

# INSTRUCTIONS

GEK-15008A

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## ST-100\* ADJUSTABLE FREQUENCY AC DRIVE

### 3S7506FV600 AND -FV700 SERIES

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

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GENERAL  ELECTRIC

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*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*

# ST-100 ADJUSTABLE FREQUENCY AC DRIVE

## 3S7506FV600 SERIES AND -FV700 SERIES

### INTRODUCTION

This manual contains the installation, operation, and maintenance instructions for the 3S7506FV600 and -FV700 series ST-100 adjustable frequency AC drives. It describes the theory of operation of the basic power unit and recommended troubleshooting procedures. Auxiliary circuits and equipment not described in this manual will be included as supplemental material.

### DESCRIPTION

The ST-100 adjustable frequency drive is a packaged, all solid state drive for controlling the speed of AC motors. The AC input is converted to adjustable DC power. A single analog reference signal controls the output frequency and the DC level into the inverter section of the power unit. The resulting output is a highly regulated three-phase, constant volts per hertz for speed control of induction or synchronous motors over a wide speed range.

A basic ST-100 drive will normally include a power unit, motor, and operator's control station.

### POWER UNIT

The power unit consists of semiconductors and related static components arranged on an extruded aluminum heat sink mounted in a NEMA 1 ventilated enclosure. (See Figure 1.) A three-phase circuit breaker or disconnect switch is provided to remove input power. Optional output voltmeter, ammeter, and test jacks may also be provided.

Most of the control circuit components are contained on printed circuit boards which are mounted on a hinged panel for ease in assembly and maintenance. The primary power conversion components are silicon controlled rectifiers (SCR's) used to convert the input AC to adjustable DC and in a bridge arrangement that inverts the DC to stepped wave AC.

### MOTOR

An induction or synchronous reluctance motor may be supplied depending on the application requirements. The motor will supply a constant torque load over the operating frequency range.

### CONTROL STATION

The type of operator's control station supplied will depend on the application. A control station for single drive applications will normally include a speed-setting potentiometer and start-stop pushbuttons. For more complex applications where several drives are cascaded to co-ordinate sections in a process, a desk-type console may be provided.

### SPECIFICATIONS

#### INPUT

FV600 Series - 208Y/120 AC  $\pm$  5%, 3 phase, 4 wire, 60 Hz.

FV700 Series - 416Y/240 AC  $\pm$  5% 3 phase, 4 wire, 60 Hz.

#### OUTPUT

FV600 Series - Rated 10KVA, 3 phase, continuous duty, suitable for 5 H. P. at maximum frequency.

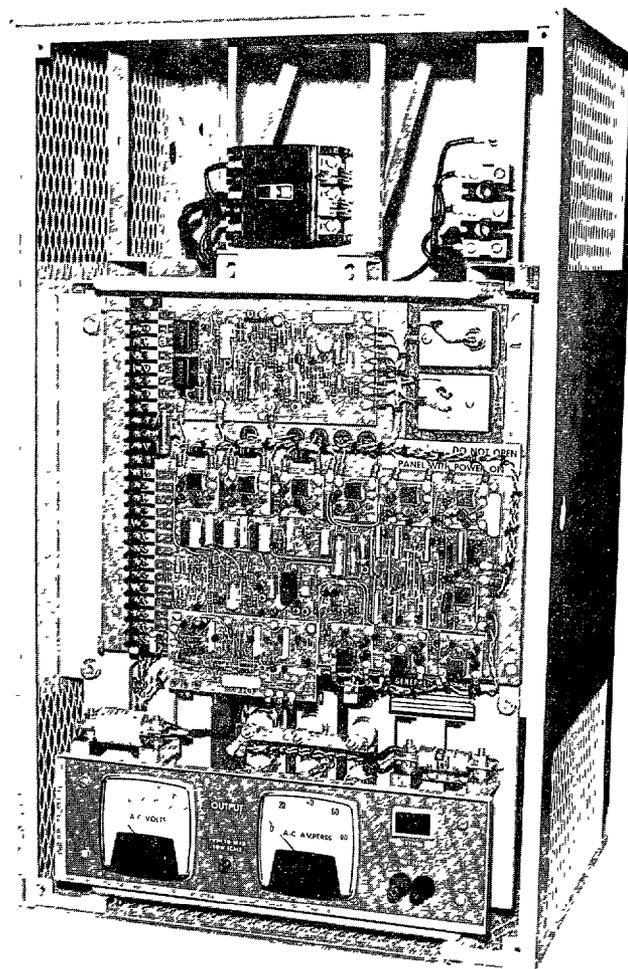


Figure 1. Typical Power Unit in Enclosure

FV700 Series - Rated 20KVA, 3 phase, continuous duty, suitable for 10 H. P. at maximum frequency.

Operating frequency - 6 to 120 Hz.

FV600 Series Output Voltage - 100 volts at maximum frequency, constant volts per Hz.

FV700 Series Output Voltage - 200 volts at maximum frequency, constant volts per Hz.

### ACCURACY

Long Term Drift - Frequency drift less than  $\pm 2\%$  of set frequency with analog reference from potentiometer.

Optional external frequency reference for drift accuracies of  $\pm 0.05\%$  or  $\pm 0.01\%$  of set frequency.

Speed Regulation -  $\pm 0\%$  from no load to full load with synchronous motors.

### Environmental Conditions

Storage Range -  $0^{\circ}\text{C}$  to  $65^{\circ}\text{C}$

Operating Range -  $10^{\circ}\text{C}$  to  $45^{\circ}\text{C}$

### PROTECTION

Circuit Breaker - Provides short circuit protection (10,000 amps interrupting capacity) for the power unit and also serves as a disconnect means to remove input power.

Fuses - Provide short circuit protection for the solid state devices in the power unit.

Current Trip - An internal static circuit provides fault current protection for semi-conductor devices in the power unit.

Current Limit - Limits the output current for temporary overloads.

Undervoltage - An internal static circuit protects against automatic restarting following AC power interruption and also protects the power unit and motor if a low voltage condition exists during normal running operation.

Phase Sequence - The unit is not phase sensitive, therefore no need for concern when connecting the AC supply lines.

### Acceleration

Time rate acceleration and deceleration is standard.

## **RECEIVING, HANDLING AND STORAGE**

Place the equipment under adequate cover immediately upon receipt. The packing cases are not suitable for outdoor or unprotected storage. Examine the shipment carefully on its arrival and check it against the packing list. Promptly report any shortage or damage incurred during shipment to the carrier and to the nearest General Electric Company Sales Office. Particular care should be exercised to prevent small parts from being mislaid or thrown away with the packing material.

If the equipment is not to be used as soon as it is unpacked, it should be stored in a clean, dry area and protected against accidental damage. Particular care should be exercised to avoid storage in a location where construction work is in progress.

## **INSTALLATION**

Mounting and Interconnection of the ST-100 drive components is described in this section. When installing the equipment, check all accessible factory connections for tightness, since connections may become loose during shipping or storage.

### POWER UNIT MOUNTING

Wall mount the power unit by using the mounting brackets at top and bottom of the enclosure or by removing the panel assembly and mounting the enclosure using the holes provided. (See outline drawing for dimensions.)

The unit can be floor mounted by using a mounting base that does not restrict air flow into the bottom of the enclosure.

Use the following procedure to remove the panel assembly for mounting:

1. Remove front cover from enclosure by loosening screw at each corner.
2. Disconnect the wires from the circuit breaker, terminal board and ground stud which are a part of the enclosure.
3. Remove the bolts holding the power unit panel assembly and slide the unit out of the enclosure. There is a latch mechanism near the top of the enclosure that must be actuated to remove the power unit completely from the enclosure.
4. Wall mount the enclosure using the two mounting holes at the top back of the enclosure and the single mounting hole at the bottom. The holes are suitable for 1/2 inch mounting bolts. (See outline drawing for dimensions.)
5. Slide the power unit panel assembly back into the enclosure, replace the mounting bolts and reconnect all wires. A hole is provided at the top of the panel for a lifting hook that can be used to lift the unit.



Install the power unit in a well-ventilated location which is not subject to ambient temperature above  $45^{\circ}\text{C}$  ( $113^{\circ}\text{F}$ ). Never install the power unit where hazardous, inflammable or combustible vapors, or dust are present.

The power unit is convection-cooled. Air enters through the bottom of the enclosure and exits

through the upper part of the front and sides. Make sure there is ample clearance around the outside of the enclosure to allow a normal flow of cooling air.

### CONTROL STATION

Mount the control station using hole locations and over-all dimensions shown on the outline drawing supplied with the equipment. Make sure the enclosure type is suitable for the environment in the mounting area.

### INTERCONNECTION

The equipment has been designed to prevent internally generated noise from causing mis-operation of sensitive control circuits. It is equally as important to prevent externally generated noise from getting into the control circuits. This can be done by following the interconnection diagram supplied with the equipment. It will show the recommended routing of control and power leads, wires that must be shielded, and recommended wire sizes.

#### IMPORTANT

Read all notes and instructions on the interconnection diagram before proceeding.

#### Input Voltage Connection:

1. The three line connections are made at the circuit breaker terminals and the neutral wire connects to the ground stud on the enclosure.

2. Make certain that the input voltage and frequency of the available power agree with the rating on the power unit nameplate. If the available supply is other than specified, it will be necessary to use a transformer. The required transformer rating is approximately 3KVA per horsepower based on the maximum horsepower supplied at top frequency.

3. It is recommended that a fused disconnect switch be installed in the AC power lines ahead of the power unit. (See interconnection diagram for recommended fuse rating.)

#### Grounding:

The ground stud should be connected directly to plant ground. If a transformer is used, the neutral wire is connected to the ground stud and grounded at that point only. It is also recommended that the control station and motor be grounded in accordance with NEC and/or local code requirements.

### FINAL CHECK

#### 1. Interconnecting Wiring

Nearly all of the problems encountered in the initial startup of any system is caused by improper

interconnecting wiring. If difficulty is encountered, the first step should be a careful recheck of all interconnecting wiring.

#### 2. Loose Connections

Loose connections may cause malfunctions; make sure all connections are tight.

#### 3. Wires

Wires may be broken due to mishandling of the control or excessive vibrations and shock (e. g. during transportation). Usually a broken wire is fairly obvious after a few minutes inspection (with power switched off).

## OPERATION AND ADJUSTMENT

### INITIAL OPERATION

When all connections have been made correctly, the drive will be ready to operate. Apply input voltage to the power unit by closing the circuit breaker. Set the speed reference for minimum operating frequency. Press the start button and gradually increase and decrease the output frequency over the required operating range by changing the speed reference.

The power units internal oscillator frequency range, volts per hertz ratio and voltage boost at low frequency have been factory adjusted to match the motor supplied. Do not change these adjustments. Acceleration and deceleration times will be set for 20 seconds unless other times are specified when the equipment is ordered.

### NORMAL OPERATION

When operating properly, the drive can be started by pressing the start button, with the speed reference set for any output frequency within the normal operating range. The power unit frequency and motor speed will accelerate at a linear timed rate from zero to the set point while maintaining the proper volts per hertz ratio. When the stop button is pressed, frequency and motor speed will decelerate to zero also at a linear timed rate. If input power is removed while the drive is operating, the frequency will immediately go to zero and the motor will coast to a stop at a rate determined by the inertia and friction in the drive system.

The sync light located on the meter panel (when external frequency reference is used) will indicate when the power unit internal oscillator is synchronized with the external frequency reference. This is a two section light and when both sections are "on", the drive is synchronized. If several motors are supplied from a single power unit, starting one motor while the others are running may cause the current trip circuit to shut down the drive. When this happens the drive can be restarted by simply pressing the start button.

When several power units are being controlled from a single external frequency reference, individual units can be started and stopped without affecting the operation of others.

### THEORY OF OPERATION

The ST-100 power unit will convert 3-phase AC line power to adjustable DC and invert the DC to adjustable frequency AC power. The simplified block diagram of Figure 2 shows the major circuit sections required to perform this function.

Input AC is converted to adjustable DC by half-wave phase controlled rectifiers. This DC is then converted to adjustable frequency AC by controlled switching of the rectifiers in a 3-phase inverter bridge.

A single speed reference signal is supplied through a timed acceleration and deceleration circuit to both the voltage regulator and frequency control circuits. The voltage regulator controls the DC voltage supplied to the inverter and the frequency control circuit sets the inverter SCR switching sequence, thus controlling the volts per hertz ratio of power supplied to the motor. A separate commutation circuit controlled by the frequency control circuit will turn off the inverter SCR's at the proper time.

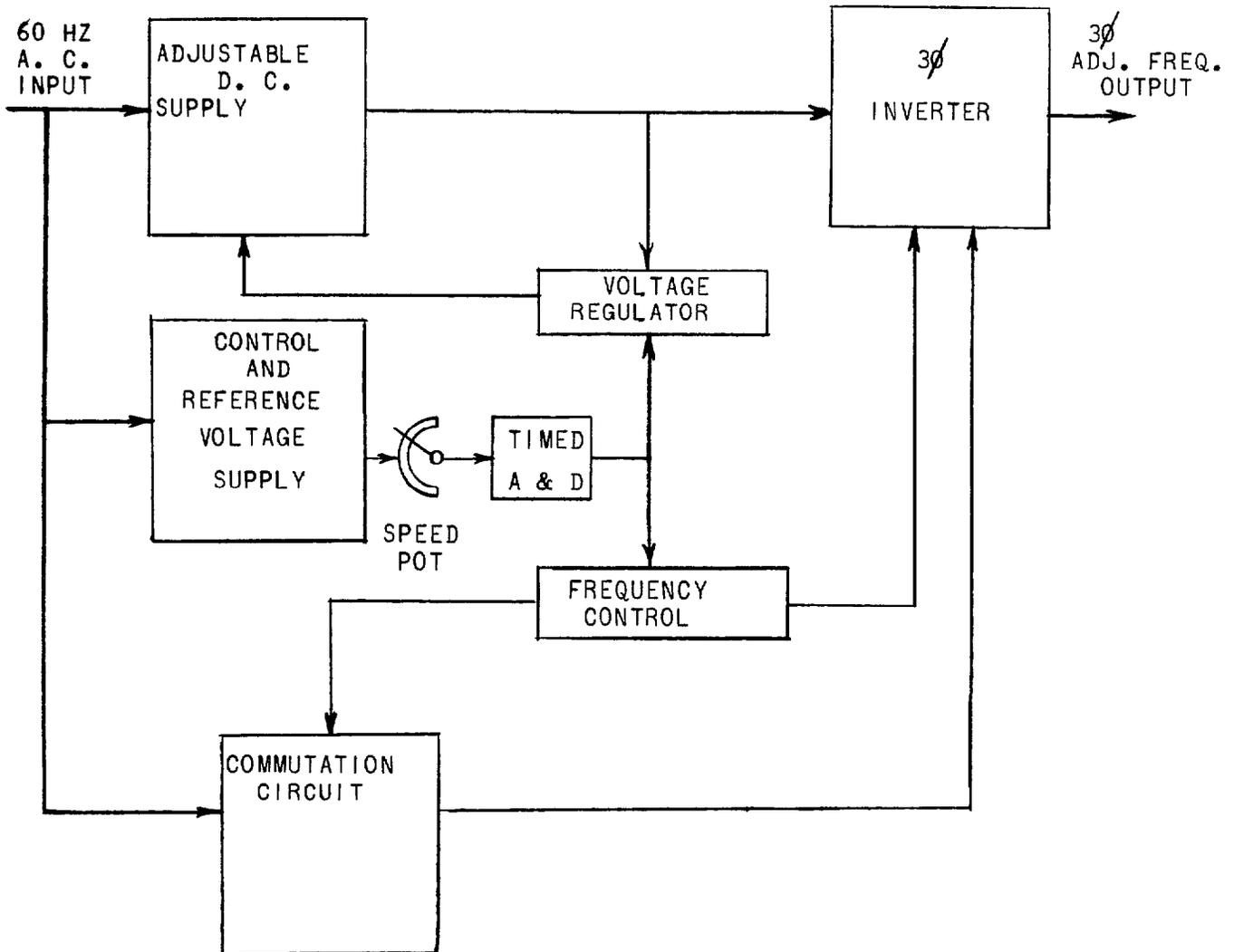


Figure 2. Power Unit Block Diagram

## MAINTENANCE

Maintenance is primarily a matter of routine inspection and good housekeeping. The inside of the enclosure should be checked at regular intervals to make sure it is free of dust or other foreign matter. The panel is the heat sink and should be kept clean to provide maximum heat dissipation.

If a power unit failure should occur, down time can be held to a minimum by replacing the complete panel assembly. All power unit components except the circuit breaker (plus dropping resistors on FV700 series) are mounted on the panel assembly which can be easily replaced. Before replacement is made, check all leads connected between the power unit, motor and control station. Make sure there are no short circuits and that all connections are tight.

### REPLACING POWER UNIT PANEL ASSEMBLY

#### **WARNING**

Make sure AC line power is removed from the power unit before touching internal parts.

1. Disconnect input power leads from the load side of the circuit breaker.
2. Disconnect leads from the terminal board(s) at top of the enclosure.
3. Disconnect incoming control wires from the main terminal board. Mark the leads so they can be replaced on the correct terminal points.
4. Remove the four mounting bolts.
5. Carefully slide the power unit out of the enclosure by means of the handles provided.
6. Slide the new unit into the enclosure. Replace mounting bolts and all wiring. Make sure that all connections are tight.

## TROUBLESHOOTING AND REPAIR

If a spare panel assembly is not available for replacement, it may be possible to repair the defective unit. Printed circuit boards containing the control circuitry and semiconductor components mounted on the heat sink can be replaced without special training or equipment. There are some simple checks that can be made, using a volt/ohmmeter, to help locate the trouble. Also, by observing the symptoms and indications that are available, it may be possible to isolate the defect to a printed circuit board or semiconductor component. If the defect is not found by these simple checks and observations, the printed circuit boards should be replaced. Troubleshooting and repair of printed circuit boards is not recommended. Return the defective printed circuit board to the fac-

tory for repair after calling your GE sales office for return instructions.

The power unit is equipped with special protective circuits to trip the unit off in case of undervoltage, heavy overloads, or short circuits on the output. These same protective circuits could also trip the unit off if the control circuits fail to operate properly. Repeated tripping will occur each time the power unit is started as long as the trouble exists. By observing the meters located on the meter panel, it may be possible to determine if the trouble is caused by excessive load current or a circuit malfunction.

Additional protection for the power unit is provided by fuses 1FU and 2FU. Referring to the elementary diagram supplied with the equipment, it can be seen that fuse 1FU protects the input SCR's and 2FU protects the commutation circuit components. Therefore, observing the fuse which has blown will be of some help in locating the trouble.

#### **CAUTION**

Replace fuses 1FU and 2FU with the exact same type and rating as supplied with the equipment. No substitution can be made.

The power diodes and SCR's are mounted on aluminum blocks which in turn are affixed to the heat sink. The heat sink itself is at ground potential but the mounting blocks are at some potential above ground. The mounting blocks are electrically isolated from the heat sink, so care must be exercised when working near the small blocks.

### CHECKING SILICON CONTROLLED RECTIFIERS

The SCR's are provided with special current and voltage protection. A malfunction of these protective devices under the right conditions could result in an SCR failure. This failure would normally be to a short, which can be found with an ohmmeter on "Times 1" scale.

### CHECKING SILICON DIODES

The characteristics of a silicon diode to block current in one direction and pass current freely in the other direction is used in a simple ohmmeter check. Connect ohmmeter leads across diode to be checked. When the meter leads are reversed, the indicated resistance should change from infinite to some very low value. (Low value will vary with different instruments).

#### **NOTE**

Silicon diodes will usually fail either to a short or an open which will be quickly discovered with the above check.

**CAUTION**

In removing or replacing any SCR or diode, use a small soldering iron of not more than 35 watts. Do not apply soldering iron heat to rectifier terminal any longer than necessary.

REPLACING STUD MOUNTED SCR'S AND DIODES

1. Remove defective rectifier from heat sink and thoroughly clean the area around the mounting hole.
2. Apply silicon grease (Dow-Corning #3) to new rectifier stud before mounting on heat sink.
3. Tighten the rectifier to assure a firm contact between rectifier and heat sink but don't overdo it. Excessive stress may damage the rectifier. If a torque wrench is available, tighten as follows:
  - a. Large SCR's and rectifiers - 70 lb-in. max.
  - b. Small rectifiers - 20 lb-in. max.

POWER UNIT TEST PROCEDURE

The possibility exists that the failure of a component in one section may cause misoperation in another section of the power unit. For this reason a definite procedure must be followed in checking circuits and components. The following test procedure should be used. Refer to the elementary and wiring diagrams supplied with the equipment and Figure 3 to locate components and circuit points.

1. Open circuit breaker. (Always check with a voltmeter to make sure that voltage has been removed.)
2. Remove both fuses, 1FU and 2FU.
3. Loose connections can cause misoperation. Check all internal and external lead connections associated with the drive to make sure they are tight.
4. Check all power semiconductor components mounted on the head sink with an ohmmeter.

It is possible that in cases where a bus bar is being used to connect three diodes or SCR's together, if a single SCR or diode is shorted, each of the components might indicate a short. It will then be necessary to remove the bus bar to locate the failed component.

If an output bridge SCR (4-9 SCR) is shorted, more than one will indicate a short with the motor leads connected. It will be necessary to disconnect the motor to determine the one that is actually shorted.

5. If the above checks are all satisfactory, close the circuit breaker applying power to the unit.

**WARNING**

Be careful not to come in contact with live parts.

6. Voltage Checks - All measurements to be made with respect to circuit 100 (terminal 14 on terminal board) and have a tolerance of  $\pm 10\%$  unless otherwise stated.

a. Check the incoming line voltage. Measure the line to line and line to neutral voltages. Be sure to check all three phases.

FV600 Series

FV700 Series

L - L = 208 VAC                      L - L = 416 VAC  
 L - Neutral = 120 VAC              L - Neutral = 240 VAC

These voltages should be within  $\pm 5\%$ . If not, take whatever corrective action is necessary to bring the voltage within these limits.

b. Measure the commutating bus voltage circuit 24 (left terminal of 2FU).

FV600 Series

FV700 Series

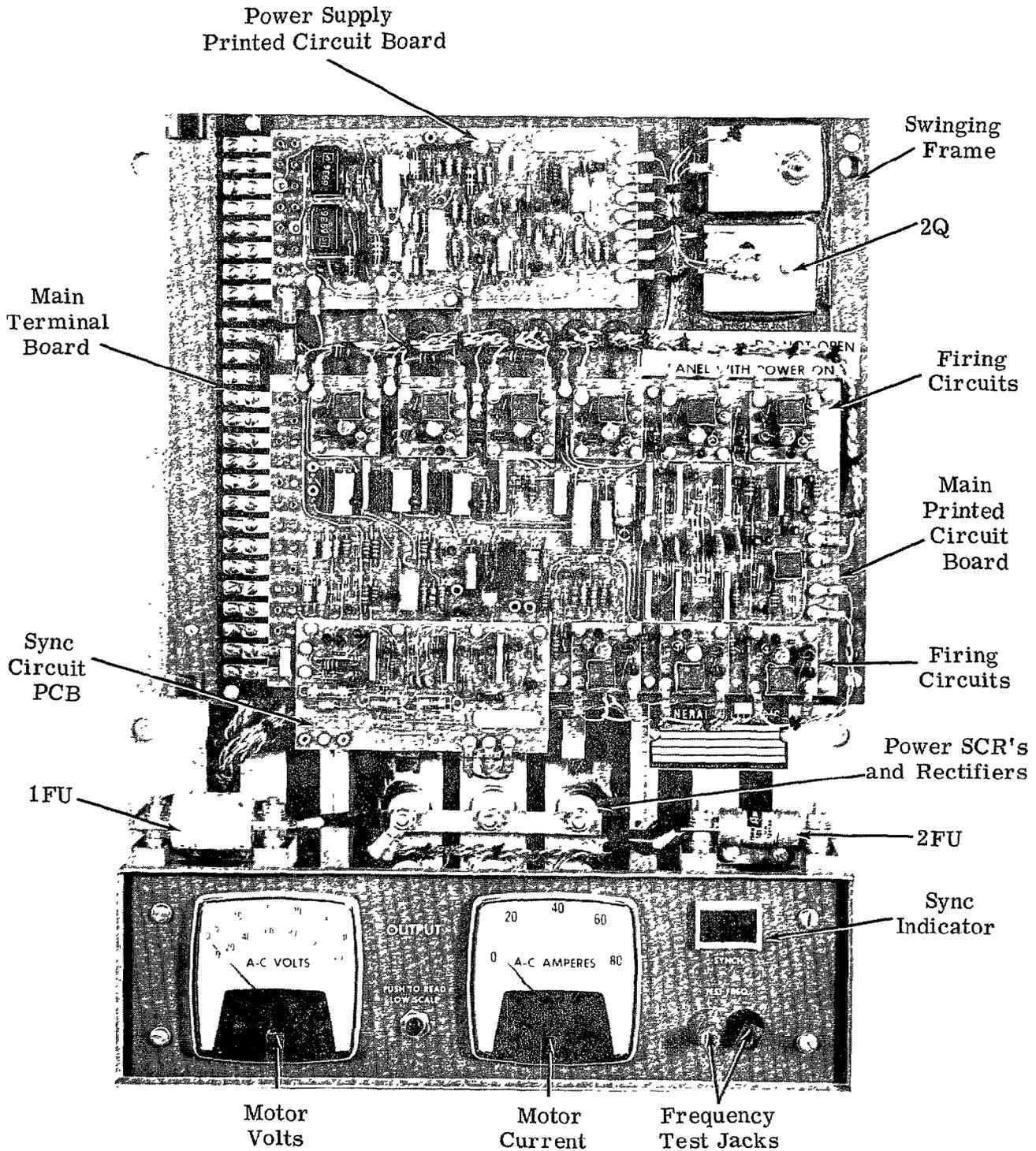
+ 160 VDC                                      +320 VDC

c. Check the following control voltage at the main terminal board.

<u>CIRCUIT #</u>	<u>TERMINAL #</u>	<u>+ VDC <math>\pm 10\%</math></u>
43	4 and 22	Zero
102	7	18V
25	8 and 15	24V
50	13	Approx. 1V
14	19	Zero

If the 24 VDC bus is low, a possible cause could be a shorted zener diode 9BD - 12BD or capacitor 18C (68MFD) on main printed circuit board or open resistor 9R (mounted on back of swinging frame). If there is a voltage at circuit 50 which is greater than 2.5 VDC, then resistor 3R or diode 20D could be open. To check, remove power from unit and with an ohmmeter, check the resistance between terminals 3 and 13 of the terminal board. With meter leads oriented in one direction, the resistance should be low (less than 10 ohms) and in the other direction, some high value. NOTE: This procedure also checks 1CR contact. If the resistance checks indicates an open circuit, replace the power supply PCB. If the 18VDC line is low, a possible cause could be shorted zener diodes 3BD - 5BD, transistor 4Q on power supply PCB or open resistor 8R (mounted on back of swinging frame).

d. If the voltage checks in sections b and c are within tolerance, leaving fuses 1FU and 2FU out of the circuit, press the "start" button. Set "speed adjust" for approximately 50% speed and check the following



TYPICAL POWER UNIT PANEL ASSEMBLY

Figure 3

control voltages at the main terminal board. All voltage readings to be made with respect to circuit 100 (terminal 14).

CIRCUIT #	TERMINAL #	+VDC +10%
43	4 and 22	6V (see note below)
50	13	45V

#### NOTE

If an external reference frequency is being used to control the speed of this equipment, rather than a potentiometer, the voltage reading at circuit 43 will be approximately 3 V DC since the output of the sync board is essentially a square wave.

If the 45 volt bus is low, check for a shorted transistor on the firing circuit boards, shorted transistor 2Q (top right hand side of swinging frame), or zener diodes 1BD and 2BD (on power supply board).

The transistor to check on the firing circuit board is the one in the metal case. The transistor case will be very hot to the touch. If so, replace the firing circuit board.

#### 7. Firing Circuit Check:

With the unit energized and the speed adjust set for an output frequency of approximately 60 cycles, connect the negative lead of the voltmeter on circuit 100 (terminal 14 of terminal board) and the positive lead on the top lead of the 47 ohm resistor of each of the nine firing circuit boards. It is located next to the metal can transistor and has a yellow band for its first color band.

#### CAUTION

Be careful not to short any components on the board.

A reading of 0.5 to 1.5 volts DC on the first three firing circuit boards from left to right at the top of the main printed circuit board and a reading of 1.5 to 2.5 volts DC on the remaining six boards is an indication that the firing circuits are operating. This simple check will not indicate all possible defects in these circuits, but should be adequate in most cases.

#### 8. Synchronizing Circuit Check (if used)

When the speed is to be controlled by an external reference frequency, a synchronizing (frequency discriminator) board is required and is mounted on the bottom left edge of the main printed circuit board. With 1FU and 2FU out of the circuit, the start circuit energized, and the "speed adjust" set for approximately 20%

speed, observe the sync light on the meter panel. If both sections of the light are on and stable, no further check of the board is required. If the light is unstable, or only one section of the light is on, replace the sync board. If the same results occur, replace the main printed circuit board.

#### 9. Commutation Circuit Check:

- Open circuit breaker.
- Turn "speed adjust" to zero set point.
- Replace fuse 2FU only.

#### WARNING

Be careful not to touch fuse clips since capacitor 35C may not be completely discharged. Check to make sure that voltage between fuse clips and heat sink is zero before proceeding.

- Close circuit breaker and press the START button.
- Turn "speed adjust" clockwise until you hear the commutation circuit operate. This will be a clicking sound.
- If fuse 2FU blows or the circuit does not operate, recheck 1D, 2D, 3D, 14D, 15D, 10SCR and 11SCR. Also check for loose connections in the commutation circuit. Before checking diodes and SCR's, make certain all power has been removed from the panel.

If the defect has not been found, replace the printed circuit boards.

#### REPLACING PRINTED CIRCUIT BOARDS

#### CAUTION

Handle printed circuit boards very carefully to prevent damage to board or components.

#### 1. Auxiliary Boards:

- Remove all leads attached to the defective board.
- Remove defective auxiliary board from main PC board by removing mounting screws.
- Install the replacement board and replace all mounting screws and leads.

#### CAUTION

Make sure the insulation strip is in place under the board and all screws are tight.

#### 2. Power Supply Board:

- Remove all leads attached to the defective board. Where necessary, tag leads to make sure they will be reconnected to the same points on the replacement board.

- b. Remove board mounting screws.
- c. The power supply board can now be removed by loosening the terminal board screws.
- d. Install the replacement board and replace all mounting screws and leads. Make sure all screws are tight.

### 3. Main Printed Circuit Board:

In order to save time in replacing the main PC board, it is recommended that the complete board assembly including auxiliary boards be replaced. If

a complete board assembly is not available for replacement, the auxiliary boards can be transferred to a new main board. The same procedure described in 2 can be used to remove and replace the main PC board assembly.

## RENEWAL PARTS

Should a component fail, a replacement part can be ordered from the nearest sales office of the General Electric Company. When ordering renewal parts, specify the quantity required, give the catalogue numbers and describe the required parts in detail. In addition, give the 3S model number and the complete nameplate rating of the equipment.

## Principal Renewal and Spare Parts List 3S7506FV600 - FV619

DIAGRAM SYMBOL	QTY.	PART NUMBER	DESCRIPTION
	1	44D236387-G0 *	Main Printed Circuit Board
	1	44C392763-G0 *	Power Supply Board
	1	44B331702-G01	Sync. Circuit Board
	9	44A332241-G01	Firing Circuit Board
	1	44A332251-G01	RC Component Board
1, 2, 3SCR	3	44B310090-105	Silicon Controlled Rectifier
4, 5, 6, 7, 8, 9, 10, 11SCR	8	44A319811-004	Silicon Controlled Rectifier
1, 2, 3D	3	44B216157-105	Rectifier
4, 8, 9, 10, 15D	5	44A319814-101	Rectifier
5, 6, 7D	3	44B216157-005	Rectifier
11, 12, 13, 14D	4	44A319814-001	Rectifier
2Q	1	44A316726-001	Transistor
2T, 3T	1	44B317027-001	Reactor
4T	1	44B317076-001	Reactor
1X	1	44B317087-001	Reactor
1C	6	44A319859-N10	10,000 MFD Capacitor
3C	1	44B313946-M10	1000 MFD Capacitor
35C	1	44C255986-712	2600 MFD Capacitor
36C	2	44A332123-J80	8MFD Capacitor
50C	1	933B597F68	Capacitor .0068MFD
2R	1	275A377D24	Resistor 24 Ohm, 40W
8R	1	275A377F18	40W, 1.8K Resistor
9R	1	275A377F10	40W, 1K Resistor
10, 11, 99R	3	275A377E10	40W, 100-Ohm Resistor
81R	1	K8622212F12	10W, 1.2K Resistor
82R	1	M6986159H30	1W, 300K Resistor
83R	1	983B565F24	5W, 2.4K Resistor
101R	1	M6986159G51	1W, 51K Resistor
102, 103, 104R	3	M6986159D47	1W, 47-Ohm Resistor
1FU	1	44A231672-002	100 AMP, 250V, Fuse (A25X100)
2FU	1	44A310533-002	50 AMP, 250V, Fuse (A25X50)
A	1	933B573P18	AC Ammeter (0-80)
V	1	44A319812-001	AC Voltmeter (Dual Scale) 0-120V., 0-30V.
CB	1	44A319816-003	Circuit Breaker, 50 AMP
SW	1	K9774777P2	Push Button (for meter)
	1	CR103DD221X	Indicating Light
	2	CR103DN2R1	Color Cap
	2	GE327	Lamp
	1	44A212135-001	Test Jack (Blk)
	1	44A212135-002	Test Jack (Red)

\*Part # for these printed circuit boards must be accompanied by panel 3S # when ordering renewal parts.

**Principal Renewal and Spare Parts List  
3S7506FV620 & UP**

DIAGRAM SYMBOL	QTY.	PART NUMBER	DESCRIPTION
	1	44D331917-G0 *	Main Printed Circuit Board
	1	44C331808-G0 *	Power Supply Board
	1	44B331702-G0 *	Sync. Circuit Board
	9	44A332241-G01	Firing Circuit Board
	1	44A318750-G01	RC Circuit Board (Input)
	1	44A318714-G01	RC Circuit Board (Output)
1, 2, 3SCR	3	44B310090-105	Silicon Controlled Rectifier
4, 5, 6, 7, 8, 9, 10, 11SCR	8	44A319811-004	Silicon Controlled Rectifier
1, 2, 3D	3	44B216157-105	Rectifier
4, 8, 9, 10, 15D	5	44A319814-101	Rectifier
11, 12, 13, 14D	4	44A319814-001	Rectifier
2Q	1	44A316726-001	Transistor
2T, 3T	1	44B317027-001	Reactor
4T	1	44B317076-001	Reactor
1X	1	44B317087-001	Reactor
1C	6	44A319859-N10	10,000 MFD Capacitor
35C	1	44C255986-712	2600 MFD Capacitor
36C	2	44A332123-J80	8MFD Capacitor
50C	1	933B597F68	Capacitor .0068MFD
7R	1	275A377C10	40W, 1-Ohm Resistor
2R	1	275A377D24	40W, 24 Ohm Resistor
8R	1	275A377F18	40W, 1.8K Resistor
9R	1	275A377F10	40W, 1K Resistor
10, 11, 99R	3	275A377E10	40W, 100-Ohm Resistor
81R	1	K8622212F12	10W, 1.2K Resistor
82R	1	M6986159H30	1W, 300K Resistor
83R	1	983B565F24	5W, 2.4K Resistor
102, 103, 104R	3	M6986159D47	1W, 47-Ohm Resistor
1FU	1	44A231672-002	100 AMP, 250V, Fuse (A25X100)
2FU	1	44A310533-002	50 AMP, 250V, Fuse (A25X50)
A	1	933B573P18	AC Ammeter (0-80)
V	1	44A319812-001	AC Voltmeter (Dual Scale 0-120V., 0-30V.)
CB	1	44A319816-003	Circuit Breaker, 50 AMP
SW	1	K9774777P2	Push Button (for meter)
	1	CR103DD221X	Indicating Light
	2	CR103DN2R1	Color Cap
	2	GE327	Lamp
	1	44A212135-001	Test Jack (Blk)
	1	44A212135-002	Test Jack (Red)

\* Part # for these printed circuit boards must be accompanied by panel 3S # when ordering renewal parts.

**Principal Renewal and Spare Parts List**  
**3S7506FV700 - FV719**

DIAGRAM SYMBOL	QTY.	PART NUMBER	DESCRIPTION
	1	44D236387-G0 *	Main Printed Circuit Board
	1	44C392763-G0 *	Power Supply Board
	1	44B331702-G01	Sync. Circuit Board
	1	44A332241-G01	Firing Circuit Board
	1	44A332606-G01	Capacitor Connector Board
	1	44A332251-G02	RC Circuit Board
1, 2, 3SCR	3	44B310090-109	SCR (Silicon Controlled Rectifier)
4, 5, 6, 7, 8, 9SCR	6	44A319811-006	Silicon Controlled Rectifier
10, 11SCR	2	44A332108-005	Silicon Controlled Rectifier
1, 2, 3D	3	1N4509R	Rectifier
5, 6, 7D	3	1N4509	Rectifier
4, 8, 9, 10D	4	44A319814-103	Rectifier
11, 12, 13, 14D	4	44A319814-003	Rectifier
15D	1	44A319814-105	Rectifier
2Q	1	44A316726-001	Transistor
2T, 3T	1	44B317229-001	Reactor
4T	1	44B317228-001	Reactor
1X	1	44B317227-001	DC Reactor
1C	8	44A332119-M33	Capacitor 3300MFD, 350VDC
3C	1	44A332118-M10	Capacitor 1000MFD, 450V
35C	1	44A332120-M15	Capacitor 1500MFD, 400VDC
36C	4	44A332123-J80	Capacitor 8MFD, 400VDC
50C	1	933B597F68	Capacitor .0068 MFD
2R	1	275A377D47	Resistor 47 Ohm, 40W
1R, 7R-A, B, C, D	5	275A377C10	Resistor 1 Ohm, 40W
8, 109, 110, 111, 112, 113, 114, 115R	7	275A377F18	Resistor 1.8K, 40W
9R, 108R	2	275A377F10	Resistor 1K, 40W
10, 11R	2	M9729441F10	Resistor 1K, 85W
81R	1	K8622212F22	Resistor 2.2K, 10W
83R	1	983B565G10	Resistor 10K, 5W
101R	1	M6986159H20	Resistor 200K, 1W
102, 103, 104R	3	M6986159D47	Resistor 47 Ohm, 1W
106, 107R	2	M6986159H30	Resistor 300K, 1W
1FU	1	44A311946-003	Fuse 100A, 600V (A60X100)
2FU	1	44A311926-003	Fuse 50A, 600V (A60X50)
A	1	933B573P18	AC Ammeter (0-80)
V	1	44A332106-001	AC Voltmeter (Dual Scale) 0-250, 0-50
CB	1		Circuit Breaker 50A
SW	1	K9774777P2	Push Button (For Meter)
	1	CR103DD221X	Indicating Light
	2	CR103DN2R1	Color Cap
	2	GE327	Lamp
	1	44A212135-001	Binding Post (BLK)
	1	44A212135-002	Binding Post (Red)

\* Part # for these printed circuit boards must be accompanied by panel 3S # when ordering renewal parts.

**Principal Renewal and Spare Parts List  
3S7506FV720 & UP**

DIAGRAM SYMBOL	QTY.	PART NUMBER	DESCRIPTION
	1	44D331917-G0 *	Main Printed Circuit Board
	1	44C331808-G0 *	Power Supply Board
	1	44B331702-G0 *	Sync. Circuit Board
	1	44A332241-G01	Firing Circuit Board
	1	44A332606-G01	Capacitor Connector Board
	1	44A318750-G02	RC Circuit Board (Input)
	1	44A318714-G02	RC Circuit Board (Output)
1, 2, 3SCR	3	44A318550-008	SCR (Silicon Controlled Rectifier)
4, 5, 6, 7, 8, 9SCR	6	44A319811-006	Silicon Controlled Rectifier
10, 11SCR	2	44A332108-005	Silicon Controlled Rectifier
1, 2, 3D	3	1N3766R	Rectifier
4, 8, 9, 10D	4	44A319814-103	Rectifier
11, 12, 13, 14D	4	44A319814-003	Rectifier
15D	1	44A319814-105	Rectifier
2Q	1	44A316726-001	Transistor
2T, 3T	1	44B317229-001	Reactor
4T	1	44B317228-001	Reactor
1X	1	44B317227-001	DC Reactor
1C	8	44A332119-M33	Capacitor 3300MFD, 350VDC
35C	1	44A332120-M15	Capacitor 1500MFD, 400VDC
36C	4	44A332123-J80	Capacitor 8MFD, 400VDC
50C	1	933B597F68	Capacitor .0068MFD
2R	1	275A377D47	Resistor 47 ohm, 40W
7R	4	M9729441C10	Resistor 1 ohm, 85W
8R	1	275A377F18	Resistor, 1.8K, 40W
9R, 108R	2	275A377F10	Resistor 1K, 40W
10, 11R	2	M9729441F10	Resistor 1K, 85W
81R	1	K8622212F22	Resistor 2.2K, 10W
83R	1	983B565G10	Resistor 10K, 5W
106, 107R	2	M6986159H30	Resistor 300K, 1W
109, 110, 111, 112, 113, 114, 115R	7	275A377F47	Resistor 4.7K, 40W
1FU	1	44A311946-003	Fuse 100A, 600V (A60X100)
2FU	1	44A311926-003	Fuse 50A, 600V (A60X50)
A	1	933B573P18	AC Ammeter (0-80)
V	1	44A332106-001	AC Voltmeter (Dual Scale) 0-250,0-50
CB	1	TEF134050WL	Circuit Breaker 50A
SW	1	K9774777P2	Push Button (For Meter)
	1	CR103DD221X	Indicating Light
	2	CR103DN2R1	Color Cap
	2	GE327	Lamp
	1	44A212135-001	Binding Post (BLK)
	1	44A212135-002	Binding Post (Red)

\* Part # for these printed circuit boards must be accompanied by panel 3S # when ordering renewal parts.

## GENERAL ELECTRIC SALES OFFICES

READY TO ASSIST YOU      When You Have Electrical Problems      Need Further Information      Require Ordering Instructions

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A - Agency & Distributor  
 C - Components Sales  
 I - Industrial Sales  
 M - Marine & Defense Facilities Sales  
 S - Installation and Service Engineering  
 U - Electric Utility Sales

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95808 2407 J St                  A M S U San Diego 92103 2580 First Ave                  A I M S U San Francisco 94106 235 Montgomery St                  A Santa Clara 95050 1400 Coleman Ave</p> <p><b>COLORADO</b>                  A C I S U Denver 80206 201 University Blvd.</p> <p><b>CONNECTICUT</b>                  I U Hamden 06518 2905 Dixwell Ave                  A Hartford 06103 704 Asylum Ave                  C I S U Meriden 06450 1 Prestige Dr</p> <p><b>DISTRICT OF COLUMBIA</b>                  I M U Washington 20005 777 14th St, N W</p> <p><b>FLORIDA</b>                  A I S U Jacksonville 32207 4100 Woodcock Dr                  A S U Miami 33134 4100 W Flagler St                  A Orlando 32803 601 N Fern Creek Ave                  U Pensacola 32502 P O Box 1027                  A C I S U Tampa 33609 2106 S Lois Ave</p> <p><b>GEORGIA</b>                  A C I S U Atlanta 30309 1860 Peachtree Rd N W                  A Macon 31204 2720 Riverside Dr                  A I S U Savannah 31405 5022 Paulsen St</p> <p><b>IDAHO</b>                  A U Boise 83701 1524 Idaho St</p> <p><b>ILLINOIS</b>                  A I M S U Chicago 60680 840 S Canal St                  C Oakbrook 60521 1200 Harger Rd                  A I U Peoria 61603 2008 N E Perry Ave                  A I Rockford 61108 4223 E State St                  U Springfield 62701 607 E Adams St                  A Springfield 62701 425 L 2 So Fifth St</p> <p><b>INDIANA</b>                  A C S U Evansville 47714 2709 Washington Ave                  C Fort Wayne 46804 1835 Broadway                  S Fort Wayne 46807 3606 S Calhoun St</p>	<p>A U Fort Wayne 46806 6001 S Anthony Bldg                  A I S U Indianapolis 46207 3750 N Meridian St                  C Indianapolis 46240 1010 E 88th St                  A C South Bend 46601 430 N Michigan St</p> <p><b>IOWA</b>                  U Cedar Rapids 52401 210 Second St, S E                  C Davenport 52722 P O Box 748                  A I S Davenport                  (1039 State St., Bettendorf 52722)                  A U Des Moines 50310 3839 Merle Jay Rd                  U Sioux City 51101 520 Pierce St</p> <p><b>KANSAS</b>                  C Overland Park 66204 7219 Metcalf St                  A Wichita 67211 820 E Indianapolis Ave                  U Wichita 67202 104 S Broadway Suite 108</p> <p><b>KENTUCKY</b>                  A U Lexington 40502 443 S Ashland Ave                  A C I S U Louisville 40218 2300 Meadow Dr</p> <p><b>LOUISIANA</b>                  A U Alexandria 71301 2001 MacArthur Dr                  I S Baton Rouge 70806 8312 Florida Blvd                  I S Lake Charles 70504 1424 Ryan St                  I S Monroe 71201 1029 N Sixth St                  A I S New Orleans 70125 4747 Earhart Blvd                  U New Orleans 70112 225 Baronne St                  M New Orleans 70130 930 Inter Trade Mart                  A S U Shreveport 71104 2620 Centenary Blvd</p> <p><b>MAINE</b>                  U Augusta 04330 152 State St                  I Bangor 04402 71 Central St                  A Portland 04102 Thompson's Point</p> <p><b>MARYLAND</b>                  I S U Baltimore 21201 1 N Charles St                  A U Columbia 21043 10221 Wincon Circle                  U Eagerstown 21740 P O Box 477                  A Salisbury 21801 P O Box 424</p> <p><b>MASSACHUSETTS</b>                  I U Boston 02117 31 St. James Ave                  I Springfield 01103 120 Maple St                  A C I M S Wellesley 02181 1 Washington St</p> <p><b>MICHIGAN</b>                  A C I S U Detroit 48202 700 Antoinette St                  I Flint 48502 800 Saginaw St                  A C I Grand Rapids 49508 2821 Madison S E                  S U Jackson 49201 210 W Franklin St.                  S Kalamazoo 49003 P O Box 3005                  A I S Saginaw 48601 1230 S Washington St</p> <p><b>MINNESOTA</b>                  I S U Duluth 55802 300 W Superior St                  U Fergus Falls 56537 201 1/2 Lincoln Ave, W                  C Minneapolis 55424 4018 W 65th St                  A I S U Minneapolis 55416 1500 Lyiac Dr, S</p> <p><b>MISSISSIPPI</b>                  U Gulfport 39502 P O Box 33                  A S Jackson 39206 333 No Mart Plaza                  U Jackson 39201 Rm 717 Electric Bldg</p> <p><b>MISSOURI</b>                  A Joplin 64802 310 Wall St                  A I S U Kansas City 64105 911 Main St                  A C I S U St. Louis 63101 1015 Locust St</p> <p><b>MONTANA</b>                  A Billings 59101 312 Transwestern Life Bldg                  A I S U Butte 59701 103 N Wyoming St</p>	<p><b>NEBRASKA</b>                  A I S U Omaha 68102 409 S 17th St.</p> <p><b>NEVADA</b>                  U Las Vegas 89106 1711 S 8th St</p> <p><b>NEW HAMPSHIRE</b>                  U Manchester 03104 46 Bay St</p> <p><b>NEW JERSEY</b>                  C East Orange 07017 56 Melmore Gardens                  A I S U Millburn 07041 25 E Willow St</p> <p><b>NEW MEXICO</b>                  A I M S U Albuquerque 87108 120 Madeira Dr, N E</p> <p><b>NEW YORK</b>                  A I M S U Albany 12201 11 Computer Dr West                  U Binghamton 13902 40 Front St                  A I S U Buffalo 14202 625 Delaware Ave                  A Elmsford 10523 3360 Monroe Ave                  A Harrison 10528 800 Mamaroneck Ave                  C Maitland 13211 P O Box 5658 E Molloy Rd                  I M S U New York 10022 341 Lexington Ave                  C Rochester 14618 3380 Monroe Ave                  A I S U Rochester 14604 339 East Ave                  A I S U Syracuse 13201 3532 James St                  A Vestal 13805 P O Box 407</p> <p><b>NORTH CAROLINA</b>                  A C I S U Charlotte 28207 141 Providence Rd                  A I Greensboro 27405 801 Summit Ave                  A U Raleigh 27603 120 N Boylan Ave</p> <p><b>NORTH DAKOTA</b>                  U Bismarck 58501 418 Rosser Ave                  A Fargo 58102 112 University Dr</p> <p><b>OHIO</b>                  A I Akron 44320 341 White Pond Dr                  I U Canton 44703 515 Third St, N W                  A C I S U Cincinnati 45206 2621 Victory Pkwy                  U Cleveland 44116 20950 Center Ridge Rd                  A I M S U Cleveland 44114 1000 Lakeside Ave                  C Columbus 43212 937 Burrell Ave                  A I S U Columbus 43218 1110 Morse Rd                  A C I U Dayton 45439 3430 S Dixie Hwy                  C Mansfield 44902 186 Park Ave, W                  U North Canton 44720 7900 Whipple Ave N W                  U Toledo 43604 420 Madison Ave                  A I S Youngstown 44507 272 E Indiana Ave</p> <p><b>OKLAHOMA</b>                  A S U Oklahoma City 73106 2000 Classen Blvd                  A I Tulsa 74105 5138 S Peoria Ave                  U Tulsa 74103 420 Mann St                  S Tulsa 74105 P O Box 7646, Southside Station                  C Tulsa 74135 3315 E 47th Place</p> <p><b>OREGON</b>                  A I U Eugene 97408 1170 Pearl St                  A U Medford 97501 107 E Lake St                  A C I S U Portland 97101 2929 N W 29th Ave</p> <p><b>PENNSYLVANIA</b>                  A I U Allentown 18102 1444 Hamilton St                  A Camp Hill 17011 1521 Cedar Cliff Dr                  A Erie 16501 3001 E Lake Rd                  I Erie 16501 1001 State St                  I U Johnstown 15902 841 Oak St                  C Philadelphia 19114 2417 Welsh Rd                  A I M S U Philadelphia 19102 3 Penn Center Plaza                  C Pittsburgh 15234 300 Mt Lebanon Blvd</p>	<p><b>PITTSBURGH 15222</b> 300 6th Ave Bldg                  A I S U Williamstown 17701 2209 First Ave                  C York 17403 1617 E Market St.</p> <p><b>RHODE ISLAND</b>                  A Providence 02904 1008 Charles St., N</p> <p><b>SOUTH CAROLINA</b>                  A I U Columbia 29205 2728 Devine St                  S Columbia 29204 Middleburg Office 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A Huntington 25701 Sixth Ave &amp; Ninth St                  I Wheeling 26002 40 14th St.</p> <p><b>WISCONSIN</b>                  A I S U Appleton 54911 3003 W College Ave                  U Madison 53704 2038 Pennsylvania Ave                  C Milwaukee 53226 Milwaukee Mayfair Plaza, 2421 N Mayfair Dr                  A I S U Milwaukee 53202 615 E Michigan St.</p> <p><b>CANADA</b>                  Canadian General Electric Company, Ltd                  Toronto</p>
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## GENERAL ELECTRIC SERVICE SHOPS

WHEN YOU NEED SERVICE These GE service shops will repair, re-condition and rebuild your electric apparatus. The facilities are available day and night seven days a week, for work in the shops or on your

premises. Latest factory methods and genuine GE renewal parts are used to maintain performance of your equipment. For full information about these services contact your nearest service shop or sales office.

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