload relay in the DC motor armature circuit tripping may be due:
   a. Excessive horsepower requirements.
   b. High ambient in power unit enclosure.

c. Thermal strip in the overload relay is not correctly rated for application.

B. Problem:

Drive does not maintain correct speed. Motor runs too slow.

Check:

The output voltage of the regulator (input voltage to the driver module), to determine the location of fault. If motor is running too slow and the output voltage of the regulator read approximately 11 volts the regulator is functioning properly and trying to correct fault. The fault is in the driver module or the SCR conversion module trouble shooting notes. If motor is running too slow and output of regulator is below 11V the fault is in the regulator or circuits associated with the regulator. See regulator elementary diagrams and instruction books in the regulator section.

C. Problem:

Drive does not maintain correct speed. Motor runs too fast.

Check:

The output voltage of the regulator (input to the driver module) to determine the location of fault. If the motor is running too fast and the output voltage of the regulator is 0 volts (or 11V in opposite direction on drives with back-to-back SCR conversion modules) the regulator is functioning properly and is trying to correct the fault. The fault is in the driver module or in the SCR conversion module. See GEK 11016A for driver module and GEK 11015A for SCR conversion module trouble shooting notes. If motor is running too fast and the output voltage of the regulator cannot be turned down by manipulation of the speed setting potentiometer, the fault is in the regulator or circuits associated with the regulator. See regulator elementary diagrams and instruction books in the regulator section.

D. Problem:

Drive is unstable.

Check:

1. Oscillation is not periodical.
2. Oscillation is periodical (sine wave). Proportional to speed.
3. Oscillation is periodical and is not proportional to speed.

Causes:

1. The oscillation is not periodical. This is usually caused by noise. Check tach voltage for ripple. If shielding is used, see that shield grounding is done at one point only.
2. The oscillation is periodical and is proportional to speed. This is usually caused by a mechanical unbalance in load or a fault in the tachometer mounting.
3. The oscillation is periodical and is not proportional to speed. In this case the fault is usually in the regulator. Readjust "stability" and the "response" potentiometer on the regulator coordination card.

GENERAL ELECTRIC COMPANY SPEED VARIATOR PRODUCTS DEPARTMENT ERIE, PA. 16501

10-73 (4M) D Reprint

GENERAL ELECTRIC

Printed in U.S.A.