INSTRUCTIONS

INVERSE TIME MAXIMUM EXCITATION LIMIT 3S7932JA117 AND 3S7932JA114

INTRODUCTION

The 3S7932JA117 or JA114 Maximum Excitation Limit is designed to protect the generator field of an AC machine with automatic excitation from overheating due to prolonged overexcitation. This overexcitation can be due to abnormal system conditions or failure of a component of the voltage regulator. The panel may be used on Diode-Rectified AC Excitation System only.

RECEIVING AND HANDLING

Immediately upon receipt, the equipment should be carefully unpacked and 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.

DESCRIPTION

An inverse-time relay which utilizes an induction voltmeter movement (J1K) is used to sense overexcitation of the generator field. This relay has inverse-time trip characteristics that approximate the generator field capability curve; it is adjusted to operate when voltage on the generator field exceeds 1.05 times rated voltage. Rated voltage is hereby defined as the generator field voltage obtained by rated, full load field current, in the field winding which is at an average temperature of 110°C.

The circuit will act sequentially to: (1) reduce the value of the excitation to 100% of rated current, (2) trip the AC regulator and transfer control to the DC regulator, and (3) trip the exciter field breaker.

The circuit functions as follows:

1. J1K will operate in 60 ±2 seconds at 120% excitation at 110°C. Higher voltage will cause the relay to operate in less time and lower voltage will result in increased time.

2. J1K energizes J2K which energizes J2KX, J3K and J4K.

3. J2KX recalibrates the current limit circuit of the AC regulator to regulate 100% AFFL (Amperes, Field, Full Load), and gives an alarm. If excitation returns to normal within 5 seconds, J1K drops out, deenergizing J2K, J3K, and J4K. The reduced limit current is still maintained by J2KX which sealed in. The operator may reset J2KX after he locates the cause of the overexcitation and corrects it. He accomplishes this by momentarily transferring from AC regulator to DC regulator.

4. But if there has been a regulator failure, i.e., J1K does not drop out within 5 seconds after operating, J3K time delay contacts close. This causes the system to transfer from AC regulator to DC regulator.

5. Finally, if the overexcitation persists for 10 seconds after J1K operates, J4K will trip the exciter field breaker.

ADJUSTMENT

The calculations in this section are based on the assumption that the temperature coefficient of resistance of the field winding is 0.00385 ohms per ohm per degree centigrade at 25°C, and on the further assumption that the ratio of AC line-to-line voltage, rms at the 3-phase bridge field rectifier to the average field voltage (rectifier output voltage) is 0.800. Also, brush voltage drop (approx. 1.7V each collector ring) and rectifier forward voltage drop (approx. 0.8V per rectifier cell) have been ignored.

If more precision is required, the rectifier conversion factor should be measured. In doing this, be sure to use an rms sensing AC voltmeter, as relay J1K is sensitive to rms voltage.

Alternatively, the rectifier conversion factor can be calculated. For a sinusoidal source, such as Alterrex* exciter internal voltage, the following equations apply:

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$$\frac{E_{AV}}{E_{L}\ (rms)} = \frac{6\sqrt{2}\ (1 + \cos u)}{4\pi - 3\ (2u - \sin 2u)}\ ;$$

$$u = \cos^{-1}\ \frac{\pi/3 - x/r}{\pi/3 + x/r}\ ,$$

$$\sin 2u = \frac{4\ (\pi/3 - x/r)\ \sqrt{\frac{\pi x}{3r}}}{(\pi/3 + x/r)^2}$$

u is the commutation angle of the field rectifiers (3-phase bridge)
x is the source reactance - between the sinusoidal voltage, and the rectifier bridge (approximately x"d for Alterrex)
r is the rectifier load resistance, including brushes and rectifier cells.

Steps 1 through 10 (following) should be performed with the exciter voltage removed from J1T, and perferably, with the excitation system disabled. In lieu of this, the trip contacts of relays J3K and J4K must be disconnected so that the system is not disturbed or interrupted inadvertently.

Steps 11 through 13 can be performed only with the excitation system operating, and preferably with considerable load on the generator so that the exciter current is reasonably high.

1. To allow this panel to be used with different machines that have different values of VFFL (Volts, Field, Full Load), the transformer J1T and relay J1K have taps and the relay also has an adjustable time delay setting.

The following table gives the various relay and transformer connections for different VFFL ranges.

Important: VFFL is defined and specified in all generator data sheets as the product of AFFL and the field resistance, with the field at a temperature of 125°C.

CALIBRATION OF MAXIMUM EXCITATION LIMIT PANEL
3S7932JA117 and 3S7932JA114

DC VOLTS VFFL*	TRANSFORMER TAP (Connection Made at Panel Terminal Board)	RELAY TAP
188-199	7	55
200-232	6	55
233-243	7	64
244-254	7	70
255-259	6	64
260-270	6	70
271-282	5	55
283-299	7	82
300-318	6	82
319-334	7	93
335-345	4	55
346-348	5	64
349-352	6	93
353-366	5	70
367-391	7	105
392-405	6	105
406-416	5	82
417-421	7	120
422-433	4	64
434-444	4	70
445-460	6	120
461-471	5	93
472-498	7	140
499-509	4	82
510-529	6	140
530-564	5	105
565-591	4	93
592-648	5	120
649-677	4	105
678-725	5	140
726-760	4	120

*Read VFFL - DC from specifications for generator field (125°C field temperature).

2. Initially, set the Time Delay Dial of J1K at 7.0.

Note: Power may be removed from the relay by pulling both the top and the bottom plug.

3. Calculate V_1, the line-to-line AC (RMS) voltage at the generator field rectifier bridge, at an excitation of 1.05 times AFFL, with the field at a temperature of 110°C.

$$V_1 = 0.8 \times \frac{1+0.00385\,(110-25)}{1+0.00385\,(125-25)} \times 1.05 \times (\text{Gen. VFFL-DC})$$

$$= 0.81 \times \text{Generator VFFL-DC}$$

4. Apply V_1 voltage (single phase, AC RMS) to the transformer primary (terminals J5 - J6). Insert one plug while observing the relay disc. If the disc begins rotating (and continues to rotate), the control spring must then be tightened to insure no movement in the disc.

Rotate the control spring adjuster to the right.

5. Raise the voltage to V_1 + 15 V. When the disc rotates approximately 30°, reduce the voltage to V_1.

6. The disc should now hold steady. If it continues to rotate toward the overvoltage stop, the spring must be tightened. Rotate the spring adjuster to the right.

If it rotates back to the undervoltage stop, the spring tension must be reduced. Rotate the spring adjuster to the left. The relay is now set for a holding voltage of V_1. If the excitation voltage exceeds this value, the relay will operate with a time delay which depends on the amount of overexcitation.

7. Next, calculate V_2 = (Generator $VFFL_{DC}$) x .926.

$$\left(V_2 = \frac{1.2 \times V_1}{1.05}\right.$$

$$= V_{AC} \quad \text{at 120\% excitation with the field at 110°C)}$$

8. Remove power and allow the relay to return to the undervoltage stop. Set the voltage to V_2 ; apply it and measure the time for the relay to reach the overvoltage stop. This time should be 60 ±2 seconds. Change the time delay dial as required to achieve this. (Higher numbers yield longer times.) Repeat as necessary.

9. Time delay relay J3K should be set for 5 seconds.

10. Time delay relay J4K should be set for 10 seconds.

11. Current limit reduction rheostat J1P should be adjusted as follows: Operate the excitation system on DC regulator. Measure the voltage developed by the generator field current limit circuit for the AC regulator. Record the generator field current at the same time. Calculate the voltage developed by the limit circuit at AFFL by dividing the measured voltage by the recorded field current and then multiplying by AFFL. Adjust the AC regulator so that the transfer meter is deflected slightly in the boost direction.

12. Obtain a power supply with an ungrounded output circuit, which is adjustable to the voltage calculated above; connect it across the current limit circuit points where the voltage was measured, being careful to disconnect the normal input first, and also being careful to obtain the proper polarity.

13. Adjust the voltage output of the power supply to the previously calculated value (corresponding to AFFL in the generator field). Connect a jumper across the contacts of J2K which pick up J2KX.

Adjust J1P to cause the transfer voltage to go to zero; the current limit circuit is now calibrated to regulate AFFL. Lock the rheostat in this position.

In steps 11 through 13 it is assumed that the DC regulator output voltage at any operating point differs only slightly from its value at any other operating point. This assumption is justified (for Alterrex) by the fact that the required exciter field voltage increases almost linearly with the exciter terminal voltage. Since these circuits are coupled by a constant ratio anode transformer and an SCR bridge, if the angle of firing of the SCR's is kept constant, then the coupling circuit fulfills the requirement exactly. The firing angle is maintained at a fixed value, (following a change in operating point) by a return of the regulator output voltage to its original value.

This completes the test and adjustment of the various components of this equipment. Care should be exercised that all jumpers and outside power source used during testing have been removed and all connections securely tightened.

MAINTENANCE

The equipment should be kept relatively clean and dry. If vibration is present, all screw type connections should be checked regularly to determine that they are properly tight. Normally, the static components should require no further attention; however, since the equipment is not activated in normal operation, the installation tests should be repeated periodically to insure that the equipment is in operating condition.

RENEWAL PARTS

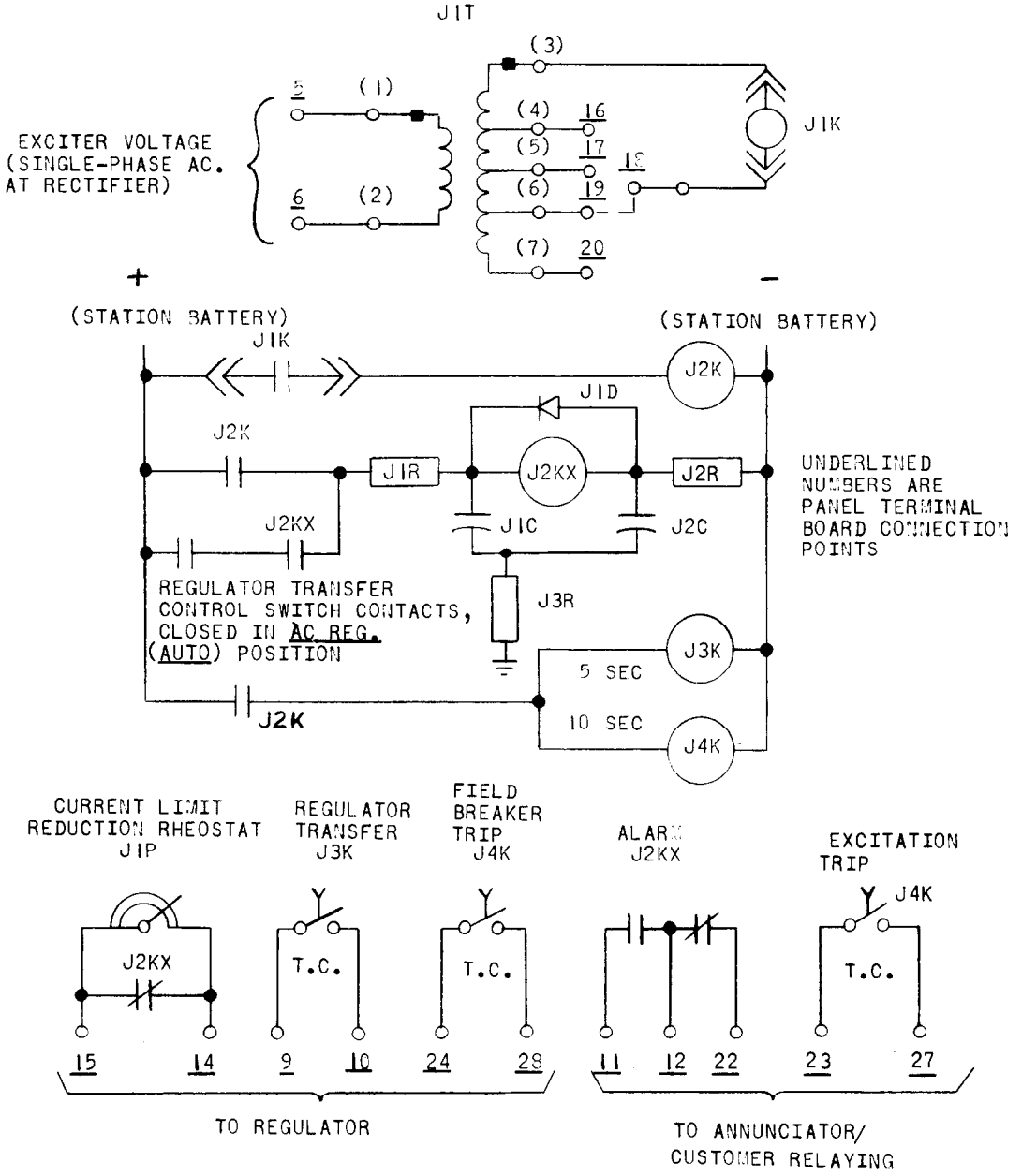
When ordering renewal parts, the following information should be given:

1. Catalog number stamped on the part, with a complete description, including use and location.

2. Complete nameplate data appearing on the assembly of which the part is a component.

3. If possible, data on original order on which equipment was first supplied, including all numerical references.

ELEMENTARY DIAGRAM OF
INVERSE-TIME EXCITATION LIMIT CIRCUIT
3S7932JA117, 3S7932JA114
FOR DIODE-RECTIFIED A.C. EXCITATION SYSTEMS



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