

GEK-36562



**DRIVE
SYSTEM
INSTRUCTIONS**

**INSTRUCTIONS
3S7930SA210G01,G02**

**SCR VOLTAGE REGULATOR
For
A C GENERATOR**

**DRIVE SYSTEMS DEPARTMENT
SALEM, VA. 24153**

GENERAL  ELECTRIC

ISSUED:April 1979

The information contained herein does 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, and maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to General Electric Company, USA.

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INTRODUCTION

This instruction book contains the description, principles of operation, installation, operation and troubleshooting pertaining to the 3S7930SA210 series SCR Voltage Regulator. This voltage regulator is used to control the armature voltage of an AC generator.

RECEIVING, HANDLING AND STORAGE

Receiving and Handling

Immediately upon receipt, the equipment should be carefully unpacked to avoid damaging the apparatus. Particular care should be exercised to prevent small parts from being mislaid or thrown away in the packing material.

As soon as the equipment is unpacked, it should be examined for any damage that might have been sustained in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company and the nearest General Electric Sales Office should be notified promptly.

Storage

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

DESCRIPTION

The SCR voltage regulator consists of a steel base upon which are mounted semiconductors, resistors, capacitors, rheostats and magnetic devices. The regulator is provided with an AC voltage sensing circuit, SCR power output circuit, a DC regulator circuit and a maximum excitation limit circuit as part of the standard package. The buildup or field flashing circuit, and the under/frequency limit circuit are optional features that can be added to the base.

A Power Potential Transformer (PPT) is supplied to provide isolation of the regulator from the power source and as a step down of the power voltage.

Performance

Output Rating (with 240 VAC PPT Secondary) Maximum Continuous 117 Volts 28 Amps
 1 Minute Forcing 175 Volts 40 Amps
 Minimum 10 Volts 200 Amps

AC Voltage Regulation +2.0% from no load to full load

AC Voltage Adjust Range +10% of nominal

Regulator Response Time 80 m sec.

Ambient Temperature Range -10° to 40°C

Reactive Current Compensation Max 8% for 1 phase sensing
 Max 12% for 3 phase sensing

DC Regulator Range 15% to 100% of Maximum output

Under Frequency Limit Set at 55 Hz. (on 60 Hz. generators).

 * WARNING *

ONLY PERSONNEL THAT ARE ADEQUATELY TRAINED AND ARE THOROUGHLY FAMILIAR WITH THE EQUIPMENT AND THESE INSTRUCTIONS SHOULD INSTALL, OPERATE AND MAINTAIN THIS EQUIPMENT.

INSTALLATION

The regulator should be mounted so that it is accessible. If furnished without an enclosure, it should be mounted in an enclosure to protect personnel from exposed voltages. The enclosure should allow a reasonable circulation of air to keep ambient temperature below 55°C. The regulator must be mounted upright as indicated on the outline drawing on page A03 of the system elementary.

The voltage adjusting potentiometer may be removed and remotely mounted, if required. Make connections to the regulator per diagrams furnished with the particular model.

 * WARNING *

APPROPRIATE GROUNDING PRACTICES/PROCEDURES ARE TO BE STRICTLY ADHERED TO.

OPERATION

* WARNING *

HEAT SINKS ON PANEL ARE AT ABOVE GROUND POTENTIAL.

Adjustments

Set "Voltage Adjust" (90P) and "Stabilizing" (3P) potentiometers at their midpoints. Set "Voltage Level Adjust" (1P) near nominal voltage. Set "Gain" (2P) and "DC Volt. Adjust" (70P) fully CCW. Set "DC Volt. Limit" (4P) and "Max. Exc. Limit" (5P) fully CW. Set the exciter for AC or auto operation. Turn both the Maximum Exc. Limit and Droop off. To turn off the Droop circuit in the single phase case, short potentiometer (6P) by placing a jumper between terminal points A8 and A9. In the three phase case, just turn the tap switches to zero. Set jumpers on 2TP for maximum capacity. To adjust the underfrequency limit, start with lead 2 on reactor USX Terminal 5.

Start prime mover and bring up to rated speed. Flash generator field if this is required. Set "Voltage Adjust" (90P) to obtain the proper generator voltage.

Remove lead on tap 10 of USX; generator terminal voltage should not be affected. If voltage tends to rise when lead was removed, set lead 2 on next lower tap until generator voltage shows no effect. Replace lead and stop generator. Observe exciter field current as generator comes to rest. This current should not exceed 30%. If field current exceeds 30% or more, move lead 2 to higher tap on USX.

Observe generator transient response by applying and rejecting load. Underfrequency limit should be set on tap where transient response is not affected.

To obtain optimum response when applying and rejecting load, vary "Stability" (3P) and the capacity at 2TB. Starting with maximum capacity, adjust 3P for best response as the capacity is decreased in steps.

Too much capacity will cause the system to be overdamped, while not enough capacity will cause the system to be under-damped. See Figure 1. Adjusting 3P will give optimum response for each step of changing capacity. System may be unstable at either end of 3P adjustment. In effect, varying capacity with jumpers at 2TB is a coarse stabilizing adjustment while varying 3P is a fine stabilizing adjustment.

With stabilizing circuit near optimum, increase the "Gain" (2P) until the generator voltage droops between 2.0% and 3.0% as the generator changes from a no-load to a rated load condition. "Droop" compensation circuit must be "Off" for this steady state regulation check. "Voltage Adjust" (90P) will need to be reset as "Gain" (2P) is increased.

Load the generator (hot) to the maximum (lagging KVA) load under which it will normally operate, keeping the generator AC voltage at the proper level with the "DC Volt. Adj." As "DC Volt. Limit" (4P) is turned CCW, the "DC Volt. Adj. (70P) will have to be turned CW to keep the AC generator voltage up. Continue this until the "DC Volt. Adj." (70P) is at its maximum CW position. Back 4P off slightly CW and lock. Return to no-load, continually readjusting the "DC Volt. Adj." (70P) to keep AC generator voltage correct.

Lock all adjustments except "Volt Adj." (90P) and "DC Volt. Adj." (70P) which will be adjusted as required during normal operation.

PRINCIPLES OF OPERATION

General

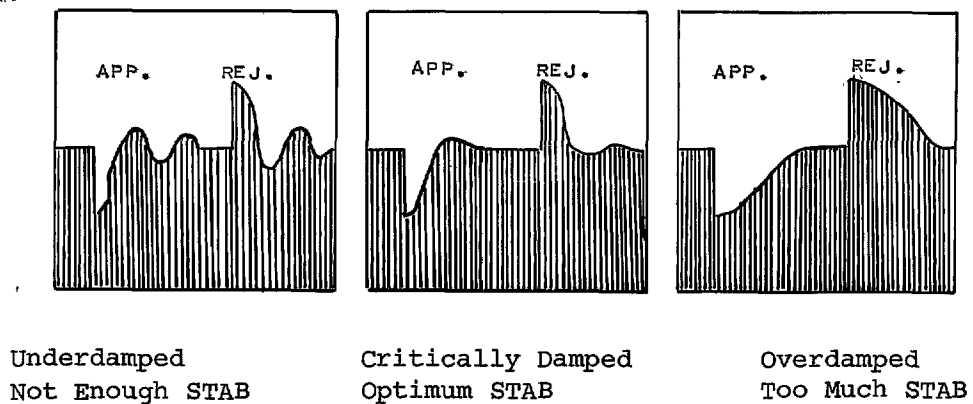
The 3S7930SA210 SCR regulator operates by taking power from the generator output; and rectifying and controlling the power to furnish DC excitation for the exciter field. Refer to the elementary in back of the instruction manual.

Silicon Rectifiers

The DC excitation power for the exciter (or generator) field is furnished by a full-wave bridge using silicon controlled rectifiers (SCR's) in two legs of the bridge. The SCR's (1CD and 2CD) are phase controlled to control the power delivered to the machine field.

The voltage regulator controls the machine field voltage by controlling the firing of 1CD and 2CD on respective positive half cycles. See Figure 2.

Go back and recheck "Stability" (3P) for optimum adjustment after "Gain" has been set.



Typical oscillograms or recordings - looking at amplified portion of generator AC line voltage

Figure 1
Stabilizing Adjustment Recordings

With the generator hot and loaded to the maximum (lagging KVA) load under which it will normally operate, turn the "Max. Exc. Limit" (5P) CCW until generator voltage begins to drop. Then back off 5P slightly CW and lock. Return to no load.

With "DC Volt. Adj." (70P) fully CCW, "DC Volt. Limit" (4P) fully CW, and generator at no-load, switch to "DC Regulator" (or manual). "DC Volt. Adj." should control generator voltage similar to a manual field rheostat. If required, the "DC Volt. Limit" (4P) may be set similarly to the "Max. Exc. Limit".

If SCR's fire early in respective positive half cycles (Figure 2b) the regulator delivers a large average voltage to the exciter (or generator) field. If the SCR's fire late in respective positive half cycles (Figure 2a) the regulator delivers a smaller average voltage to the exciter (or generator) field. Although the voltage applied to the exciter field is portions of a sine wave, the current through the field is continuous because of the inductance of the field winding. The field current "free-wheels" through 3D and 4D during the time that neither 1CD or 2CD is conducting.

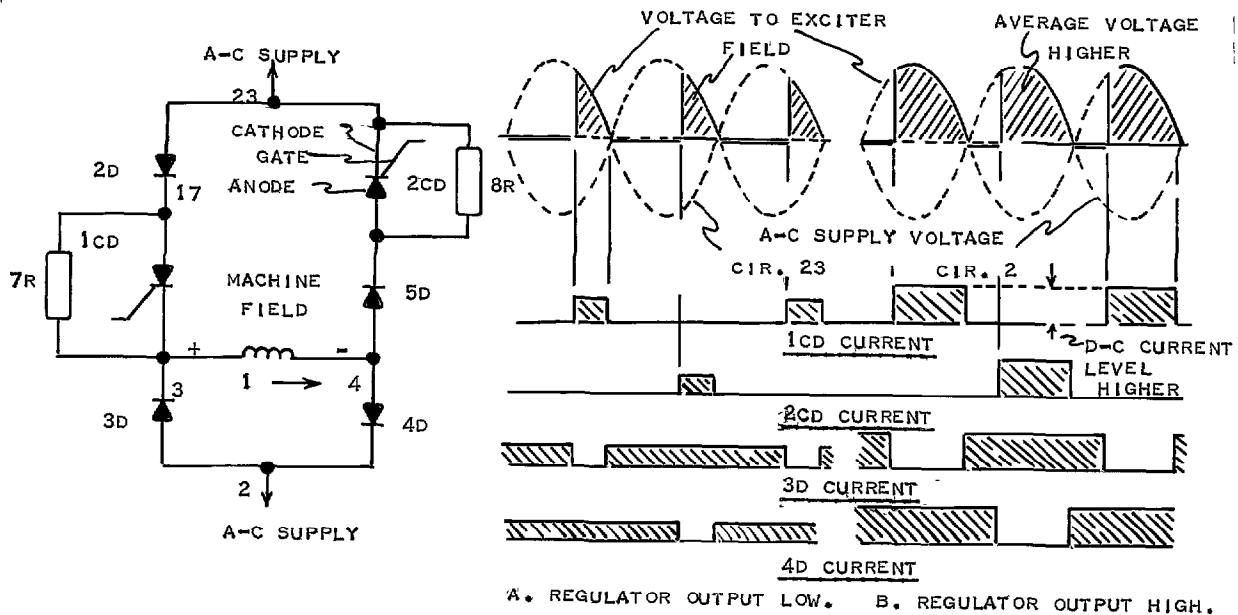


Figure 2.
Phase Controlled Output of SCR's 1CD and 2CD.

Rectifiers 2D and 5D are series diodes that appear as very high impedances when their associated SCR's are not firing; thus, taking most of the inverse voltage during the negative half cycles. This protects the SCR's from permanent damage due to excess transient inverse voltage. Resistors 7R and 8R provide leakage paths around 1CD and 2CD and cause most of the inverse voltage to appear across 2D and 5D.

Firing Circuit

The pulses for firing 1CD and 2CD come from saturable reactors 1SX and 2SX respectively. The gate winding is connected between the gate and anode of the SCR, while the reset winding is connected to a DC source (Figure 3). During the time that point A is positive with respect to B, the gate winding accumulates enough volt-seconds to saturate the reactor and fire the SCR.

When A is negative with respect to B, the flux in the reactor is reset to a value set by the amount of DC current in the reset winding. Increasing and decreasing the reset current causes the SCR to fire later or earlier in the positive half cycle of the supply voltage. The amount of current through the load is therefore dependent on the amount of reset or error signal current in the reset winding.

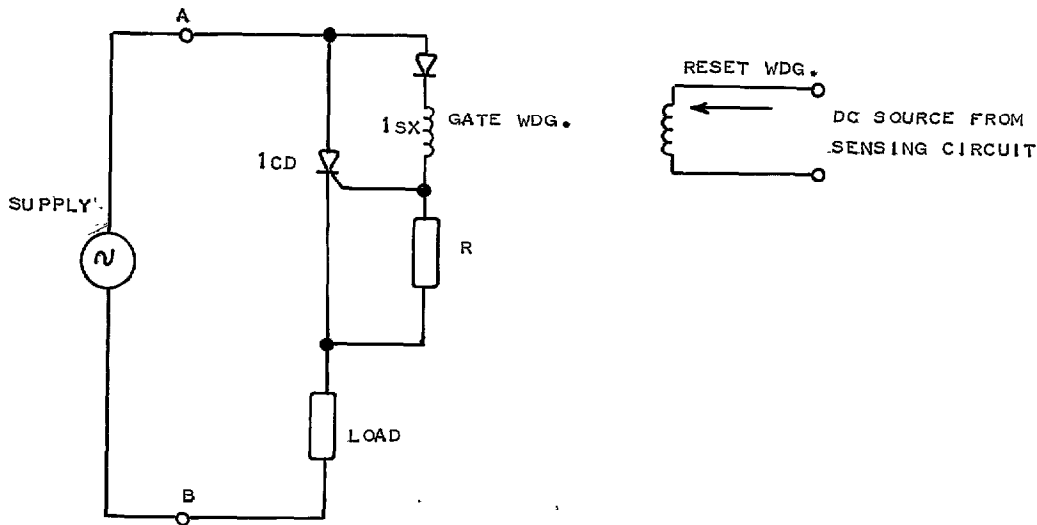


Figure 3
Simplified Version of SCR Circuit

Firing Circuit

The SCR supply voltage is obtained from one phase of the PPT secondary; it is this voltage that is applied across the SCR's and their associated firing networks. The firing network for the LCD SCR consists of a series combination of 9R, 1SX, and 1D with the gate of LCD connected between 9R and 1SX5 (see Elementary). As the supply voltage increases in the positive direction, 1SX accumulates enough volt seconds to saturate its core, and once the core saturates, the voltage across all coils wound on the 1SX core becomes zero. When this occurs, the voltage across 1SX becomes zero, therefore, causing the voltage across 9R to increase rapidly and fire the LCD SCR. When the supply voltage goes negative, the same sequence of events occurs for the 2CD SCR. During the time LCD is conducting, current flows through the LCD SCR, through the control windings and through 4D to the supply transformer. The circuitry is so arranged that the current flows through the control windings in the same direction when either the LCD or 2CD SCR fires. The average of these current pulses is the DC that controls the SCR's.

Sensing Circuit and Reference

The sensing circuit consists of rectifiers 7D-12D, resistor 1R, and capacitor 1C. This circuit produces a DC voltage proportional to the AC line voltage. If the generator wave shape is distorted, the sensing circuit voltage will more nearly follow the average (or RMS) line voltage instead of the peak line voltage.

The output DC voltage from the sensing circuit produces both the reference and feedback voltages. See Figure 4. The 62 volt reference voltage across the zener diode 1Z does not vary with changes in line voltage. The feedback voltage is proportional to the sensing circuit voltage and varies with AC line voltage change. The difference between the reference voltage and the feedback voltage is the error or reset voltage signal. The error voltage causes current to flow from 9OP to 1Z, thus controlling the flux reset in 1SX and 2SX. There is always a slight error voltage, as required to regulate AC line voltage under a particular condition.

Potentiometer 9OP is the voltage adjust control which sets the desired operating point. Voltage level adjuster 1P sets the range over which the feedback voltage at 9OP can vary to produce an error voltage signal. Should line voltage drop, the error through 1SX and 2SX will decrease. The smaller current will reset the flux in 1SX and 2SX cores a smaller amount during the negative or off cycles; therefore, 1SX and 2SX will saturate earlier on the positive half cycle to fire LCD and 2CD earlier and increase the voltage to the machines. The increase in excitation will increase the AC line voltage to decrease the original error. The opposite of the above reaction will take place if line voltage should rise.

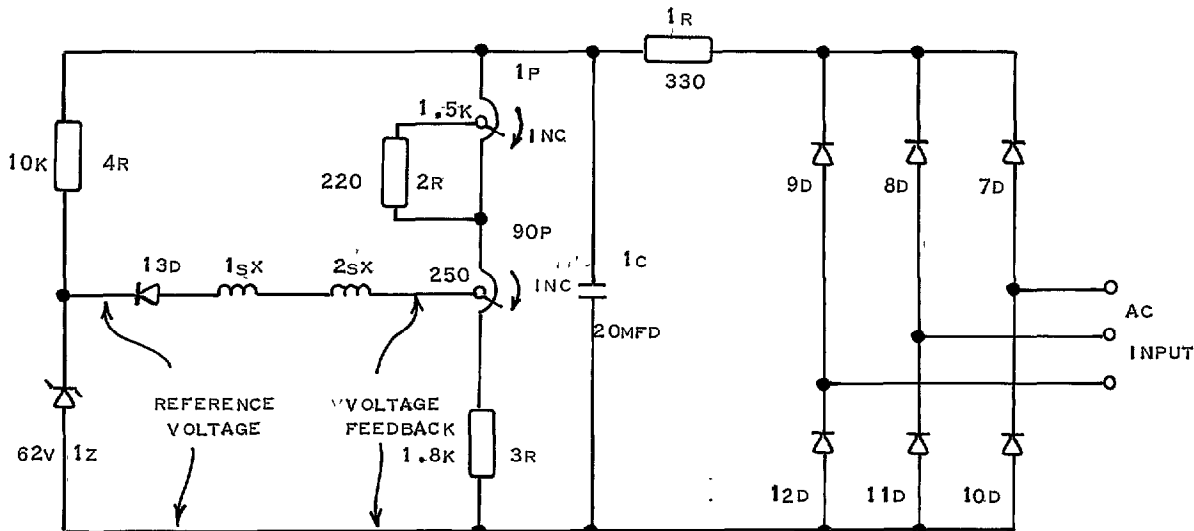


Figure 4 Sensing Circuit and Reference

Reactive Current Compensation

The RCC circuit is used to apportion reactive KVA and to prevent circulating reactive current between generators when two or more generators with individual regulators are operating in parallel.

The voltage that is added to the sensing circuit due to RCC will cause the sensing circuit voltage to increase or decrease, depending on the phase relationships. See Figure 5.

When the generator is supplying unity power factor current (Figure 5 (a)) the voltage across the compensator will add to the input voltage at an angle such that the sensing circuit voltage and input voltage will be nearly the same. Should reactive current tend to increase in the lagging direction (Figure 5 (b)) the regulator sensing circuit will see a higher than normal voltage, indicating over-excitation; thus, the regulator will decrease excitation to lower line voltage, thereby decreasing the lagging reactive current. Should reactive current tend to increase in the leading direction (Figure 5 (c)) the regulator sensing circuit will see a lower than normal voltage, indicating under-excitation; thus the regulator will increase excitation to raise line voltage, thereby decreasing the leading reactive current.

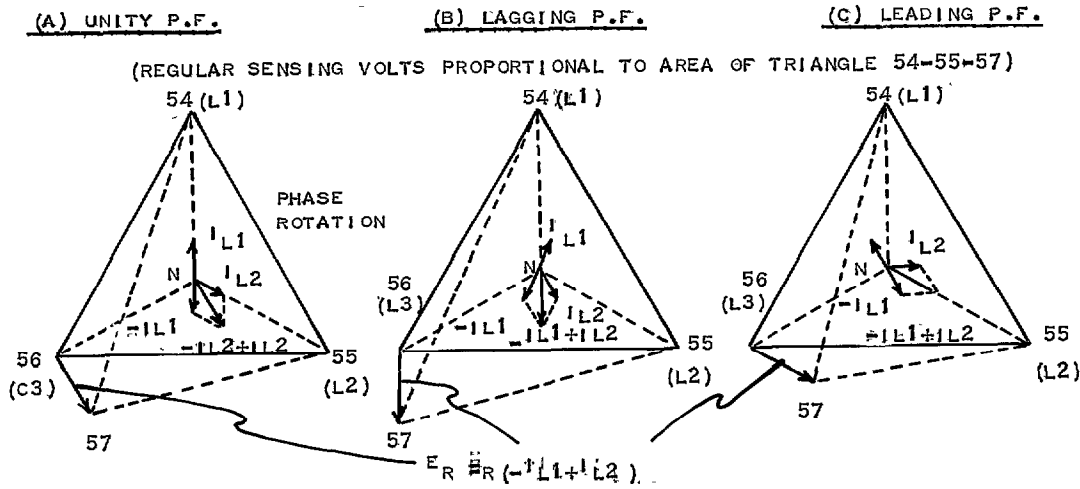


Figure 5
Operation of Paralleling (Droop) Circuit

To achieve this compensation in the single phase sensing regulator, the RCC circuit consists of a CT droop adjusting rheostat. It delivers the AC voltage that adds to the regulator sensing voltage. The rheostat is connected in series with one leg of the AC regulator sensing circuit. When connections from the rheostat are reversed, the reverse of the above action takes place. The generator terminal voltage is then raised as lagging reactive current is increased, the amount of compensation depending on the setting of the droop adjusting rheostat.

In the three phase sensing regulator the adjustable winding of a reactor is connected to the secondary of a current transformer located in one of the generator lines. The insulating winding is connected in one phase of the three-phase regulator sensing lines. IT IS ESSENTIAL THAT BOTH WINDINGS OF THE COMPENSATOR BE CONNECTED IN THE SAME PHASE.

The effect of the compensator can be increased by increasing the reactance appearing in the current transformer secondary circuit. This may be done by the use of tap switches connected to the reactor.

The compensator is adjustable in one-volt steps, on the basis of five amperes in the current-transformer secondary, by means of two manually-operated tap switches. One of the separately-adjustable tap switches gives coarse adjustments and the other fine adjustments. The voltage across this winding in the regulator sensing voltage circuit is proportional to the current flowing through the current transformer secondary winding.

If two generators are connected through transformers, the compensator is not always used as described above. Instead, one winding may be reversed to obtain the opposite effect as that described above. This makes it possible to adjust the apparent transformer impedance to an optimum value of 6 or 7 percent on a reactive basis, improving system voltage regulation.

Stabilizing and Feedback Circuit

Control windings of 1SX and 2SX are provided for positive feedback to increase system gain, and transient negative feedback to stabilize the system.

Both positive and negative feedback circuits take the regulator output, or machine field voltage, and feedback signals to 1SX and 2SX windings for "Gain" and "Stabilizing". Reactor 2X is a filter to provide a reasonably smooth DC feedback voltage.

The positive feedback signal (through 2P, 6R, and 1SX and 2SX windings 9 to 10) adds to the original error signal through windings 8 to 6 to increase system gain; thus, providing close control AC line voltage.

The transient negative feedback signal (through 3P, 3C or 4C, and 1SX and 2SX windings 12 to 11) transiently opposes the original error signal through windings 8 to 6; thus, retarding action of the system as required for stabilizing. Changing jumper connections on 2TB provides a range of stabilizing capacity.

Harmonic Suppression Filter

Reactor 1X, capacitors 2C and 5C, and resistor 5R are provided to reduce the distortion of generator waveshape caused by the SCR full-wave bridge circuit.

Because of the fast "turn-on" characteristics of an SCR, the current from the generator line supplying the SCR must increase by the amount of machine field current in several microseconds. This high rate of change of current will usually cause a spike or notch in the generator wave; thus, it may create some unwanted harmonics. This notching or distortion is usually negligible on applications using rotating exciters; however, it may be objectionable on static exciter applications because the excitation current taken from the generator line is a large percentage of the generator rated current.

The taps on 1X provide more or less filtering. As little as possible of 1X should be used, because as 1X increases, the maximum regulator output voltage is decreased. Increasing 1X also slows system transient performance, and may decrease system gain.

Build-Up Relay and Field Flashing Circuit(s) Options

To assure generator voltage build-up, a build-up relay or field flashing circuit may be provided and mounted on the regulator panel. The build-up relay is furnished as an aid in starting the generators with rotating exciters having low residual voltage output. The relay contacts are connected across SCR's 1CD and 2CD, and short the SCR's to apply full available voltage to the exciter field from a separate power source to insure generator start-up. The circuit consists of a flashing relay and resistor that are connected across the regulator output (A3 to A4). On many applications, such as small and (or) high speed machines where generator residual voltage is high, or where the machine is separately excited, the system will build-up automatically without a build-up or field flashing circuit.

DC Regulator

The DC regulator keeps the DC output voltage regulated by manual control of the DC voltage adjust potentiometer 70P. This is useful when paralleling with a rotating exciter as may be required when changing to a spare exciter for maintenance, or to provide manual control of the static exciter (similar to a field rheostat). See Figure 6.

The DC regulator operates on DC voltage feedback from the exciter output. This voltage is filtered by 3X, 11R and 6C so that the DC voltage across circuits A4 and A13 is a smooth DC that is proportional to the average voltage applied to the exciter field. When 43CS is in the "DC Regulator" (or manual) position, (AC Regulator Off) the filtered DC voltage is applied across the DC regulator, circuits A15 and A4, and firing reactors 1SX and 2SX are controlled by the DC regulator only. The error voltage that resets the firing reactors is by the DC regulator only. The error voltage that resets the firing reactors is the difference between the feedback voltage (volt. at 70P) and the reference voltage (volt. across 2Z). Should the DC output voltage drop due to the generator voltage dropping (load application), the feedback voltage will drop and there will be less error voltage left to reset the firing reactors. The firing circuits will then turn on to increase the DC output voltage. The feedback voltage will increase to its original value along with the DC output voltage, even through the generator AC voltage may now be lower. Should the exciter output voltage tend to rise the opposite of the above reaction would occur. The DC regulator holds a constant feedback voltage, so the DC level of voltage is set by the "DC Voltage Adjust" (70P). A maximum on the range of adjustment made by 70P is set by the "DC Voltage Limit" potentiometer 4P.

Maximum Excitation Limit

The maximum excitation limit circuit, which is similar to the DC regulator, is used with the AC regulator on, as compared to the DC regulator that is used alone. The MEL sets a maximum limit on the DC voltage out of the exciter regardless of AC regulator action. This prevents over exciting the generator under such conditions as overload, under frequency, excessive lagging reactive current or AC regulator failure.

If the AC regulator tries to turn the firing circuit full-on by applying little or no reset voltage to the firing reactors, the MEL circuit will take over and furnish the firing reactor more reset voltage so that the firing circuit is not over driven. Rectifier 14D prevents reverse error voltage from being applied to the firing circuit, and thus isolates the MEL circuits unless the DC feedback signal is high enough to take over.

The time lag of the filter 3X, 11R, and 6C is such that the maximum limit does not take over until after about 10 cycles; therefore, it does not limit transient forcing voltage out of the exciter as is required for heavy load application. The reference voltage for the maximum excitation limit circuit is higher than that for the DC regulator because the maximum limit circuit does not need to take over at as low a voltage as the DC regulator must operate.

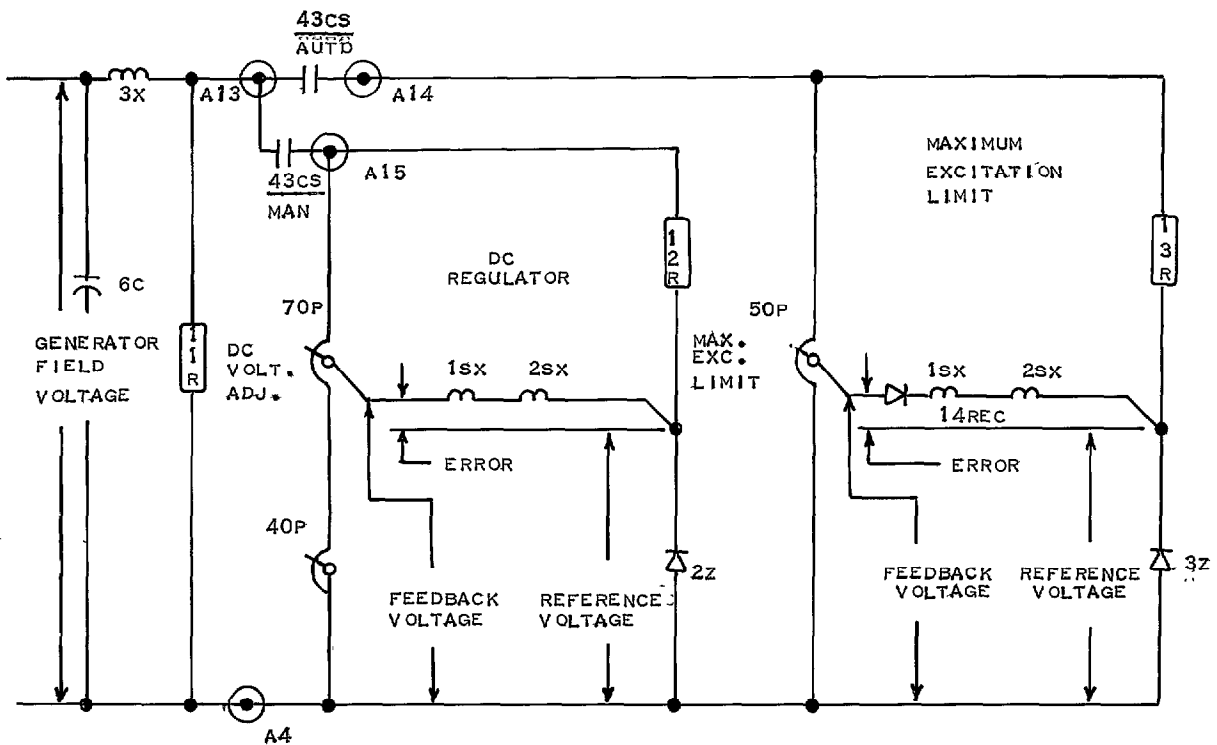


Figure 6
DC Regulator and Maximum Excitation Limit

Underfrequency Limit Option

The PT sensing is clipped and clamped to a 24V maximum square wave, (Figure 7) and applied to transformer USX which is frequency sensitive below approximately 55 cycles. As the generator frequency is decreased, the voltage across the secondary of transformer USX increases causing transistor U1Q to turn on. This essentially shorts out the reference diode U1Z and causes additional current to flow through windings (8 to 6) in 1SX and 2SX in the sensing circuit, and through transistor U1Q. This increase in current through 1SX and 2SX causes a decrease in regulator output to keep the voltage to frequency ratio at a nearly constant level.

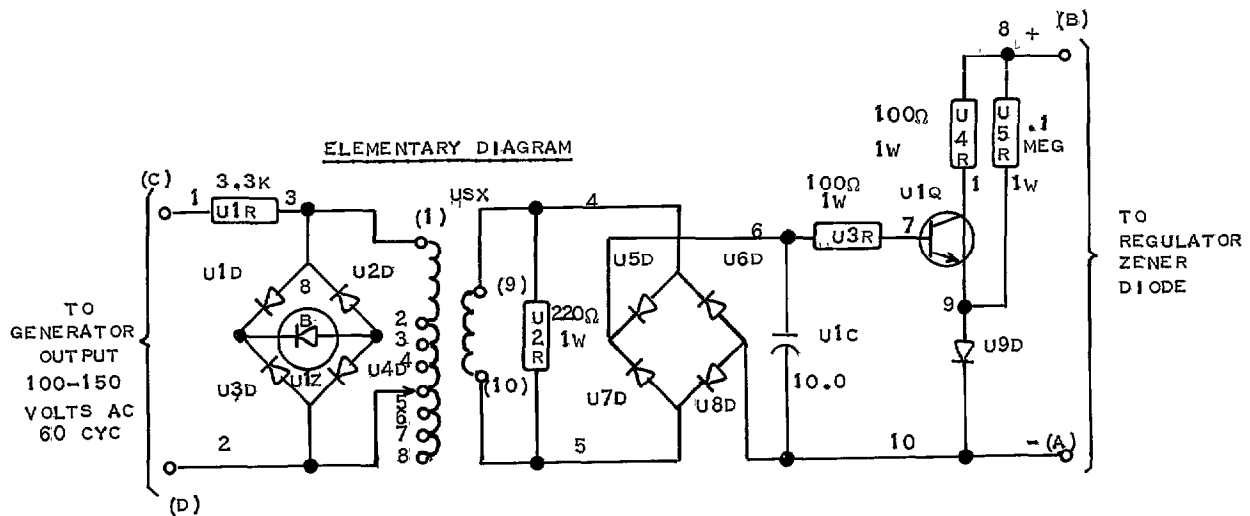


Figure 7
Elementary Diagram of Underfrequency Limiter

Motor Operated Voltage Adjuster (Optional)

A motor driven voltage adjuster (MOVA) can be provided for either or both the DC voltage regulator and the AC regulator in a separate enclosure containing one or both MOVA's. One MOVA motor is connected to the DC regulator potentiometer 70P and the other to the voltage adjust potentiometer 90P, through a system of gears. The potentiometer shaft is limited to 310° of rotation by the motor limit switches on the shaft. The limit switches also provide contact closures for position indicating lamps. The motor power is a 120 VAC or DC source and the direction of the motor is controlled by an SB switch.

MAINTENANCE

Since there are no moving parts in this exciter regulator, little maintenance should be required. Periodic checks should consist of checking the voltage level, voltage regulation, and performance as required for the particular application. The regulator should be cleaned with a blower as required to prevent an accumulation of dust and dirt.

* CAUTION *

DO NOT USE A METAL NOZZLE ON THE BLOWER. IT CAN CAUSE COMPONENT DAMAGE AND/OR INSULATION BREAKDOWN. USE A RUBBER NOZZLE.

ALSO, DO NOT USE HIGH PRESSURE AIR. IF AIR PRESSURE IS TOO HIGH, COMPONENTS MAY BE DAMAGED.

TROUBLESHOOTING

The following chart may be helpful for troubleshooting and locating faulty components; however, a thorough study of the Principles of Operation will be the greatest aid in troubleshooting.

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>CHECK</u>
I. Generator voltage not built up.	1. No power to generator field.	a. Connections to regulator. b. Build up relays across SCR's (if present). c. Rectifiers 2D, 3D, 4D, 5D, and SCR's 1CD, 2CD. d. Field flashing circuit (if present).
II. Generator voltage goes to ceiling.	1. Improper operation	a. If on DC reg. set 7P fully CCW to start
	2. No feedback voltage	a. "Droop" circuit connections. b. 90P connections c. Rect. 7D-10D d. 1ZD
	3. No control of SCR's	a. Build-up relay. b. Firing reactor 1SX, & 2SX c. SCR's 1CD & 2CD.

<u>TROUBLE</u>	<u>PROBABLE CAUSE</u>	<u>CHECK</u>
III Poor voltage regulation	1. Loss in system gain	a. Gain (2P) adjust per OPERATION. b. Exciter output to generator field. c. Droop circuit effect. Regulation should be checked without droop. d. Regulator output for unbalanced firing of 1CD and 2CD.
	2. Distorted input to sensing circuit	a. For unbalance 3-phase loads. b. Generator wave shape.
IV System unstable	1. Excess system transient again.	a. Gain adjustment per OPERATION. b. Stabilizing per OPERATION. c. Rectifier 14D. d. Add extra capacity on 2TB (A and D). e. Try with Max. Exc. Limit Off.
V Slow system response	1. Low system transient gain.	a. Stabilizing adjust per OPERATION b. Loss in system gain; check step III.
VI Paralleled generators will not divide reactive KVA.	1. Droop circuit	a. Reverse connections on loading rheostat or 4X reactor. b. Increase Droop adjust. c. Check generator phase sequence. Must be L1-L2-L3.
VII Line drop compensation not working.	1. Compensation circuit	a. Same check as for Droop circuit.

RENEWAL PARTS

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

ELEMENTARY DIAGRAM G01, G02

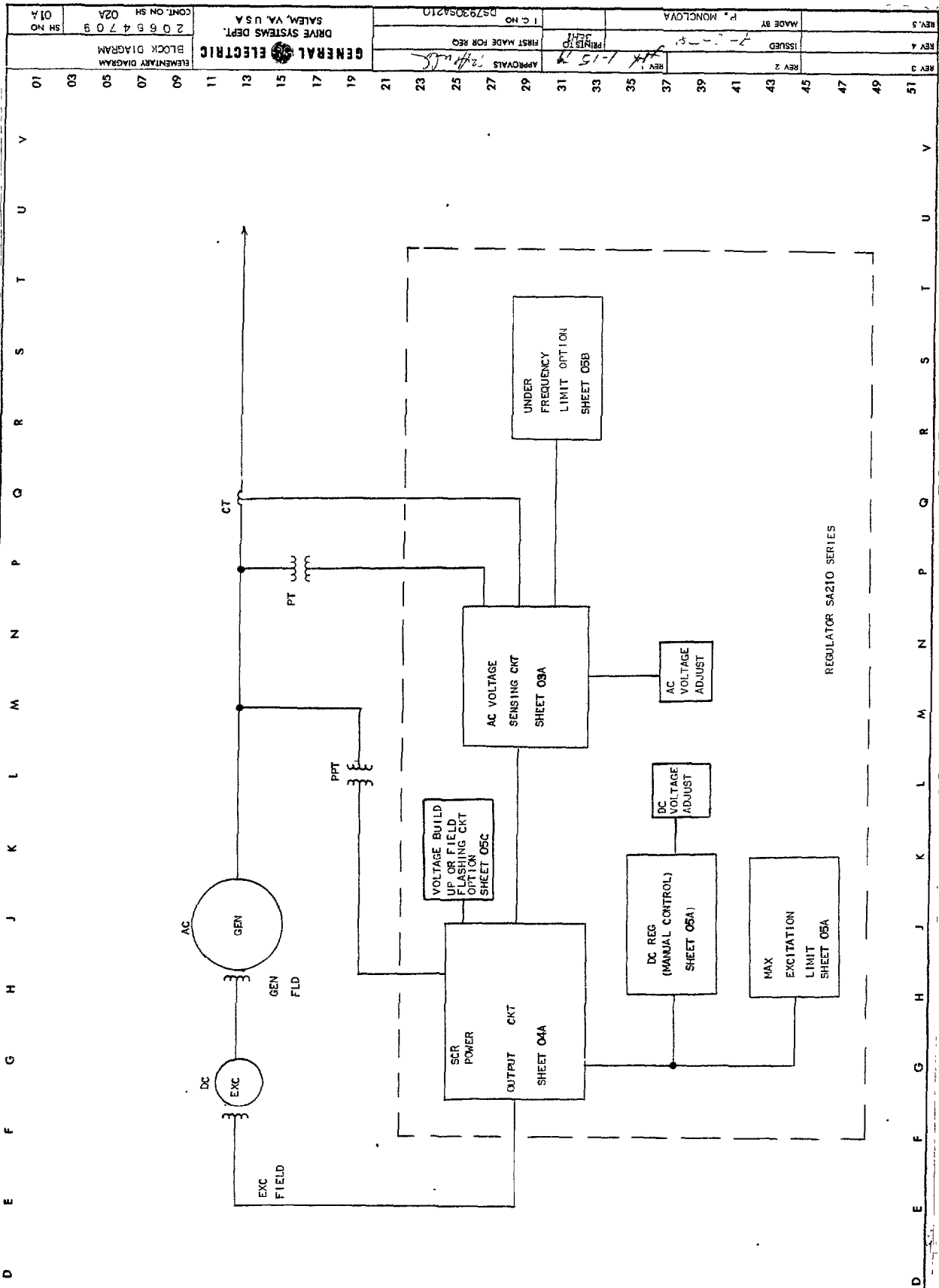
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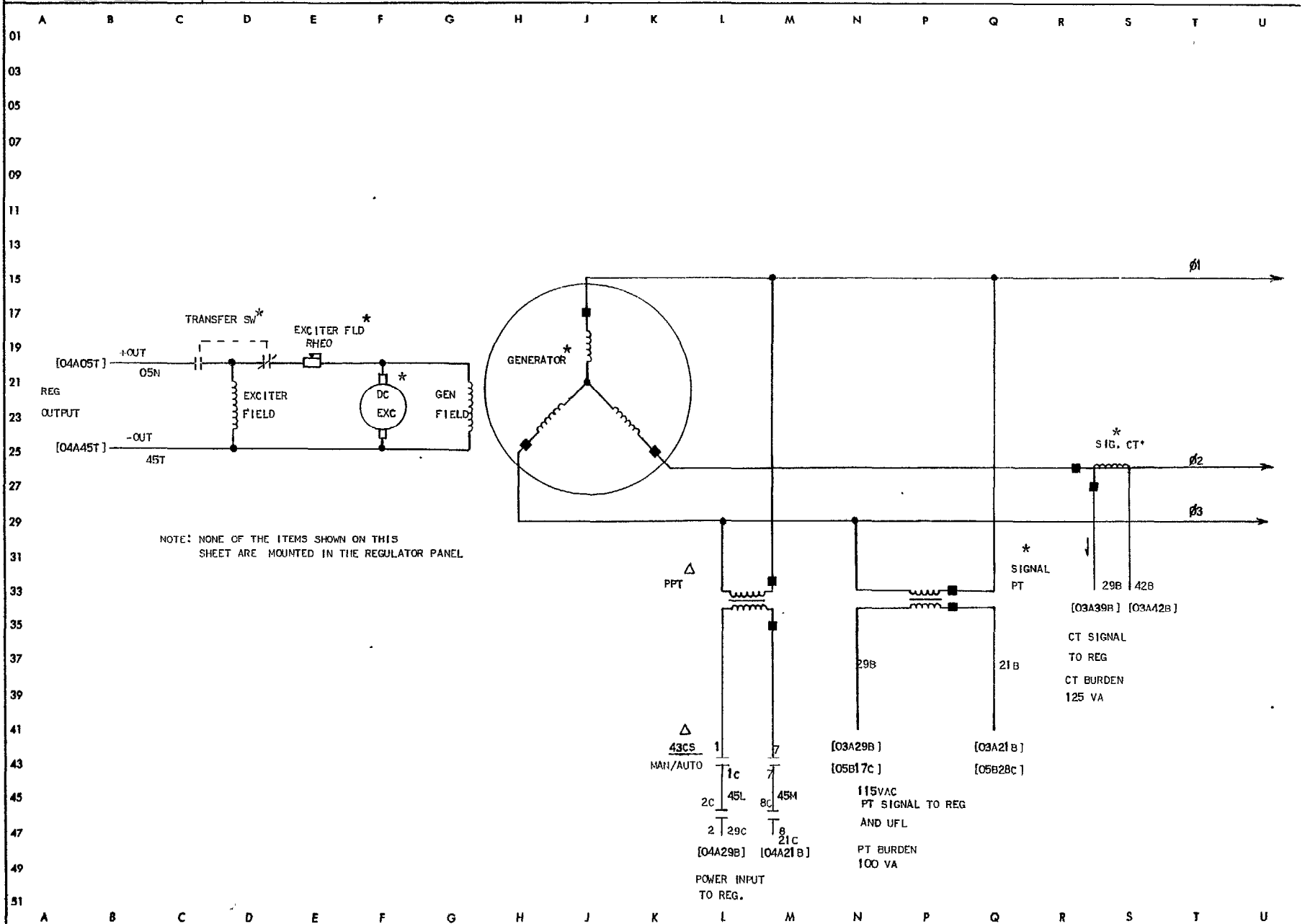
AC VOLTAGE REGULATOR

MODEL 3S7930SA210 SERIES
 SINGLE PHASE SENSING SA210 G01
 FREQUENCY 50/60HZ (40HZ SPECIAL CASE)
 OUTLINE SHEET A03
 INSTRUCTION BOOK GEK36562

REV 3	REV 2 <i>Mar 3-12-79</i>	REV 1 <i>Jan 1-15-79</i>	APPROVALS <i>[Signature]</i>	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM	
REV 4	ISSUED <i>9-12-78</i>	PRINTS TO 3EHT	FIRST MADE FOR REG		TITLE <i>TITLE</i>	
REV 5	MADE BY P. MONCLOVA	I.C. NO. <i>DS7930SA21C</i>			20684709	SH NO A01
				CONT ON SH		A02



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REV 3 <i>Red Deck 4-26-79</i>	REV 2 <i>mal 3-12-77</i>	REV 1 <i>1-13-79</i>	APPROVALS <i>[Signature]</i>	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM / GENERATOR AND EXC.	
REV 4	ISSUED <i>9-12-78</i>	PRINTS TO 3EH1	FIRST MADE FOR REG		2 C 6 B 4 7 0 9	SH. NO. 02A
REV 5	MADE BY P. MONCLOVA		I.C. NO DS7930SA210		CONT ON SH 03A	

CUSTOMER NOTES

SYMBOLS USED

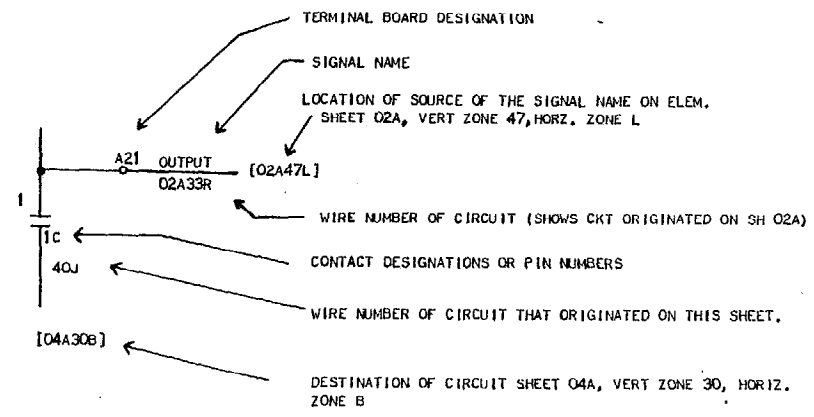
- * PURCHASERS EQUIP
- △ NOT MOUNTED ON REG PANEL
- FACTORY TERMINAL BOARD CONNECTION
- CIRCUIT CONNECTION (DOES NOT DESIGNATE LOCATION)
- ⊙ CUSTOMER TERMINAL BOARD CONNECTION ON REG PNL
- ⊖ SPRING RETURN TO NORMAL
- ⊞ CUSTOMER CABLE CONNECTION
- | | RELAY OR SWITCH CONTACT
- | | RELAY CONTACT WITH BLOW OUT COIL
- FIXED RESISTOR
- ▭ ADJUSTABLE RESISTOR (SLIDER).
- ⊞ INDUCTIVE, TRANSFORMER WINDING OR FIELD WINDING, (WITH POLARITY IF REQUIRED)
- | | FUSE
- ⊞ DISCONNECT SWITCH
- ⊞ SHORTING SWITCH
- ⊞ BREAKER
- ⊞ BREAKER WITH OVERCURRENT TRIP
- ⊞ RECTIFIER
- ⊞ THYRISTOR (SCR)
- ⊞ ZENER DIODE
- ⊞ POTENTIOMETER
- ⊞ GROUNDED RECEPTACLE
- ⊞ LIGHT EMITTING DIODE (LED) INDICATOR
- ⊞ THYRITE RESISTOR
- ⊞ RELAY COIL
- ⊞ CAPACITOR
- ⊞ HEATER
- ⊞ INDICATING LAMP
- ⊞ METER
- ⊞ SHUNT
- ⊞ SHIELDED WIRE SHIELD
- Ⓜ REGISTERED TRADE MARK

43cs △

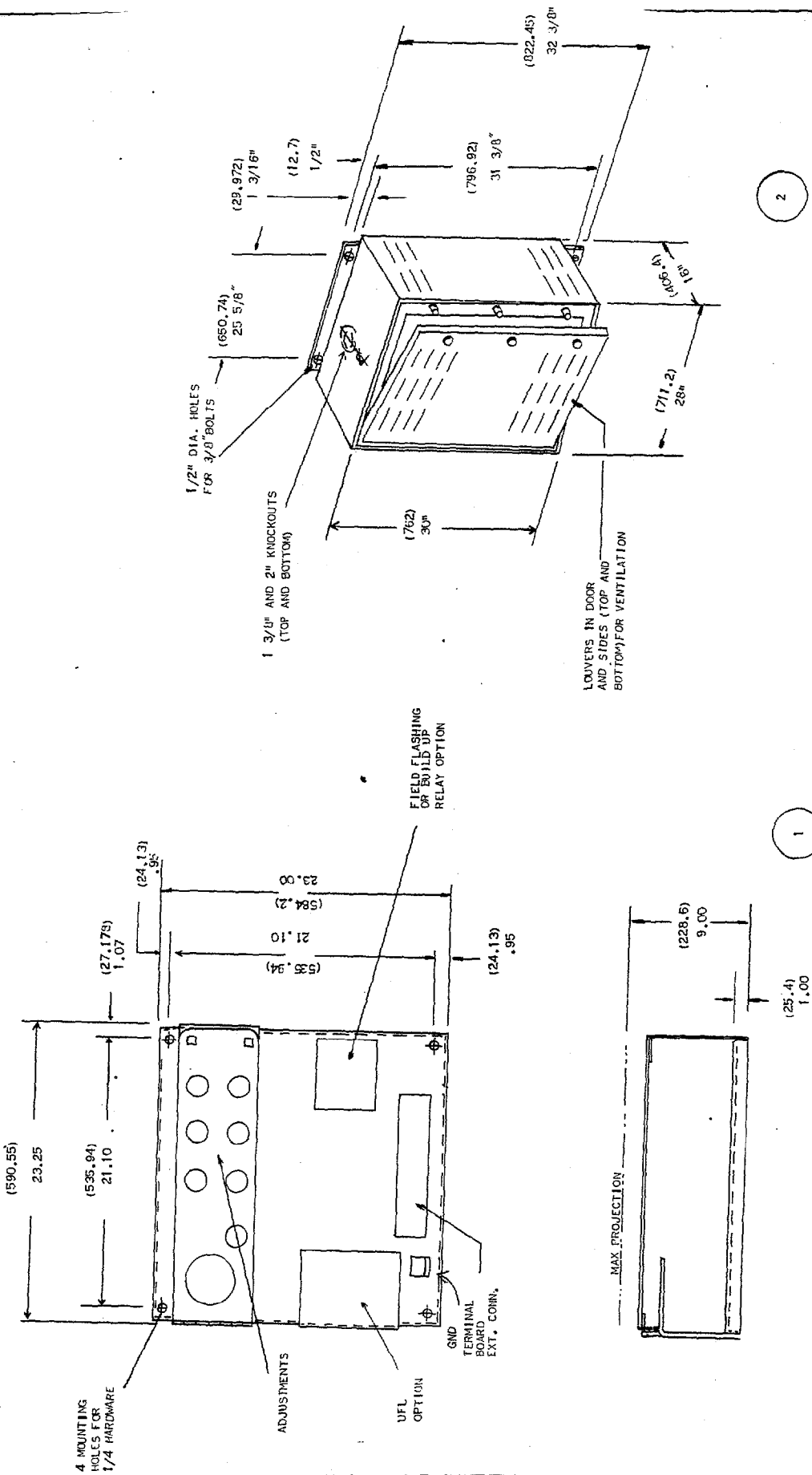
REGULATOR CONTROL SWITCH

CONTACTS	HANDLE END	NO	AUTO	MAN	OFF	SH. NO
1 1c 2c 2	0-1-0-0-1-0	1	X	X		O2A43L
		2	X	X		O2A43M
3 3c 4c 4	0-1-0-0-1-0	3		X		SPARE
		4	X			O5A19D
5 5c 6c 6	0-1-0-0-1-0	5		X		O5A21D
		6	X			O4A7T
7 7c 8c 8	0-1-0-0-1-0	7		X		SPARE
		8	X			O3A25L

SB SWITCH FURNISHED WITH MANUAL CONTROL OPTION.



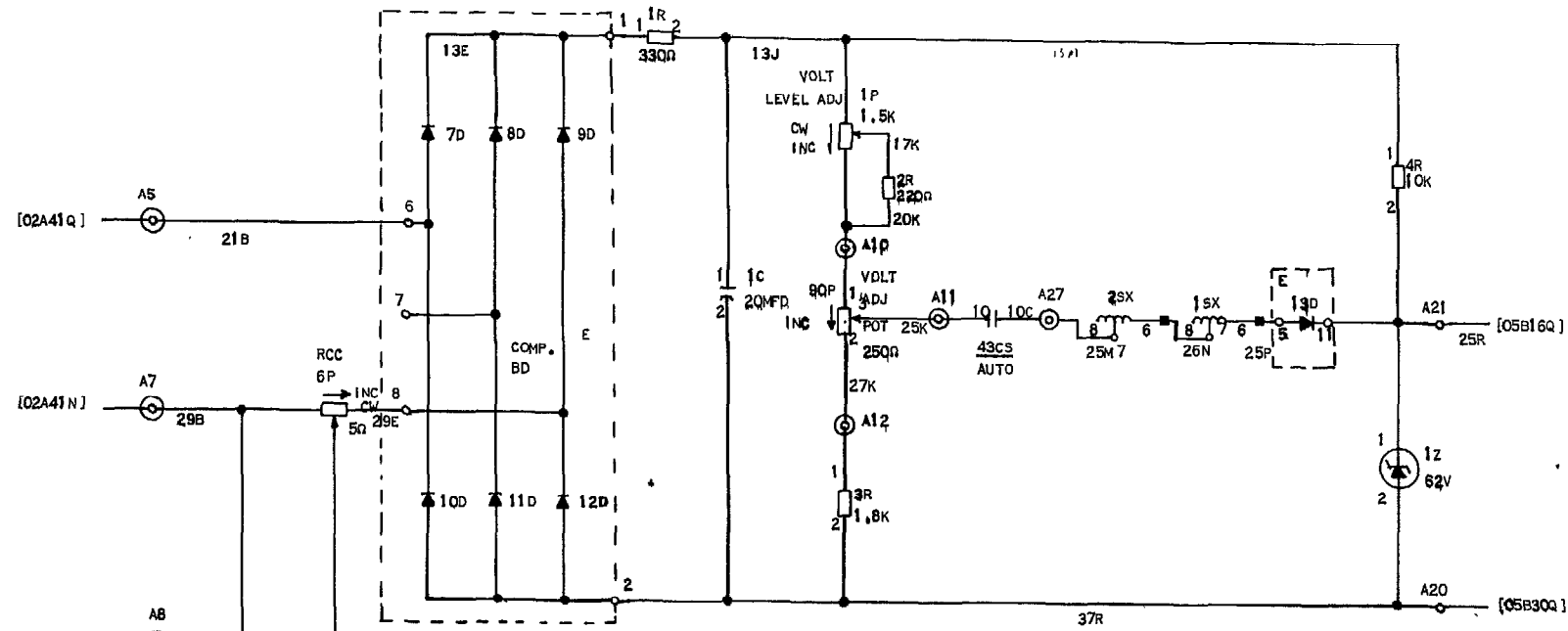
REV. 3	REV. 2	REV. 1-15-79	APPROVALS	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM CUSTOMER NOTES	
REV. 4	ISSUED 9-12-78	PRINTS TO 2-11-78	FIRST MADE FOR REG.		206B4709	SH. NO. A02
REV. 5	MADE BY P. MONCLOVA		I.C. NO. DS7930SA210		CONT. ON SH. A03	



TYPICAL WALL MOUNTED ENCLOSURE

() ALL DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS

REV. 3	ISSUED	REV. 1	APPROVALS	GENERAL ELECTRIC	ELEMENTARY DIAGRAM
REV. 4	ISSUED	1-11-79	P. MONCLOVA	DRIVE SYSTEMS DEPT.	OUTLINE
REV. 5	MADE BY	P. MONCLOVA	257-38540	SALEM, VA. U.S.A.	206B4709
					SH. NO.
					CONT. ON SH. 01A
					A03

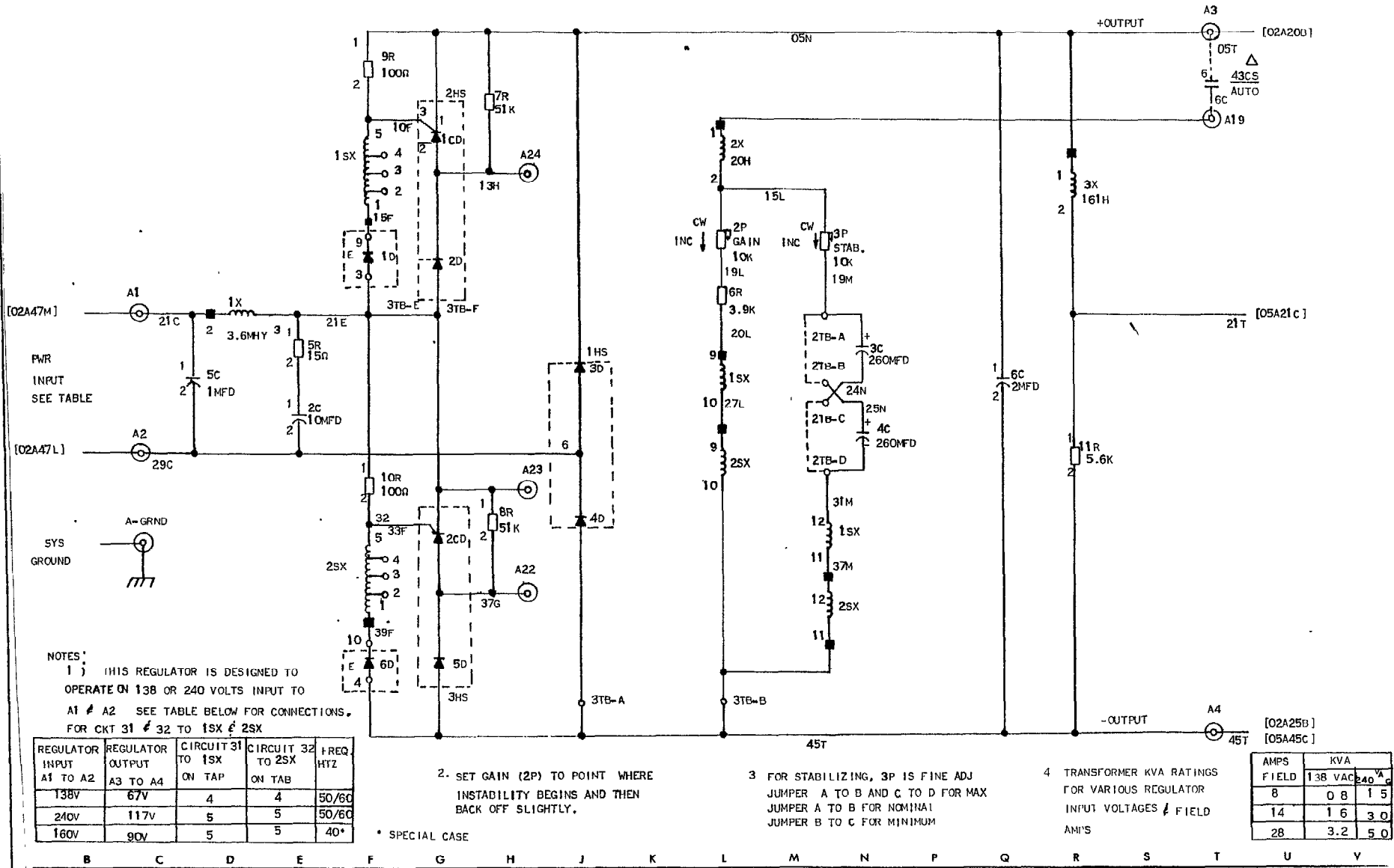


NOTES

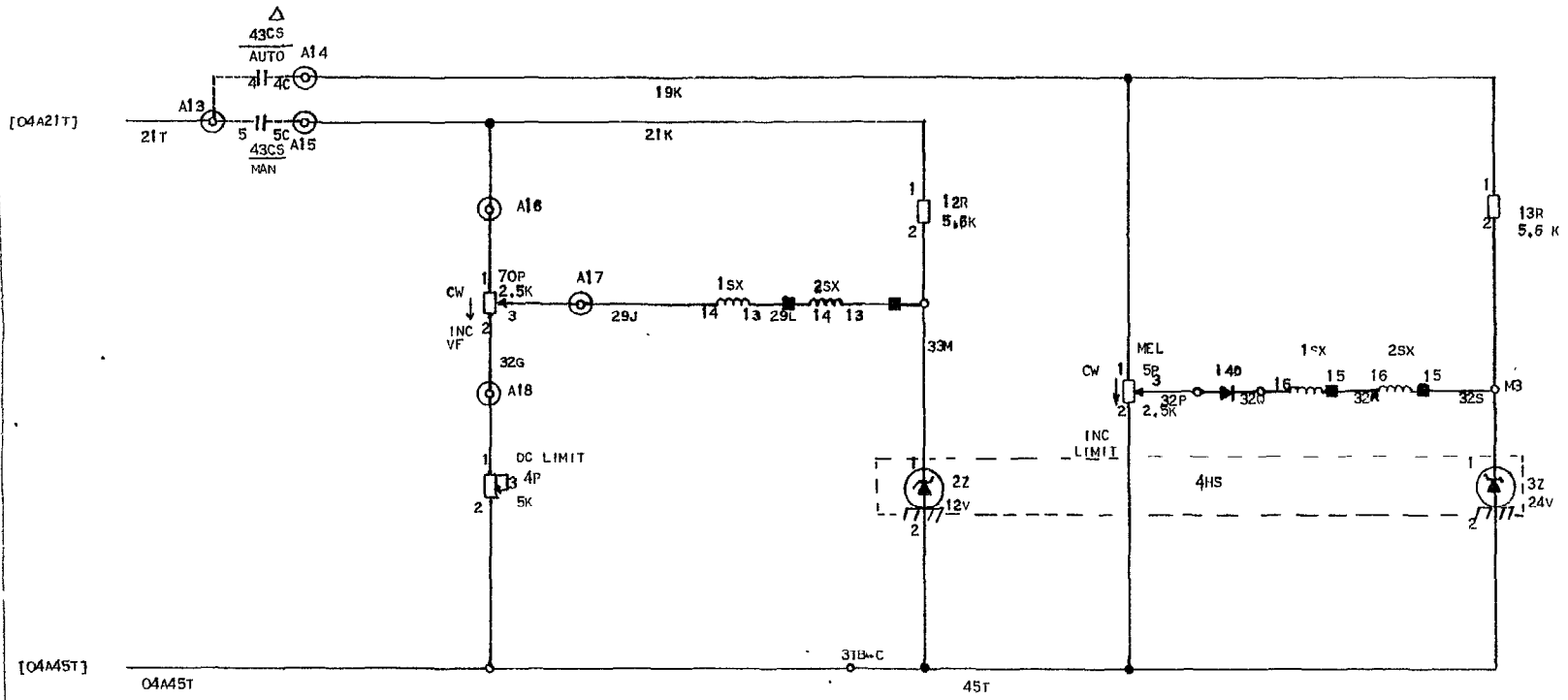
1. POT 1P IS VOLTAGE LEVEL ADJ. TO SET RANGE, PLACE 90P AT MID POINT. ADJUST 1P NEAR NOMINAL VOLTAGE WITH GEN AT NO LOAD
2. 90P (VOLTAGE ADJUST POTENTIOMETER) IS PANEL MOUNTED. IT MAYBE REMOVED FOR REMOTE MOUNTING OR DISCONNECTED WHEN USING A MOTOR OPERATED RHEOSTAT, SEE SHEET 06C.
3. CONNECT CURRENT TRANSFORMER AS SHOWN FOR REACTIVE CURRENT COMPENSATION (DROOP). REVERSE CONNECTIONS AT A8 + A9 FOR LINE DROP, SHORT TERMINALS AND TURN 1P FULLY CLOCKWISE.
4. BUILD UP OR FIELD FLASHING RELAY (WHEN FURNISHED) IS TO BE CONNECTED TO PT SECONDARY FOR START UP. REFER TO SHEET 5C

A B C D E F G H J K L M N P Q R S T U

REV 3 3/1/79 4-26-79	REV 2 3/12-79	REV 1 1-15-79	APPROVALS B. B. B.	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM SINGLE PHASE SENSING	
REV 4	ISSUED 9-12-78	PRINTS TO 3EN1	FIRST MADE FOR REQ	20684709	SH NO 04A	03A
REV 5	MADE BY P. MONCLOVA	T. C. NO DS7930SA210		CONT ON SH		



REV 3 22 Oct 78-79	REV 2 Mar 31-79	REV 1 1-15-79	APPROVALS <i>[Signature]</i>	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM OUTPUT STAGE	
REV 4	ISSUED 7-12-78	PRINTS TO 3EH-1	FIRST MADE FOR REQ		20684709	SH NO 04A
REV 5	MADE BY P. MONCLOVA	T.C. NO 0579305A210			CONT ON SH 05A	



[O4A21T]

[O4A45T]

O4A45T

DC VOLTAGE REGULATOR

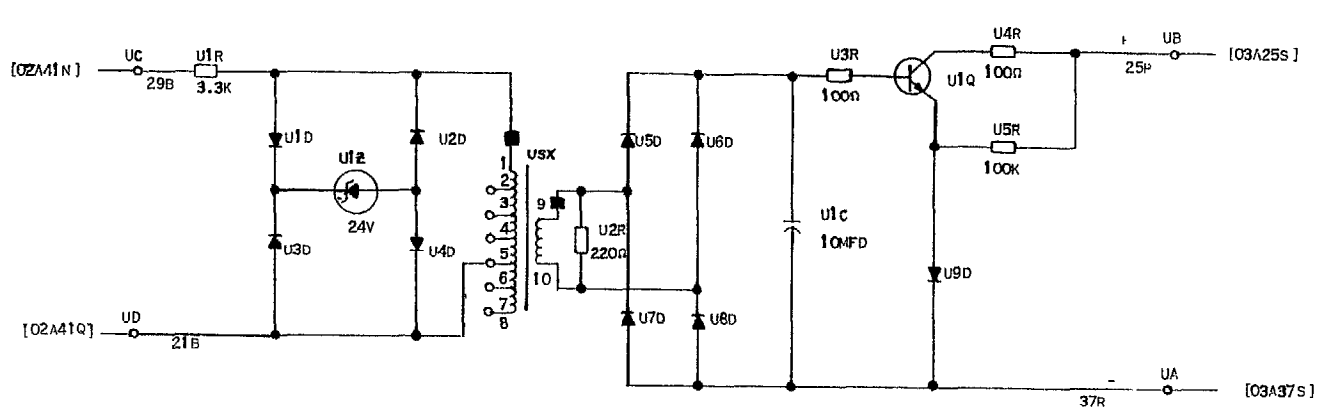
MAX EXCITATION LIMIT

NOTE

1 70P (DC VOLTAGE ADJUST POTENTIOMETER) IS PANEL MOUNTED. IT MAY BE REMOVED FOR REMOTE MOUNTING OR DISCONNECTED WHEN USING A MOTOR OPERATED RHEOSTAT. SEE SHEET 05C.

B C D E F G H J K L M N P Q R S T

REV 3 Ad Beck 4-26-79	REV 2 MAR 3-12-79	REV 1 1-15-79	APPROVALS 34	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM DC REG AND MEL	
REV 4	ISSUED 4-17-78	PRINTS TO 3EH1	FIRST MADE FOR REG		2 0 5 8 4 7 0 9	SH NO J5A
REV 5	MADE BY P. MONCLOVA		I C NO DS7930SA210		CONT ON SH C5B	



NOTES:

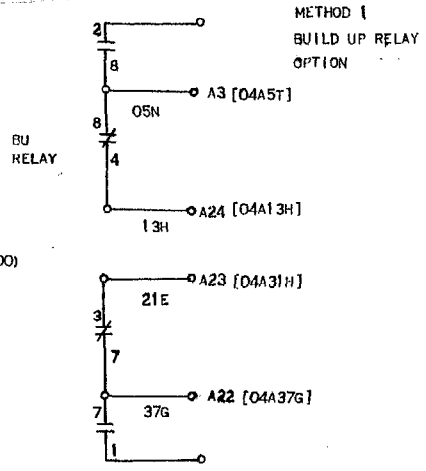
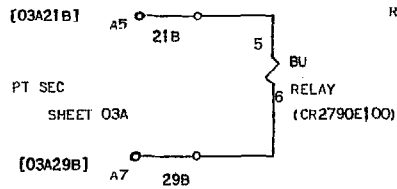
1. ADJUST LEAD 2, USX REACTOR TAPS 2 TO 8 TO POSITION WHERE AC VOLTAGE BEGINS TO DROOP, THEN MOVE TO NEXT LOWER TAP. LET GENERATOR COAST TO STOP AND OBSERVE FIELD CURRENT. FIELD CURRENT SHOULD NOT INCREASE MORE THAN 20 TO 30%
2. OBSERVE GENERATOR TRANSIENT RESPONSE BY APPLYING AND REJECTING LOAD. UNDERFREQUENCY LIMIT SHOULD BE SET ON TAP WHERE TRANSIENT RESPONSE IS NOT AFFECTED.

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A B C D E F G H J K L M N P Q R

REV 3	REV 2 <i>20/2/79</i>	REV 1 <i>1-15-79</i>	APPROVALS <i>B. H. H. H.</i>	GENERAL ELECTRIC DRIVE SYSTEMS DEPT SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM	
REV 4	ISSUED <i>7-2-79</i>	PRINTS TO 3EH1	FIRST MADE FOR REQ		UNDER FREQ. LIMIT	
REV 5	MADE BY P. MONCLOVA		I.C. NO. DS7939SA210		2 0 6 8 4 7 0 9	SH NO 05B
						CONT ON SH 05C

METHODS FOR CONNECTING BUILD UP RELAY OR FIELD FLASHING OPTION. REFER TO CONTRACT FOR OPTION SUPPLIED.

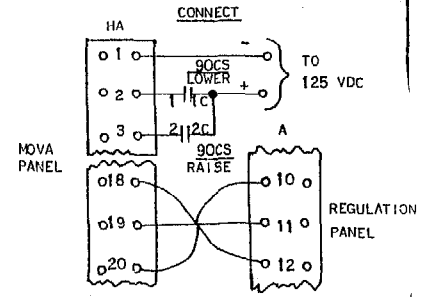


METHOD 1
BUILD UP RELAY
OPTION

MOTOR OPERATED VOLTAGE
ADJUST CONNECTIONS
REFER TO CONTRACT
FOR OPTIONS SUPPLIED.

90P (AUTO REGULATOR)

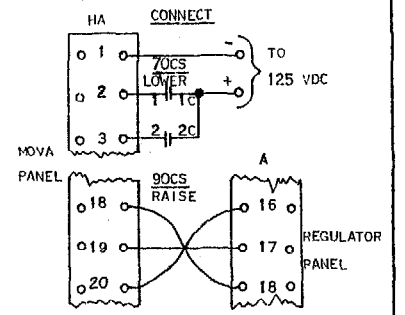
DISCONNECT
90P-1 AT A12
90P-2 AT A11
90P-3 AT A10



METHOD 2
FIELD FLASHING
OPTION

70P (MANUAL REGULATOR)

DISCONNECT
70P-1 AT A18
70P-2 AT A17
70P-3 AT A16

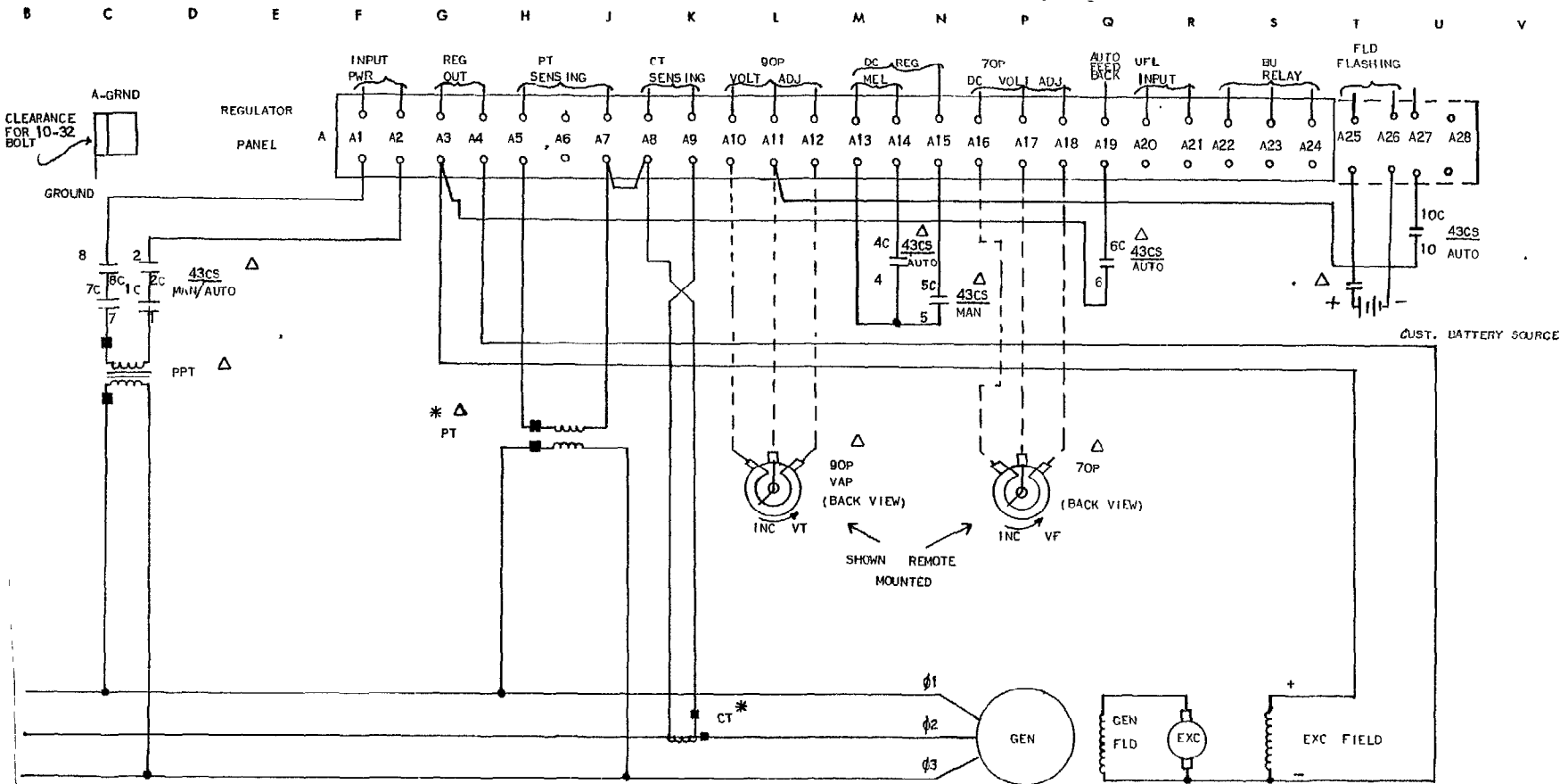


FLASHING VOLTAGE	FR
125 VDC	ALL IN
60 VDC	50% IN
30 VDC	25% IN

26

B C D E F G H J K L M N P Q R S T U V

REV. 3 4-26-79	REV. 2 3-12-79	REV. 1 1-15-79	APPROVALS <i>[Signature]</i>	GENERAL ELECTRIC DRIVE SYSTEMS DEPT. SALEM, VA. U.S.A.	ELEMENTARY DIAGRAM
REV. 4	ISSUED 9-12-78	PRINTS TO JEH	FIRST MADE FOR REQ.		BUILD UP CIRCUIT
REV. 5	MADE BY P. MONCLOVA		I. C. NO. DS7930SA210		206B4709 SH. NO. CSC



27

REV. 3 3-27-79	REV. 2 Mar 3-12-79	REV. 1 1-15-79	APPROVALS <i>[Signature]</i>	ELEMENTARY DIAGRAM	
REV. 4 Dec 4-26-79	ISSUED 7-1-79	PRINTS TO 3 EMT	FIRST MADE FOR REG	CONNECTION DIAG	
REV. 5	MADE BY P. MONCLOVA	I.C. NO 357930SA210	GENERAL ELECTRIC DRIVE SYSTEMS DEPT SALEM, VA U.S.A.	2 0 6 8 4 7 0 9 CONT ON SH FNL	SH. NO. 06A

GENERAL ELECTRIC COMPANY



DRIVE SYSTEMS DEPARTMENT

SALEM, VA. 24153

GENERAL  ELECTRIC