



INSTRUCTION MANUAL

TYPE VR 65
VOLTAGE REGULATOR

DESCRIPTION * INSTALLATION * OPERATION
ADJUSTMENT * MAINTENANCE
With
RENEWAL PARTS ORDERING INFORMATION

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SECTION 1 INTRIDUCTION AND DESCRIPTION

1.1 INTRODUCTION

The type VR voltage regulator controls the voltage of a synchronous generator by varying the current supplied to the exciter field. The regulator consists of a controlled rectifier bridge and circuitry to control the bridge output. The circuitry is completely solid state; it consists of transistors, resistors, capacitors, integrated circuits, rectifiers and transformers. Figure 1 shows a typical unit with cover installed.

1.2 STANDARD FEATURES

The regulator has an output capability of 12 amperes dc continuously and 17 amperes for 1 minute. Regulator power transformers with 120 volt ac center tapped secondary windings are normally applied for generators with exciter

field resistance of 2.5 to 5.5 ohms and provide up to 32 volts dc continuously, 45 volts for 1 minute. Regulator power transformers with 240 volt ac center tapped secondary windings provide up to 63 volt dc continuously, 90 volts for 1 minute for generators with exciter field resistance of 5.5 ohms or greater. One phase of the generator voltage is sensed by the unit. A relay (BUR) for automatic build-up on start-up is furnished with a dust cover.

1.3 OPTIONAL FEATURES

- a. A build-up relay (BUR) in a hermetically sealed enclosure.
- b. Three phase sensing.
- c. Short circuit boost excitation.
- d. Manual control equipment.



Figure 1. The VR 65 Voltage Regulator With Cover.

SECTION 2 INSTALLATION

2.1 HANDLING

The regulator should be handled with normal care required for any piece of electronic equipment. Storage should be in a clean, dry area.

2.2 MOUNTING

The voltage regulator can be mounted in a vertical or horizontal position. For optimum cooling a vertical mounting position with terminal block at the bottom is recommended. Second choice for vertical mounting would be with the terminal block on the left hand side, which allows for the best heat dissipation of rheostat R3. The regulator may be mounted directly on the generator. Use a toothed lockwasher to insure a satisfactory ground. Although the regulator is designed to withstand extremely high ambient temperatures (70°C, 158°F), the longest and most trouble-free operation will result when the regulator is mounted in a relatively cool and dry place.

The power transformer (T5) is always mounted external to the regulator. The voltage adjusting rheostat (VAR), shown in Figure 2, is also mounted external and separate from the regulator.



Figure 2. Voltage Adjusting Rheostat (VAR)

2.3 CONNECTIONS

A connection diagram is normally furnished. A typical connection diagram is shown in Figure 3. The recommended wire size for all connections is 14 AWG. For sensing and voltage adjusting rheostat (VAR) leads, size 16 or 18 AWG wire could be used. However, many customers prefer the 14 AWG wire for greater mechanical reliability. It is always best to run the voltage sensing and VAR leads separate from other conductors to avoid magnetic interference. If the leads are in close proximity to large current carrying conductors then a twisted pair of wires (twisted by hand or purchased, e.g. Belden cat. #8460 or #8461) will usually resolve interference problems.

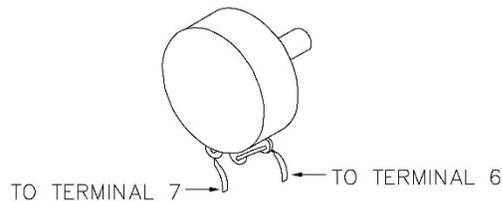


Figure 4. VAR Connections

The length of the VAR leads has little effect on operation provided there is no electrical interference induced. Refer to Figure 4 for proper connection of the VAR.

2.3.1 Voltage Sensing

The voltage regulator responds to the voltage that appears at E1, E2, E3 sensing terminals. An internal transformer (T1) provides nominal 120, 240, and 480 volt taps. Changing the connection to the sensing voltage terminal block near the reactive current compensation rheostat allows the regulator to operate on 100-120, 190-240, 380-480 volt systems without requiring any separate potential sensing transformer.

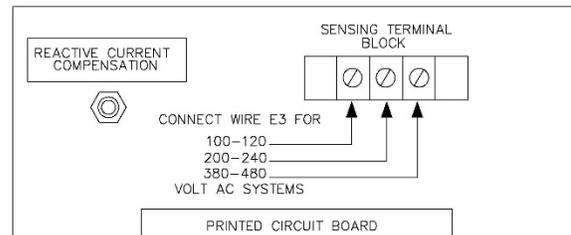


Figure 5. Sensing Transformer Connections

NOTE

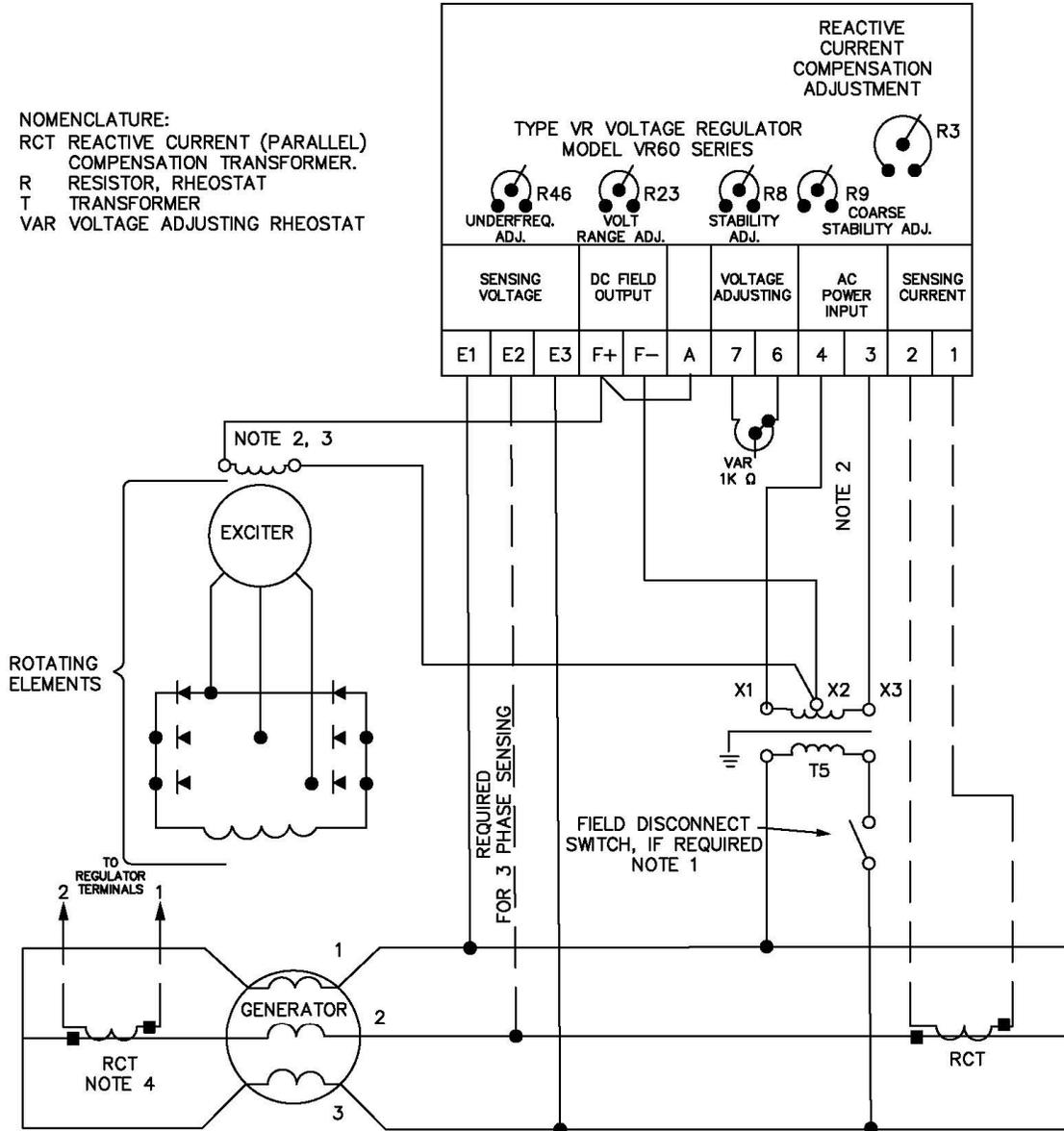
The regulators are normally shipped with wire E3 connected to 120 volt sensing terminal. Make sure the connection is properly made for each generator application.

The sensing terminal block is not present on regulators equipped for 3 phase sensing. The voltage tap connections are made on sensing transformers T1 and T2 mounted below the regulator chassis.

For voltages above 600 volts a potential transformer (PT) must be used to step down the voltage before it is applied to the regulator. The PT need not be of metering quality as long as the voltage ratio remains constant during load changes. Any loads in parallel with regulator sensing (only about 15 VA) would tend to cause secondary PT voltage to droop and this would change the effective voltage ratio. Especially undesirable would be periodic loads. One point on the PT secondary side is normally grounded for personnel safety. This ground will not affect the regulator operation since internal transformer T1 provides isolation. For units that are to operate in parallel with other machines it is important that proper polarity of the sensing connections be observed.

Loss of sensing voltage results in excessively high generator voltage. For a paralleled generator reactive overloading of the machine would result. Therefore, all possibilities for accidental loss of sensing must be eliminated by proper design and secure wiring connections.

NOMENCLATURE:
 RCT REACTIVE CURRENT (PARALLEL)
 COMPENSATION TRANSFORMER.
 R RESISTOR, RHEOSTAT
 T TRANSFORMER
 VAR VOLTAGE ADJUSTING RHEOSTAT



- NOTES:
1. NEVER OPEN DC SIDE OF FIELD CIRCUIT.
 2. KEEP LEADS AS SHORT AS POSSIBLE TO REDUCE ELECTRO MAGNET INTERFERENCE. (EMI)
 3. CONNECTION SHOWN IS FOR PHASE SEQUENCE OF 1-2-3.
 4. ALTERNATE POSITION OF RCT.

Figure 3. Typical Regulator Connection Diagram

2.3.2 Reactive Current Sensing

Current is sensed to provide reactive current compensation required for parallel operation of the generator. Polarity of primary and secondary current transformer (CT) connections must be observed. One point in the current circuit may be grounded. On high voltage systems it is common practice to ground the secondary side of the CT for personnel protection. Internal transformer T3 provides isolation for the regulator circuitry.

Reactive droop compensation is commonly used. It creates a droop in generator voltage proportional to reactive current and equivalent to that which would be produced by the insertion of a reactor between the generator terminals and the paralleling point.

For special applications a reactive differential (no droop) compensation can be used where droop in generator voltage is not wanted. It is obtained by a series of differential connections of the various generator current transformer secondaries and reactive compensators. The difference current from any generator from the common series current creates a compensating voltage in the input to the particular generator voltage regulator which acts to modify the generator excitation to reduce to minimum (zero) its differential reactive current. Refer to Figure 6. Care must be employed since only one ground can exist in the current transformer circuitry. Of course, isolation transformers could be used so that the secondary side of each CT could be grounded. When the secondary currents are equal there will be no current in R3 since circulating current will flow only through the CT secondary windings. If there is a difference in currents of one CT to the other, then current must flow through R3. This tends to raise or lower excitation to again obtain balanced currents in all CT's. Note that a unit

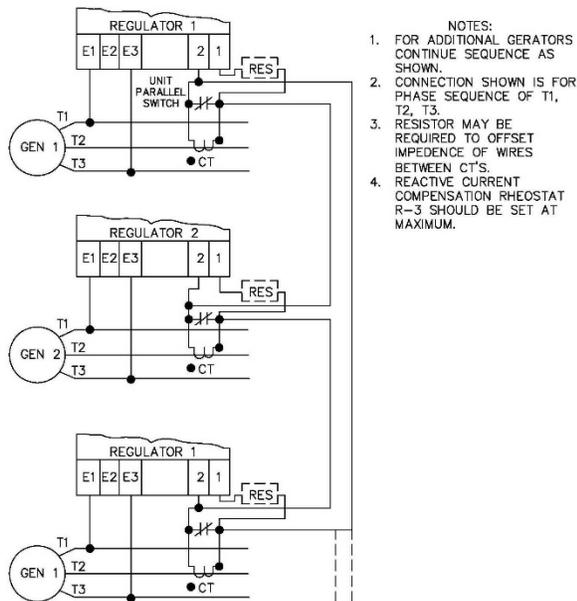


Figure 6. Reactive Differential (No Droop) Compensation Connections.

Parallel switch must be used if only some of the generators are to run at one time.

WARNING

Energized current transformer may be short-circuited, but must never be open-circuited, as extremely high voltages can result.

2.3.3 Power Circuit

The regulator is furnished without an internal power transformer (see Figure 3). A power transformer must be used with the VR Model 65 regulator. The power circuit should be interrupted only on the power transformer primary side. The dc side, from terminal F+ to the center tap of power transformer T5, must never be opened due to the inductive nature of the field which can generate destructive voltages for the semi-conductors in the regulator. The approximate volt-amperes (VA) required for a power transformer may be calculated by multiplying dc field current times power transformer ac secondary voltage.

The reference circuit supply voltage is obtained from the regulator power input terminals. A connection is made to printed circuit board terminal block 10 when 240 volt ac (120 volt to center tap) regulator power transformers are used. This connection should be changed to terminal 9 when 120 volt ac (60 volt to center tap) power transformers are used.

CAUTION

A transfer switch (if used in the field circuit) must have overlapping contacts in the field circuit to prevent opening the field during transfer. Opening an energized field will quickly destroy switch contacts resulting from the arc formed by the stored energy. In addition, exciter field insulation or semiconductors may be damaged.

2.4 ELECTRO-MAGNETIC INTERFERENCE (EMI)

Any circuit employing thyristors (SCR's) creates EMI, also known as radio frequency interference (RFI). This EMI may be radiated directly from the regulator or its associated wiring or it may be conducted by the power wiring to be radiated later on. In many installations EMI poses no problem and can be ignored. Below are a few salient points that can be followed to reduce EMI.

The conducted EMI can be significantly suppressed by a power transformer having a grounded static shield between its primary and secondary windings. All power transformers furnished by EMICC for voltage regulators have a static shield. This shield wire must be connected to ground.

The radiated EMI can be suppressed by keeping the power wiring (connected to terminal 3, 4, F+, F-) separate from all other wiring. In addition, the wires can be placed inside a grounded shield to prevent radiation.

When a cover is furnished, securely tighten the mounting screws to insure proper grounding.

SECTION 3 PRINCIPLES OF OPERATION

3.1 GENERAL DESCRIPTION

The voltage regulator maintains the terminal voltage of a generator within $\pm 1/2\%$ by controlling the dc current applied to the exciter field. The regulator senses and responds to single phase (or three phase) average terminal voltage. On

applications where the generator waveform is distorted, the regulator will more closely control average rather than rms or peak generator voltage.

A simplified block diagram of the control system is shown in Figure 7. See Figure 17 for a detailed schematic.

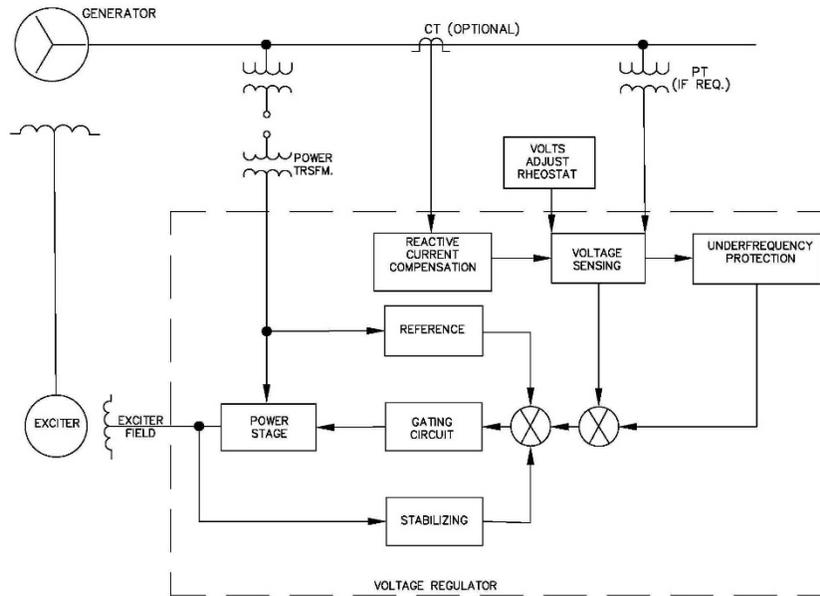


Figure 7. Block Diagram of Type VR 65 Voltage Regulator

3.2 POWER CIRCUIT

The power circuit of the voltage regulator (see Figure 8) uses two silicon controlled rectifiers (SCR's) and converts ac from a center tapped transformer into a variable dc output. The two SCR's (also known as thyristors) are encapsulated in a plastic module. The regulator chassis is used as a heatsink; however, the rectifiers are electrically isolated from the heatsink.

The SCR's will conduct current when they are forward biased only after they have been fired, or turned on, with a positive voltage signal from gate to cathode. By controlling the point in each half cycle at which the SCR's are turned on, the dc output voltage of the circuit may be varied.

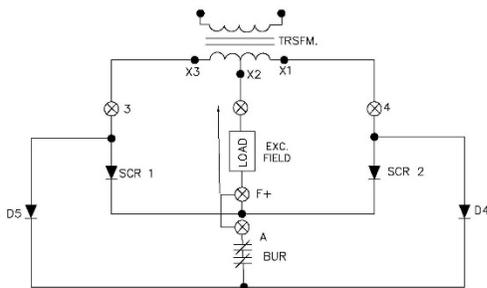


Figure 8. Voltage Regulator Power Circuit

With a resistive load the current flow through the SCR would cease whenever the voltage from anode to cathode is no longer positive at the anode. With an inductive load, such as an exciter field, the current continues to flow even though the supply voltage has reversed. This has been referred to as inversion, i.e., energy stored in the inductance is fed back into the ac supply line. This circuit has the advantage of being able to decrease, as well as increase, current very rapidly. The ability to decrease current under transient conditions (instead of letting it decay at a rate determined by its field time constant) results from the negative voltage that can be applied to the field. This can only be done as long as there is current flowing in the circuit. Notice that current does not reverse, it can only flow through the SCR's in the forward direction. Fig. 9

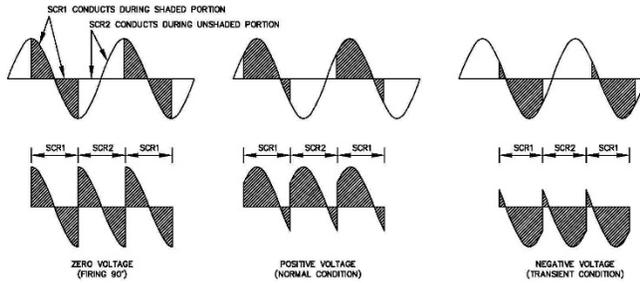


Figure 9. Waveform of Regulator Voltage Output

3.3 VOLTAGE BUILD-UP CIRCUIT

Most generators are self-excited, which means that excitation power for the exciter field is taken from the generator terminals. During start-up the generator residual voltage is used to build up machine voltage automatically. Rectifier diodes D4 and D5 convert all available ac voltage into dc field current. At about 50% of nominal voltage, the build-up relay (BUR) opens its contacts and the relay no longer performs any active function. The SCR's are then controlling the field current of the exciter. A minimum of 2% residual voltage is required for build-up. If less than that is available, field flashing from an external supply may be necessary.

3.4 POWER CONTROL CIRCUITRY

The majority of components on the voltage regulator are used to generator a control or gate signal for the power circuit. The control circuitry can be broken down into 6 circuits: sensing, reference, error detection and pulse generation, stabilization, minimum firing pulse, and under frequency protection.

3.4.1 REACTIVE CURRENT COMPENSATION (RCC)

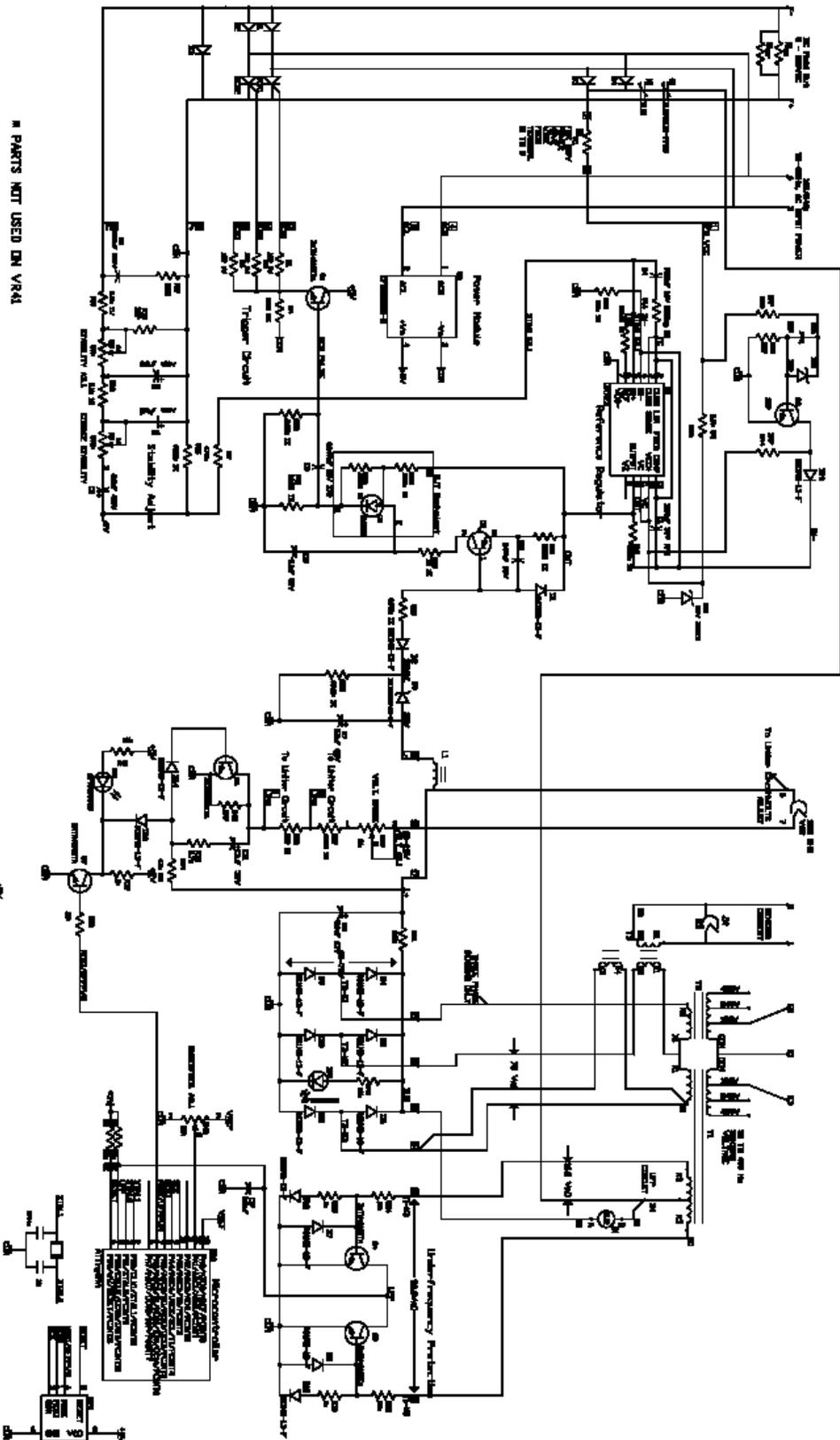
When two or more generators with automatic voltage regulators are to be operated in parallel, some provision must be made to insure that reactive current loading is divided among the paralleled generators. An adjustable circuit consisting of rheostat R3 and isolation transformer T3. A current, proportional in phase angle and magnitude to generator line current, is used to develop a voltage across R3. The resulting voltage is inserted in series with sensing transformer(s) T1 (and T2) to modify the sensing voltage. At unity power factor load the compensation has very little effect on regulator performance, since the voltage of T3 is at right angle to the sensing voltage of T1 (and T2).

For reactive "lagging" loads (generator overexcited) the voltage of T3 adds directly to the sensing voltage. The regulator then reduces generator excitation, thereby reducing its share of reactive load.

For reactive: leading" loads (generator under excited) the voltage on T3 would subtract from the sensing voltage. The regulator then increases generator excitation, thereby increasing its share of reactive load.

3.4.2 UNDERFREQUENCY PROTECTION

When a generator is operated below rated frequency with its voltage regulator energized, serious damage can result from overheating of the exciter and voltage regulator. The regulator sensing circuit operates from a rectified and filtered signal which is insensitive to frequency. In order to protect the entire system an under frequency protection circuit is provided. Its purpose is to modify the sensed voltage when frequency decreases and thereby change the characteristics of the voltage regulator to a volts per cycle regulator.



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FIGURE 10. VR MODEL 65 TYPICAL SCHEMATIC

SECTION 4 OPERATION

4.1 SAFETY PRECAUTIONS

Observe the following precautions when operating this equipment:

- All circuits not known to be "dead", must be considered "live" and dangerous at all times.
- Regard exposed terminals as "live" and treat them accordingly.
- When working near live electrical circuitry, do not use metal rules, flashlights, metallic pencils or any other objects having exposed conductive material.
- Do not wear metallic rings, watchbands or other conductive objects on fingers or wrists while working near power equipment.
- Be certain that you, especially your "other" hand, are not grounded whenever you are adjusting equipment or using measuring equipment.
- In general, use one hand only when servicing "live" equipment.
- Be sure to de-energize all equipment before connecting meters or test leads.
- When connecting meters to terminals for measurement, use a range higher than the expected voltage.
- Use caution even when measuring low voltages; high voltages may be present in a low voltage circuit because of insulation breakdown.
- Use caution when working near the regulators sensing transformer(s). Even with 120 volt sensing, 480 volts will be present as a result of autotransformer action.

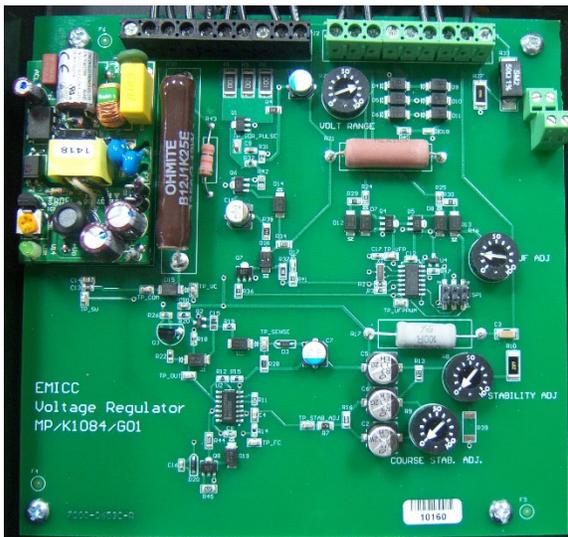


Figure 11. Top View of Typical PC Board

4.2 INITIAL START-UP AND ADJUSTMENTS

If the regulator is furnished and interconnected as part of a generator set, then factory testing has been done and the generator set should be ready for operation. For voltage regulators that have not been tested with their respective generator, follow the steps outlined below for initial start-up:

- Check the generator nameplate and potential transformer ratio (if furnished) to determine the line to line sensing voltage which will appear at regulator terminals E1 and E3. The wire E-3 should be connected to the 120 volt terminal for application of 120 volt and below. It should be connected to the 240 volt terminal for application of 190 to 240 volts. It should be connected to the 480 volt terminal for applications of 380 to 480 volts.
- A 240 volt power is furnished when the VR-65 regulator is applied to a BEMAC-III or similar machine with 5.5 ohms or greater exciter field resistance. Connect wire 11 to printed circuit board terminal 10 for 240 VAC center tap secondary transformer.

Wire 11 should be connected to circuit board terminal 9 for applications using a 120 volt power secondary transformer (60 volts to center tap) for BEMAC- II or similar machines with 5.5 ohms or lower exciter field resistance.

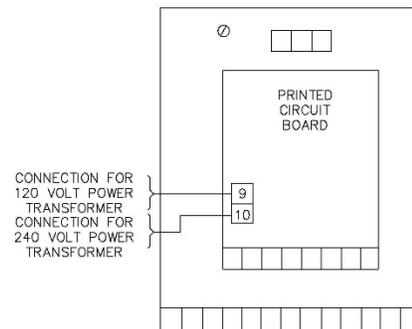
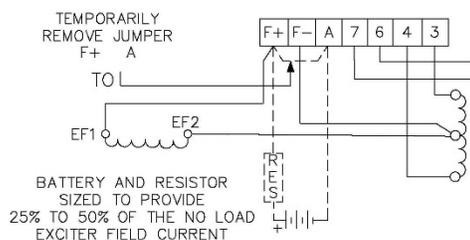


Figure 12. Top View of Typical VR Model 65 Regulator

- Set the voltage range adjusting rheostat R23 on the printed circuit (PC) board to position 0 (zero). See Figure 9 for view of typical PC board.
- Set the voltage adjusting rheostat (VAR) to maximum resistance. With correct connections this means a maximum counterclockwise (CCW) position.
- Bring the prime mover up to rated speed.

- f. Close the switch in the power circuit external to the voltage regulator (if used).
- g. If field flashing is used, it would be applied at this time. If voltage build-up from residual magnetism is used, then it should function automatically. If it does not build up, and on new machines, this may happen, then temporary flashing of the field from a dc source may be required, be sure to connect the positive terminal of the dc source to regulator terminal F+, and remove the jumper from F+ to A on the terminal block for flashing.



- h. Figure 13. Connections for Field Flashing Circuit. flashing is removed, thoroughly check the power circuit connections. If the regulator has been furnished with an under frequency protection circuit, mark the factory set position of rheostat R46 on the PC board and then set it to position 0. After successful build-up of voltage, R46 should be returned to its original position or set per procedures outlines below in paragraph 4.2.3. Assuming that voltage on the generator has built up to some appreciable value, proceed to the adjustments.

4.2.1 Voltage Range Adjustment

Turning of the screwdriver slot of rheostat R23 on the PC board raises or lowers the range as desired. For initial operation set the VAR to midpoint and then adjust R23 to obtain rated voltage.

4.2.2 Stability Adjustment

Begin adjusting the stability network with the R8 stability adjusting rheostat in position 5. Move R9, coarse stability rheostat to a position where the generator voltage has no continuous oscillations under any load conditions (at or near position 0 for most generators 1000k VA or lower). Make fine adjustment using R8 stability adjusting rheostat such that the voltage regulator will respond to load change or rapid change of VAR setting by moving quickly and with a minimum of oscillations to the final voltage level.

If stability cannot be obtained by manipulation of R8 and R9, verify the prime mover is operating at a constant speed, then consult the factory.

4.2.3 Under frequency Protection Checkout

Voltage regulators are factory adjusted for 60 Hz applications to protect the system from under frequency operation.

To set the units for 50 Hz systems or to check the factory settings:

Note the position of the R46 potentiometer then turn it counterclockwise to zero. Connect a temporary voltmeter across regulators terminals E1 to E3. Start the prime mover and use the VAR to adjust voltage to rated value. Set the prime mover speed to 95% of its rating. Adjust rheostat R46 on the PC board until line voltage starts to decrease, then adjust R46 very slowly in the opposite direction until rated voltage is just barely restored. This completes the checkout. The voltage regulator will now act similar to a volts per cycle regulator whenever speed drops below 95% of rated speed.

4.3 NORMAL START-UP

When the prime mover reached rated speed, voltage may be built up automatically from residual magnetism. Relay BUR will open the build-up circuit when about 50% of rated voltage has been reached. Voltage may now be adjusted by manipulation of the VAR.

4.4 SINGLE GENERATOR OPERATION

When a generator is to be operated alone, the voltage regulator will hold steady state voltage at the regulated point to within $\pm 1/2\%$, as load is varied from zero to rated. To check the regulation accuracy of the voltage regulator, it is recommended that no connection be made to terminals 1 and 2, i.e., if a CT is furnished, it should be shorted at its terminals and one wire should be opened at terminal 1 or 2. Under single generator operation, the VAR does exactly what its name implies — it can be used to adjust the generator voltage.

4.5 PARALLEL OPERATION OF GENERATORS

Before generators can be connected in parallel, verify that voltages at the connection point are equal, and that frequency and phase sequence are identical. Also, insure that phase relationships (polarity) of sensing voltage (terminals E1, E3 for 1 phase sensing) are correct with respect to sensing current (terminals 1 and 2). Before starting to parallel, set rheostat R3 of each regulator to midpoint. If .8PF load is available, it would be well to check each generator by itself to verify that voltage will droop about 3% when rated load is added with R3 set at midpoint. If the voltage should rise, then the CT secondary connection should be reversed after the unit had been shut down.

By observing a synchroscope or lights, the generators may be connected to common bus at the indicated period of synchronization. Observe the ammeters of each individual generator, as large circulating currents could develop between generators if there is a connection error or other malfunction. More information on this is included in the generator instruction manual. If operation at no load is satisfactory, the units may now be loaded as outlined below.

4.5.1 Real (KW) Loading of Generations

As real load is applied to a bus to which two or more generators are connected, the sharing of this load must be accomplished by the prime mover speed control (governor). The voltage regulator cannot be responsible for lack of proper real load division among paralleled machines. Refer to the instruction manual on the prime mover for additional details.

If a generator is tied in parallel with one or more machines already carrying load, the incoming generator may be loaded with real load (watts) by adjusting the frequency regulator (governor) in a "raise frequency" direction.

4.5.2 Reactive (KVAR) Loading of Generators

The reactive current compensation (RCC) circuit of the voltage regulator accomplishes the sharing of reactive load either by a voltage droop method (most commonly used) or by a differential circulating current in the current transformers of the paralleled machines.

It is common practice to use as little RCC as possible so that voltage droop is held to a minimum. When connected to a bus with other machines, the paralleled generators should share reactive load in proportion to their rating.

To decrease the relative proportion of reactive load change taken by a specific machine, increase the resistance of R3 by turning it in a CW direction. This increases the compensation.

If a generator is connected in a parallel with one or more machines already carrying load, the incoming generator may be loaded with reactive load by adjusting the VAR in a "raise voltage" direction. Reactive load may be removed from a paralleled machine by adjusting the VAR toward a "lower voltage" direction.

One quick way to check whether RCC is properly connected is as follows:

- a. Rheostat R3 should be set fully CW for maximum resistance.
- b. Connect a temporary short circuit through a switch to terminals 1 and 2 of the regulator.
- c. Connect a dc voltmeter across regulator output terminals F+ and F-.
- d. The generator must be connected in parallel with other machines and carry some reactive load.
- e. Close the switch momentarily and note if regular output starts to rise. This indicates correct functioning of the RCC circuit.

4.6 SHUTDOWN

CAUTION

Before a generator is shut down, any load is normally removed. The ac power supply voltage to the regulator should be interrupted. Under emergency conditions the ac voltage may be disconnected while the generator is still carrying load. The dc field circuit must not be opened under any circumstances.

NOTE

If the regulator is furnished with under frequency protection, then the ac power supply voltage may be left connected during shutdown. The regulator will then limit the field voltage and thus protect itself and the exciter from damage during the shutdown period.

SECTION 5 MAINTENANCE

5.1 GENERAL MAINTENANCE

Under normal conditions, the voltage regulator requires only visual inspection. The voltage regulator should be cleaned periodically to remove accumulated dirt, dust, grease, etc. No special tools are required for inspection and maintenance of the equipment.

Use low pressure compressed air, a hand bellows or a vacuum cleaner to remove dust and dirt from all control components. If compressed air is used, it must not contain grit or moisture. Remove oil and grease with nontoxic

cleaning fluid such as alcohol. Be sure to provide adequate ventilation during this operation.

5.2 TROUBLESHOOTING

The following chart lists various troubles that may occur, their probable cause and suggested solutions. This chart is intended both as a diagnostic aid and as a quick answer sheet. If source of malfunction is unknown, or correction is not achieved after using this chart, report matters to the nearest EMICC Field Engineering Office.

TROUBLESHOOTING CHART

Trouble	Probable Cause	Remedy
No voltage build-up	Residual magnetism too low. Open or short circuit between power source and exciter field. Prime mover not up to rated speed. Some load on generator. Relay BUR in open position. Defective regulator. Defective exciter.	Field Flashing. Locate and repair. Adjust. Remove load. Replace. Check power circuit per para. 5.3.2. Check field current.
Voltages builds up and then decays	No firing pulses applied to the SCR's.	Check power para. 5.3.2
Low voltage.	Misconnection on sensing terminal block. Volts adjust rheostat (VAR) or R23 improperly adjusted. VAR circuit open. Speed of generator low. Underfrequency adjustment wrong. Voltmeter not reading properly.	Reconnect as necessary. Adjust. Check wiring and rheostat. Adjust. Mark setting of R46, then set to position 0. if wrong, reset per para. 4.2.3. Replace.
High Voltage.	Misconnection on sensing terminal block. VAR or R23 improperly adjusted. No sensing voltage available at the regulator terminals. Defective BUR relay. Defective voltage regulator. Voltmeter not reading properly.	Reconnect as necessary. Adjust for more resistance. Check connections, fuses. Check wiring and relay operation. Test per paragraph 5.3.1. Bench test per paragraph 5.3.1. Replace.
Generator voltage hunting (oscillating) at no load.	Frequency unstable. Improperly adjusted stabilizing circuit. Defective exciter. Defective PC board.	Check prime mover speed. Adjust R8 and R9. Check exciter field current. Replace.
Generator voltage fluctuating with irregular intervals.	Loose connection. Indicted interference.	Check. Twist VAR and sensing leads.

TROUBLESHOOTING CHART

Trouble	Probable Cause	Remedy
Poor generator voltage regulation.	Voltmeter in different location than regulator sensing point.	Connect voltmeter across regulator terminals E1 and E3.
	Reactive current compensation causing droop.	Make inoperative by shorting secondary side of CT and open wiring at regulator terminals 1 and 2.
	Too much resistance in exciter field circuit.	Check regulator output voltage.
	Supply voltage at terminals 3 and 4 too low.	Check.
	Defective rectifier module.	Check per paragraphs 5.3.2.
Parallel generators not dividing real (KW) load.	Defective PC board.	Replace.
	Prime mover governor not properly adjusted.	Refer to governor instruction manual.
Parallel generators not dividing reactive (KVAR) load.	Rheostat R3 shorted out or set for insufficient resistance.	Check, add resistance if necessary.
	CT connected with revers polarity.	Reverse connections.
	CT secondary terminals shorted out.	Check current (between 3-5 amp req.) at regulator terminals 1 or 2. CAUTION: Do not open circuit under load.
	CT not in proper generator phase with respect to sensing voltage.	Check location.
	Unit parallel switch (if used) closed.	Check.

5.3 REGULATOR BENCH TEST

Observe the following:

The information on bench test is provided to allow some checks of the regulator to be performed in the field by competent service personnel with a minimum of tools and equipment. In some situations it may not be clear whether a regulator is at fault or whether the problem lies elsewhere.

1. Check voltage across capacitor C7. This should be a variable DC voltage by adjusting R23.

5.3.1 Sensing Circuit Bench Checkout

For regulators with single phase sensing this completes the checkout. If part 1 through 4 check out, then the sensing circuit is "ok," and the reason for the malfunctioning system appears to be outside of the regulator.

If the voltage is uncontrollable, the sensing circuit of regulators with single or three phase sensing can be bench checked with any 110-120 VAC source. Refer to figure 21.

1. Connect a jumper from terminals 6 to 7 or leave the VAR connected and turn it fully CW to short it out.
2. Set the voltage range adjusting rheostat R23 to position 0.
3. Terminals 1, 2, 3, 4, F+, F-, A-, and E2 should be open for this test. Disconnect BUR contacts.
4. Apply 110-120 Vac between terminal E1 and E3.

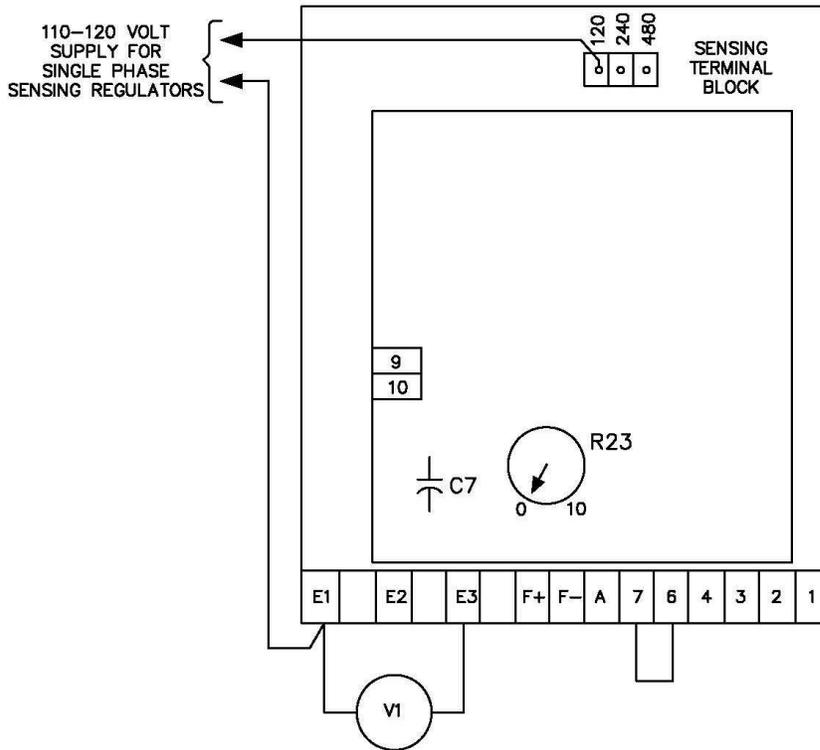


Figure 14. Sensing Circuit Bench Test

5.3.2 Power Circuit Bench Checkout

If there seems to be insufficient output voltage from the regulator or other malfunction, then a bench check of the power circuit might be in order (refer to Figure 22 for details).

1. With terminal A open, check resistance from terminals F+ to 3 and from F+ to 4. The circuit should be 20,000 ohms or higher.
2. Connect a resistor load (a 50 to 200 watt light bulb in s trouble light is usually available) across terminals F+ to the center tap of the power transformer T5.
3. Terminals E1, E2, E3 and A must be open.
4. Disconnect the center-tapped power transformer from the generator power source.
5. Apply 110-120 volt ac to the secondary side of the power transformer.
6. Observe the ac voltage at terminals 3 and 4.
7. Observe the dc voltage across resistor load. With 120 Vac applied, the dc voltage should be about 50 Vdc, i.e., the dc voltage should be 41% of the line-line ac voltage.

A dc voltage that is approximately correct indicates that both SCR's are functioning and are receiving gate signals. Be sure the wire to terminal A is connected before putting the regulator back in service.

5.4 MEGGER AND HIGH POTENTIAL TESTS

CAUTION

Before conducting any high potential or Meggers Tests on the generator or associates equipment, be sure to disconnect the voltage regulator completely. Semiconductors can be destroyed by the application of high voltages.

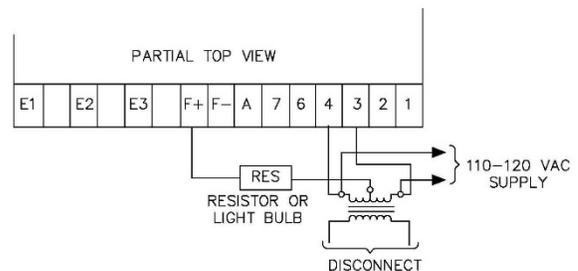


Figure 15. Power Circuit Bench Test

SECTION 6 RENEWAL PARTS

6.1 HOW TO ORDER

Correct parts can only be furnished when complete information has been given by the customer. Most important is the regulator type number which is stamped on the nameplate on the end opposite from the terminal block (see Figure 23).

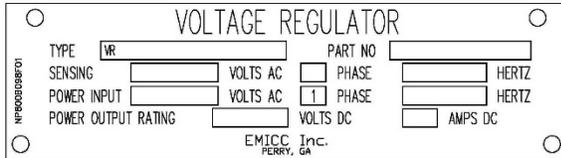


Figure 16. Typical Nameplate

Order all parts giving the following information:

Quantity required

Part name (including symbols such as T1)

Part number (as shown on devices or from parts list)

Regulator part number (obtain from nameplate similar to that shown above)

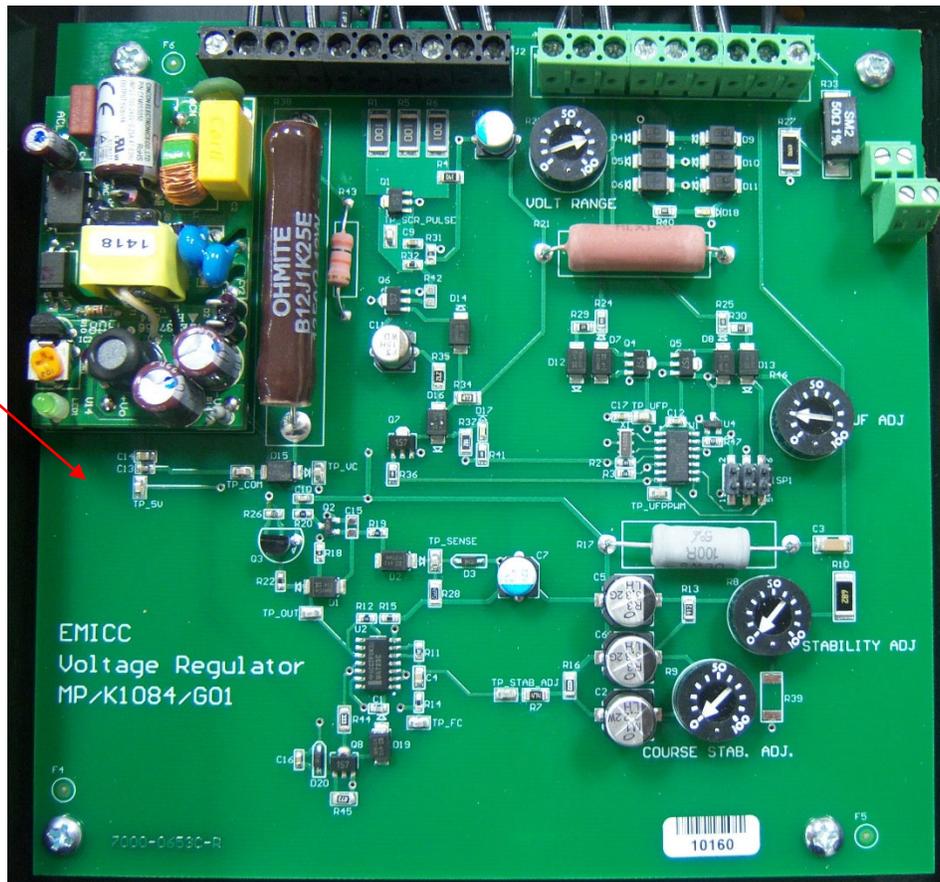
Code number

Repair the printed circuit (PC) board by the user is not recommended since special facilities, techniques and test equipment are required. The possibility also exists that semiconductors may have suffered internal damage which visual inspection and / or commonly available test equipment will not reveal. Therefore, board components will not be furnished to a customer by EMICC. A PC board may be returned to the factory for repair.

6.2 RENEWAL PARTS FOR TYPE VR 65 VOLTAGE REGULATOR (Refer to Figures 20 and 21).

ITEM	DEVICE SYMBOL	PART NAME	NUMBER	
			Single Phase Sensing	Three Phase Sensing
1	T1 (T2)	Transformer	388A407G01	388A724G01
2	T3	Transformer	388A328G01	388A751G01
3	L1	Choke	388A327G01	
4	R3	Rheostat, .5 ohm, 50 watt	800A210F08	
5	VAR	Rheostat Voltage Adjusting with Screw-driver Slot and Locknut	801A680F01	
6 (EXTERNAL)	BUR	Relay, 2 PNC, 75 VDC Coil	801A464F01	
	BUR*	Relay, Hermetically Sealed * The hermetically sealed relay will fit into the same space as the standard relay (with dust cover) provided a special mounting bracket is used.	800B107F01	
7	PC BD	Printed Circuit Board	MP/K1084/G01	
8	D4, D5	Rectifier Assembly	801A495F02	
9	DCR1, D7 SCR2, D8	Rectifier SCR Assembly	802A152F02	
10	R1	Resistor, 1.2 K ohm, 10 watt	801A489F02	

⑦



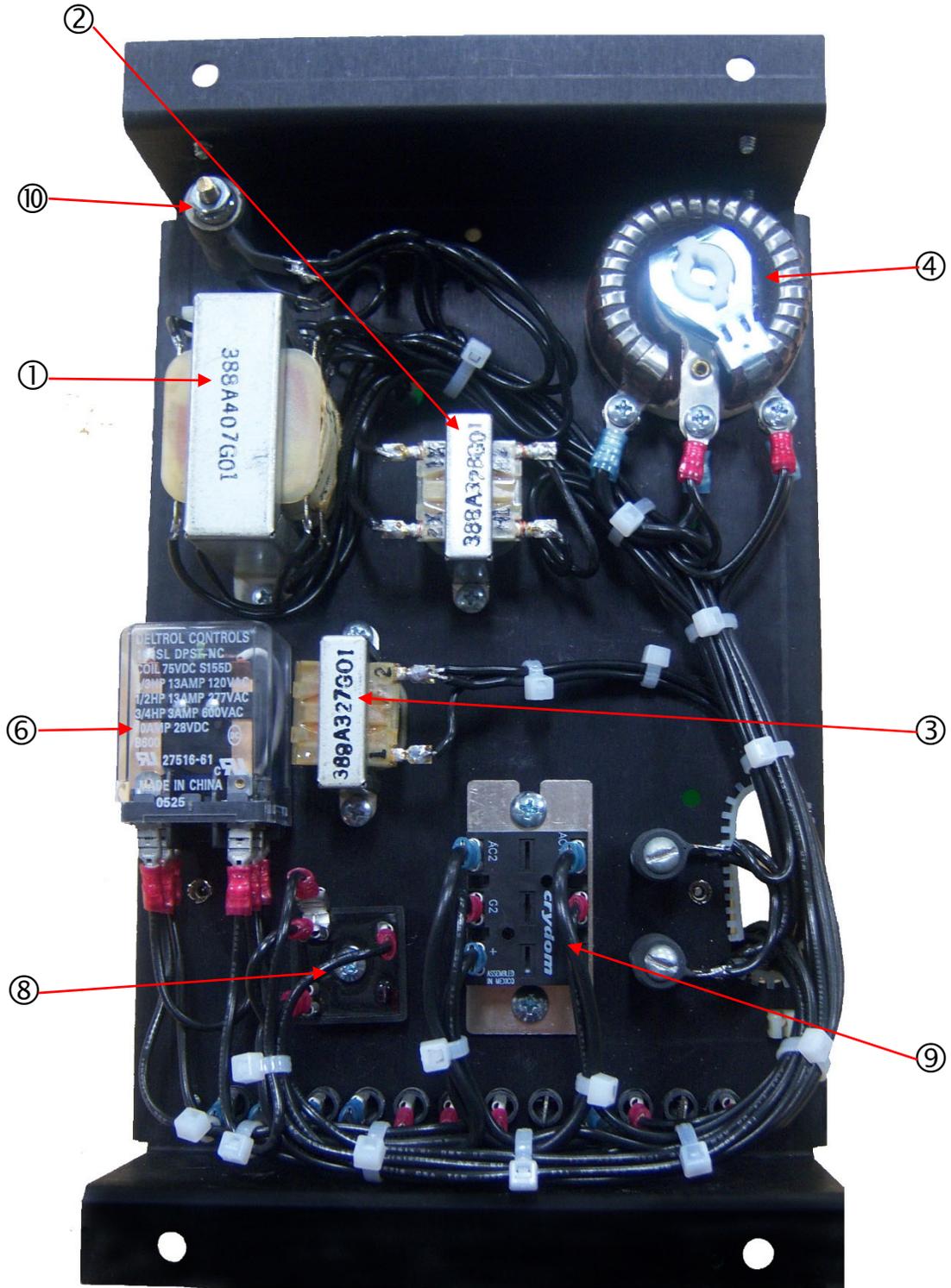


Figure 17. Bottom View of Typical VR 65 Regulator.