GEK-14784

INSTRUCTIONS

ST-100* ADJUSTABLE FREQUENCY AC DRIVE

3S7506FV320 THRU -FV350

AND

3S7506FV420 THRU-FV450

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GENERAL ELECTRIC

CONTENTS

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

3S7506FV320 THRU -FV350 AND -FV420 THRU FV450

INTRODUCTION

This manual contains the installation, operation, and maintenance instructions for the 3S7506FV320 thru -FV350 and FV420 thru -FV450 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 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 the front of the 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

208Y/120 AC ± 5%, 3 phase, 4 wire, 60 Hz.

OUTPUT

FV300 Series - Rated 4KVA, 3 phase, continuous duty, suitable for 2 H.P. at maximum frequency.

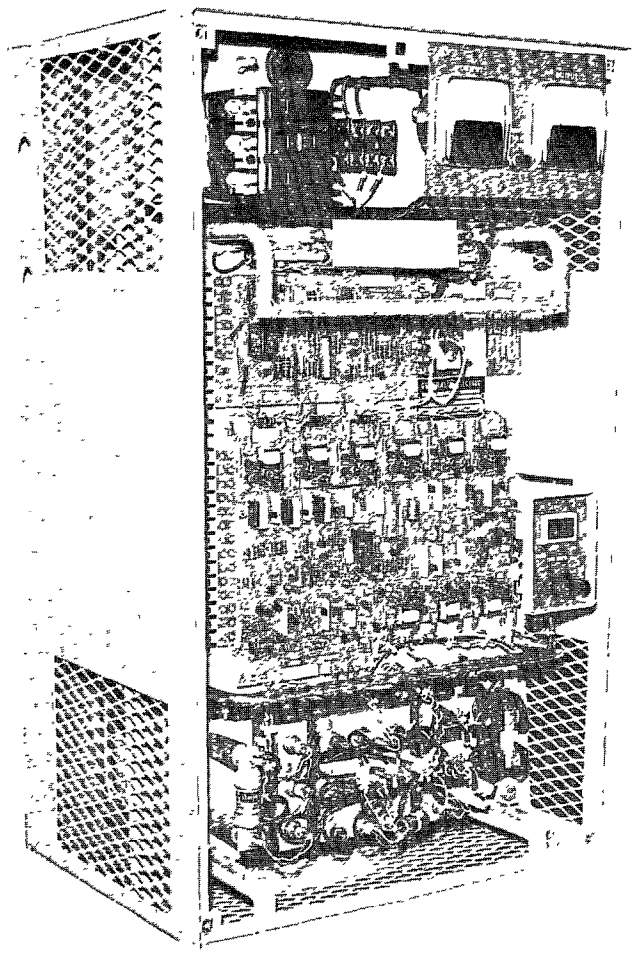


Figure 1. Typical Power Unit in Enclosure

FV400 Series - Rated 6KVA, 3 phase, continuous duty, suitable for 3 H. P. at maximum frequency.

Operating frequency - 6 to 120 Hz.

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

ACCURACY

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

Optional external frequency reference for drift accuracies of ±0. 05% or ±0. 01% of set frequency.

Speed Regulation - ±0% from no load to full load with synchronous motors.

Environmental Conditions

Storage Range - 0° C to 65° C

Operating Range - 10° C to 45° 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

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 using handles provided.

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.

CAUTION

Install the power unit in a well-ventilated location which is not subject to ambient temperature above 45° C (113° 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.

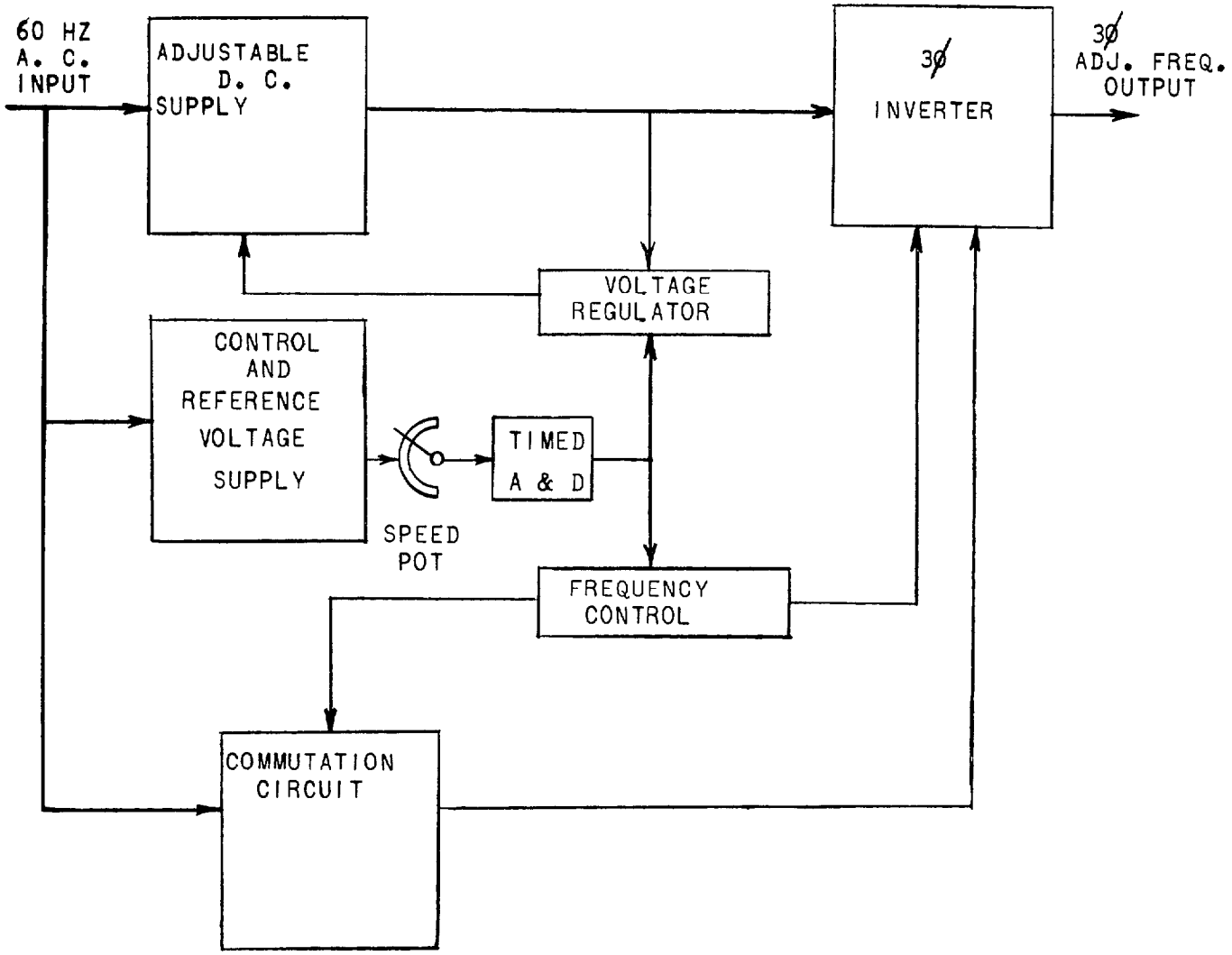


Figure 2. Power Unit Block Diagram

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 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 factory 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 componemts. 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 throughly 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:

Stud mounted SCR's and rectifiers - 25 lb- in.

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 Jumper wire 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 Jumper 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 ± 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.

L - L = 208 VAC
L - Neutral = 120 VAC

These voltages should be within ±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).

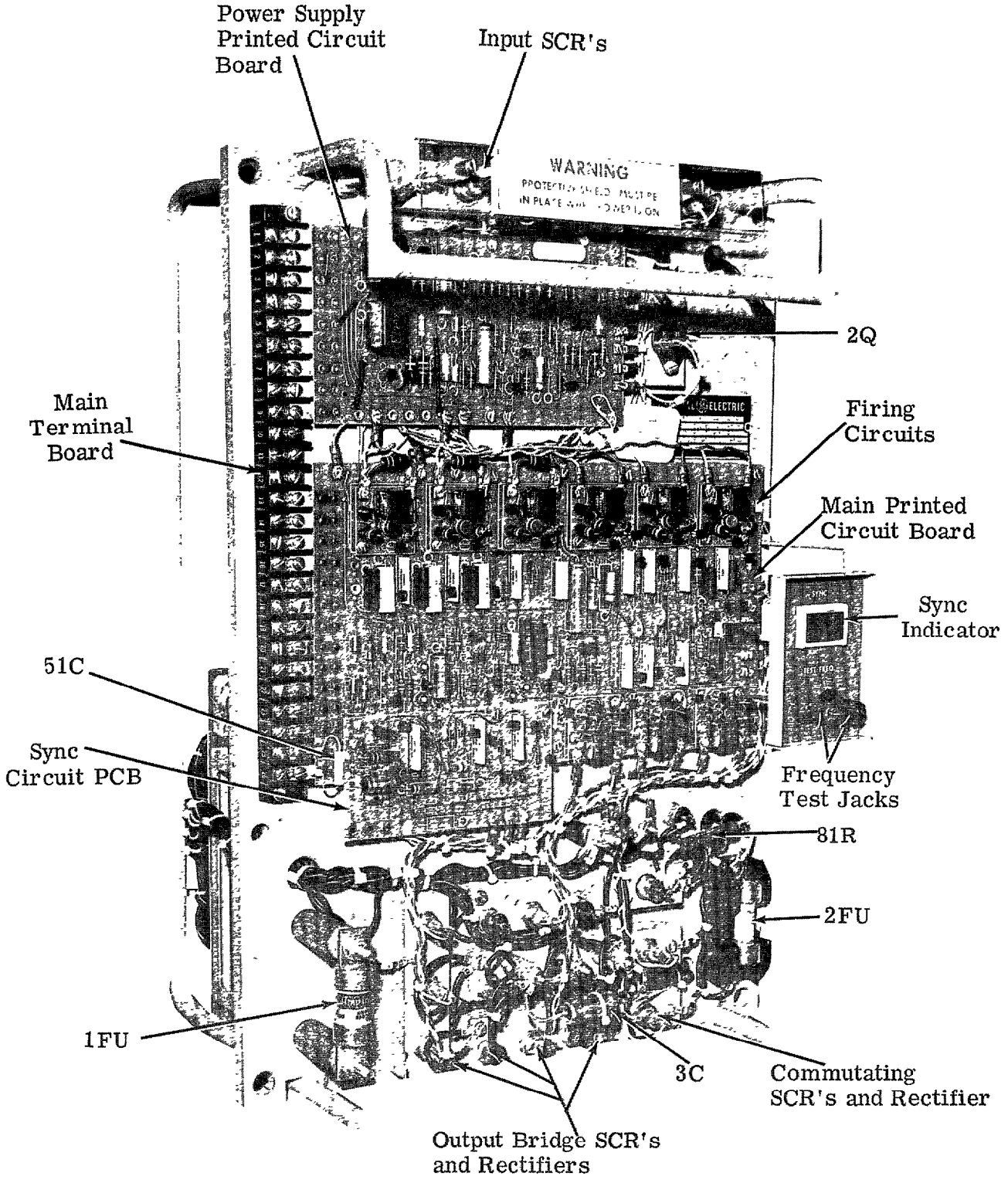
+ 160 VDC

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

CIRCUIT #	TERMINAL #	+ VDC ± 10%
43	4 and 22	Zero
102	7	18V
25	8 and 15	24V
50	13	Approx. 1V
40	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 panel). 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 panel).

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 panel), 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:

a. Open circuit breaker.

b. Turn "speed adjust" to zero set point.

c. 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.

d. Close circuit breaker and press the START button.

e. Turn "speed adjust" clockwise until you hear the commutation circuit operate. This will be a clicking sound.

f. 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:

a. Remove all leads attached to the defective board.

b. Remove defective auxiliary board from main PC board by removing mounting screws.

c. Install the replacement board and replace all mounting screws and leads.

2. Power Supply Board:

a. 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, specifiy 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

3S7506FV320 - FV350

DIAGRAM SYMBOL	QTY.	PART NUMBER	DESCRIPTION
	1	*	Main Printed Circuit Board
	1	44C331808-G0*	Power Supply Board
	1	44B331702-G0*	Sync. Circuit Board
	1	44A332241-G01	Firing Circuit Board
	1	44B331704-G01	Capacitor Connector Board
1, 2, 3 SCR	3	44B212741-008	SCR (Silicon Controlled Rectifier)
4-11 SCR	8	44A390255-005	SCR
4, 8, 9, 10, 15D	5	44B216157-105	Rectifier
11, 12, 13, 14D	4	44B216157-005	Rectifier
2Q	1	44A316726-001	Transistor
15BD	1	IN3330A	Zener 47V, 50W
2-3T	1	44B333075-001	Reactor
4T	1	44B333074-001	Reactor
1X	1	44B317293-001	DC Reactor
1C	2	44A315997-M73	Capacitor 7300 MFD, 150V
3C	1	K9381750J10	Capacitor 1 MFD, 200V
35C	1	43F3058CA4	Capacitor 600 MFD, 200V
36C	1	44A316739-J60	Capacitor 6 MFD
50C	1	933B597F68	Capacitor .0068 MFD
51C	1	933B597G47	Capacitor .047 MFD
52C	1	44B310009-K68	Capacitor 68 MFD, 50V
1R	1	44B310084-A50	Resistor .05 OHM, 110W
2R	1	275A377D24	Resistor 24 OHMS, 40W
8R	1	275A377F10	Resistor 1K OHMS, 40W
9R	1	275A377F18	Resistor 1.8K OHMS, 40W
10, 11, 99R	3	275A377E10	Resistor 100 OHMS, 40W
81R	1	44A310531-F12	Resistor 1.2K OHMS, 10W
83R	1	983B565F24	Resistor 2.4K OHMS, 5W
102, 103, 104R	3	M6986159D47	Resistor 47 OHMS, 7W
105R	1	275A377E51	Resistor 510 OHMS, 40W
1FU	1	44A310533-001	Fuse 40 AMP, 250V
2FU	1	44A231666-009	Fuse 15 AMP, 250V
	1	44B211519-048	Main Terminal Board
	1	44B318855-003	Safety Shield
CB	1	44A319816-004	Circuit Breaker, 30A
SW	1	K9774777P2	Pushbutton (For Meter)
A	1	933B573P17	AC Ammeter (0-30A)
V	1	44A318545-001	AC Voltmeter (Dual Scale) 0-30, 0-120
	1	CR103DD221X	Sync 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

KEY TO SALES OPERATIONS

A - Agency & Distributor
C - Components Sales
I - Industrial Sales
M - Marine & Defense Facilities Sales
U - Electric Utility Sales

ALABAMA		
A C I U	Birmingham 35205	2151 Highland Ave
I	Huntsville 35801	3322 Memorial Pkwy S
A I	Mobile 36606	1111 S Beltline Hwy
ARIZONA		
A C I U	Phoenix 84012	3550 N Central Ave
A I U	Tucson 85711	40 No. Swan Rd
ARKANSAS		
A C I	N Little Rock 72119	120 Main St
U	Pine Bluff 71602	P O Box 1033
CALIFORNIA		
A	Burlingame 94010	770 Airport Blvd
C	Burlingame 94010	1675 Rollins Rd
A I	Emeryville 94608	5000 Shellmound St
A I	Fresno 93728	1532 N West Ave
C	Los Angeles 90015	1543 W Olympic Blvd
A I M U	Los Angeles 90054	212 N Vignes St
A	Oakland 94621	8105 Edgewater Dr
A	Ontario 91764	214 West E St
S	Palo Alto 94303	960 San Antonio Rd
A U	Sacramento 95808	2407 "J" St
A M U	San Diego 92103	2560 First Ave
A I M U	San Francisco 94119	55 Hawthorne St
A	Santa Clara 95050	1400 Coleman Ave
COLORADO		
A C I U	Denver 80206	201 University Blvd
CONNECTICUT		
I U	Hamden 06518	2905 Dixwell Ave
A	Hartford 06105	764 Asylum Ave
C I U	Meriden 06450	1 Prestige Dr
DISTRICT OF COLUMBIA		
I M U	Washington 20005	777-14th St , N W
FLORIDA		
A I U	Jacksonville 32207	4040 Woodcock Dr
A 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 U	Tampa 33609	2106 S Lois Ave
GEORGIA		
A C I U	Atlanta 30309	1860 Peachtree Rd N W
A	Macon 31204	2720 Riverside Dr
A I U	Savannah 31405	5002 Paulsen St
IDAHO		
A U	Boise 83701	1524 Idaho St
ILLINOIS		
A I M 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 1/2 So Fifth St
INDIANA		
A C I U	Evansville 47711	401 N Congress Ave
C	Fort Wayne 46804	1635 Broadway
A U	Fort Wayne 46806	6001 S Anthony Blvd
A I U	Indianapolis 46207	3750 N Meridian St
C	Indianapolis 46240	1010 E. 86th St
A C	South Bend 46601	430 N. Michigan St.
IOWA		
U	Cedar Rapids 52401	210 Second St , S. E
C	Davenport 52722	P O Box 748
A I	Davenport	(1039 State St., Bettendorf 52722)
A U	Des Moines 50310	3839 Merle Hay Rd
U	Sioux City 51101	520 Pierce St.
KANSAS		
C	Overland Park 66204	7219 Metcalf St
A	Wichita 67211	820 E Indianapolis Ave
U	Wichita 67202	104 S. Broadway Suite 1408
KENTUCKY		
A U	Lexington 40502	443 S. Ashland Ave
A C I U	Louisville 40218	2300 Meadow Dr
LOUISIANA		
A U	Alexandria 71301	2001 MacArthur Dr
I	Baton Rouge 70806	8312 Florida Blvd.
I	Lake Charles 70604	1424 Ryan St.
I	Monroe 71201	1028 N. Sixth St
A I	New Orleans 70125	4747 Earhart Blvd
U	New Orleans 70112	225 Baronne St
M	New Orleans 70130	930 Inter Trade Mart
A U	Shreveport 71101	2620 Centenary Blvd
MAINE		
U	Augusta 04330	152 State St
I	Bangor 04402	77 Central St
A	Portland 04102	Thompson's Point
MARYLAND		
I U	Baltimore 21201	1 N Charles St
A U	Columbia 21403	10221 Wincopin Circle
U	Hagerstown 21740	P O Box 477
A	Salisbury 21801	P O Box 424
MASSACHUSETTS		
I U	Boston 02117	31 St James Ave
I	Springfield 01103	120 Maple St
A C I M	Wellesley 02181	1 Washington St
MICHIGAN		
A C I U	Detroit 48202	700 Antoinette St
M	Detroit 48237	15160 W Eight Mile Rd
I	Flint 48502	801 S Saginaw St
A C I	Grand Rapids 49508	2821 Madison Ave , S E
U	Jackson 49201	210 W Franklin St
A I	Saginaw 48601	1230 S Washington Ave
MINNESOTA		
I 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 U	Minneapolis 55416	1500 Lilac Dr , S
MISSISSIPPI		
U	Gulfport 39502	P O Box 33
A	Jackson 39206	333 No Mart Plaza
U	Jackson 39201	Rm 717 Electric Bldg
MISSOURI		
A	Joplin 64802	310 Wall St
A I U	Kansas City 64105	911 Main St
A C I U	St Louis 63101	1015 Locust St
MONTANA		
A	Billings 59101	312 Transwestern Life Bldg
A I U	Butte 59701	103 N Wyoming St
NEBRASKA		
A I U	Omaha 68102	409 S 17th St
NEVADA		
U	Las Vegas 89106	1711 S 8th St
NEW HAMPSHIRE		
U	Manchester 03104	46 Bay St
NEW JERSEY		
C	East Orange 07017	56 Melmore Gardens
A I U	Millburn 07041	25 E Willow St
NEW MEXICO		
A I M U	Albuquerque 87108	120 Madeira Dr , N E
NEW YORK		
A I M U	Albany 12201	11 Computer Dr West
U	Binghamton 13902	40 Front St
A I U	Buffalo 14202	625 Delaware Ave
A	Elmsford 10523	44 N Central Ave
A	Harrison 10528	600 Mamaroneck Ave
C	Mattydale 13211	P O Box 5858 E Molloy Rd
I M U	New York 10022	641 Lexington Ave
C	Rochester 14618	3380 Monroe Ave.
A I U	Rochester 14604	339 East Ave
A I U	Syracuse 13201	3532 James St
A	Vestal 13805	P.O. Box 407
NORTH CAROLINA		
A C I U	Charlotte 28207	141 Providence Rd
A I	Greensboro 27405	801 Summit Ave
A U	Raleigh 27603	120 N Boylan Ave
NORTH DAKOTA		
U	Bismarck 58501	418 Rosser Ave
A	Fargo 58102	112 University Dr
OHIO		
A I	Akron 44320	341 White Pond Dr
I U	Canton 44720	7900 Whipple Ave N W
A C I U	Cincinnati 45206	2621 Victory Pkwy
C	Cleveland 44116	20950 Center Ridge Rd
A I M U	Cleveland 44114	1000 Lakeside Ave.
C	Columbus 43212	937 Burrell Ave.
A I U	Columbus 43216	1110 Morse Rd
A C I U	Dayton 45439	3430 S. Dixie Hwy.
C	Mansfield 44902	166 Park Ave , W
U	North Canton 44720	7900 Whipple Ave N W
U	Toledo 43604	420 Madison Ave
A C I	Toledo 43606	3450 W. Central Ave.
A I	Youngstown 44507	272 E Indianola Ave
OKLAHOMA		
A U	Oklahoma City 73106	2000 Classen Blvd.
A I	Tulsa 74105	5138 S Peoria Ave.
U	Tulsa 74103	420 Main St.
C	Tulsa 74135	3315 E 47th Place
OREGON		
A I U	Eugene 97409	1170 Pearl St.
A U	Medford 97501	107 E. Main St.
A C I U	Portland 97210	2929 N W 29th Ave.
PENNSYLVANIA		
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
A I U	Johnstown 15902	841 Oak St
C	Philadelphia 19114	2417 Welsh Rd
A I M U	Philadelphia 19102	3 Penn Center Plaza
C	Pittsburgh 15234	300 Mt. Lebanon Blvd
A I U	Pittsburgh 15222	300 6th Ave Bldg
A	Williamsport 17701	2209 Fink Ave
C	York 17403	1617 E Market St
RHODE ISLAND		
A	Providence 02904	1006 Charles St , N
SOUTH CAROLINA		
A I U	Columbia 29205	2728 Devine St.
A I	Greenville 29606	1403 Laurens Rd.
SOUTH DAKOTA		
A	Sioux Falls 57105	513 Main Ave
TENNESSEE		
U	Chattanooga 37402	832 Georgia Ave.
A C I M	Chattanooga 37411	5800 Bldg Eastgate Center
I	Kingsport 37664	1170 E Eastman Rd
A U	Knoxville 37921	1301 Hannah Ave , N W
A I U	Memphis 38116	3385 Airways Blvd.
A	Murfreesboro 27130	117 N W Broad St
A U	Nashville 37203	1717 West End Bldg
C	Nashville 37204	2930 Sidco Drive
M	Oak Ridge 37830	253 Main St , East
TEXAS		
U	Abilene 79601	442 Cedar St
U	Amarillo 79101	303 Polk St.
A I U	Beaumont 77704	1385 Calder Ave
U	Corpus Christi 78401	205 N. Chaparral St
A C I U	Dallas 75247	8101 Stemmons Freeway
I U	El Paso 79902	215 N Stanton St.
A	El Paso 79902	2800 N Stanton St.
A	Fort Worth 76107	100 N. Univ Dr
U	Fort Worth 76102	408 W 7th St
A C I U	Houston 77027	4219 Richmond Ave
A I	Lubbock 79408	500 E 50th St
A	Midland 79704	122 N "N" St.
A U	San Antonio 78204	419 S. Main Ave.
UTAH		
A I U	Salt Lake City 84110	431 S. Third E St.
VERMONT		
U	Rutland 05702	38 1/2 Center St.
VIRGINIA		
A M	Newport News 23601	311 Main St
A I U	Richmond 23230	1508 Willow Lawn Dr.
A I U	Roanoke 24015	2018 Colonial Ave., SW
WASHINGTON		
A I M U	Seattle 98188	112 Andover Park, E.
A I U	Spokane 99220	E 1805 Trent Ave.
WEST VIRGINIA		
A I	Charleston 25328	306 MacCorkle Ave., SE
I U	Fairmont 26555	310 Jacobs Bldg
A	Huntington 25701	Sixth Ave. & Ninth St.
I	Wheeling 26002	40 14th St.
WISCONSIN		
A I U	Appleton 54911	3003 W College Ave.
U	Madison 53704	2038 Pennsylvania Ave.
C	Milwaukee 53226	Mayfair Plaza, 2421 N. Mayfair Rd.
A I U	Milwaukee 53202	615 E Michigan St.
CANADA		
	Canadian General Electric Company, Ltd. Toronto	

COMMUNICATION AND CONTROL DEVICES DEPARTMENT, GENERAL ELECTRIC COMPANY, WAYNESBORO, VA.

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