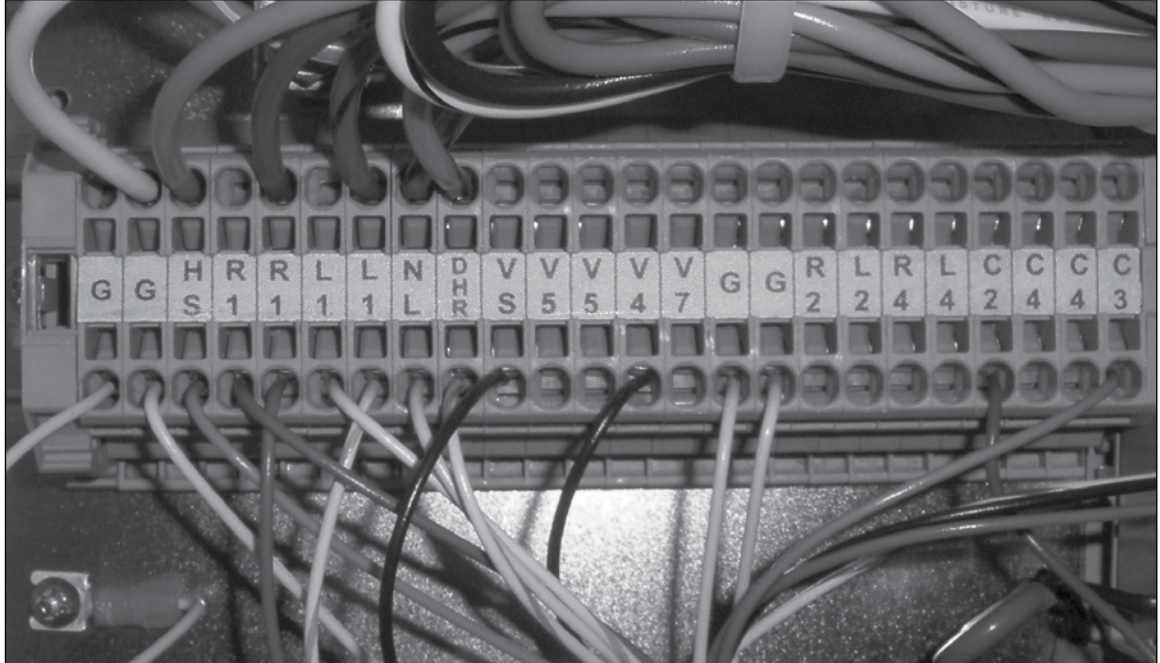


External application of a motor start capacitor on a single-phase voltage regulator



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Contents

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY I

SAFETY FOR LIFE III

SAFETY INFORMATION III
 Safety instructions iii

PRODUCT INFORMATION 1
 Introduction 1
 Standards 1

PROCEDURE INSTRUCTIONS 1
 Limitations 3
 Assistance 3



Safety for life



Eaton's Cooper Power series products meet or exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Cooper Power Systems employees involved in product design, manufacture, marketing and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high-voltage lines and equipment and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians, who are familiar with this equipment should install, operate and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

 DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

 WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

 CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

 DANGER

Hazardous voltage. Contact with high voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment.

 WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage.

 WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply may result in death, severe personal injury and equipment damage.

 WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage.

Product information

Introduction

A step voltage regulator utilizes a capacitor to start and run the tap-changer motor. A number of regulators operating in the field have internally mounted, under-oil motor capacitors. The motor capacitor, if failed, will not allow the tap-changer to operate. In this situation, the motor may be able to be operated by temporary installation of a capacitor in the control box.

Refer to *MN225003EN, CL-7 voltage regulator control installation, operation, and maintenance instructions* and *MN225008EN, VR-32 Voltage Regulator with Quik-Drive Tap-Changer Installation, Operation and Maintenance Instructions* or the literature applicable to your equipment for detailed service information on Eaton's Cooper Power series voltage regulators and controls.

This procedure offers suggestions for installing a temporary capacitor in voltage regulators from manufacturers other than Eaton. Refer to the product literature from the applicable manufacturer for more detailed instructions and safety guidelines.

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment.

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or processes described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your representative.

Standards

ISO 9001 Certified Quality Management System

Required items

The procedure will require the following items.

1. **Appropriately sized temporary capacitor.** If in doubt as to correct capacitor size, refer to applicable manufacturer's literature. All Eaton's Cooper Power series voltage regulators utilize capacitors rated for 440 VAC and 100 °C. The capacitor sizes required are as follows:

Spring-drive: 7.5 µF

Direct-drive: 40 µF (pre-1994); 50 µF (1994 and later)

QD3: 12 µF (60 Hz); 15 µF (50 Hz)

QD5 and QD8: 50 µF

2. **Temporary capacitor leads.** Leads should be connected to the temporary capacitor terminals and have terminals on the free lead end that can be attached to a control box terminal screw or wire. Alligator clips work well in most applications.
3. **Screwdriver.** As needed to allow capacitor leads to be attached into the control circuit where screw terminals are present.

Procedure instructions

CAUTION

De-energize control. Refer to applicable manufacturer's literature for instructions on how to de-energize the control. Remove power from the control box on Eaton's Cooper Power series regulators by opening the V1 and V6 (if present) knife-blade switches and closing the C knife-blade switch. Failure to do so could result in an electrical shock and personal injury.

1. Before continuing with this procedure, test the motor capacitor using the steps in publication MN225064EN to confirm that the capacitor is faulty.
2. SHORT the raise and lower circuits. Place a momentary short circuit across the raise and lower leads to discharge any residual capacitive voltage that may be in the motor circuit.

Identify the raise and lower circuit coming into the control box from the regulator. The following are typical lead identifiers for the various manufacturers.

Siemens	Raise = J	Lower = K
General Electric	Raise = 27	Lower = 28
Eaton	Raise = R1	Lower = L1

Note: For Eaton, the R1 and L1 terminals can be found at the top of the back panel behind the control on TB1. See Figures 1 and 2.

External application of a motor start capacitor on a single-phase voltage regulator

3. Connect temporary capacitor leads

Connect the temporary capacitor leads across the raise and lower circuit lead wires. Refer to Figure 1 and Figure 2.

A capacitor connected in this way electrically “replaces” the failed internal capacitor. Refer to Figure 3 and Figure 4.

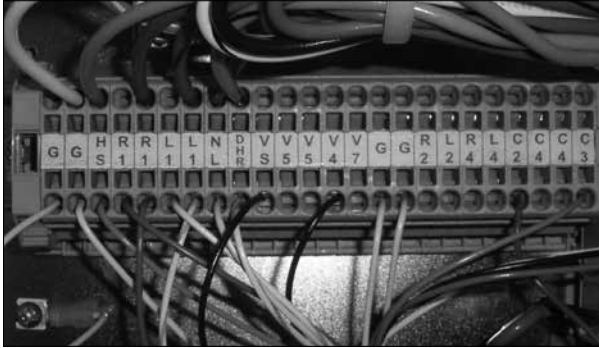


Figure 1. Standard dead-front back panel, TB1 located at top of control box

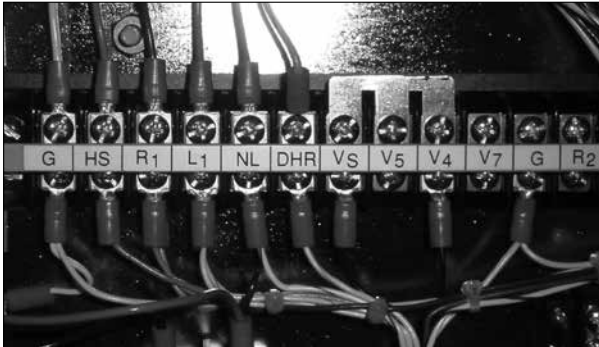


Figure 2. Legacy back panel, TB1 located at top of control box

4. Operate the tap-changer

Energize the control and run the regulator to neutral. Remove the regulator from service and replace the capacitor.

Note: Replacement of the capacitor in the tank or installation of a capacitor conversion kit to permanently install the capacitor in the control box is recommended.

5. Replacing the capacitor

The capacitor can be replaced in the tank, but for Eaton’s Cooper Power series regulators it is recommended that units with capacitors located in the tank be converted to locate them in the control box. Conversion kits and the updated control cables required for conversion are available and can be ordered by contacting your Eaton representative.

On Eaton’s Cooper Power series regulators with spring-drive and direct-drive tap-changers, permanently installed external capacitors must be located between the motor and limit switches in the position indicator (see Figure 3). The limit switches are identified in Figure 3 as LLS and RLS.

On Eaton’s Cooper Power series regulators with Quik-Drive™ tap-changers, permanently installed external capacitors must be located across terminals JBB-S6 and JBB-S7 in the junction box (see Figure 4). If a regulator has a Quik-Drive tap-changer and does not have a JBB-S6 and JBB-S7, a conversion kit must be ordered that provides an updated junction box terminal board.

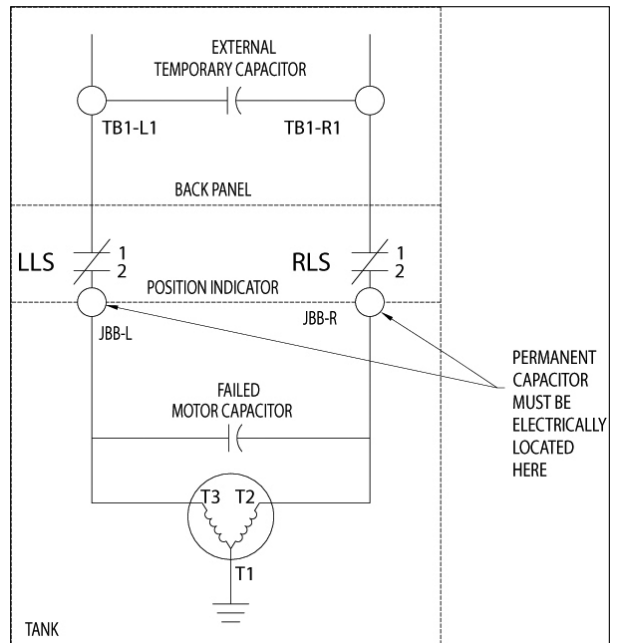


Figure 3. Electrical representation of temporary capacitor in the motor circuit of an Eaton’s Cooper Power series spring-drive or direct-drive voltage regulator

External application of a motor start capacitor on a single-phase voltage regulator

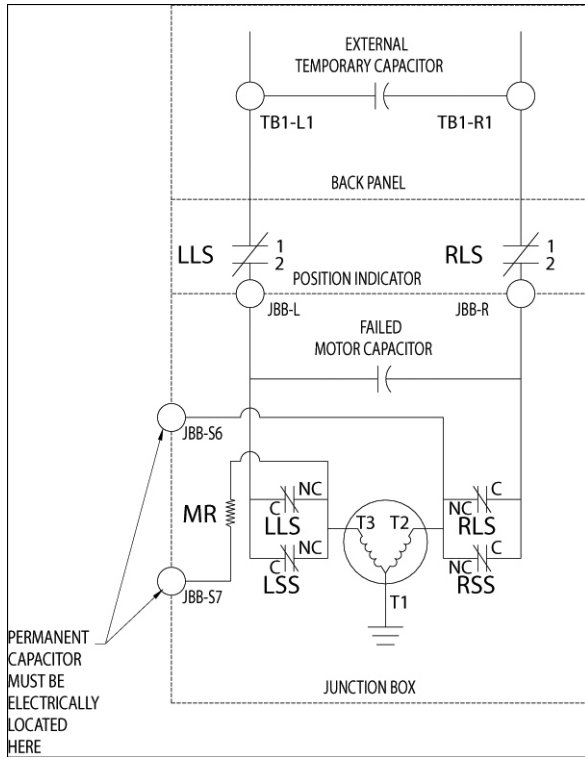


Figure 4. Electrical representation of temporary capacitor in the motor circuit of a an Eaton's Cooper Power series Quik-Drive Voltage regulator

Limitations

Installing a temporary capacitor as described in this procedure will work in cases where the limit switches located in the position indicator are closed. Closed switches provide the electrical path necessary for the capacitor to be across the raise and lower motor windings. If either of the limit switches are open the capacitor will be isolated from the motor and the motor will not run. Limit switches are typically open at 16 raise or 16 lower. Any permanent placement of a capacitor must be electrically between the motor and the limit switches.

In voltage regulators with CL-5E controls and newer, the SOFT-ADD-AMP™ function can be used to inhibit the position indicator limit switches from opening by setting the limits to 14 and -14. One caveat to using this method is that the SOFT-ADD-AMP limits can be over-ridden by manually tapping beyond them.

Assistance

Contact your Eaton representative to request further assistance.



Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Eaton.com/cooperpowerseries

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