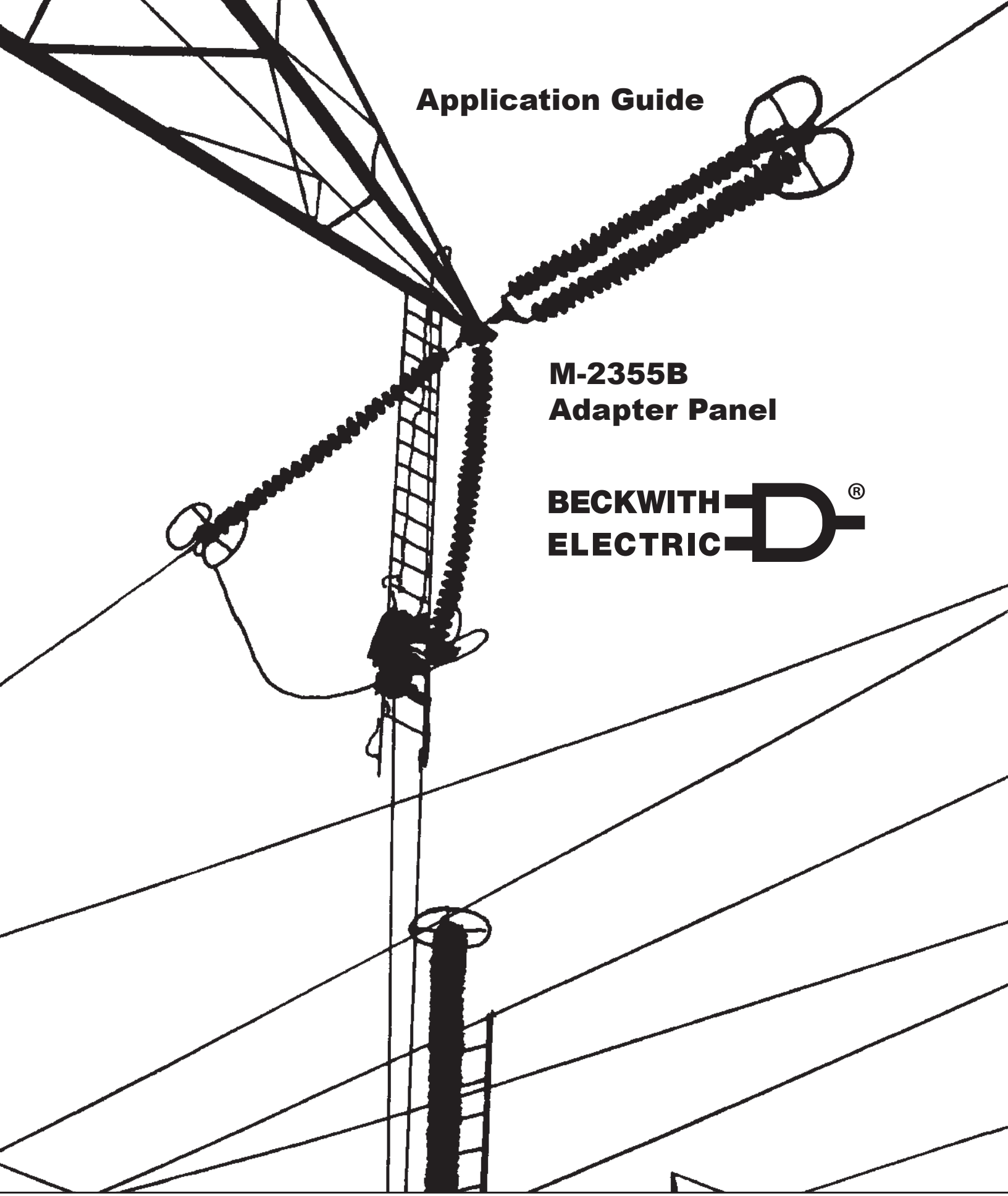
Application Guide

M-2355B
Adapter Panel



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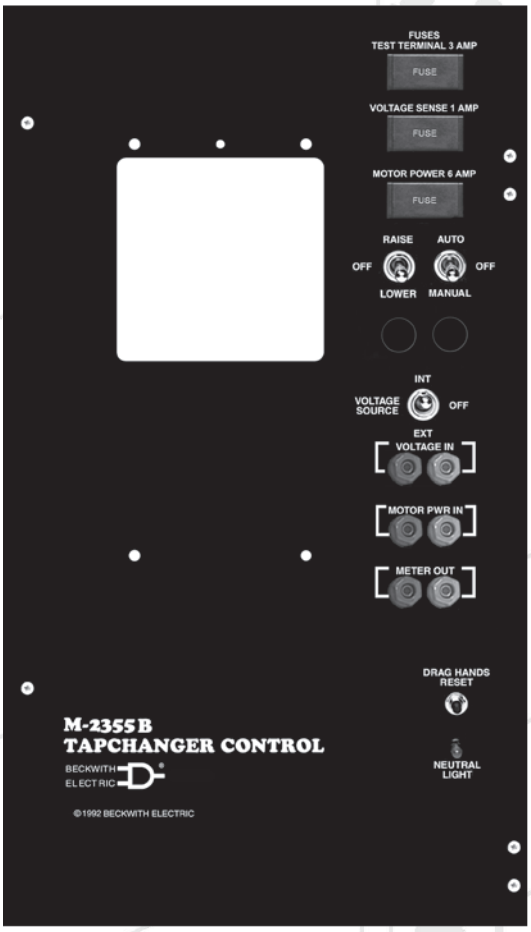
M-2355B
Adapter Panel

Adapts M-2001 Series Digital Tapchanger Control to Replace Cooper CL-2, CL-2A, CL-4A, CL-4B, and CL-4C Regulator Controls



- Connects easily to the M-2001 Series Digital Tapchanger Control using mounting screws and 24-pin connector
- Fits directly into existing regulator control cabinet using the same two hinge pins
- Provides built-in CT shorting protection when the M-2001 Series Digital Tapchanger Control is removed
- Optional SCADA Cutout (LOCAL/REMOTE) switch (for use with SCADA enabled M-2001C controls) allows Local Blocking of SCADA commands
- Optional SCAMP™ (SCADA Controllable AUTO/MANUAL Pushbutton) switch replaces AUTO/OFF/MANUAL toggle switch
- Optional 2 level Local Voltage Reduction switch

The M-2355B is an adapter panel which, when combined with the M-2001 Series Digital Tapchanger Control, provides convenient direct replacement for Cooper (formerly McGraw-Edison) CL-2, CL-2A, CL-4A, CL-4B, and CL-4C regulator controls. The M-2355B consists of a front door panel with hinge leaves on the right side. It mounts into the control cabinet using the same two hinge pins, which ***must be saved*** from the original control.

Interface

External connections are made using a wiring harness that connects from a fifteen-position terminal block to the terminal block in the existing control cabinet. An additional terminal block provides auxiliary functions, including self-test alarm, user-programmable alarm, auto-disable, and manual raise/lower.

Features

Separate fuses for test terminal, voltage sensing and motor power are on the front panel. Spare fuses for each are in the fuse holder.

Binding posts on the front panel allow easy connections for test procedures.

RAISE/OFF/LOWER, **AUTO/OFF/MANUAL** and **VOLTAGE SOURCE** switches, **DRAG HANDS RESET** pushbutton, and **NEUTRAL LIGHT** are standard.

NEUTRAL LIGHT will light to indicate that the regulator or transformer is in the neutral position, for those products equipped with a circuit for this purpose.

Contains circuitry necessary for motor current seal-in.

Options

SCADA Cutout (LOCAL/REMOTE) switch allows local blocking of SCADA commands (for use with SCADA enabled M-2001C controls). The SCADA Cutout switch must be used with a M-2001 Series Control with firmware version D-0146V08.01.22 or later installed.

SCAMP™ (AUTO/MANUAL) pushbutton switch allows the Auto/Manual state on the adapter panel to be changed by a SCADA command. The SCAMP pushbutton switch must be used with a M-2001 Series Control with firmware version D-0146V08.05.XX or later installed.

VOLTAGE REDUCTION switch allows 2 levels of Voltage Reduction to be selected.

Testing Specifications

High Voltage: All input and output terminals will withstand 1500 Vac RMS to chassis or instrument ground for one minute with a leakage current not to exceed 25 mA, for all terminals to ground. Input and output circuits are electrically isolated from each other, from other circuits and from ground.

Surge Withstand Capability: All input and output circuits are protected against system transients. Units pass all requirements of ANSI/IEEE C.37.90.1-1989 defining surge withstand capability.

Radiated Electromagnetic Withstand Capability: All units are protected against electromagnetic radiated interference from portable communications transceivers.

Environmental

Temperature Range: Functionality is maintained from -40° to +85° C.

Humidity: Functionality is maintained under 95% relative humidity (non-condensing).

Fungus Resistance: A conformal printed circuit board coating inhibits fungus growth.

Physical

Size with M-2001 Series Digital Tapchanger Control:
17–7/8" high x 10-1/8" wide x 4-1/8" deep (45.4 cm x 25.7 cm x 10.5 cm)
Approximate Weight: 4 lbs (1.81 kg)
Approximate Shipping Weight: 7 lbs (3.18 kg)
Approximate Weight with M-2001 Series Digital Tapchanger Control: 7 lbs, 11 oz (3.49 kg)
Approximate Shipping Weight with M-2001 Series Digital Tapchanger Control: 12 lbs, 11 oz (5.75 kg)

Warranty

The M-2355B Adapter Panel is covered by a five year warranty from date of shipment.

Specification subject to change without notice.

Trademarks

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M-2355B-SP-04 12/23

WARNING

DANGEROUS VOLTAGES, capable of causing death or serious injury, are present on the external terminals and inside the equipment. Use extreme caution and follow all safety rules when handling, testing or adjusting the equipment. However, these internal voltage levels are no greater than the voltages applied to the external terminals.

DANGER! HIGH VOLTAGE

– This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

PERSONNEL SAFETY PRECAUTIONS

The following general rules and other specific warnings throughout the manual must be followed during application, test or repair of this equipment. Failure to do so will violate standards for safety in the design, manufacture, and intended use of the product. Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric assumes no liability for the customer's failure to comply with these requirements.

– This sign means that you should refer to the corresponding section of the operation manual for important information before proceeding.

Always Ground the Equipment

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test area, the Protective Earth Terminal must be attached to a separate ground securely by use of a tool, since it is not grounded by external connectors.

Do NOT operate in an explosive environment

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible fire or explosion.

Keep away from live circuits

Operating personnel must not remove the cover or expose the printed circuit board while power is applied. In no case may components be replaced with power applied. In some instances, dangerous voltages may exist even when power is disconnected. To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

Exercise care during installation, operation, & maintenance procedures

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified personnel should install, operate, test, and maintain this equipment. Be sure that all personnel safety procedures are carefully followed. Exercise due care when operating or servicing alone.

Do not modify equipment

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair facility is preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure that safety features are maintained.

PRODUCT CAUTIONS

Before attempting any test, calibration, or maintenance procedure, personnel must be completely familiar with the particular circuitry of this unit, and have an adequate understanding of field effect devices. If a component is found to be defective, always follow replacement procedures carefully to that assure safety features are maintained. Always replace components with those of equal or better quality as shown in the Parts List of the Instruction Book.

Avoid static charge

This unit contains MOS circuitry, which can be damaged by improper test or rework procedures. Care should be taken to avoid static charge on work surfaces and service personnel.

Use caution when measuring resistances

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instruction Book, is likely to cause damage to the unit.

TABLE OF CONTENTS

M-2355B Adapter Panel
Application Guide

1.0 Introduction

The Beckwith Electric M-2355B Adapter Panel, used in conjunction with the M-2001 Series Digital Tapchanger Control, uses modern electronic digital design and digital processing circuitry to achieve an overall stability and resolution unattainable with electromechanical and analog design tapchanger controls. CMOS semiconductors are used throughout the design.

1.1 Description

Standard Features

The M-2355B Adapter Panel, with the M-2001 Series Digital Tapchanger Control, provides a solid-state voltage control relay designed to directly replace Cooper CL-2, CL-2A, CL-4A, CL-4B and CL-4C regulator controls. The combination of the Tapchanger Control and Adapter Panel includes the following features:

- Voltage waveform sampling and digital processing circuitry ensure accurate RMS voltage sensing in the presence of distortion on the input voltage and current.
- Control accuracy is ±0.3 % when tested in accordance with the ANSI/IEEE C57.15.9-1999 standard over a temperature range of -30° C to +65° C. The control accuracy is ±0.5 % when tested over the full operational temperature range of -40° C to +85° C.
- Input and output circuits are protected against system transients. Units pass all requirements of ANSI/IEEE C37.90.1-1989, which defines surge withstand capability. All input and output terminals will withstand 1500 Vac RMS to chassis or instrument ground for one minute with a leakage current not to exceed 25 mA, from all terminals to ground. Input and output circuits are electrically isolated from each other, from other circuits and from ground.

Control Switches

AUTO/OFF/MANUAL switch allows auto operation of the control or manual operation from the panel by using the Raise/Lower toggle switch. The **AUTO/OFF/MANUAL** switch status may be read by a M-2001 series control with firmware version D-0067V07.08.15 or later installed.

VOLTAGE SOURCE switch in the **EXT** position disconnects the voltage transformer input and connects the **EXTERNAL POWER** binding posts to the voltage input and motor circuit.

The unit can be tested using an external 120 V RMS source of proper polarity applied to these terminals. Testing can be accomplished by adjusting the amplitude of the external source.

▲**CAUTION:** Do not reverse the ground and hot wires when connecting an external source. A 3 AG (F2) is installed to protect the relay from damage if these connections are accidentally reversed.

The **VOLTAGE SOURCE** switch will disconnect all power from the unit when in the **EXT** position with no source connected to the front panel voltage and motor power inputs.

DRAG HANDS RESET pushbutton resets the tapchanger position indicator drag hands.

Binding Posts

VOLTAGE IN binding posts on the front panel allow application of a 120 V RMS nominal voltage to the unit for test procedures.

MOTOR PWR IN binding posts on the front panel allow application of a 120 RMS nominal voltage to the unit for test procedures.

■**NOTE:** If the Motor Power Input configuration has a different return from the 120 V regulated Voltage Input, then Jumper J12 on the printed circuit board must be removed and TB1-16 should be used for the separate motor power source and return connections (See Figure 4 through Figure 7 for J12 location).

METER OUT binding posts on the front panel allow reading of the input voltage when used in conjunction with the **BIAS TEST VOLTAGE** screen of the M-2001 Series Digital Tapchanger Control.

Status Indicators

NEUTRAL LIGHT illuminates when the regulator is in the neutral tap position.

Separate motor power, test terminal and voltage sensing fuses are easily changed from the front panel and spare fuses are provided in their respective fuseholders.

Optional Control Switches

SCADA Cutout (LOCAL/REMOTE) switch allows the local blocking of SCADA commands. The SCADA Cutout switch must be used with a M-2001 Series Control with firmware version D-0146V08.01.22 or later installed.

SCAMP (AUTO/MANUAL) pushbutton allows the Auto/Manual state on the adapter panel to be changed by a SCADA command. The SCAMP pushbutton switch must be used with a M-2001 Series Control with firmware version D-0146V08.05.XX or later installed.

VOLTAGE REDUCTION (VR1/OFF/VR2) switch allows local voltage reduction 1 or 2 to be initiated.

2.0 Application

Typical Connections

In general, the tapchanger motor must be operated from a different transformer than the VT used to measure regulated voltage. If this is not done, hunting at the upper band edge may result. As soon as the motor starts and before it is sealed in, the motor current can drop the voltage within the band and reset the control. Some motor seal-in schemes are fast enough to prevent this, but others are not.

Typical connections for the M-2355B are shown in Figure 3 through Figure 7 depending on the panel configuration. Connections are simplified and may not show all functions required in a typical load tapchanging transformer control scheme; for example, seal-in contacts, limit switches, etc.

External Connections

Motor Power and voltage sensing are obtained either from a common source, having a nominal 120 Vac output, or from independent sources. Normally, this is line-to-neutral voltage, although line-to-line voltage can also be used if recognition is made of any phase shift between the voltage and current signals when using line drop compensation.

Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2355B current inputs. The Beckwith Electric M-0121 (5.0 A to 0.2 A) or M-0169A (5.0 A or 8.66 A to 0.2 A) Auxiliary Current Transformer can be used for this purpose. The M-0121 can be used with Beckwith Electric Tapchanger Controls when the only burden present is the Line Drop Compensator circuit of the voltage regulating relay. The M-0169A is used in high burden circuits, such as are found in paralleling schemes. Outputs of the auxiliary CTs are protected against overvoltage. For further information, obtain Beckwith Electric Application Note #17, *"Basic Considerations for the Application of LTC Transformers and Associated Controls."*

The external connections for the M-2355B are made to terminal blocks TB1 and TB2 on the printed circuit board at the base of the adapter panel. For example, if SCADA is being used to control the voltage reduction step #1 function in the M-2355B, connections for the external dry contact may be made between TB1-7 and TB2-28 as shown in Figure 3 through Figure 7. The dry contact inputs for non-sequential input, voltage reduction, motor seal-in, counter input and neutral detection may be "wetted" by connecting to terminal TB2-28. The wiring harness and external connections for the M-2355B are shown in Figure 4 through Figure 7.

Lightning Protection

▲CAUTION: For proper protection against system surges, chassis ground (M-2001C chassis stud) must be connected to earth ground.

It has been determined that transient voltages in excess of 1500 Vac RMS can exist on the "ground" lead normally tied to TB1-8 on the printed circuit board of the adapter panel. In the Tapchanger Controls, these voltages are suppressed by varistors which still permit the unit to pass a 1500 Vac Hi Pot test for one minute with a leakage current of approximately 15 mA, all terminals to ground.

Multiple VT grounds far apart must be avoided since a varying difference in ground voltage could add or subtract from the effective voltage and cause variation in the Tapchanger Control's bandcenter voltage setpoint.

Neutral Light Circuit

The M-2355B is prepared for use with regulators which use a neutral light. Cooper products require that the Neutral Light terminal TB1-11 (NL) be powered when the light is to be illuminated. A switch on the printed circuit board (Figure 4 through Figure 7) is used to select the desired configuration (Up-Neutral, Down-Hot).

For Cooper products, the Neutral Light terminal TB1-11 will be powered inside the regulator when the light is illuminated. For this operation, place the **S1** switch (located in the right-hand corner of the adapter panel printed circuit board, Figure 4 through Figure 7) in the "down" (Hot) position.

Non-Sequential Operation

Non-Sequential operation is not available with Motor Seal-in circuit.

Counter Input

Counter Input is not available with Motor Seal-in circuit.

Automatic Disable Input

To disable automatic operation of the M-2355B, remove Jumper #15 (See Figure 4 through Figure 7, for location) on the printed circuit board.

If SCADA is used to enable and disable this function, a contact rated at 6 A minimum can be connected between the terminals.

Auto disable may also be accomplished by closing a contact between TB1-1 and TB2-28.

Local/Remote Input

Removing Jumper #14 (See Figure 4 through Figure 7, for location) prohibits M-2001 operation by disabling the automatic raise and lower outputs and also by disabling the M-2355B Adapter Panel's manual **RAISE/OFF/LOWER** toggle switch. Removing this jumper does ***not*** disable the SCADA-supplied motor voltage input to the manual raise/manual lower contacts on the adapter panel.

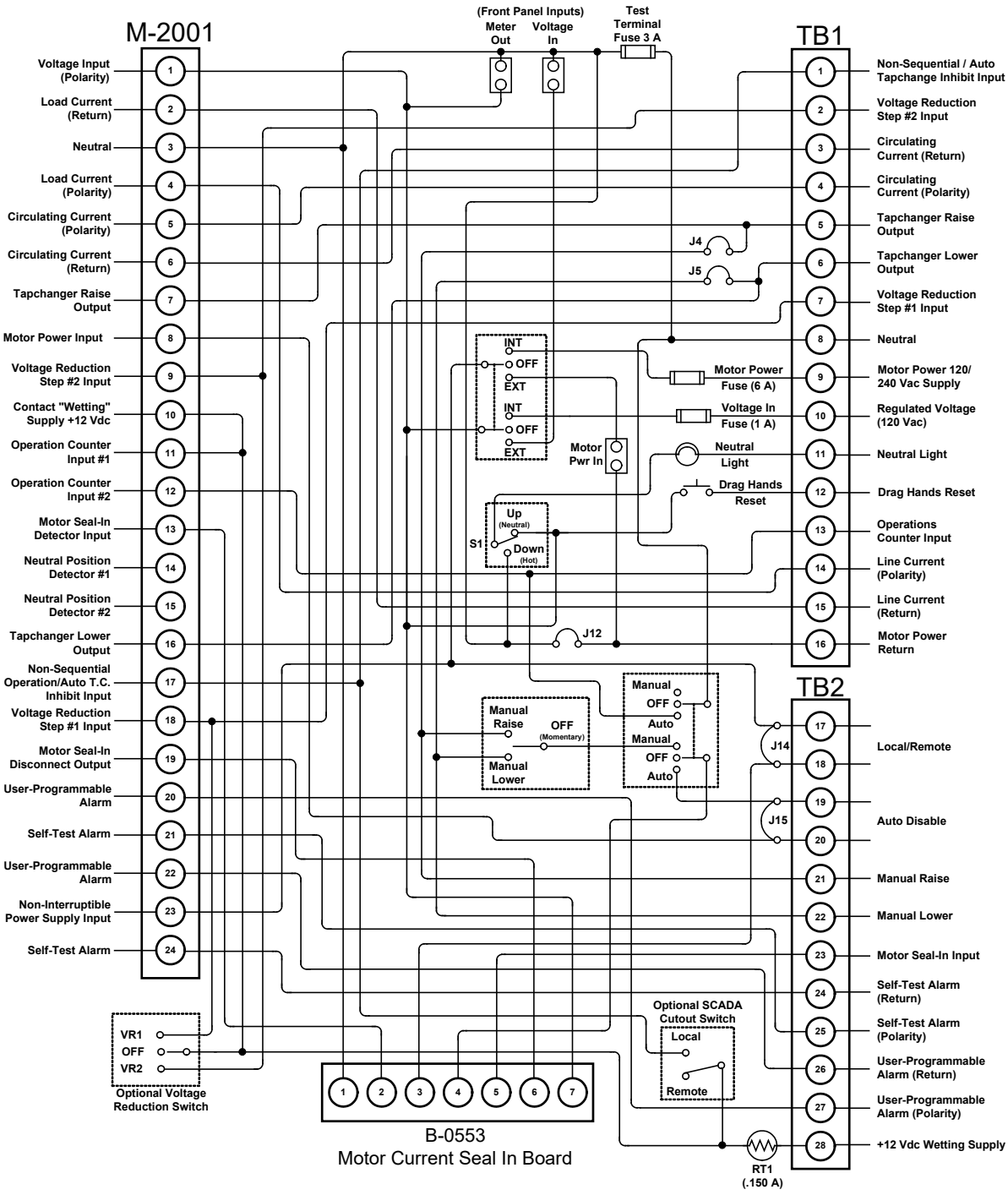
Multi-Step Voltage Reduction

▲CAUTION: Voltage applied through dry contacts to actuate Voltage Reduction Steps 1, 2, and 3 ***must*** be +12 Vdc obtained from pin TB2-28 of the M-2355B adapter panel. If an M-0355 analog-version tapchanger control had previously been installed, the wiring harness must be reconfigured to remove the 120 Vac "wetting" voltage obtained from TB1-9. Carefully examine the contacts of these functions to remove 120 Vac wetting voltages.

On the M-2355B, TB1-2 and TB1-7 on the printed circuit board are used together to provide up to three levels of voltage reduction. The external connections to achieve these steps are shown in Table 1, below, and Figure 3 through Figure 7. Voltage reduction amounts are set within the M-2001 Series Digital Tapchanger Control software.

Voltage Reduction Setpoint Multiplier Range	Apply "Wetting Voltage" from TB2-28 Terminal
Voltage Reduction Setpoint #1: 0 to 10%	TB1-7
Voltage Reduction Setpoint #2: 0 to 10%	TB1-2
Voltage Reduction Setpoint #2: 0 to 10%	TB1-7 and TB1-2

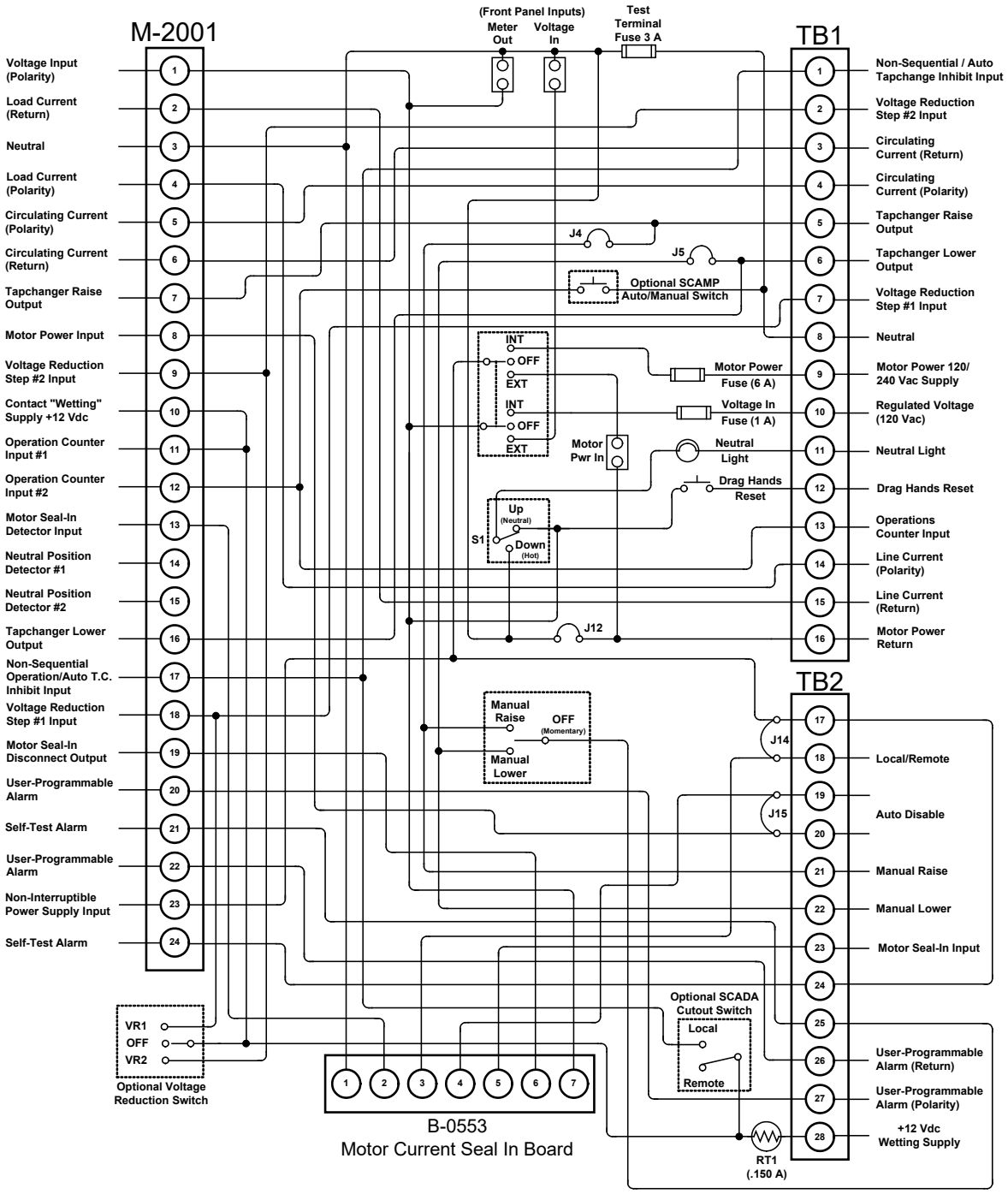
Table 1 Multi-Step Voltage Reduction External Connections



▲CAUTION: Voltage applied through dry contacts to actuate non-sequential input ***must*** be +12 Vdc obtained from pin TB2-28 of the M-2355B adapter panel. If an M-0355 analog-version tapchanger control had previously been installed, the wiring harness must be reconfigured to remove the 120 Vac "wetting" voltage obtained from TB1-9. Carefully examine the contacts of these functions to remove 120 Vac wetting voltages.

■NOTE: If the Motor Power Input configuration has a different return from the 120 V regulated Voltage Input, then jumper J12 on the printed circuit board must be removed and TB1-16 should be used for the separate motor power source and return connections (See Figure 4 through Figure 7 for J12 location).

Figure 1 M-2001 and M-2355B Adapter Panel with Standard AUTO/OFF/MANUAL Toggle Switch and Optional Voltage Reduction and SCADA Cutout Switches



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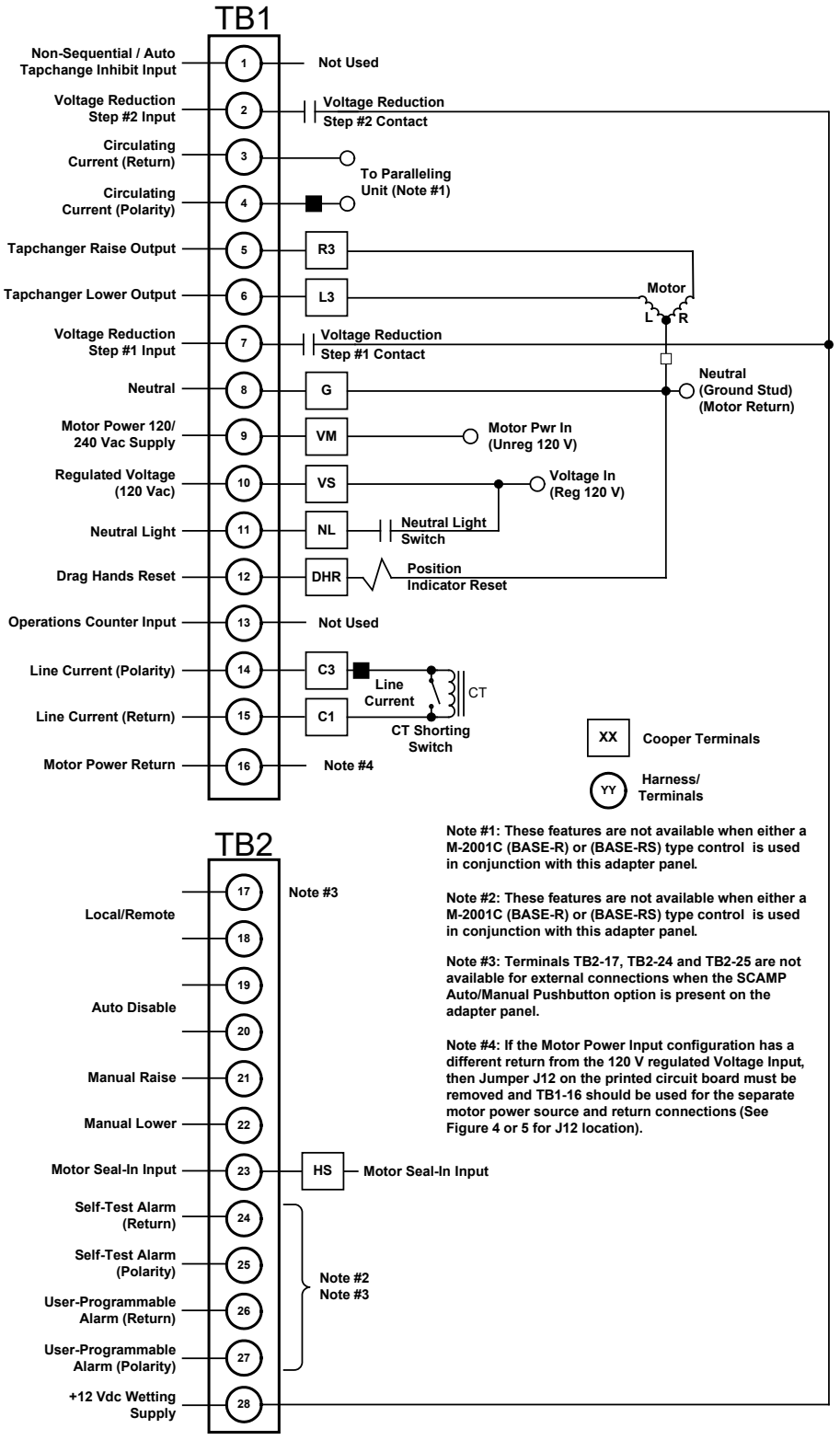
■NOTE: If the Motor Power Input configuration has a different return from the 120 V regulated Voltage Input, then jumper J12 on the printed circuit board must be removed and TB1-16 should be used for the separate motor power source and return connections (See Figure 4 through Figure 7 for J12 location).

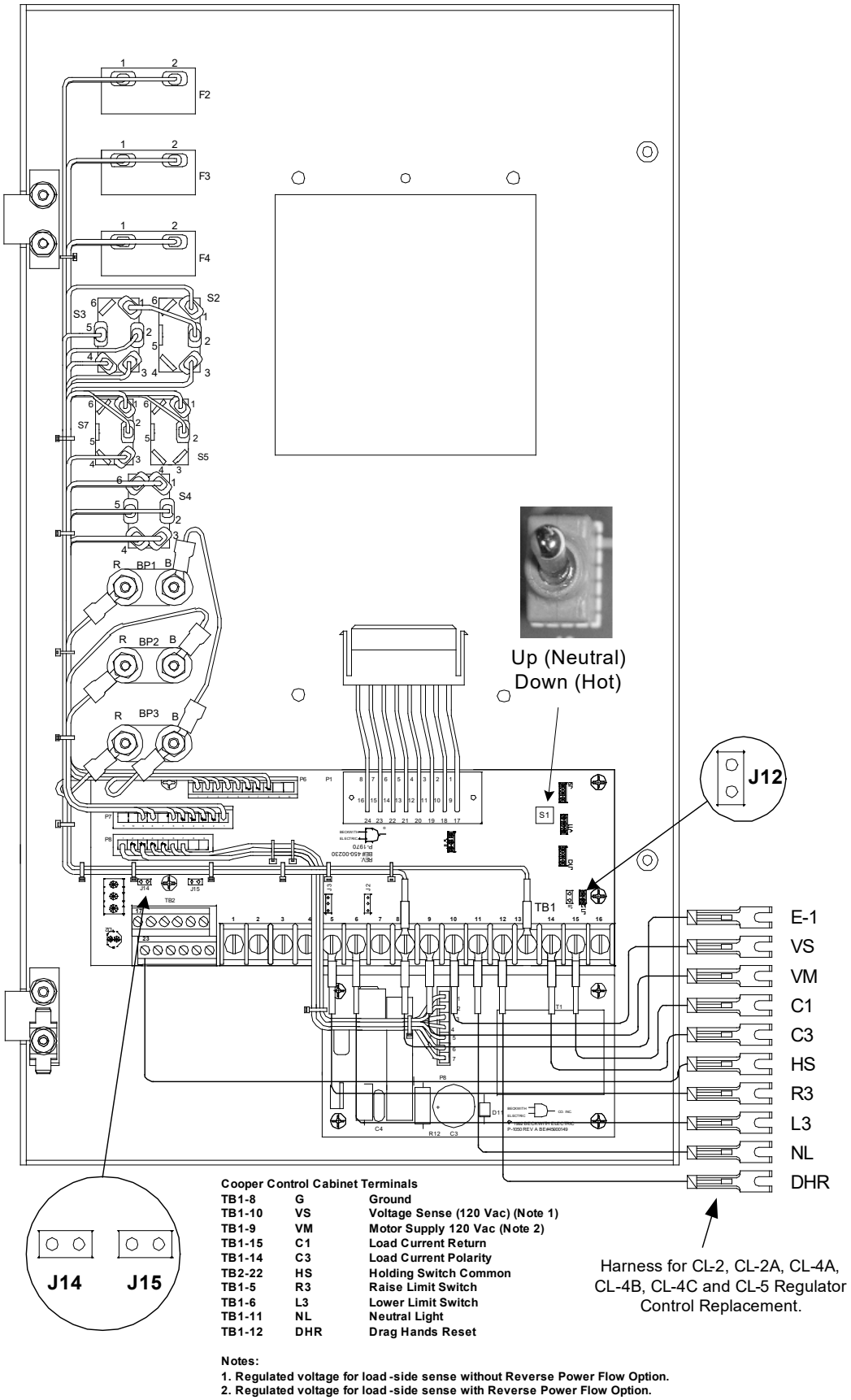
Figure 2 M-2001 and M-2355B with Optional SCADA Cutout Switch, Voltage Reduction Switch and SCAMP Pushbutton Switch



WARNING: In no case should the line current circuit be interrupted with the regulator or transformer energized. Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

NOTE: TB1-13 in the M-2355B is provided for the operations counter input, although alternate circuitry for activating the operations counter is typically used by Cooper regulator controls.

Figure 3 External Connections

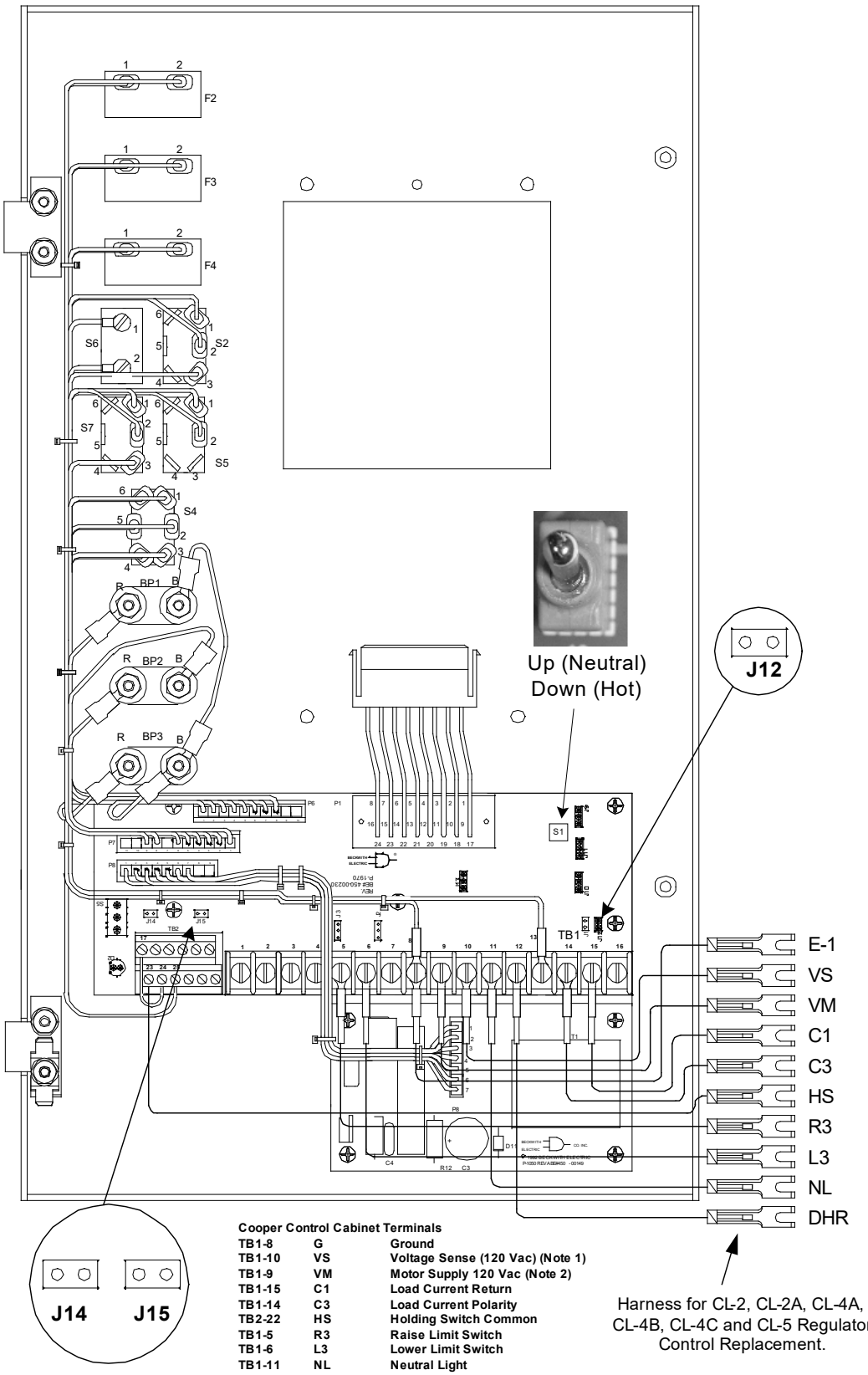


Cooper Control Cabinet Terminals

TB1-8	**G**	**Ground**
TB1-10	**VS**	**Voltage Sense (120 Vac) (Note 1)**
TB1-9	**VM**	**Motor Supply 120 Vac (Note 2)**
TB1-15	**C1**	**Load Current Return**
TB1-14	**C3**	**Load Current Polarity**
TB2-22	**HS**	**Holding Switch Common**
TB1-5	**R3**	**Raise Limit Switch**
TB1-6	**L3**	**Lower Limit Switch**
TB1-11	**NL**	**Neutral Light**
TB1-12	**DHR**	**Drag Hands Reset**

Notes:
1. Regulated voltage for load-side sense without Reverse Power Flow Option.
2. Regulated voltage for load-side sense with Reverse Power Flow Option.

Figure 4 M-2355B Wiring Harness and External Connections with SCADA Cutout and Voltage Reduction Switches

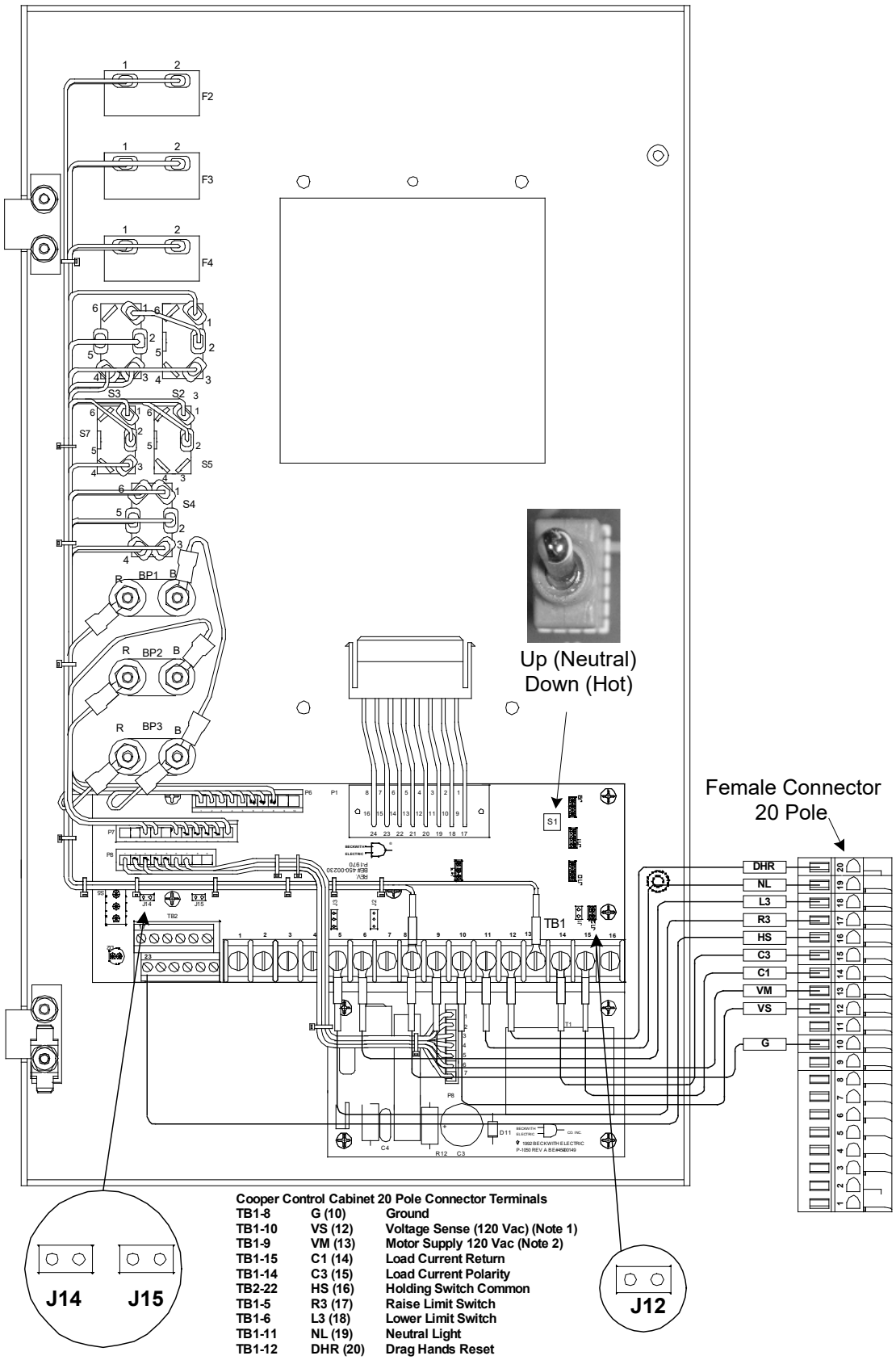


Cooper Control Cabinet Terminals

TB1-8	G	Ground
TB1-10	VS	Voltage Sense (120 Vac) (Note 1)
TB1-9	VM	Motor Supply 120 Vac (Note 2)
TB1-15	C1	Load Current Return
TB1-14	C3	Load Current Polarity
TB2-22	HS	Holding Switch Common
TB1-5	R3	Raise Limit Switch
TB1-6	L3	Lower Limit Switch
TB1-11	NL	Neutral Light
TB1-12	DHR	Drag Hands Reset

Notes:
1. Regulated voltage for load-side sense without Reverse Power Flow Option.
2. Regulated voltage for load-side sense with Reverse Power Flow Option.

Figure 5 M-2355B Wiring Harness and External Connections with Optional SCADA Cutout Switch, Voltage Reduction Switch and SCAMP Pushbutton Switch

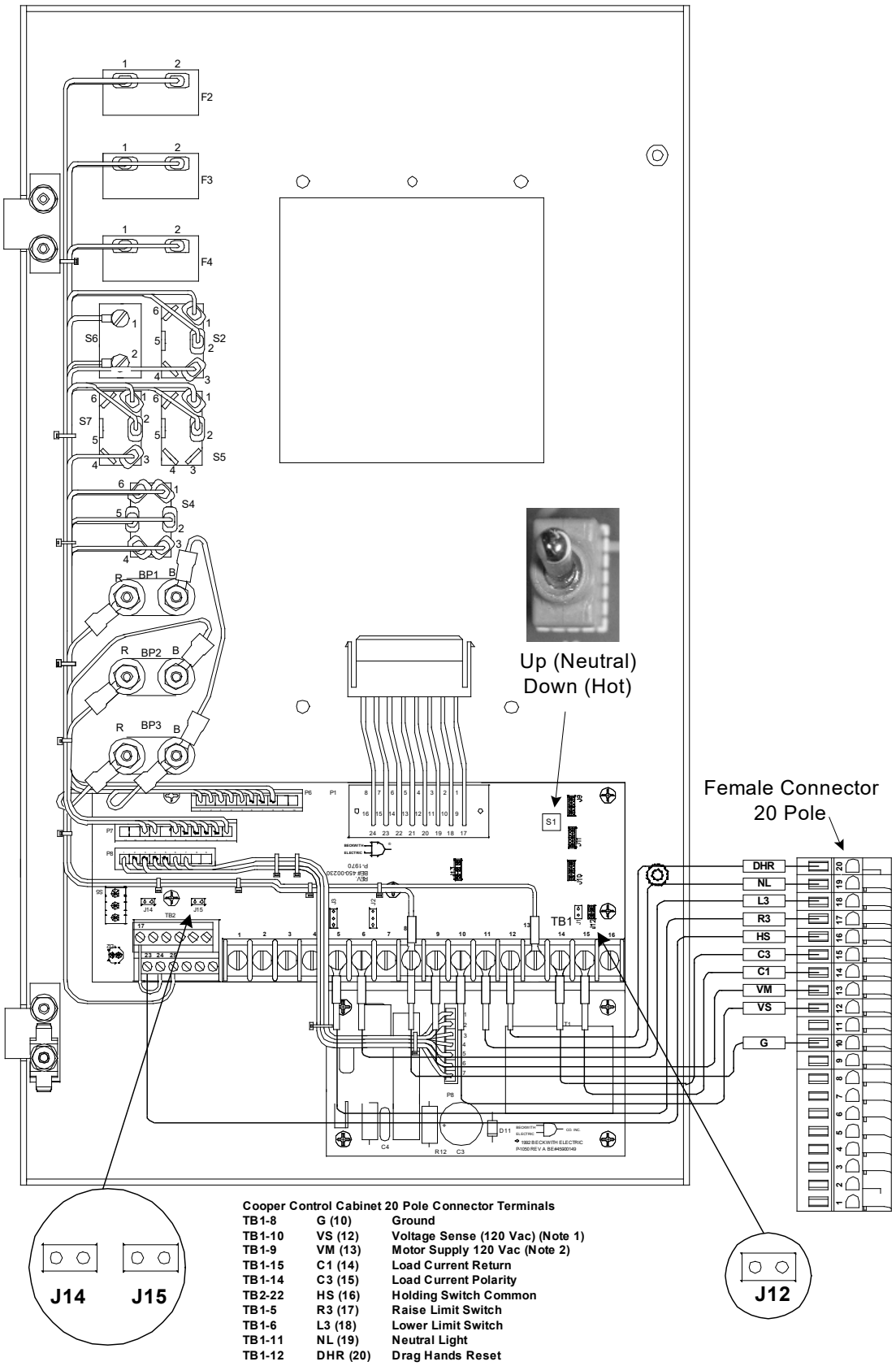


Cooper Control Cabinet 20 Pole Connector Terminals

TB1-8	G (10)	Ground
TB1-10	VS (12)	Voltage Sense (120 Vac) (Note 1)
TB1-9	VM (13)	Motor Supply 120 Vac (Note 2)
TB1-15	C1 (14)	Load Current Return
TB1-14	C3 (15)	Load Current Polarity
TB2-22	HS (16)	Holding Switch Common
TB1-5	R3 (17)	Raise Limit Switch
TB1-6	L3 (18)	Lower Limit Switch
TB1-11	NL (19)	Neutral Light
TB1-12	DHR (20)	Drag Hands Reset

Notes:
1. Regulated voltage for load-side sense without Reverse Power Flow Option.
2. Regulated voltage for load-side sense with Reverse Power Flow Option.

Figure 6 M-2355B Wiring Harness 20 Pole Connector with SCADA Cutout and Voltage Reduction Switches



Cooper Control Cabinet 20 Pole Connector Terminals

TB1-8	G (10)	Ground
TB1-10	VS (12)	Voltage Sense (120 Vac) (Note 1)
TB1-9	VM (13)	Motor Supply 120 Vac (Note 2)
TB1-15	C1 (14)	Load Current Return
TB1-14	C3 (15)	Load Current Polarity
TB2-22	HS (16)	Holding Switch Common
TB1-5	R3 (17)	Raise Limit Switch
TB1-6	L3 (18)	Lower Limit Switch
TB1-11	NL (19)	Neutral Light
TB1-12	DHR (20)	Drag Hands Reset

Notes:
1. Regulated voltage for load-side sense without Reverse Power Flow Option.
2. Regulated voltage for load-side sense with Reverse Power Flow Option.

Figure 7 M-2355B Wiring Harness 20 Pole Connector with Optional SCADA Cutout Switch, Voltage Reduction Switch and SCAMP Pushbutton Switch

Use of the M-0329B LTC Backup Control with the Tapchanger Control

The M-0329B is a single-phase, solid-state backup control that prevents a defective tapchanger control from running the voltage outside the upper and lower voltage limits. The Block Raise and Block Lower voltage levels are set by accurately calibrated dials.

The M-0329B LTC Backup Control is connected as a two terminal device to the voltage transformer. Figure 8, below, illustrates a typical interconnection of the two devices with motor auxiliary relays.

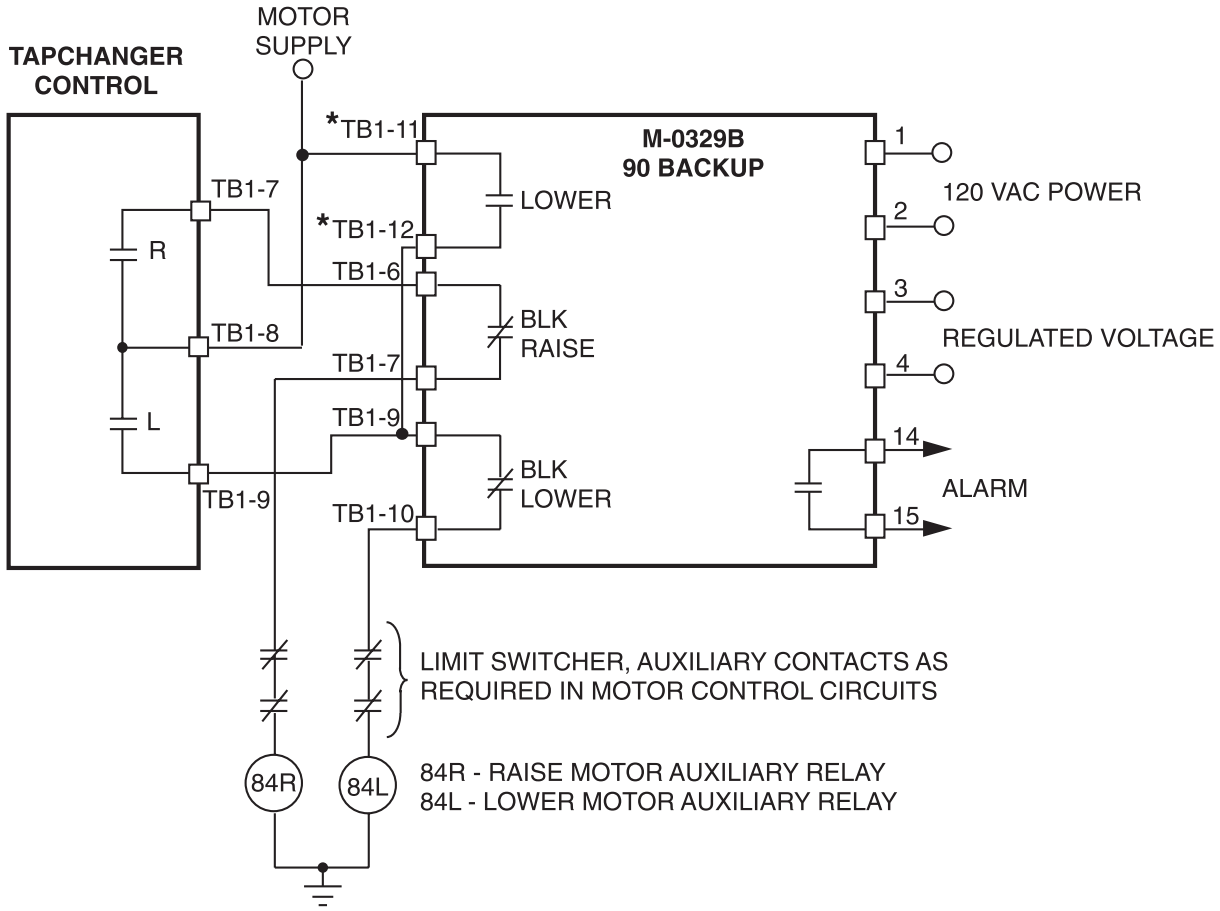


Figure 8 Tapchanger Control and LTC Backup Control Interconnections

■**NOTE:** ***If first customer protection is not required, delete these connections.

The M-0329B Instruction Book is available on request and gives added details. Please refer to the M-0329B Instruction Book for complete ordering information.

3.0 Installation

The M-2355B Adapter Panel is equipped with hinges located on the right side that allow easy mounting into the existing Cooper control cabinet. Refer to Figure 9, for outline dimensions and general orientation of adapter panel components.

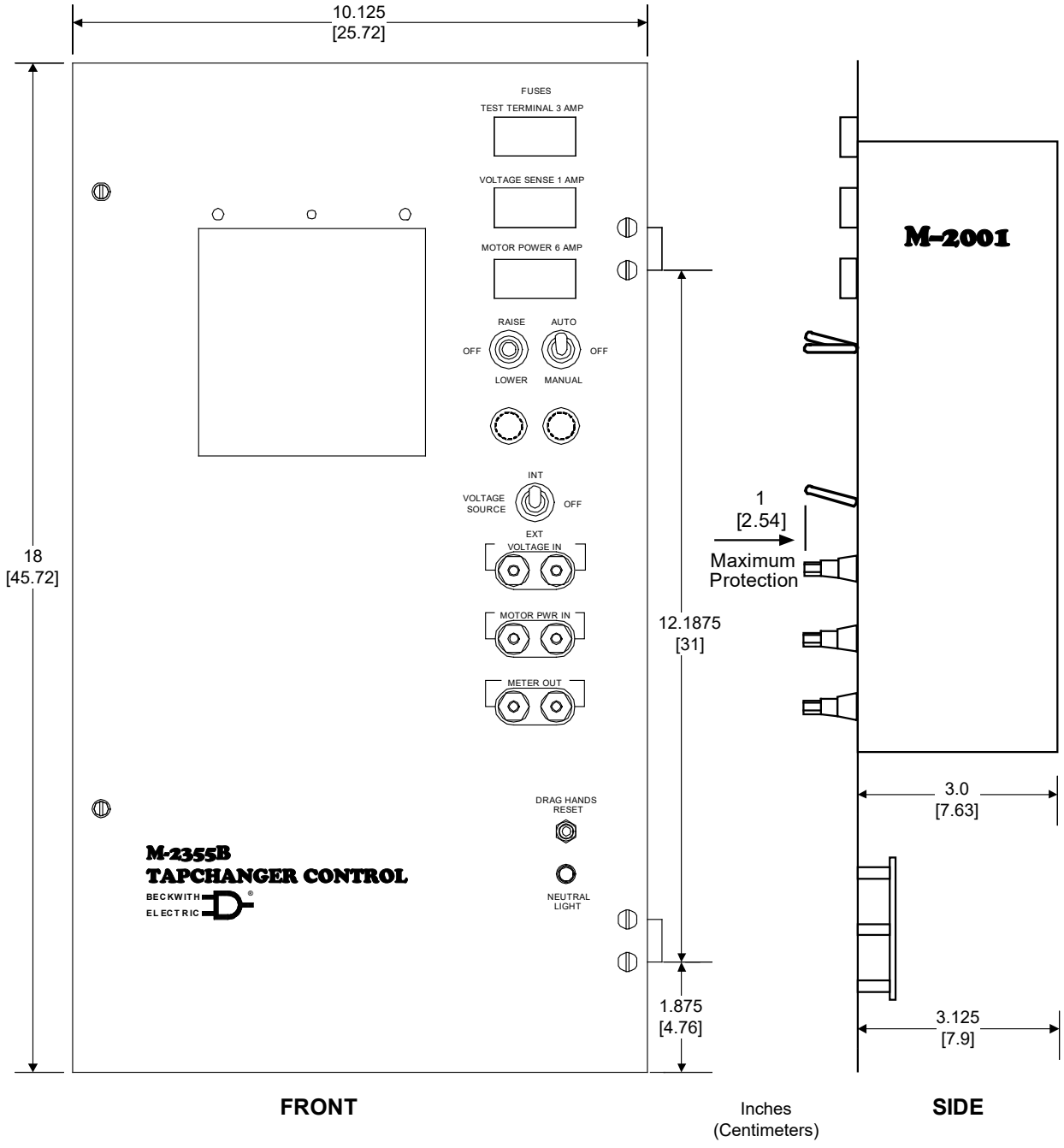


Figure 9 Front Panel Outline Dimensions

Removal of the Cooper Control

Refer to Figure 10.

1. Open the cabinet door of Cooper control.
2. Turn the knobs on the control panel and swing the panel outward.

WARNING: In no case should the line current circuit be interrupted with the regulator or transformer energized. Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

3. De-energize the control by opening the VT disconnect switch and placing the CT switch in the shorting position. Ensure that the CT in the regulator has been properly shorted.
4. Loosen the screws on the spreader bar terminal block at the bottom of the cabinet, then pull down on the spreader bar to disconnect it.

NOTE: The two hinge pins **must be saved** from the original control.

5. Remove and save the two hinge pins, then lift the panel off of the hinges and remove it from the cabinet.

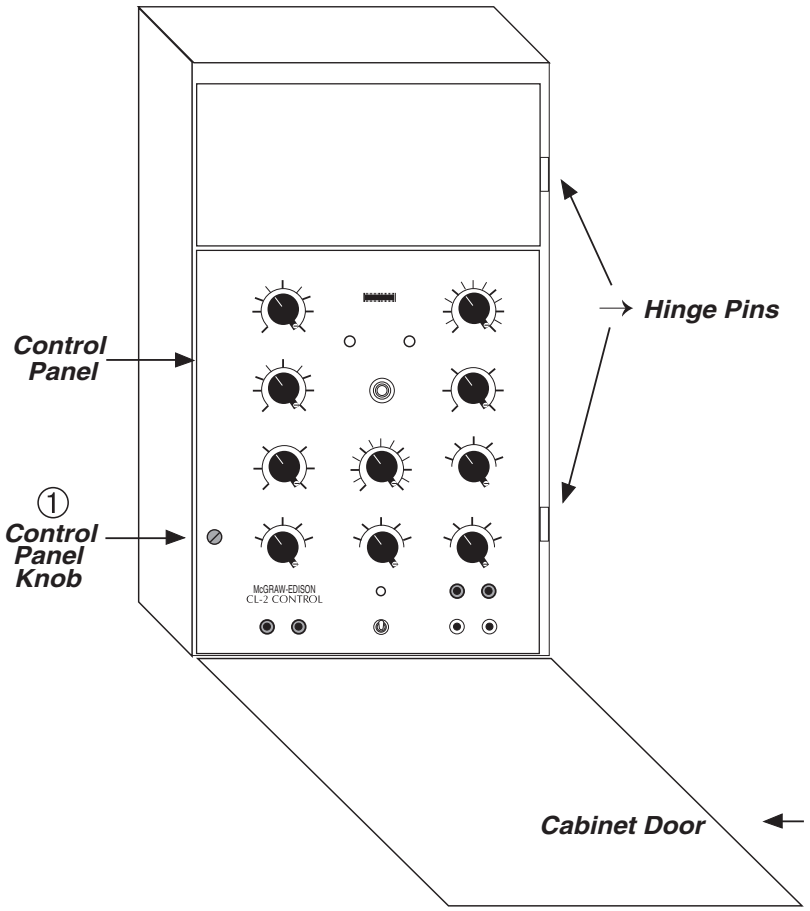


Figure 10 Cooper Control in Cabinet

Installing the M-2355B/M-2001

1. Mount the M-2001 to the M-2355B Adapter Panel using the hardware provided in the cloth bag. Use the supplied lock washers between the screws and the top of the front panel.

■NOTE: The blue connector is keyed by a "V" notch in the middle to prevent incorrect mating (Figure 11). Check location of the key before plugging connector into the M-2001.

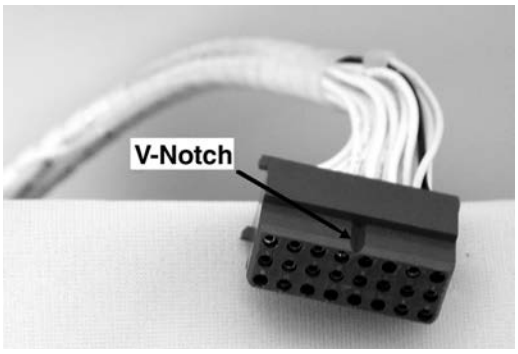


Figure 11 M-2001 Harness "V" Notch Connector

2. Plug the blue connector of the M-2355B harness into the bottom of the M-2001 (Figure 12).
   If desired, bench testing may be performed at this time as described in Section 5.0, **Bench Test**.

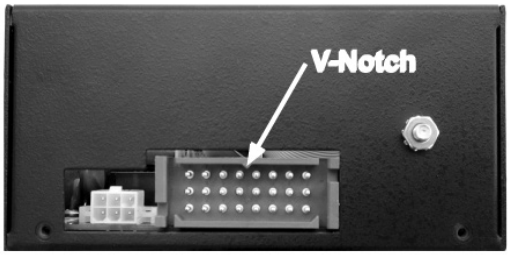


Figure 12 M-2001 V-Notch Orientation

3. Mount the M-2355B Adapter Panel (with the M-2001 Series Digital Tapchanger Control) onto the hinges in the control cabinet (Figure 10), then install the two hinge pins saved from the original control. Leave the panel swung outward so that the back of the panel is accessible.
4. If the frame that the Adapter Panel is mounted to requires the use of longer panel thumbscrews, then replace the two panel thumbscrews with the longer versions provided in the cloth bag.
5. Connect the M-2355B's wiring harness to the terminal block at the bottom of the cabinet. Refer to Figure 3 through Figure 7 as applicable.
6. To re-energize the control, open the CT switch, removing the CT short circuit, and close the VT disconnect switch. Swing the adapter panel closed and turn thumbscrews to latch securely.
7. Close cabinet door.

4.0 M-2001 Tapchanger Control Software Settings

Adjust the **BANDCENTER** setting to the nominal voltage desired. Adjust the **BANDWIDTH** setting to the desired voltage band, centered on the Bandcenter setpoint, that the voltage must exceed before timer and subsequent tapchanger operation occurs. Adjust the **TIME DELAY** setpoint to a sufficient amount to eliminate excessive tapchanger operations. The **LINE DROP COMPENSATOR** should be set for the line impedance from the transformer to the load center. For further information, obtain Beckwith Electric Application Note #17, "Basic Considerations for the Application of LTC Transformers and Associated Controls".

4.1 M-0329B LTC Backup Control Settings

The **BANDCENTER** and **BANDWIDTH** dials on the M-0329B LTC Backup Control should be set so that the Block Lower limit is a small amount (approximately 2 V) below the lower band limit of the Tapchanger Control, and the Block Raise limit is a similar amount above the upper limit if line drop compensation is **not** used.

If line drop compensation is used, the M-0329B Block Raise limit should be set at the maximum voltage desired at the transformer secondary under full load.

The M-0329B LTC Backup Control also includes a deadband or runback function that regulates the maximum voltage from the transformer. This "Lower" function operates slightly above the Block Raise limit and is connected to force the tapchanger to lower the voltage if the upper limit is exceeded.

5.0 Bench Test (M-2001 Connected to M-2355B)

Test Equipment

- 0–200 mA current supply with phase angle settings of 0° to +90°

WARNING: The current input to the M-2001C is rated at 0.2 A continuous, 0.4 A for two hours, and 4.0 A for 1 second.

- 90–145 Vac voltage source at 60 Hz
- High impedance true RMS voltmeter with accuracy on ac of at least ±0.2% of reading
- Accurate Stop watch

Setup

1. Make electrical connections as shown in Figure 13, M-2355B Test Procedure External Connections.

NOTE: Refer to the M-2001C Instruction Book Appendix A, for the locations of screens within the software.

NOTE: There is a one second delay between out-of-band condition and panel LED indication.

2. Enter initial M-2001 settings:

Bandcenter	120.0 V
Bandwidth	2.0 V
LDC Resistance	0.0 V
LDC Reactance	0.0 V
Paralleling	Circulating Current method
Block Raise	135.0 V
Block Lower	105.0 V
Deadband	2.0 V
Timer	5.0 seconds

Table 2 Initial Settings

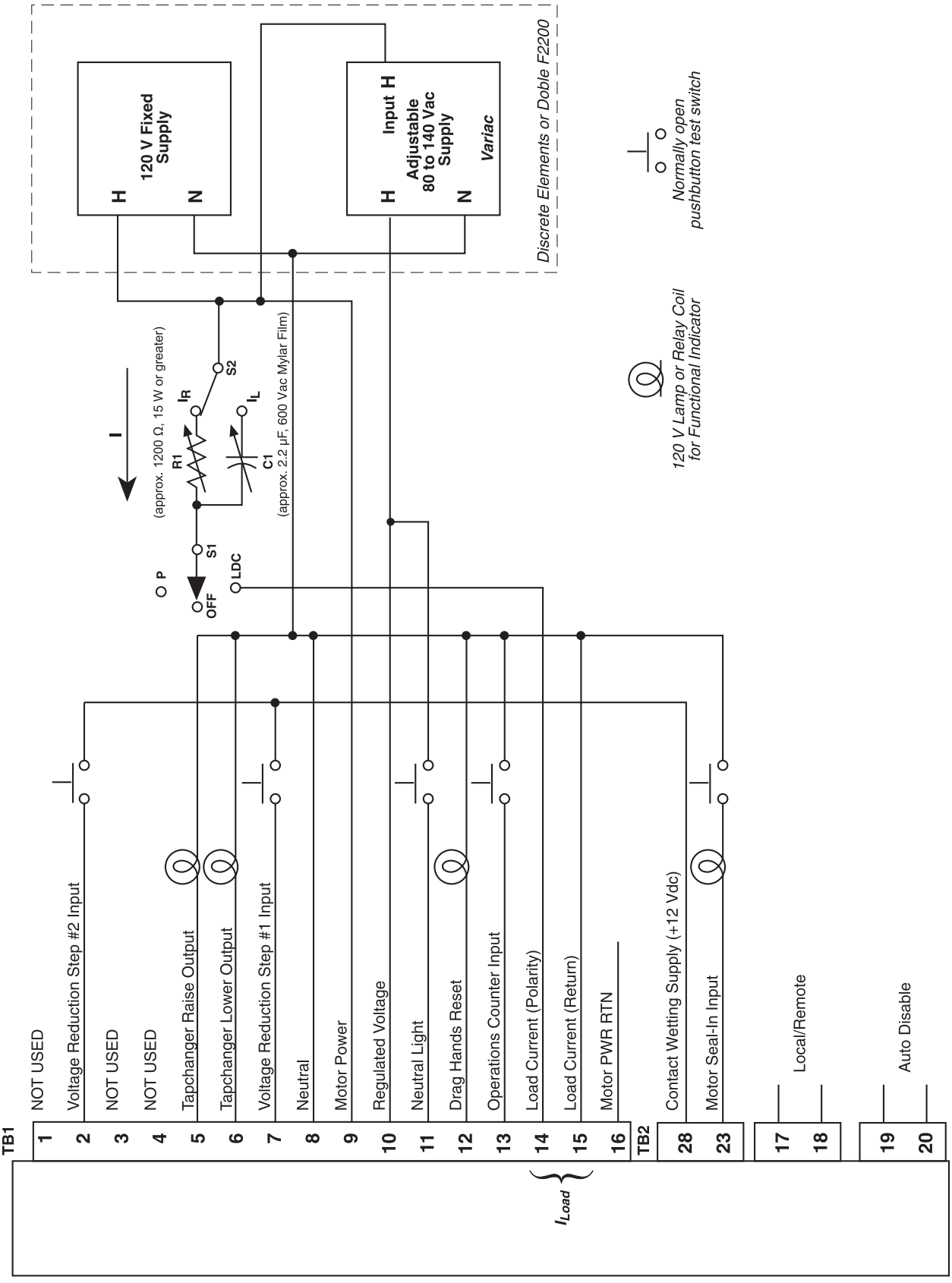


Figure 13 M-2355B Test Procedure External Connection

Procedure

▲CAUTION: Do not reverse the ground and hot wires when connecting an external source.

1. Apply 120.0 Vac from power source.
2. The display of the M-2001 will automatically advance to the **Local Voltage** screen.
3. Increase voltage to 121.2; **LOWER** LED should illuminate.
4. Decrease voltage to 118.8; **RAISE** LED should illuminate.
5. Set input voltage to 120.0 Vac. Wait for **RAISE** and **LOWER** LEDs to extinguish.
6. Increase voltage to 122.0 Vac, then start timing when voltage passes 121.0 V.
7. Stop timing when the lamp connected to the **LOWER** output illuminates (should be 5 seconds).

Resistance

1. Apply 100.0 mA in-phase current to TB1-14 (load current-polarity) and TB1-15 (load current-return) of the adapter panel. (Set S_1 to LDC and S_2 to I_R.)
2. Set **LDC Resistance** to 24.0 V; **RAISE** LED should light.
3. Increase input voltage to 132.0 Vac; **RAISE** and **LOWER** LEDs should be extinguished.
4. Set **LDC Resistance** to -24.0 V; **LOWER** LED should illuminate.
5. Decrease input voltage to 108.0 Vac; both **RAISE** and **LOWER** LEDs should extinguish.
6. Set **LDC Resistance** to 0.0 V.

Reactance

1. Apply 100.0 mA 90° leading current to TB1-14 (load current-polarity) and TB1-15 (load current-return) of the adapter panel. (Set S_1 to LDC and S_2 to I_L.)
2. Set **LDC Reactance** to 24.0 V; **LOWER** LED should illuminate.
3. Decrease input voltage to 108.0 Vac; **RAISE** and **LOWER** LEDs should be extinguished.
4. Set **LDC Reactance** to -24.0 V; **RAISE** LED should illuminate.
5. Increase input voltage to 132.0 Vac; both **RAISE** and **LOWER** LEDs should be extinguished.
6. Set **LDC Reactance** to 0.0 V.

Voltage Source Switch

1. Set **AUTO/OFF/MANUAL** switch to **OFF**.
2. Set **VOLTAGE SOURCE** switch to **EXT**.
3. Verify no manual **Raise** or **Lower** output.
4. Attach voltmeter to **Meter Out** terminals.
5. Verify no voltage is present.
6. Apply 120 Vac to both the **VOLTAGE IN** and **MOTOR PWR IN** jacks (Black-Neutral, Red-Hot).
7. Set **AUTO/OFF/MANUAL** switch to **AUTO**.
8. Verify normal raise and lower operation.
9. Return the **VOLTAGE SOURCE** switch to **INT**.

Drag Hands Reset

1. Connect a lamp or ac relay between TB1-12 (drag hands reset) and TB1-8 (neutral) of the adapter panel.
   - Depress the **Drag Hands Reset** switch. The connected lamp or ac relay should operate.

Counter/Neutral Light/Tap Position

1. Set the M-2001 Tapchanger Control to display the **Operations Count** screen.
2. Connect a switch between TB1-13 (operations counter input) and TB1-8 (neutral) of the adapter panel.
3. Lower the input voltage until the **RAISE** LED illuminates.
4. Allow the delay timer to time out, then activate the switch between TB1-13 (operations counter input) and TB1-8 (neutral). The tap position should change.
5. Jumper TB1-11 (neutral light) to TB1-10 (hot).
6. Set Neutral Light switch S1, located on the adapter panel printed-circuit board (Figure 4 through Figure 7), to the toggle down position.

   The Neutral Light on the adapter panel should illuminate and the tap position should return to "0 Neutral."
7. Remove the jumper.

Block Raise/Block Lower/Dead Band

1. Set **BLOCK RAISE** to 126.0 V.
2. Set **BLOCK LOWER** to 114.0 V.
3. Set the M-2001 Tapchanger Control to display the **BIAS VOLTAGE** screen.
4. Press **ENTER**.
5. Increase voltage to 126.5 V; **BR** should appear on the screen.
6. Increase voltage to 128.5 V; **BR** goes off and FL appears on the screen.
7. Decrease voltage to 113.5 V; **BL** appears on the screen.

Motor Seal-In

1. Set input voltage to 122.0 V.
2. Allow the lamp connected to the **LOWER** output to illuminate.
3. Press and hold (for approximately 2 seconds) the switch connected to TB2-23; the lamp connected to the **LOWER** output should extinguish.
4. Release switch; after a one- to two-second delay, the lamp connected to the LOWER output should illuminate.

—Bench Test Complete—

5.1 M-2001 Checkout Procedure

■**NOTE:** This test of the M-2001 assumes that the unit remains connected to the adapter panel.

Basic Operational Test

1. Apply 120.0 Vac to TB1-9 (motor power) and TB1-10 regulated voltage) of adapter panel.
2. Connect neutral to TB1-8 (neutral).
3. Verify local voltage ≈ input voltage ±0.3 V.
4. Apply 100.0 mA in-phase current to TB1-14 (load current-polarity) and TB1-15 (load current-return) of the adapter panel. Verify Control Load I ≈ 100 mA and Power Factor ≈ 1.0 ±0.02.
5. Apply 100.0 mA 90° leading current to TB1-4 (circulating current-polarity) and TB1-3 (circulating current-return) of the adapter panel.
6. Verify Control Circ I ≈ 100.0 mA ±2 mA.
7. Verify the **UP**, **DOWN** and **ENTER** pushbuttons operate properly.

—Checkout Procedure Complete—

5.2 In-Service Test

1. Set the M-2001 to display the **BIAS VOLTAGE** screen.
2. Press **ENTER**.
3. Utilizing the **UP** and **DOWN** pushbuttons to initiate **RAISE** and **LOWER** outputs.

—In-Service Test Complete—

Return unit to desired settings

5.3 M-2355B Checkout Procedure

Power Checkout

■**NOTE:** All Beckwith Electric units are fully calibrated at the factory. There is no need to recalibrate the units before initial installation.

1. Set the **AUTO/OFF/MANUAL** switch to **OFF**, then inspect the **MOTOR POWER** and **VOLTAGE** fuses to ensure they are correctly sized and are not blown.

⬢**WARNING:** **Do not connect any voltage source at the METER OUT test terminal. Voltage applied at the METER OUT test terminal may energize the regulator or transformer to a high voltage through the voltage transformer. Death or severe electrical shock can occur.**

▲**CAUTION:** Do not reverse the ground and hot wires when connecting an external source. A 3 AG fuse (F2) is installed to protect the relay from damage if these connections are accidentally reversed. Spare fuses are supplied inside the fuse holders.

2. Remove any external connection between TB1-9 and TB1-10 which are located on the adapter panel printed circuit board.
3. Remove any voltage applied to TB1-9 externally.
4. Using a voltmeter, make ensure that the voltage applied to TB1-10 is nominal 120 Vac with respect to TB1-8 (neutral).
5. Apply power to TB1-10 (hot) and TB1-8 (neutral).
6. Connect a voltmeter to the **METER OUT** test terminal on the front of the adapter panel. 120 Vac should be indicated.
7. Apply motor power to TB1-9 (hot) and TB1-8 (neutral).
8. Set the **AUTO/OFF/MANUAL** switch to **MANUAL**, then using the **RAISE/OFF/LOWER** switch, verify that the motor runs in the proper direction when the switch is placed in the **RAISE** and **LOWER** positions.
9. Set the **AUTO/OFF/MANUAL** switch to **AUTO**.

   Refer to the Field Checkout Procedure as found in the Status & Setpoint review Guide of the M-2001 Tapchanger Control Instruction Book for test/operation procedures.

Current Checkout

1. Setup the M-2355B for current checkout as illustrated in Figure 14.

WARNING: Do not remove auxiliary current transformers without shorting the current inputs. In no case should the load current circuit be interrupted with the regulator or transformer energized. Death or severe electrical shock can occur.

2. Temporarily place a shorting device across the LDC-CT secondary to short the line drop compensator circuit, then place a shorting device across TB1-3 and TB1-4 to short the circulating current paralleling input, for the load current check.
3. Place an ammeter between the polarity input and TB1-14.
4. Open the load current shorting device, then with a known load on the transformer or regulator measure the current in the load current circuit. Ensure that the measured current is correct for 0.2 A full load.

WARNING: Do not remove auxiliary current transformers without shorting the current inputs. In no case should the load current circuit be interrupted with the regulator or transformer energized. Death or severe electrical shock can occur.

5. Replace the shorting device across the load current input, then remove the ammeter.
6. Reconnect polarity to the unit, then remove both jumpers. The **LINE DROP COMPENSATOR** will be activated.

   Correct CT polarity can be checked by simply incorporating sufficient +R compensation. The regulator should time out and run so as to raise the output voltage.

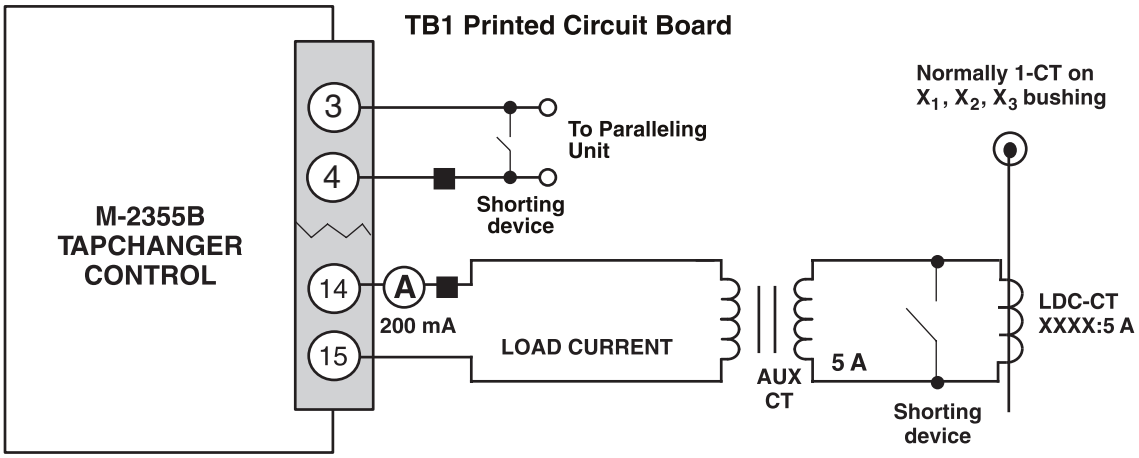


Figure 14 Setup for Current Checkout Procedure

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Legal Information

Patent

The units described in this manual are covered by U.S. Patents, with other patents pending.

Buyer shall hold harmless and indemnify the Seller, its directors, officers, agents, and employees from any and all costs and expense, damage or loss, resulting from any alleged infringement of United States Letters Patent or rights accruing therefrom or trademarks, whether federal, state, or common law, arising from the Seller's compliance with Buyer's designs, specifications, or instructions.

Warranty

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used herein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of five years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to perform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided, however, that Buyers shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to replacement value of the equipment furnished under this contract.

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Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

Indemnification

The Seller shall not be liable for any property damages whatsoever or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary, or consequential damages, including but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence, or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

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