GEK-12428

INSTRUCTIONS

3S7930NA--- SERIES

STATIC EXCITER AUTOMATIC VOLTAGE REGULATOR

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.

3S7930NA--- STATIC EXCITER AUTOMATIC VOLTAGE REGULATOR

INTRODUCTION

The automatic regulator (3S7930NA--- series) for the 3S7931EA100 series of General Electric Static Exciter is an SCR device. This replaces the magnetic amplifier type of automatic regulator used prior to the development of the SCR unit.

The silicon controlled rectifiers (SCR's) ability to be gated on and off at a predetermined point in their supply voltage makes them easily adaptable to exciter application. The point at which the SCR's fire is dependent upon the error signal obtained from the comparison circuit. The output of this SCR circuit is fed into the saturating windings of the saturable current transformer (SCT), therefore, controlling the amount of current allowed to flow into the generator field. In this manner the regulators function of the automatic regulators is performed.

RECEIVING, HANDLING AND STORAGE

RECEIVING AND HANDLING

Since the automatic regulator is located on a panel in the excitation equipment, the care and caution taken in readying the equipment for operation applies equally well to this particular panel.

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

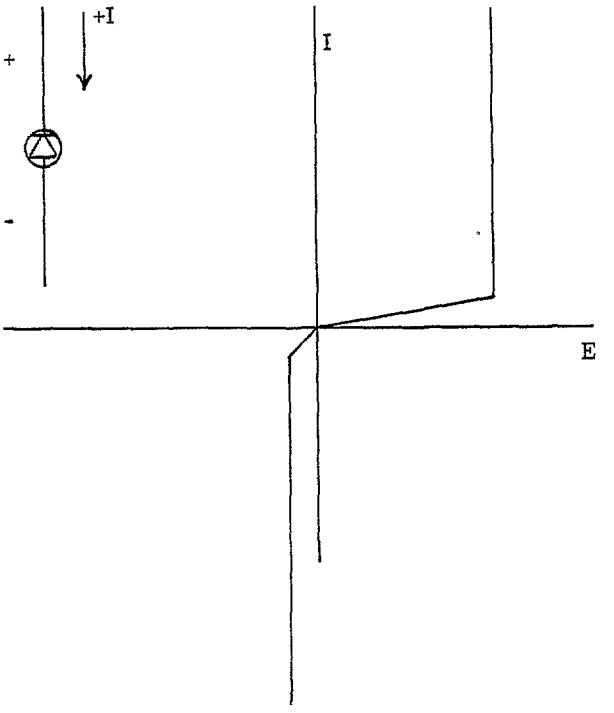
1. Comparison circuit
2. SCR firing circuit
3. Stabilizing circuit
4. SCR Supply Voltage Circuit

All circuits are located on the Comparison and Triggering Panel with the designation 3S7930NA-----, the number being uniquely defined by a particular job.

AUTOMATIC REGULATOR COMPONENT FUNDAMENTALS

Zener Diode

The current-voltage characteristic of a zener diode is shown in Figure 1. A zener diode conducts current at a constant voltage which is independent of the value of current. It is an open circuit for all voltages less than its break-down voltage.



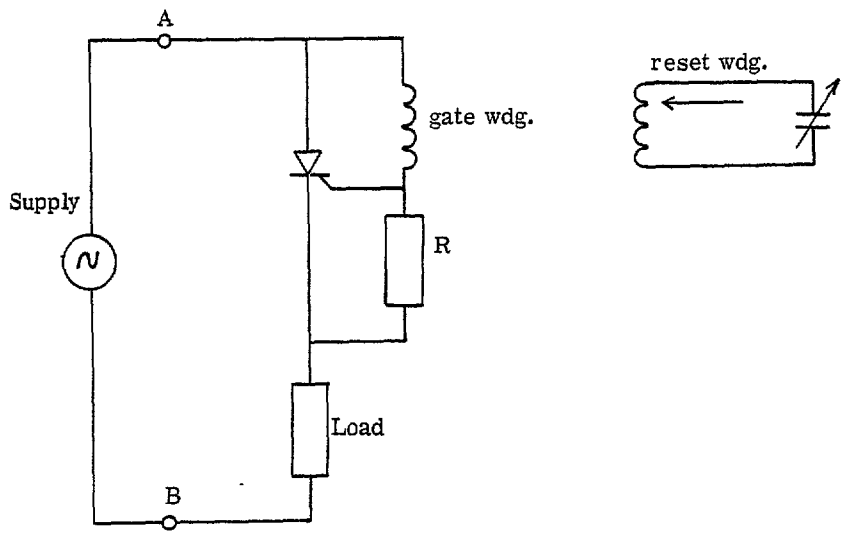
Current-voltage Characteristic of a Zener Diode

Figure 1

Saturable Reactor As a Firing Element

Figure 2 shows a simplified version of the SCR circuit used in this regulator with its associated firing reactor. The gate winding is placed between the gate and cathode of the SCR, while the reset winding is connected to a d-c source. 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 dictated by the amount of d-c 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. In this way the amount of current measured through the load is dependent upon the amount of reset or error signal current in the reset windings.

The saturable reactors not only fire the SCR's, but they also provide stabilization and positive feedback for the system.



Simplified Version of SCR Circuit

Figure 2

OPERATION OF THE AUTOMATIC REGULATOR

The signal PT's monitor the line voltage and feed the three phase bridge whose output delivers the d-c signal proportional to the line voltage to the comparison circuit. This signal, applied to a voltage divider and reference zener diode branch connected in parallel through the reset windings of the saturable reactors, controls the firing signals for the SCR's. The voltage divider is preset in the factory such that 11 ma will flow through the reset windings when the machine is working at its proper voltage. If the line voltage increases, the reset current decreases, and likewise it the line voltage decreases the reset current increases. It must be emphasized at this point that current will flow through the reset windings in only one direction because of the diode in series with these windings. To digress to the old days, a "buck" signal decreases the reset current, and "boost" signal increases the reset current.

The saturable reactors are used to provide the necessary gate pulses to fire the SCR's. Refer to Figure 4 in following this discussion. 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 A2CD SCR consist of a series combination of A9R, A2SX1, and A6D with the gate of A2CD connected between A9R and A2SX1. As the supply voltage increases in the positive direction (5 more positive than 8 on B1T) A2SX1 accumulates enough volt-seconds to saturate its core, and once the core saturates the voltage across all coils wound on the A2SX core become zero. When this occurs, the voltage across A2SX1 becomes zero, therefore, causing the voltage across A9R to increase rapidly and fire the A2CD SCR. When the supply voltage goes negative the same sequence of events occurs for the A1CD SCR. During the time A2CD is conducting, current flows from C20 to C19 through the control windings to A10, through the A2CD SCR and to the B1T supply transformer, from the B1T supply transformer it then goes through A3D and back to C20. The circuitry is so arranged that the current flows through the control windings in the same direction when either A1CD or A2CD SCR's fire. The average of these current pulses is the d-c that the SCT control windings see.

The error signal current flowing through A1SX2 and A2SX2 in the comparison circuit resets each core for the next operation and dictates how many volt seconds of the supply voltage will be needed to fire the SCR's. If the error signal increases the amount of reset for each SCR is greater, therefore, more volt-seconds of the supply voltage is needed to saturate A1SX and A2SX. Since more volt-seconds are needed, the SCR's fire later in each half cycle, allowing current to flow through the control windings for a shorter period of time; hence, less d-c current flows in the control windings. To become more familiar with this operation lets take the case in which the generator line voltage increases. The sequence of events are as follows:

(1.) P. T. output increases

(2.) D. C. output of bridge increase

(3.) error signal current through A1SX2 and A2SX2 decreases-less reset flux in each core.

(4.) SCR's fire earlier in each half cycle of the supply voltage-conduct longer

(5.) D-C current through control windings increases

(6.) Current thru SCT secondary increases

(7.) drop across reactor increases

(8.) excitation decreases

(9.) generator line voltage decreases

Other windings on the saturable firing reactor are A1SX3, A2SX3, A1SX4, A2SX, A1SX5, and A2SX5. The A1SX3 and A2SX3 windings are wired in series with a linear reactor and potentiometer; together these items make up the positive feedback network used to increase the gain. Windings A1SX4 and A2SX4 are used for the under excited reactive ampere limit when applicable. Remaining are the A1SX5 and A2SX5 windings used for the rate feedback stabilization. All windings mentioned above are wound on the two saturable reactors A1SX and A2SX.

During the time that each SCR is not conducting, diodes A5D and A2D along with resistors A8R and A7R protect the SCR's from reverse voltages. The diodes appear as very high impedance when their associated SCR's are not conducting, thus, all the reverse voltage exist across the diode and not the SCR's.

When the SB-1 switch is in any position other then AUTO, the output of the automatic regulator is fed into the dummy load resistor U8R.

Before each unit is shipped from the factory, gain curves are taken, and potentiometers are checked and set.

Figures 3a, 3b and 3c indicate typical curves obtained from the SCR units prior to shipment.

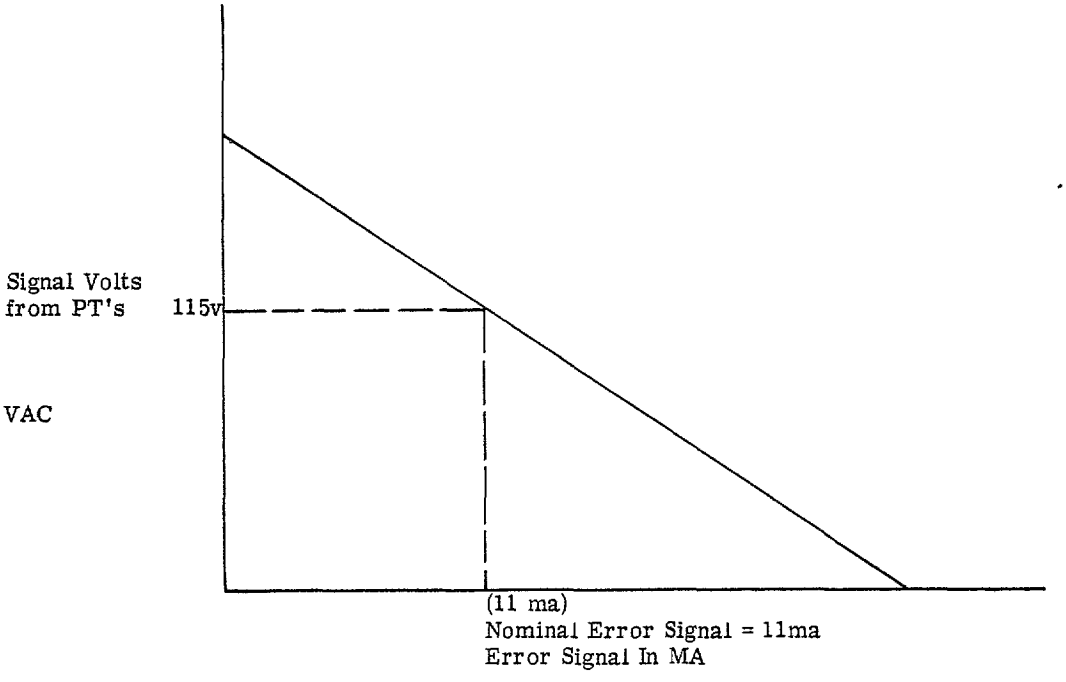


Figure (3a)

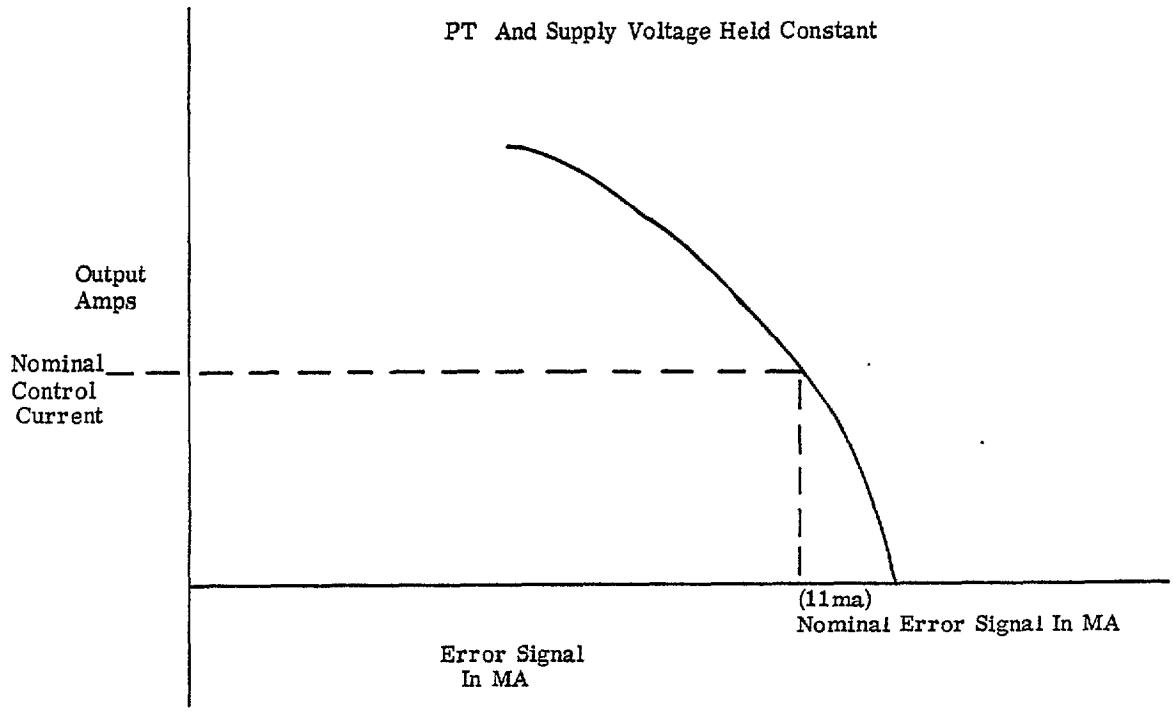


Figure (3b)

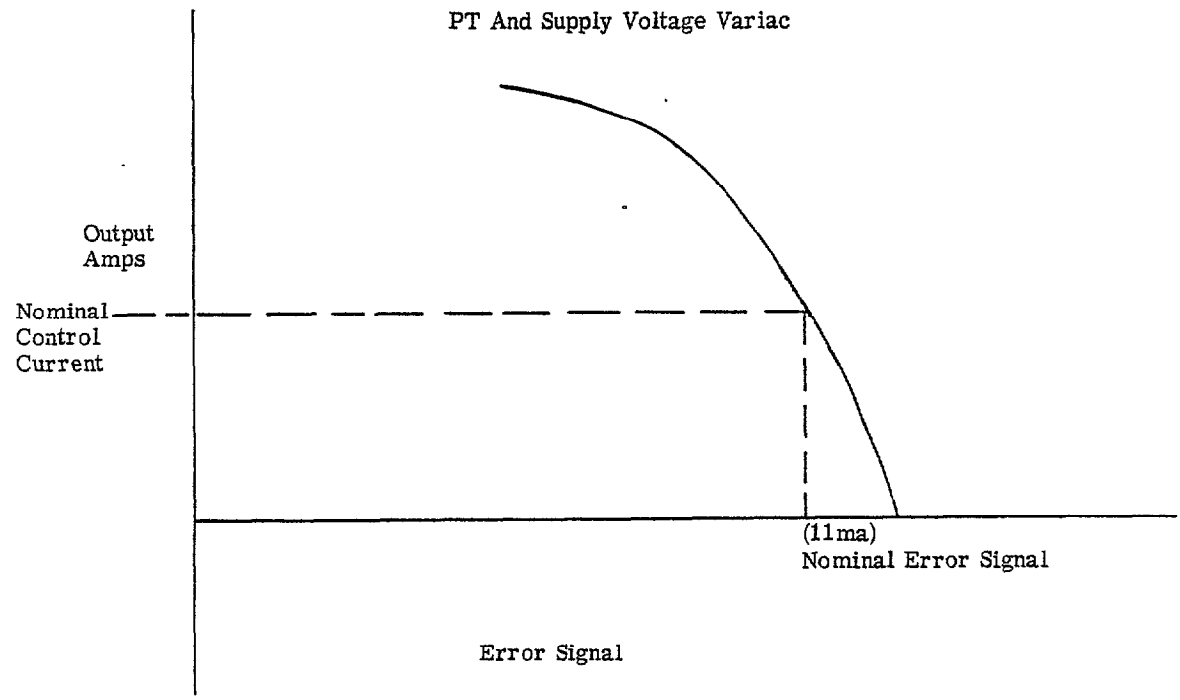


Figure (3c)

TEST AND ADJUSTMENTS

Prior to switching the regulator into the Test mode all connecting and components should be checked for defects resulting from shipment and storage. Once the SB-1 switch is changed to the Test position, the automatic regulator is ready for its initial testing.

The supply voltage should be measured across terminals 8 and 5 of supply transformer B1T (see Figure 4); this voltage should measure 127.5 volts for units with an 8.5 volt, 2 amp SCT saturating winding, and 255 volts for units with a 17 volt, 2 amp SCT saturating winding.

The stabilizing network should be so connected that it stabilizes the field voltage. See GEK-12427 for polarity checks.

The current in the reset windings A1SX2 and A2SX2 at rated terminal voltage should be about 11ma. If this is too far off, pots A3P and A4P may be adjusted to bring this current within its desired range.

The gain of the SCR circuit may be increased by decreasing A1P in the positive feedback circuit. It must be emphasized here that too high a gain often creates stability problems and should be checked if unit is not operating properly. As for the gain calculation see GEK-12427.

INSTALLATION

The automatic regulator should be ready for operation upon delivery, however, sometimes field conditions etc., cause problems. A problem frequently encountered is the pick-up in the leads running from the control board mounted automatic voltage adjuster (ARVA) and the comparison circuit. The low level nature of this circuit makes it vulnerable to noise pick-up, therefore, causing erratic operation of the regulator. It should be emphasized that either shielded leads or a motor operated ARVA should be used if the control board is more than 150 feet from the excitation cubicle.

MAINTENANCE

Since this is primarily a semiconductor regulator, very little maintenance need be performed above and beyond routine checks insuring proper ventilation and dust free relay contacts. Failure to provide either of the two checks could result in needless complications.

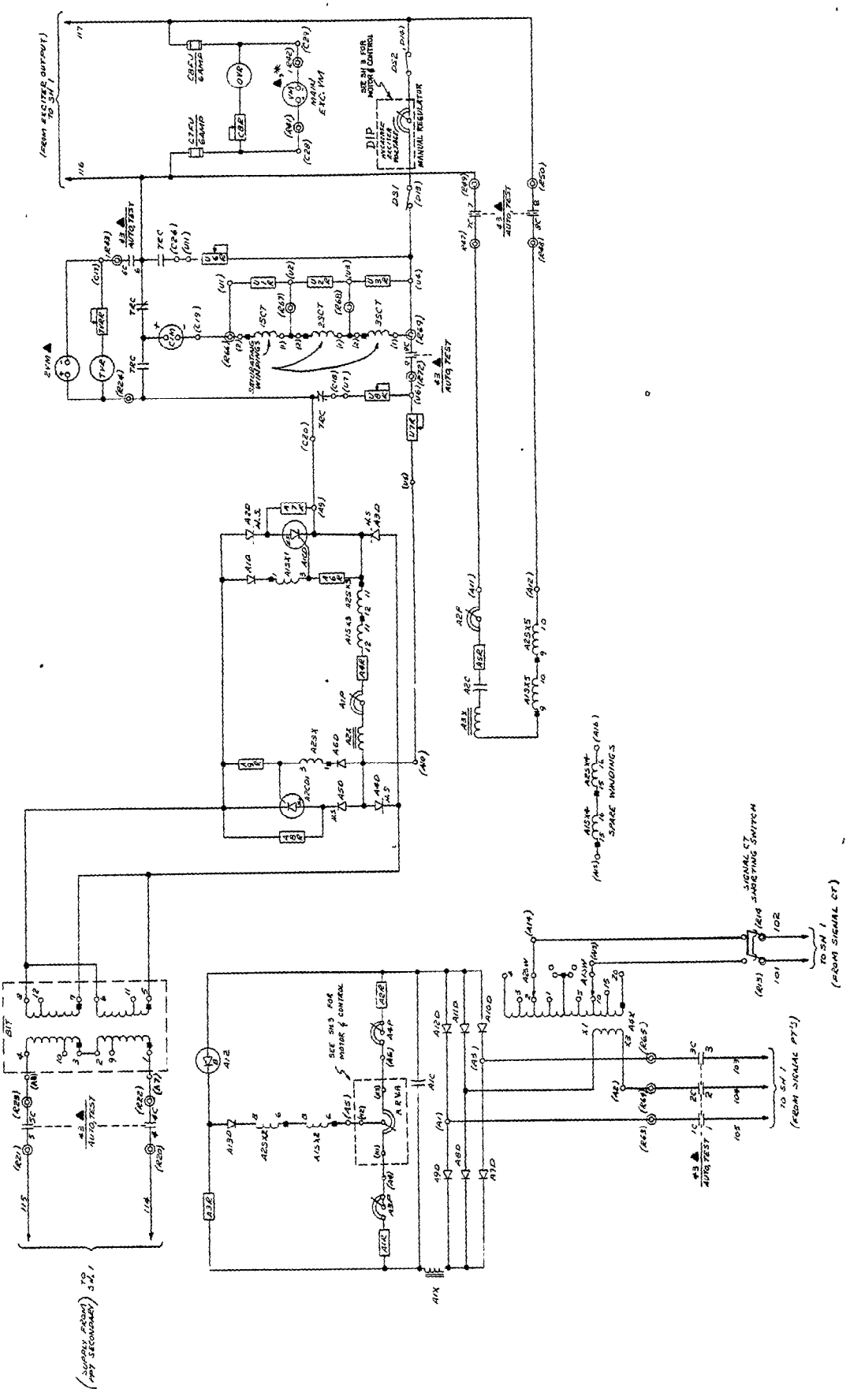


Figure 4. Elementary Diagram for the Static Exciter Regulator (3S7931EA117G9 Rev. 0)