INSTRUCTION MANUAL
FOR

VOLTAGE REGULATOR

Model: SR32H/E
SR63H/E
SR125H/E
SR250H/E

Part Number: 9 1256 00 100 through 9 1256 00 107

Basler Electric

Publication Number: 9 1256 00 990
Revision: F 07/99

WARNING

To prevent personal injury or equipment damage, only qualified technicians/operators should install, operate, or service this device.

CAUTION

Meggers and high potential test equipment should be used with extreme care. Incorrect use of such equipment could damage components contained in the device.

It is not the intention of this manual to cover all details and variations in equipment, nor does it provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to change without notice. Should further information be required, call Basler Electric Company, Highland, IL.

SECTION 1

GENERAL INFORMATION

1-1. GENERAL

a. The regulators precisely control the output voltage of an ac power generating system by controlling the amount of current supplied to the exciter or generator field. This includes brush type rotary exciters, brushless rotary exciters or direct excitation into the generator field.

b. The Basler SRH/E regulator is available in eight different models: SR32H, SR32E, SR63H, SR63E, SR125H, SR125E, SR250H and SR250E. These units are used with exciters and generator fields of 32, 63, 125 and 250 VDC, and have a continuous dc output current rating of twenty (20) amperes (SR-H) or 36 amperes (SR-E) at their respective voltage ratings with a field forcing capability of 40% above nominal. All regulators are field connectable for single or three phase sensing and 5 VA or 25 VA maximum burden for the parallel compensation circuit.

1-2. DESCRIPTION

a. The regulators consist of an integrated circuit, silicon transistors, transformers, silicon diodes, resistors, and non-electrolytic capacitors.

b. All components are mounted on a formed sheet metal chassis with a metal cover (open-end perforated grill) mounted to the chassis.

1-3. SPECIFICATIONS

Refer to Table 1-1 for the Electrical Specifications, Table 1-2 for the Physical Specifications, and to Table 1-3 for the Input and Output Power of the Regulators.

Table 1-1. Electrical Specifications.

Regulation:	±0.5 of 1% of no-load to full-load.
Regulation Drift:	Less than ±0.5% for a 50°C temperature change (including warm-up).
Regulation Response:	Less than 0.017 second.
Sensing Input (Connectable for 1 or 3-phase):	Ac voltage (50/60 Hz) - NEMA Standard (120/208, 240/416, 480/600.
Sensing Burden:	10 VA Max per phase.
Parallel Compensation Input Amperage:	5 A
Parallel Compensation Burden:	5 VA at terminals 1 and 2L. 25 VA at terminals 1 and 2H.
Voltage Build-up:	Provides generator voltage build-up from a residual voltage of 10%.
Voltage Adjust Range:	±10% of nominal.
Overvoltage Protection:	Provides built-in overvoltage protection that limits the generator output to 135% of nominal.

Table 1-2. Physical Specifications.

Ambient Operating Temperature:	-40°C (-40°F) to +70°C (+158°F).
Storage Temperature:	-40°C (-40°F) to +100°C (+212°F).
Vibration:	Withstands 1.3 G's from 5 to 26 Hz, 0.036 inch double amplitude from 26 to 52 Hz, and 5 G's from 52 to 260 Hz.
Shock:	Withstands 15 G's in each of three mutually perpendicular axes.
Finish:	Dark brown, lusterless, textured baked enamel.
Weight:	50 lbs (22.7 kg) met.
Dimensions:	Refer to Figure 4-1.

Table 1-3. Power Input/Output Specifications.

Model	Part Number	Power Input (50/60 Hz)*		Output Rating				Field Resistance Ohms	
				Continuous		Forcing			
		Vac	KVA†	Vdc	Adc	Vdc	Adc	Min.	Max.
SR32E	9 1256 00 104	60	2	32	36	45	52	0.89	200
SR63E	9 1256 00 105	120	3.5	63	36	90	52	1.75	200
SR125E	9 1256 00 106	240	7.0	125	36	180	52	3.50	200
SR250E	9 1256 00 107	480	13.5	250	36	360	52	7.00	200
SR32H	9 1256 00 100	60	1	32	20	45	28	1.60	200
SR63H	9 1256 00 101	120	2	63	20	90	28	3.20	200
SR125H	9 1256 00 102	240	4	125	20	180	28	6.20	200
SR250H	9 1256 00 103	480	8	250	20	360	28	12.5	200

NOTES:

* If correct voltage is not available for power input, a suitable power transformer must be selected. Transformer KVA rating is determined by the output dc power required.

† When the Regulator is operated at less than maximum output, the power isolation transformer rating can be determined by multiplying the input volts by the continuous dc output current.

1-4. ACCESSORIES

a. The following accessories are available for use with SR-H, SR-E voltage regulator.

(1) Power Isolation Transformers
(2) Motor Operated Controls
(3) Underfrequency-Overvoltage Protection
(4) Current Transformers Parallel Reactive Load Divisions

b. Information regarding these accessories may be obtained by consulting the applicable operation manual/product bulletin or by contacting your nearest Basler Electric Sales Representative or Basler Electric Company, Highland, Illinois.

SECTION 2

THEORY OF OPERATION

2-1. INPUT POWER

Power input is applied to terminals 3 and 4 and then to the SCR Power Stage.

2-2. SCR POWER STAGE

The conduction angle of the SCR Power Stage determines the amount of output current to the generator exciter field. The conduction angle in turn, is controlled by the timing of the gating pulses from the Sensing and Gating Circuitry. The greater the angle of conduction of the SCR's the greater the output current.

2-3. GENERATOR SENSING

On single-phase sensing voltage regulators, the sensing voltage is connected to terminals El and E3. Three-phase sensing voltage is connected at E1, E2, and E3. The regulator is customer connectable for single or three-phase sensing. When two or more generators are operated in parallel, it is important that the "A" phase supplies E1 and the "C" phase supplies E3. The tap selection on the primary winding of the transformer(s) is dependent upon the application (120, 208, 240, 416, 480, or 600 volts). The output voltage from the transformer secondary winding is rectified as a representative sample, taken from a voltage divider network. This signal is then applied to the Sensing and Gating Circuitry.

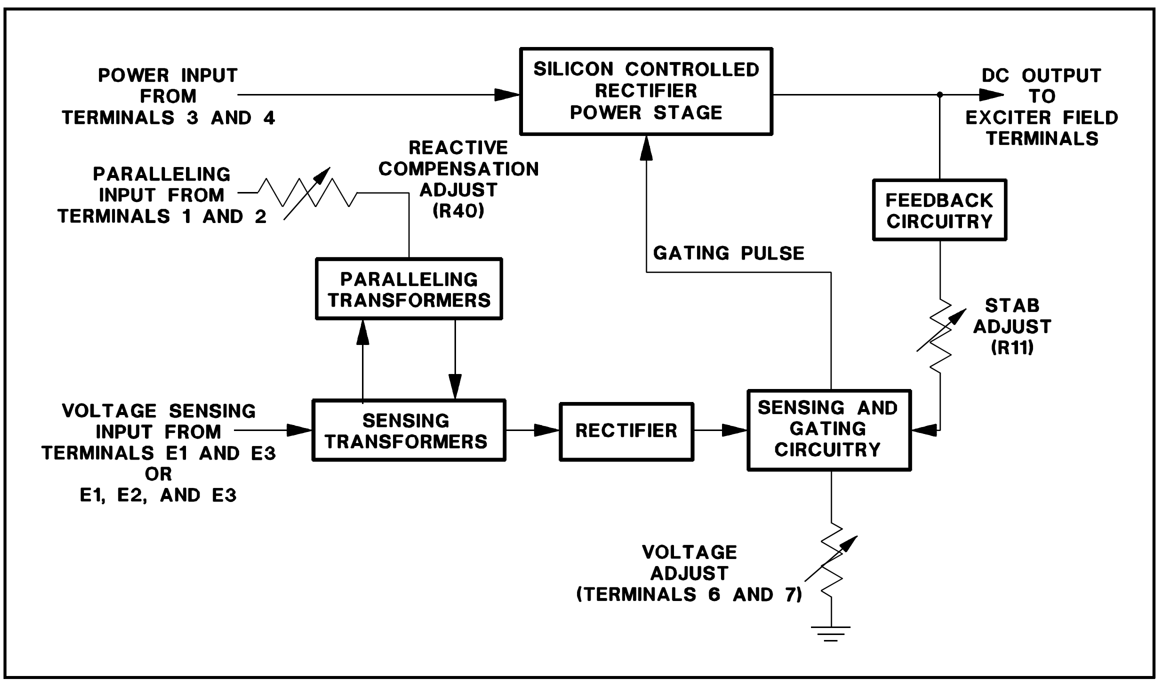

Figure 2-1. Block Diagram.

2-4. SENSING AND GATING CIRCUITRY

The Sensing and Gating Circuitry senses any change in generator output voltage and translate such changes into phase control of the gating pulses. The gating pulse is sent to the SCR Power Stage to permit it to conduct and provide the correct exciter field current to maintain a constant generator voltage. When the Sensing and Gating Circuitry determines that the generator output is low, the gating pulse is applied to the SCR's earlier in the cycle causing a greater output current to flow. When the generator output voltage is high, the gating pulse is applied later in the cycle causing less current to flow to the exciter field.

2-5. VOLTAGE BUILD-UP

The Sensing and Gating Circuitry provides voltage build-up without the use of a relay. It supplies gate pulses to the SCR's when the voltage at the power input terminals is 5% to 10% of nominal. These gate pulses cause the SCR's to conduct, excite the field and raise the generator voltage to nominal.

2-6. STABILIZATION ADJUST

A feedback signal taken from the regulator output is applied to the Sensing and Gating Circuitry. This signal, controlled by the Stability Control Adjust rheostat R11 prevents system voltage from hunting or oscillating.

2-7. VOLTAGE ADJUST

The external Voltage Adjust rheostat connected across terminals 6 and 7 allows adjustment of the generator voltage, ±10% of nominal.

2-8. PARALLEL COMPENSATION

a. If two or more generators are operated in parallel, a current input from the B phase of the generator is applied to terminals 1 and 2L or 2H. This current is proportional in amplitude and phase to the line current. A portion of this current is applied to the primary winding of the paralleling transformer. The secondary of this transformer is connected in series with the secondary of the sensing transformer(s) and the rectifier bridge. The ac applied to the rectifier bridge, therefore, is the vector sum of sensing voltage and the parallel CT signal. The result is that if two generators are operating in parallel and the field excitation of one becomes excessive, the parallel compensation circuit will adjust field excitation between the generators so that circulating currents are minimized and each supplies a proportional amount of inductive load current.

b. The action and circuitry just described is called parallel droop compensation (reactive droop compensation). Although it reduces circulating current flow, it allows the system voltage to droop with increasing inductive reactive load.

c. Reactive differential compensation allows two or more paralleled generators to share inductive reactive loads with no decrease or droop in the generator system voltage. These regulators provide the necessary circuit isolation so that parallel cross-current compensation can be used. This is accomplished by the action and the circuitry described previously for parallel droop compensation, and the addition of cross connecting leads between the parallel CT secondaries as shown in Figure 4-5. By connecting the finish of one parallel CT to the start of another, a closed series loop is formed which interconnects CT's of all generators to be paralleled. The signals from the interconnected CT's cancel each other when the line currents are proportional and in phase. If this type compensation is used, it is *mandatory* that all regulators used in the paralleling network have the same type paralleling circuit. It is also necessary that all generators supplying power to that bus be included in the interconnection circuit.

SECTION 3

CONTROLS, TERMINALS, AND ADJUSTMENTS
(Refer to Figure 3-1)

3-1. CONTROLS

a. ***Voltage Adjust Rheostat R49.*** This rheostat is supplied as a separate item for panel mounting to provide adjustment of the regulated generator voltage. When the jumper is connected as shown in the interconnection diagrams, adjusting it to its maximum resistance position (CCW), will obtain minimum generator voltage. Maximum generator voltage is obtained with minimum resistance (CW). A 500 Ω, 25 W rheostat (P/N 06874) is available from Basler Electric for use as the Voltage Adjust Rheostat, R49.

b. ***Stability Control Adjust R11*****.** Potentiometer R11 is located on the printed circuit board. It provides stable operation by controlling the amount of feedback that is applied to the Sensing and Gating Circuitry. Normally it is factory set near the extreme clockwise (CW) position. This setting normally assures good stability, but tends to slow the response time of the generator. If rotated counterclockwise (CCW), the system response time becomes faster. However, if rotated too far CCW, the generator voltage may oscillate (hunt). It should then be rotated CW well above the point where oscillating occurred. The system voltage stability is most critical at no-load. If a setting is desired that provides the fastest possible voltage response with good generator stability, an oscilloscope or some voltage recording device should be used. R11 operates in conjunction with the stability selection jumper.

c. ***Voltage Range Adjust R14.*** Potentiometer R14 is located on the printed circuit board. It provides a means of varying the limits of the external voltage adjust rheostat. Normally, the external voltage adjust rheostat is set to mid-range and R14 is adjusted for rated generator voltage. This allows an external voltage adjust range of ±10%.

3-2. TERMINAL SELECTION

a. ***Sensing Connections.*** The regulator single-phase sensing terminals are E1 and E3. Three-phase sensing terminals are El, E2, and E3. The PH wire is connected to the 1PH terminal (TB2) for single phase sensing and to the 3PH terminal (TB2) for three phase sensing. The regulator is factory connected for single phase 120 Vac sensing. Internal sensing transformers have provisions for sensing 120, 208, 240, 416, 480, and 600 VAC. The transformers are factory connected to the 120 volt tap and must be reconnected to another tap before operation if other than 120 volt sensing is employed. On generating systems with voltages above 600 VAC, instrument type potential transformers must be used to step down the voltage to match one of the regulator sensing voltages.

b. ***Stability Selection.*** Stability selection is accomplished on terminal strip TS2 located on the printed circuit board. With these connections, the regulator's two basic stability time constants can be changed. These are "*exciter*" time constant and "*generator*" time constant. The "*exciter*" time constant can be changed to '*fast*' or '*slow*'. The "*generator*" time constant can be changed to '*fast*' '*medium*', or '*slow*'. Each time constant operates in conjunction with the stability adjust potentiometer R11 to provide a wide range of stability adjustment. The stability time constants provided allows operation on applications consisting of brush type rotary exciters, brushless rotary exciters or static exciters operating directly into a generator field. These circuits are designed to provide system voltage stability for power generator systems ranging from 10 KW to 10,000 KW. Table 3-1 is provided as a guide to proper connection for various generator systems. Variance from these recommended connections is acceptable and desirable if optimum system voltage stability results.

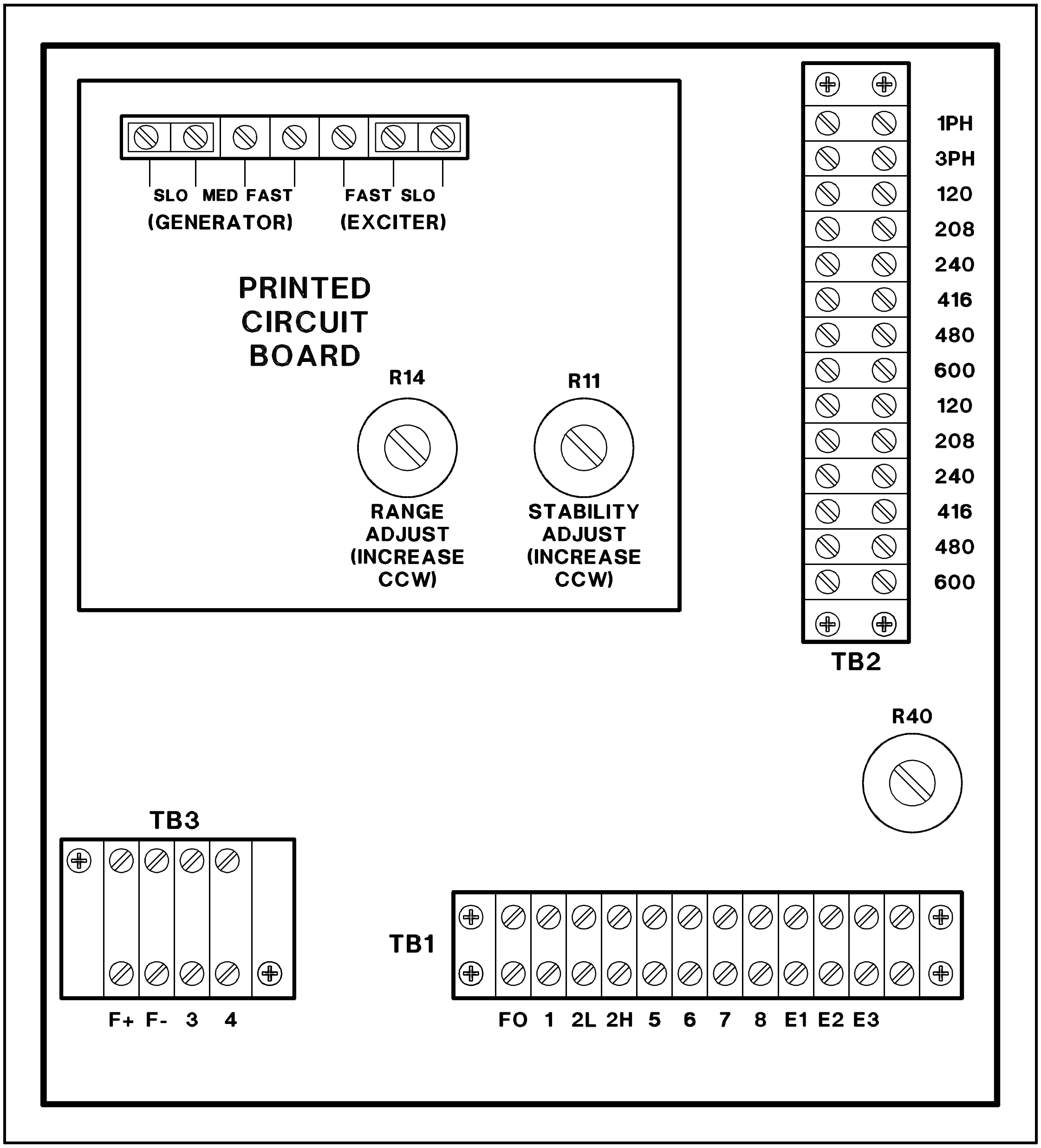

Figure 3-1. Location of Controls, Terminals, and Adjustments.

Table 3-1. Stability Select Guide.

In this type of Application:	These jumpers are selected:	
	Exciter Link	Generator Link
Brush Type Exciter	Slow	Med or Slow
Brushless rotary exciter or generators rated above 150 kW.	Slow	Med or Slow
Brushless rotary exciter or generators rated below 150 kW.	Slow	Fast or Med
Static Exciter operating directly into generator field.	Fast	Fast or Med

3-3. OTHER ADJUSTMENTS

a. *Parallel Compensation Adjust R40*. This wire wound resistor provides a method of adjusting the amount of reactive droop compensation when generators are operated in parallel. For maximum droop, move the slider up towards the chassis, for minimum droop, move the slider down away from the chassis.

SECTION 4

INSTALLATION AND OPERATION

4-1. INSTALLATION

a. *Mounting*. The unit is convection cooled and should not be mounted near heat generating equipment or inside totally enclosed switchgear where the temperature rise could exceed its operating limit. Vertical mounting is recommended to obtain optimum convection cooling. Refer to Figure 4-1 for the outline drawing.

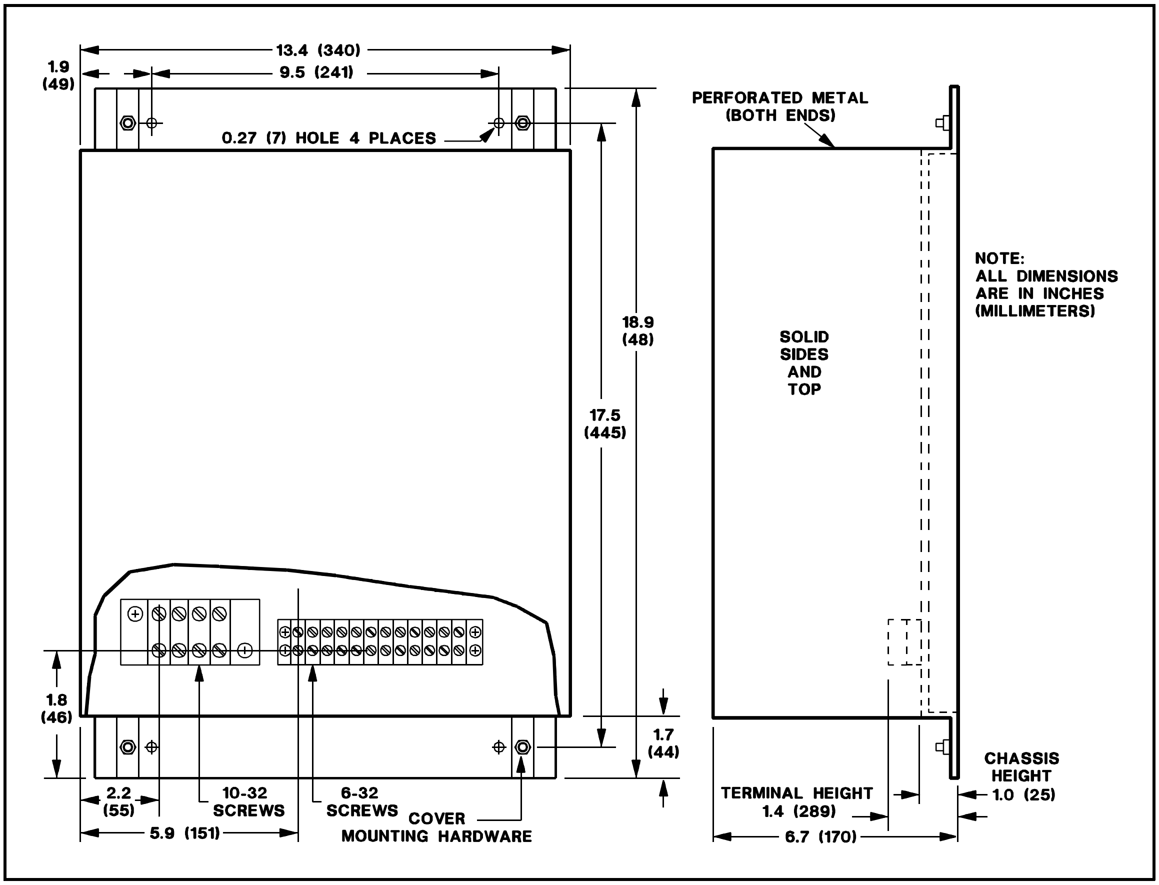

Figure 4-1. Outline Drawing.

b. *Interconnection*.

> **CAUTION**
>
> Meggers and high potential text equipment must not be used. Incorrect use of such equipment will destroy the regulator semiconductors.

The regulator must be connected to the generator system as shown in the Interconnection Diagrams Figures 4-2, 4-3, or 4-4. Even momentary operation with an incorrect connection can damage the control equipment. Number 12 gauge (SR-H) or number 8 gauge (SR-E) wire or larger should be used for connections to terminals 3, 4, F+ and F-. Number 16 gauge wire is satisfactory for all other connections.

c. *Input Power*.

(1) The regulator operates on a power input voltage applied to terminals 3 and 4. Nominal input voltages for each model regulator are listed in Table 1-3. The input power may be taken from any generator lines that provide the required voltage (line to line or line to neutral). If the available generator voltage is different from the required voltage, a power transformer must be used to match the generator voltage to the regulator power input. If the field or field flashing circuit is grounded, a power isolation transformer must be used to isolate the regulator input from ground. Failure to use an isolation transformer may result in blown fuses (The input fuses for the SR-H are mounted inside the regulator. The SR-E fuses are mounted external to the regulator and are supplied as loose items). On single-phase sensing model regulator, it is recommended that the input power be taken from a phase other than the one used for regulator sensing to insure optimum voltage stability.

CAUTION

The voltage regulator dc output (Terminals F+ and F-) must never be opened during operation. To do so will produce inductive arcing that can possibly damage the exciter field and/or the voltage regulator. Therefore, *never* place the voltage shutdown switch in the exciter field circuit.

(2) The permanent installation of a voltage shutdown switch as shown in Figures 4-2, 4-3, or 4-4 is recommended. It permits immediate removal of field excitation if necessary. In any case, its use is suggested during initial checkout.

d. *Modified Voltage Regulator Input (Terminals 5 and 8)*. The terminals are used only on special modified versions such as UFOV applications, or special sensing inputs. Terminal 5 is used for UFOV applications and Terminal 3 is used for the special sensing input (consult factory for additional information regarding Terminal 8).

e. *Voltage Regulator Sensing*.

(1) The regulator has internal sensing transformers with taps for sensing voltages of 120, 208, 240, 416, 480, and 600 Vac. They are shipped connected to the 120 volt taps. If voltage other than 120 volts is required, make the necessary tap connections. On generating systems with voltages above 600 Vac, instrument type potential transformers must be used to step the voltage down to match one of the regulator sensing voltages. For single-phase sensing, the sensing leads are connected to terminals E1 and E3. For three-phase sensing, leads are connected to terminals E1, E2, and E3. E1 is connected to the "A" phase, E2 is connected to the "B" phase (only if three-phase sensing is required) and E3 is connected the "C" phase. If single-phase sensing is used, the PH wire must be connected to the 1PH terminal. For three-phase sensing, connect the PH wire to 3PH terminal. It should be noted that the type of sensing bears no relationship to the type of generator used. Although most generators employing an SR-H/SR-E regulator are three-phase, in most applications, single-phase sensing is entirely adequate.

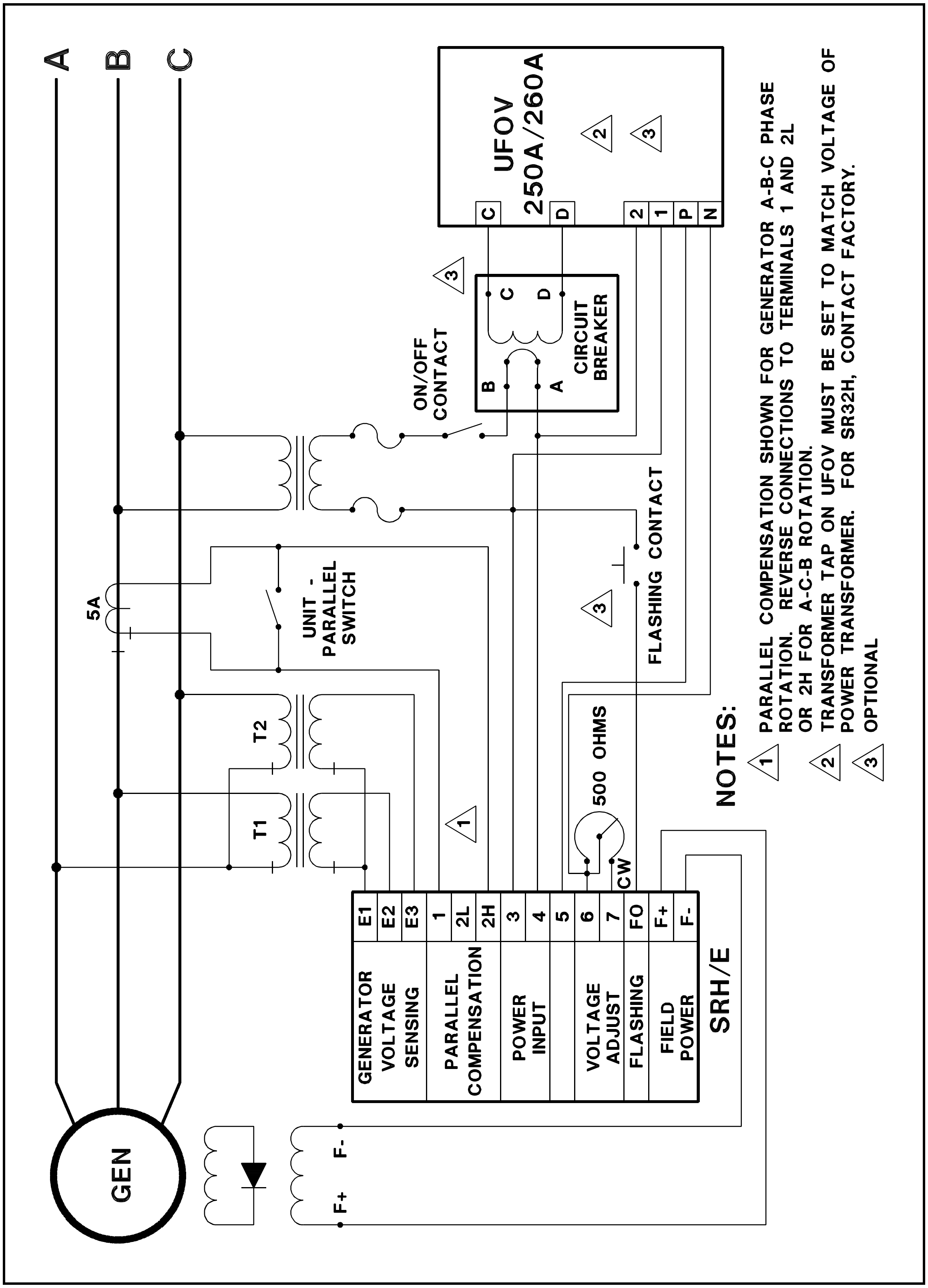

Figure 4-2. SR-H Interconnection Diagram, Brushless Exciter.

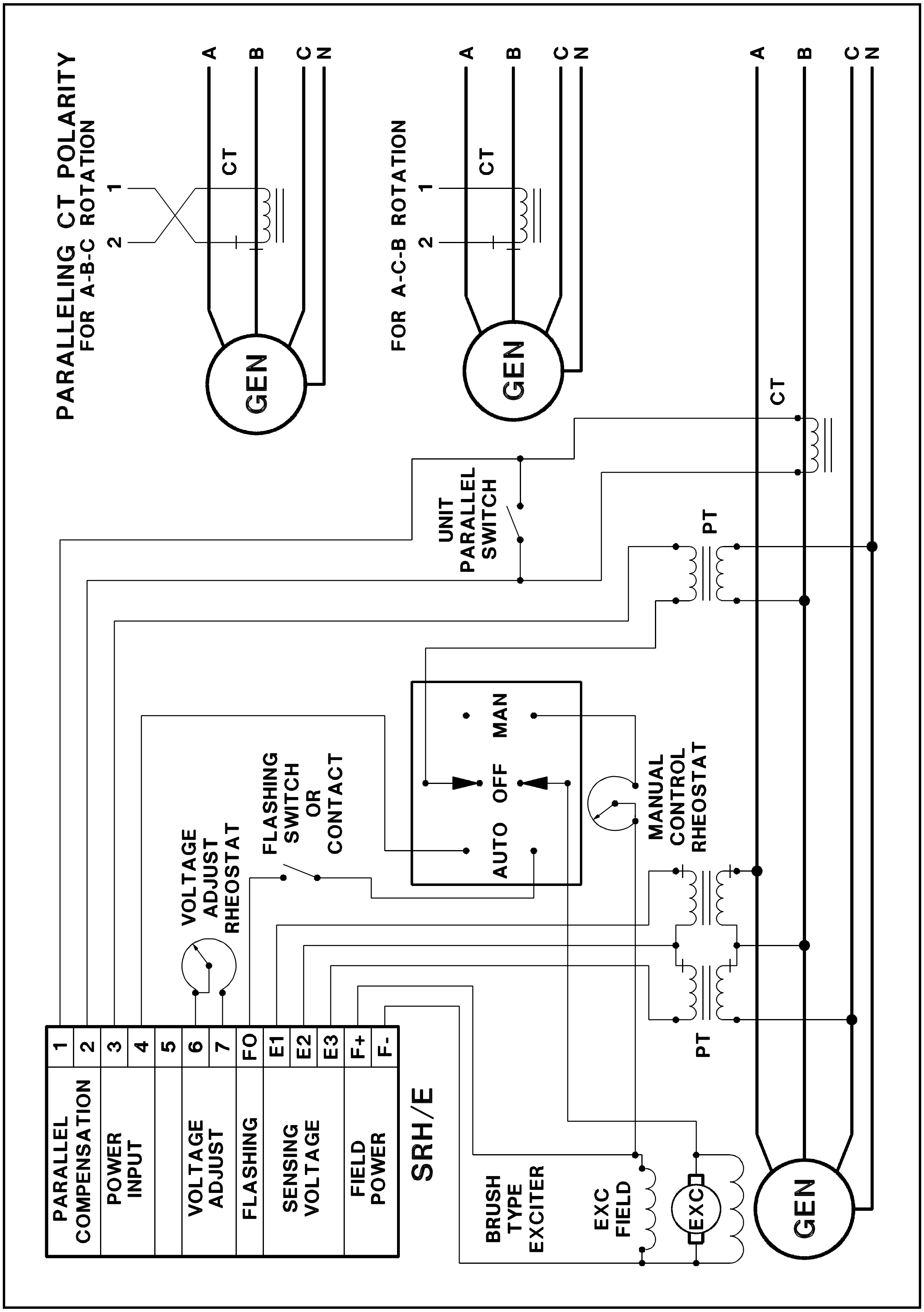

Figure 4-3. Interconnection Diagram, Brush-Type Exciter.

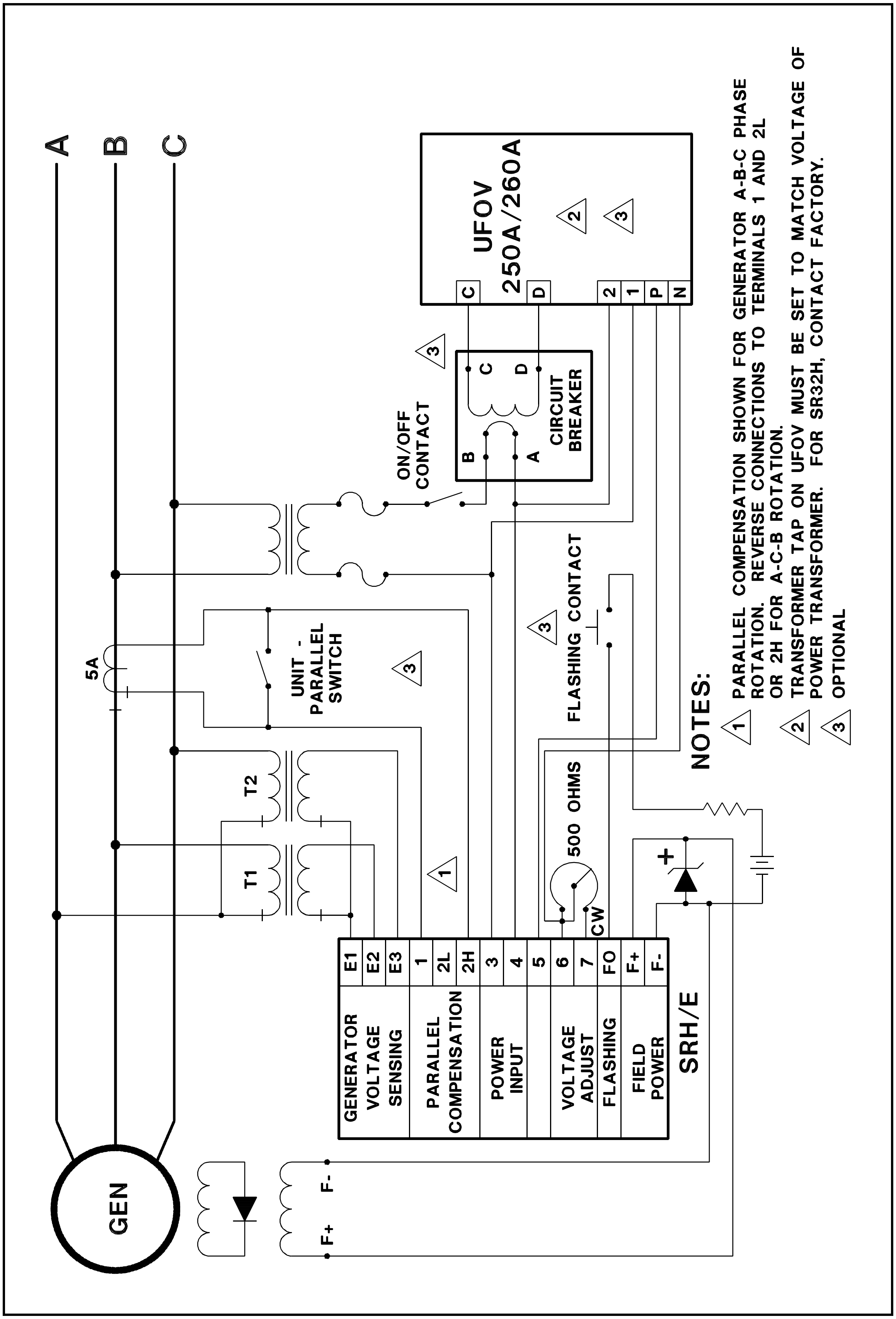

Figure 4-4. SR-E/H Interconnection Diagram, Static Exciter.

b. For precise regulation, the sensing leads should be connected as close as possible to the point where regulation is desired. Of course, the leads must remain on the generator side of the breaker. The regulator regulates the voltage applied to its sensing terminals and cannot correct for cable or bus voltage drop that may occur at points other than where the sensing leads are connected. The sensing leads should not be used to supply any other equipment.

f. *Field Power*.

(1) The maximum continuous output current of these regulators (terminals F+ and F-) is 20 ADC for the SR-H regulators or 36 ADC for the SR-E regulators. The dc resistance of the field into which the regulator operates must be as specified in Table 1-3.

(2) When making connections to a rotary exciter, polarities must be observed. The regulator F+ terminal connects to the field positive terminal and the F- terminal to the negative terminal. With brush-type rotary exciter applications, it is important to observe polarities between generator field, exciter output, and exciter field. If the polarities are not known and the system has manual voltage control, polarities can be determined by operating the system on manual voltage control before connecting the regulator.

g. *Voltage Adjust Rheostat*. The external rheostat is rated at 500 ohms, 25 Watts. It connects across terminals 6 and 7. The jumper should be connected as shown in the interconnection diagrams so that clockwise rotation results in decreased resistance and increased generator voltage.

h. *Parallel Compensation*.

(1) Use of terminals 1 and 2L or 1 and 2H is required only if generators are operated in parallel. If parallel operation is not anticipated, terminal 1 should be connected to terminal 2L with a jumper.

(2) If paralleling is required, a current transformer (CT) with a 5 amp secondary rating is installed in the generator phase B line. This current transformer should deliver from 3 to 5 amps secondary current at rated generator load. The maximum burden of the regulator parallel compensation circuit is 5 VA (terminals 1 and 2L) or 25 VA (terminals 1 and 2H). A Unit-Parallel switch can be used to short the paralleling CT when the system is operated as a single unit. Shorting the CT secondary prevents a droop signal from being injected into the voltage regulator.

(3) The phase relationship between the paralleling current transformer signal applied to voltage regulator terminals 1 and 2L or 1 and 2H and the voltage sensing signal applied to regulator terminals El, E2, and E3 is very important. It is equally important that the paralleling current transformer secondary polarity be correct for the existing generator phase sequence (A-B-C or A-C-B). These connections must be made as described in the interconnection diagrams, Figure 4-2, 4-3, or 4-4. (Regulator terminal E2 is not used for single-phase sensing).

(4) If it cannot be determined which generator lines are Phase A, B and C, follow this procedure:

(a) With a three-phase sensing voltage regulator, always place the paralleling current transformer in the generator phase that *does* supply sensing voltage to regulator terminal E2. When a single-phase sensing regulator is used, place the current transformer in the generator phase that *does not* supply sensing voltage to the regulator.

(b) When step (a) is observed, the only unknown remaining is the correct polarity of the paralleling current transformer secondary signal. If an inductive reactive load is available, this can be determined by the test as outlined in paragraph 4-2d.

(c) If the generator load outlined in step (b) is not available and it becomes necessary to parallel the generator without knowing the correct paralleling current transformer secondary polarity, *extreme caution must be observed or equipment damage may result*. If abnormally high generator current results after closing the breaker, *immediately reopen the breaker*, shut down the generating system, and reverse the secondary connections of the paralleling current transformer (the leads to regulator terminals 1 and 2L or 1 and 2H).

NOTE

The parallel compensation circuit of all interconnected voltage regulators must have the same ampere and voltage-ampere ratings.

(5) If parallel cross-current compensation (reactive differential compensation) is desired, make the same installation connections as previously described and illustrated in Figure 4-2, 4-3, or 4-4. Then interconnect with the cross-current loop as shown in Figure 4-5 and as described in paragraph 2-8c.

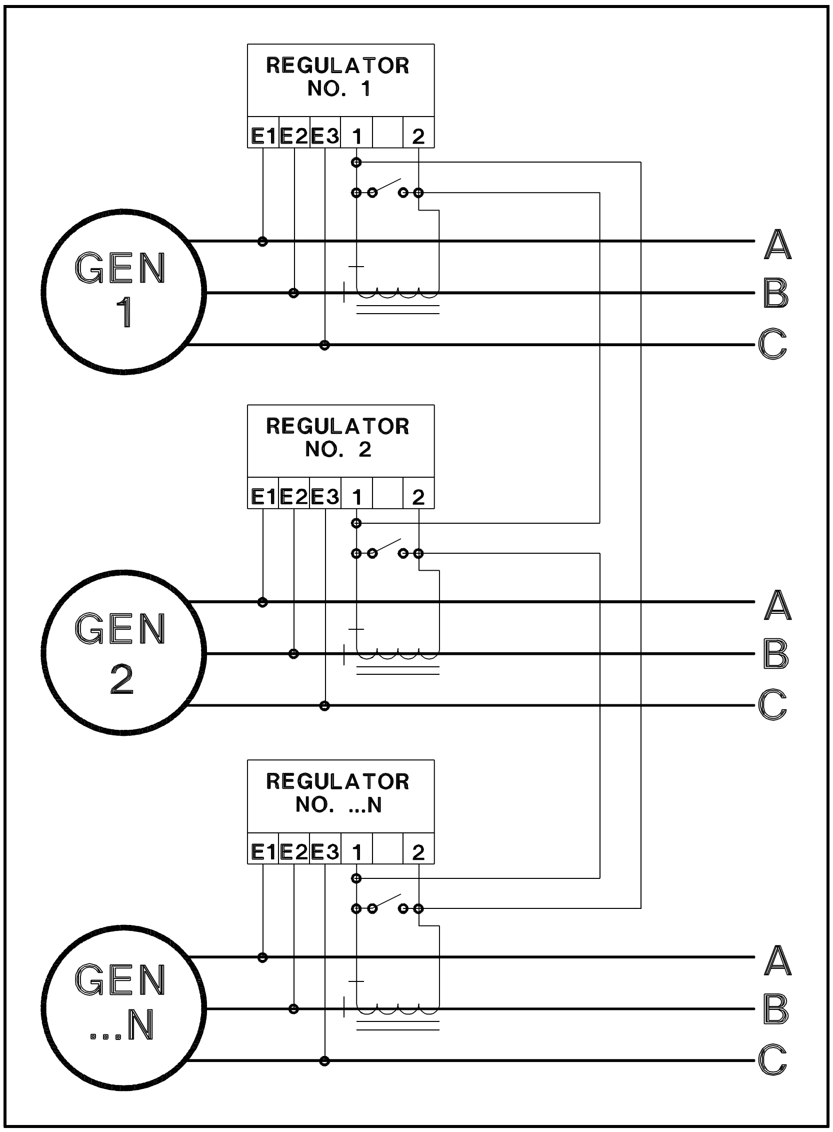

Figure 4-5. Cross-Current Compensation CT Connection.

(6) It is recommended that the cross-current connecting loop be left open at one point until proper parallel operation is achieved with the parallel droop compensation circuit only.

(7) On applications utilizing cross-current compensation, an auxiliary breaker contact should be used to short out the current transformer secondary if that generator is not on the load bus. If such a contact is not used, a voltage droop will be introduced into the system because the unloaded generator paralleling CT is not supplying the compensating signal and a voltage drop occurs across it. This drop will also cause the voltage of the incoming generator to fluctuate prior to paralleling. The solution is to connect an auxiliary contact on the main generator which must be closed when the main generator circuit breaker is across the paralleling current transformer secondary. This auxiliary contact must be closed when the main breaker is open, and open when the main generator breaker is closed.

4-2. OPERATION

a. *Field Flashing*.

(1) The regulator contains an internal circuit for automatic voltage build-up. Usually there is sufficient residual voltage to allow the generator voltage to build up without an additional flashing circuit. However, if field flashing is required, apply a 12 Vdc flashing source with the prime mover at rest, across terminals FO and F- on the regulator. The positive of the flashing source must be connected to FO and the negative of F-. This action remagnetizes the field poles and allows build-up when the system is restarted. A diode in the regulator allows the flashing source to be removed from the field without danger of inductive arcing.

(2) If the generator field is flashed during system startup, the field flashing source must be removed after nominal generator voltage is obtained. This can be accomplished with a push button or switch on manual field flash applications, and with a relay on automatic field flash applications. If a relay is used, it should sense the generator voltage and open the flashing circuit at approximately 70% of rated voltage. On automatic field flashing applications, provisions (such as a speed switch) must be made to open the circuit when the generator is secured (not rotating). For proper connection instructions, refer to the interconnection diagrams.

b. *Unit (Single or Non-Parallel) Operation*.

(1) Operation (No Load).

(a) Set the external voltage rheostat to approximately mid-range.

(b) Start the prime mover and bring up to rated speed. If a voltage shutdown switch is used, close switch. When this switch is not used, generator voltage should build up automatically. (If field flashing is necessary, see paragraph 4-2a.).

(c) Verify that generator voltage is within ±10% of rated. Slight voltage corrections can be made with the voltage adjust rheostat. If the voltage is not at rated but within ±10%, leave the voltage adjust pot at mid-range and re-adjust the voltage range adjust pot, R14 located on etched circuit board.

(2) Overvoltage, Undervoltage or Unstable Voltage Condition. If an overvoltage, undervoltage or unstable voltage condition results, review the following:

(a) *Overvoltage Condition (+15% or more above rated)*. If an overvoltage condition occurs, open the shutdown switch immediately and/or stop the prime mover. The regulator's internal overvoltage limit circuitry should prevent an overvoltage condition from exceeding approximately 135% above rated. An overvoltage condition may result because the regulator sensing leads are not connected. If the cause of over voltage cannot be determined, refer to the troubleshooting section of this manual.

(b) *Undervoltage Condition (-15% or less of rated)*. If an undervoltage condition exists, stop the prime mover and determine the cause. If necessary, refer to the troubleshooting section of this manual.

(c) *Unstable Generator Voltage*. If the system voltage oscillates or hunts, adjust the voltage stability potentiometer R11 located on the etched circuit board. If necessary refer to the troubleshooting section.

(3) Operation (With Load).

(a) Apply rated load to the generator.

(b) Verify that no-load to full-load regulation is less than ±1/2%. If the generating system has a paralleling CT, make certain that the CT secondary is shorted before starting the test. If acceptable regulation is not obtained, refer to the troubleshooting section.

(c) Alternately remove and apply load to determine the generator voltage remains stable. If the generator voltage becomes unstable, readjust R11.

NOTE

Unstable governors are frequently the cause of generator voltage instability. If a stability problem still exists after performing the procedures described in this manual, a thorough check of the governor should be made.

c. *Parallel Operation*.

(1) To parallel generators and to check for proper parallel operation, generators should be equipped with the following instrumentation:

Ac Voltmeter
Frequency Meter
Synchroscope or a set of lights, etc.
Ac Ammeter

(2) It is also desirable to have a KVAR or a Power Factor Meter and a Generator or Exciter Field Current Ammeter.

d. *Preliminary Tests Prior to Paralleling*.

It is recommended that correct operation of the regulator and generator be verified for unit operation prior to attempting paralleling. Then the following preliminary steps should be accomplished:

(1) Adjust parallel compensation rheostat R40 to its nearly full resistance position. This adjustment provides maximum droop signal and should be set nearly identically on all regulators to be paralleled.

(2) Make certain that the paralleling CT secondary is not shorted (Unit-Parallel switch is in the Parallel position).

(3) With the generating set operating at rated voltage and frequency, apply from 25 to 100%, unity power factor load. Generator voltage should not change more than ±1/2%. (The frequency should decrease if the governor is set for droop operation).

(4) Apply a 25 to 100%, 0.8 power factor load to the generator. The voltage should droop from 4 to 6% (with full load and with parallel compensation rheostat R40 set nearly full resistance). If the voltage rises instead of drooping, reverse the parallel current transformer secondary leads.

(5) Repeat this test on all generators to be operated in parallel. After satisfactorily completing these tests, the generators should parallel properly.

e. *Paralleling Procedure*.

CAUTION

The incoming generator voltage phase sequence (phase rotation) must be the same as that of the bus to which it is to be paralleled.

(1) Adjust the voltage of the incoming generator (the generator to be paralleled with the bus) to match the bus voltage.

(2) Adjust the incoming prime mover speed so that its frequency is slightly faster than the load bus.

(3) Observing the synchroscope (or synchronizing lights) close the oncoming generator circuit breaker when it is in phase with the bus.

(4) Immediately after closing the breaker, observe the generator line current ammeter. It should read well within the rating of the generator. *If not, immediately reopen the circuit breaker and completely review paragraph 4-1, proceed to subparagraph (f) below, and/or refer to Section 5.0.*

(5) If operation after paralleling is normal, adjust the prime mover speed control so that the generator takes on KW load, thereby avoiding the possibility of the reverse power relay tripping the generator off line.

(6) Adjust voltage so that the generator just placed on the bus assumes its share of KVAR load.

(7) If two or more generators using the same type voltage regulators are on a common bus, vary the bus load and make voltage, speed and parallel compensation R40 adjustments as necessary to obtain the optimum load sharing.

f. *Paralleling Problems*.

(1) If, upon paralleling with the bus, improper operation results, try to determine which control system is at fault: the voltage control or the speed control. A high ammeter reading, or circuit breaker opening may occur in either case. Immediately after closing the oncoming generator circuit breaker, observe the KVAR and KW meters.

(a) A large KVAR reading (incoming or outgoing) indicates a faulty voltage regulating system.

(b) A large KW reading would indicate a faulty speed regulating system.

(2) Another method of determining which control system is at fault is to operate the system on manual voltage control (on systems having manual control). If proper parallel operation is obtained on manual voltage control, the voltage regulating system is probably at fault. If proper operation is not obtained, the speed regulating system is probably at fault.

(3) If the trouble is isolated to the voltage regulating system, recheck the interconnection diagrams, Figure 4-2, 4-3, or 4-4. Almost all paralleling problems encountered with these voltage regulators are caused by incorrect system interconnections.

SECTION 5

MAINTENANCE AND TROUBLESHOOTING

5-1. PREVENTIVE MAINTENANCE

This unit should be cleaned and inspected periodically to ensure that the air flow is not restricted.

5-2. OPERATIONAL CHECK-OUT

If trouble is to be avoided during initial operation, the importance of eliminating wiring errors cannot be over-emphasized. The voltage regulator cannot operate properly until it is connected correctly and may be damaged or even fail if operated while incorrectly connected. An effective test, used to determine if the regulator is basically operational, is given below (Refer to Figure 5-1).

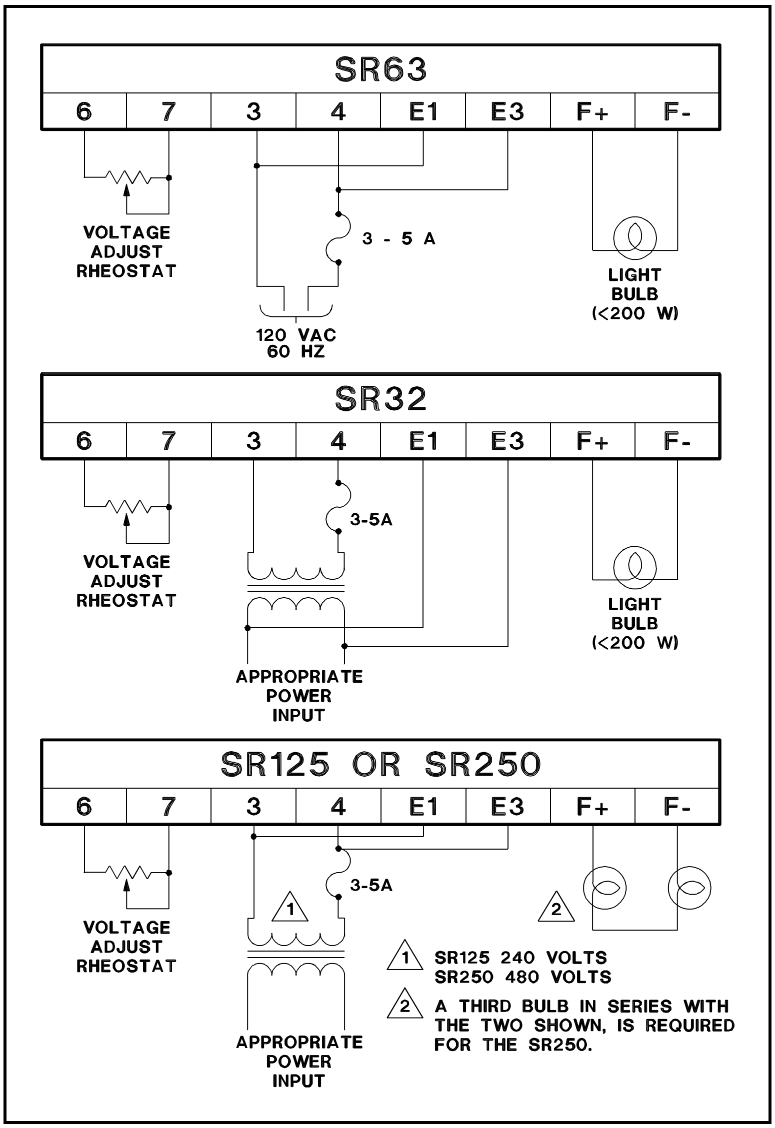

Figure 5-1. Operational Checkout.

a. Select single-phase and adjust the taps as follows:
   SR63: Position to the 120 Vac taps.
   SR32: Position to taps which correspond to the transformer primary voltage.
   SR125: Position to the 240 Vac taps.
   SR250: Position to the 480 Vac taps.

b. Connect as shown in Figure 5-1. Identical 120 V light bulbs should be used. (Any wattage below 200 W is satisfactory.)

c. Adjust the Voltage Adjust Rheostat for maximum resistance.

d. Apply power. (Note that the light bulbs may flash on momentarily when power is applied.

e. Slowly adjust the Voltage Adjust Rheostat toward minimum resistance. Before reaching minimum resistance, the light bulb(s) should come to near full brilliance. (Light bulb will not be as bright when testing an SR32).

f. At the regulating point, a small change in the Voltage Adjust Rheostat should turn the light bulb on or off. Note that this test does not and cannot reveal a stability problem.

g. Before installing the Voltage Regulator into the system, connect the regulator sensing transformer to the original tap(s).

5-3. TROUBLESHOOTING

a. Some of the possible malfunctions that could occur during operation of the voltage regulator and the corrective action are listed in Table 5-1.

b. It is recommended that the regulator be returned to Basler Electric Company for repair if the problem cannot be resolved using Table 5-1. In such instances, ensure that the regulator is adequately packed to prevent damage in transit.

NOTE

a. If, when troubleshooting a generating system, a defective voltage regulator is found, do not install a replacement regulator without first measuring the dc resistance of the exciter field winding to ensure that the resistance is above the minimum specified in Table 1-3 for that regulator model.

b. On generating systems not using a power isolation transformer, or using a power isolation transformer with a grounded secondary, ensure that the exciter field winding or circuitry is not grounded before installing a new voltage regulator.

Table 5-1. Troubleshooting Chart

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. VOLTAGE DOES NOT BUILD UP TO RATED VALUE.

Step 1. Check for low residual voltage and/or incorrect polarity relationship between exciter output and generator field.

If either condition exists, flash the generator field.

If neither condition exists, proceed to Step 2.

Step 2. Verify that the Voltage Shutdown Switch is closed.

If the Voltage Shutdown Switch is open, close the switch.

If the Voltage Shutdown Switch is closed, proceed to Step 3.

Step 3. Verify that the prime mover is operating at rated speed.

If the prime mover is not operating at rated speed, adjust speed.

If prime mover is operating at rated speed, proceed to step 4.

Step 4. Incorrect or missing voltage at regulator power input terminals (3 & 4).

If this condition exists, repair wiring.

If this condition does not exist, proceed to step 5.

Step 5. Verify regulator output voltage at terminals F+ and F-.

If voltage is incorrect or missing, repair wiring and/or adjust/repair regulator.

If voltage is correct, proceed to step 6.

Step 6. Verify that generator output is neither shorted nor overloaded.

If generator output is shorted, remove short and repair wiring.

If generator is overloaded, shed excess load.

If generator output is not overloaded or shorted, proceed to step 7.

Step 7. Verify that the External Voltage Adjust Potentiometer is properly wired.

If the External Voltage Adjust Potentiometer is incorrectly wired, reconnect wiring properly.

If the External Voltage Adjust Potentiometer is correctly wired, proceed to step 8.

Table 5-3. Troubleshooting Chart - Continued.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. VOLTAGE DOES NOT BUILD UP TO RATED VALUE - Continued.

Step 8. Verify that the exciter wiring is correct.

If the exciter wiring in incorrect, reconnect the exciter.

If the exciter wiring is correct, proceed to step 9.

Step 9. Check for a defective exciter.

If exciter is defective, repair or replace the exciter.

If the exciter is not defective, proceed to step 10.

Step 10. If the above steps fail to correct the malfunction, replace or repair the voltage regulator.

2. VOLTAGE BUILDS UP UNTIL RELAY ACTUATES, THEN DECAYS.

Step 1. Check for a defective Voltage Adjust Rheostat (R1) and/or defective associated circuitry.

If the circuitry is defective, repair the circuit/wiring.

If the rheostat is defective, replace the rheostat.

If neither the rheostat or the circuit is defective, proceed to step 2.

Step 2. Check for input power to terminals 3 and 4 (Brush-type Rotary Exciters ONLY. All others proceed to step 3.)

If power is not present, check and repair wiring as necessary.

If power is present, proceed to step 3.

Step 3. If the above steps do not correct the malfunction, replace or repair the voltage regulator as necessary.

3. VOLTAGE HIGH AND UNCONTROLLABLE WITH VOLTAGE ADJUST RHEOSTAT.

Step 1. Check for sensing voltage at terminals E1, E2, and E3.

If sensing voltage is not present, repair wiring.

If sensing voltage is present, proceed to step 2.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. VOLTAGE HIGH AND UNCONTROLLABLE WITH VOLTAGE ADJUST RHEOSTAT - Continued.

Step 2. Check that the transfer switch (if used) is in AUTO position. (If transfer switch is not used, proceed to step 3.)

If transfer switch is not in AUTO position, place in AUTO.

If transfer switch is in AUTO position, proceed to step 3.

Step 3. Check for a shorted external Voltage Adjust Potentiometer (R1).

If Voltage Adjust Potentiometer is shorted, replace Voltage Adjust Potentiometer.

If Voltage Adjust Potentiometer is not shorted, proceed to step 4.

Step 4. Verify that the sensing transformer is set to the proper tap.

If transformer tap is improperly selected, reconnect to proper tap.

If transformer tap is properly selected, proceed to step 5.

Step 5. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

4. VOLTAGE HIGH AND CONTROLLABLE WITH VOLTAGE ADJUST RHEOSTAT.

Step 1. Check that the sensing transformer is set to the proper tap.

If transformer tap is improperly selected, reconnect to proper tap.

If transformer tap is properly selected, proceed to step 2.

Step 2. Check that Voltage Range Adjust Potentiometer is not set too high.

If Voltage Range Adjust Potentiometer is set too high, adjust potentiometer.

If Voltage Range Adjust Potentiometer setting is within limits, proceed to step 3.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. VOLTAGE HIGH AND CONTROLLABLE WITH VOLTAGE ADJUST RHEOSTAT - Continued.

Step 3. Check that the Voltage Adjust Potentiometer resistance is not too low.

If the Voltage Adjust Potentiometer resistance is too low, replace potentiometer with one of the proper value.

If the Voltage Adjust Potentiometer resistance is proper, proceed to step 4.

Step 4. Verify that the sensing leads are properly connected to the generator and regulator.

If the sensing leads are improperly connected, reconnect properly.

If the sensing leads are properly connected, proceed to step 5.

Step 5. Verify that three-phase sensing is applied to regulator. (Three-phase sensing models only. For single-phase sensing models, proceed to step 6.)

If single-phase sensing is applied, reconnect for three-phase sensing.

If three phase sensing is applied, proceed to step 6.

Step 6. Verify the accuracy and connection of the voltmeter.

If voltmeter is improperly connected, reconnect voltmeter properly.

If voltmeter is defective, replace voltmeter.

If voltmeter is connected properly and not defective, proceed to step 7.

Step 7. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

5. VOLTAGE LOW AND CONTROLLABLE WITH VOLTAGE ADJUST RHEOSTAT.

Step 1. Check that the sensing transformer is set to the proper tap.

If transformer tap is improperly selected, reconnect to proper tap.

If transformer tap is properly selected, proceed to step 2.

Step 2. Check that Voltage Range Adjust Potentiometer is not set too low.

If Voltage Range Adjust Potentiometer is set too low, adjust potentiometer.

If Voltage Range Adjust Potentiometer setting is within limits, proceed to step 3.

Table 5-3. Troubleshooting Chart - Continued.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. VOLTAGE LOW AND CONTROLLABLE WITH VOLTAGE ADJUST RHEOSTAT - Continued.

Step 3. Check that prime mover is operating at rated speed.

If prime mover is operating below rated speed, adjust prime mover speed to rated.

If prime mover is operating at rated speed, proceed to step 4.

Step 4. Verify that the sensing leads are properly connected to the generator and regulator.

If the sensing leads are improperly connected, reconnect properly.

If the sensing leads are properly connected, proceed to step 5.

Step 5. Verify the accuracy and connection of the voltmeter.

If voltmeter is improperly connected, reconnect voltmeter properly.

If voltmeter is defective, replace voltmeter.

If voltmeter is connected properly and not defective, proceed to step 6.

Step 6. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

6. POOR REGULATION.

Step 1. Verify that exciter/generator field requirements are not in excess of voltage regulator capability.

If regulator application is incorrect for regulator, contact Basler Electric.

If regulator application is within regulator limits, proceed to step 2.

Step 2. Verify that input voltage at terminals 3 and 4 is of the correct value.

If input voltage is incorrect, apply correct voltage to terminals 3 and 4.

If input voltage is correct, proceed to step 3.

Step 3. Check that the voltmeter is connect to the same location as the regulator sensing.

If voltmeter is not connected to same location as the regulator sensing, reconnect voltmeter.

If voltmeter is properly connected, proceed to step 4.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

6. POOR REGULATION - Continued.

Step 4. Check that the generator output waveform is not distorted due to harmonic content (Regulator senses average voltage; meter may be indicating RMS values.)
If this condition exists, consult the generator manufacturer.

If this condition does not exist, proceed to step 5.

Step 5. Check that the UNIT/PARALLEL switch (if installed, if not go to step 6) is in the PARALLEL position when the generator is paralleled and in the UNIT position when the generator is operating alone. Also check that the switch functions properly.

If the switch is not in the proper position, set switch to correct position.

If the switch is defective, replace switch.

If the switch is set to the proper position, proceed to step 6.

Step 6. Check that load is not unbalanced as regulator averages all three phases together. (Three-Phase Sensing ONLY. All others proceed to step 7.)

If load is unbalanced, balance load.

If load is balanced, proceed to step 7.

Step 7. Verify that prime mover is operating at rated speed.

If prime mover is not operating at rated speed, change prime mover speed to rated.

If prime mover is operating at rated speed, proceed to step 8.

Step 8. Check for fault in either exciter or generator.

If a fault exists, correct fault condition.

If a fault does not exist, proceed to step 9.

Step 9. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

7. POOR VOLTAGE STABILITY.

Step 1. Verify that the generator frequency is stable.

If the frequency is unstable, consult with the governor manufacturer.

If the frequency is stable, proceed to step 2.

Table 5-3. Troubleshooting Chart - Continued.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

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7. POOR VOLTAGE STABILITY - Continued.

Step 2. Verify that voltage does not fluctuate to the point when K1 either energizes or de-energizes.

If this condition occurs, refer to MALFUNCTION 2.

If this condition does not exist, proceed to step 3.

Step 3. Verify that the sensing voltage and input power are not taken from the same power isolation transformer secondary.

If the above condition exists, reconnect sensing to a separate source.

If the above condition does not exist, proceed to step 4.

Step 4. Verify that the Stability Adjust Potentiometer is not maladjusted.

If potentiometer is maladjusted, adjust Stability Adjust Potentiometer to proper setting.

If potentiometer is not maladjusted, proceed to step 5.

Step 5. Verify that the field resistance is correct.

If field resistance is too low (Refer to Table 1-3), contact our Customer Service Department of the Power Systems Group, Basler Electric for assistance.

If the field resistance is correct, proceed to step 6.

Step 6. Verify Stability Selection.

If Stability Selection is correct, proceed to Step 7.

Step 7. Check for fault in either exciter or generator.

If a fault exists, correct fault condition.

If a fault does not exist, proceed to step 8.

Step 8. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

8. VOLTAGE RECOVER SLOW WITH LOAD CHANGE.

Step 1. Verify that the correct regulator is being used for the application.

If the incorrect regulator is being used, contact Basler Electric.

If the correct regulator is being used, proceed to step 2.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

8. VOLTAGE RECOVER SLOW WITH LOAD CHANGE - Continued.

Step 2. Verify that Stability Adjust Potentiometer is not maladjusted.

If potentiometer is maladjusted, adjust Stability Adjust Potentiometer to proper setting.

If potentiometer is not maladjusted, proceed to step 3.

Step 3. Verify that the generator frequency is stable.

If the frequency is unstable, consult with the governor manufacturer.

If the frequency is stable, proceed to step 4.

Step 4. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

9. PARALLEL GENERATORS DO NOT DIVIDE REAL KW LOAD EQUALLY.

Consult with the governor manufacturer for improving the power sensing of the governor and/or adjustment of the governor droop setting.

10. NO REACTIVE DROOP COMPENSATION CAN BE OBTAINED FOR PARALLEL GENERATORS.

Step 1. Verify that the tap on droop resistor is not set to the minimum position.

If the tap is set to the minimum position, adjust the droop resistor to obtain the required droop.

If the tap is set properly, proceed to step 2.

Step 2. Verify that the Parallel CT provides the required 3 to 5 A secondary current.

If the CT does not provide the required 3 to 5 A secondary current, replace CT.

If the CT does provide the required 3 to 5 A secondary current, proceed to step 3.

Step 3. Verify that terminals 1 and 2 of the regulator are not shorted by the UNIT/PARALLEL switch.

If the switch is set to UNIT, set switch to PARALLEL.

If the terminals are shorted, replace the switch and/or repair the wiring.

If the terminals are not shorted, proceed to step 4.

Step 4. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

11. PARALLEL GENERATORS DO NOT DIVIDE REACTIVE KVAR LOAD EQUALLY. (Circulating Reactive Current Between Generators).

Step 1. Verify that the tap on the droop resistor is not set to the minimum position.

If the tap is set to the minimum position, adjust tap to obtain the required droop.

If the tap is set properly, proceed to step 2.

Step 2. Verify that the Parallel CT provides the required 3 to 5 A secondary current.

If the CT does not provide the required 3 to 5 A secondary current, replace the CT.

If the CT does provide the required 3 to 5 A secondary current, proceed to step 3.

Step 3. Verify that the paralleling CT's polarity is correct.

If the CT's polarity is incorrect, reverse the CT secondary leads.

If the CT's polarity is correct, proceed to step 4.

Step 4. Verify that the paralleling CT is in the correct generator phase (line).

If the CT is not in the correct phase, place CT in correct line.

If the CT is in the correct phase, proceed to step 5.

Step 5. Check that all paralleled generators have the same type of sensing (either single-phase or three-phase).

If all paralleled generators do not have the same type of sensing, make necessary corrections.

If all paralleled generators do have the same type of sensing, proceed to step 6.

Step 6. If the above steps fail to correct the malfunction, replace or repair the voltage regulator as necessary.

SECTION 6
REPLACEMENT PARTS

6-1. SR-H SERIES REGULATOR

The following list (Table 6-1) contains parts and assemblies which are maintenance significant. When ordering replacement parts, always specify the complete model number and the part number of the voltage regulator.

Table 6-1. SR-H Replacement Parts.

Reference Designation	Basler Part Number	Qty	Description	Effectivity
----------	9 0597 01 100	1	Circuit Board Assembly	SR32H,SR63H SR125H
----------	9 0597 01 101	1	Circuit Board Assembly	SR250H
C23	11788	1	Capacitor, 2 µf, 100 V	SR32H,SR63H SR125H
C23,C25	11790	2	Capacitor, 0.5 µf, 1500 V	SR250H
C25	11792	1	Capacitor, 10 µf, 200 V	SR32H
C25	11791	1	Capacitor, 3 µf, 1000 V	SR63H,SR125H
CR32,CR33	9 0950 00 015	2	SCR	SR32H,SR63H SR125H
CR32,CR33	11853	2	SCR	SR250H
CR34,CR36	08609	2	Diode, 70 HR80A	SR32H,SR63H SR125H
CR34,CR36	11852	2	Diode, R36160	SR250H
CR35,CR37 CR38	08608	3	Diode, 70 H80A	SR32H,SR63H SR125H
CR35,CR37 CR38	11851	3	Diode, S36160	SR250H
F1,F2	08614	2	Fuse	All Units
L1	BE 08794-003	1	Reactor	All Units
R40	13468	1	Resistor, Adj.; 0.2 Ω, 25 W	All Units
R42	03603	1	Resistor, WW, 4700 Ω, 10 W, 5%	All Units
R43	07291	1	Resistor, WW, 2700 Ω, 10 W, 5%	All Units
R46-R48	03993	3	Resistor, WW, 50 Ω, 25 W, 5%	SR63H,SR125H
R46,R48	03343	2	Resistor, WW, 16 Ω, 25 W, 5%	SR32H
R46,R51	03224	2	Resistor, WW, 25 Ω, 25 W, 5%	SR250H
R47	06648	1	Resistor, WW, 100 Ω, 25 W, 5%	SR32H
R47,R48	06648	2	Resistor, WW, 100 Ω, 25 W, 5%	SR250H

Table 6-1. SR-H Replacement Parts - Continued.

Reference Designation	Basler Part Number	Qty	Description	Effectivity
R49	06874	1	Resistor, Variable, 500 Ω, 25 W	All Units
R50	13318	1	Resistor, 0.75 Ω, 100 W, 10%	All Units
T1,T2	BE 17290-001	2	Transformer, Sensing	All Units
T3	BE 10351-001	1	Transformer	All Units
T5	BE 13069-001	1	Transformer	SR32H
T5	BE 10365-001	1	Transformer	SR63H,SR125 H
T5	BE12374-001	1	Transformer	SR250H

6-2. SR-E SERIES REGULATOR

The following list (Table 6-2) contains parts and assemblies which are maintenance significant. When ordering replacement parts, always specify the complete model number and the part number of the voltage regulator.

Table 6-2. SR-E Replacement Parts.

Reference Designation	Basler Part Number	Qty	Description	Effectivity
----------	9 0597 01 102	1	Circuit Board Assembly	SR32E
----------	9 0597 01 100	1	Circuit Board Assembly	SR63E,SR125E
----------	9 0597 01 101	1	Circuit Board Assembly	SR250E
C23	11788	1	Capacitor, 2 µf, 1000 V	SR32E,SR63E SR125E
C23,C25	11790	2	Capacitor, 0.5 µf, 1500 V	SR250E
C25	11792	1	Capacitor, 10 µf, 200 V	SR32E
C25	11791	1	Capacitor, 3 µf, 1000 V	SR63E,SR125E
CR32,CR33	9 0950 00 015	2	SCR	SR32E,SR63E SR125E
CR32,CR33	11853	2	SCR	SR250E
CR34,CR36	08609	2	Diode, 70 HR80A	SR32E,SR63E SR125E
CR34,CR36	11852	2	Diode, R36160	SR250E
CR35,CR37 CR38	08608	3	Diode, H80A	SR32E,SR63E SR125E
CR35,CR37 CR38	11851	3	Diode, SR36160	SR250E
F1,F2	11913	2	Fuse	All Units
L1	BE 08794-003	1	Reactor	All Units

Table 6-2. SR-E Replacement Parts.

Reference Designation	Basler Part Number	Qty	Description	Effectivity
R40	13468	1	Resistor, Adj.; 0.2 Ω, 25 W	All Units
R42	03603	1	Resistor, WW, 4700 Ω, 10 W, 5%	All Units
R43	07291	1	Resistor, WW, 2700 Ω, 10 W, 5%	All Units
R46,R48	03343	2	Resistor, WW, 15 Ω, 25 W, 5%	SR323E
R46-R48	03993	3	Resistor, WW, 50 Ω, 25 W, 5%	SR63E,SR125E
R46,R51	03224	2	Resistor, WW, 25 Ω, 25 W, 5%	SR250E
R47	06648	1	Resistor, WW, 100 Ω, 25 W, 5%	SR32E
R47,R48	06648	2	Resistor, WW, 100 Ω, 25 W, 5%	SR250E
R49	06874	1	Resistor, Variable, 500 Ω, 25 W	All Units
R50	13318	1	Resistor, 0.75 Ω, 100 W, 10%	All Units
T1,T2	BE 17290-001	2	Transformer, Sensing	All Units
T3	BE 10351-002	1	Transformer	All Units
T5	BE 13069-001	1	Transformer	SR32E
T5	BE 10365-001	1	Transformer	SR63E,SR125E
T5	BE 12374-001	1	Transformer	SR250E

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