



Application Guide

**M-2354C
Adapter Panel**

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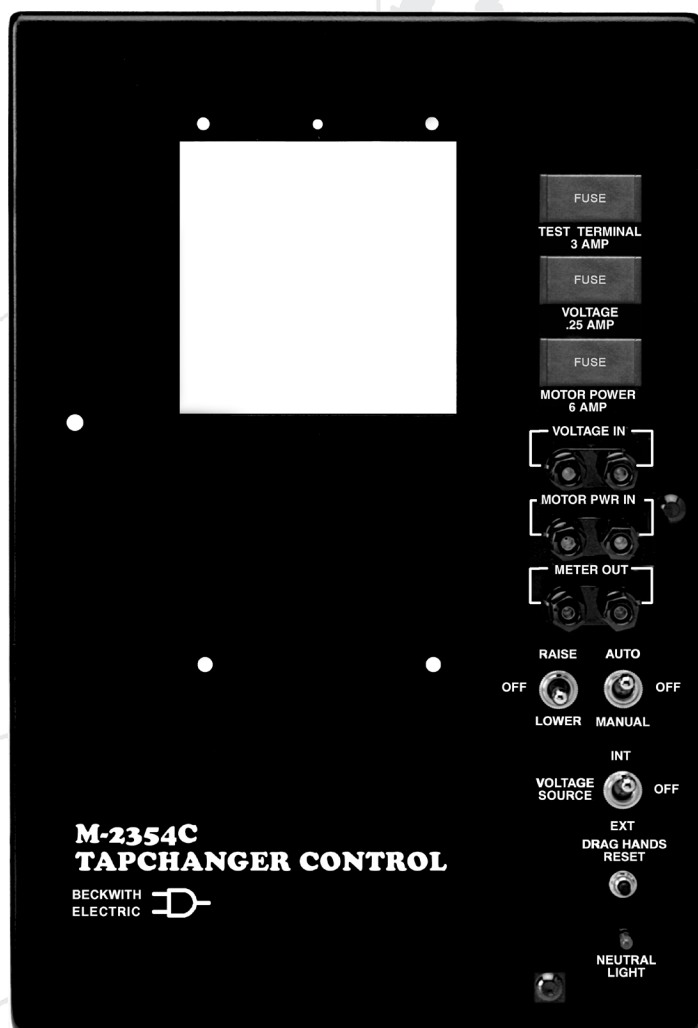
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Adapter Panel M-2354C

**Adapts M-2001 Series Digital Tapchanger
Control to Replace McGraw-Edison 550 BHS
LTC Transformer Controls**



- Connects easily to the M-2001 Series Digital Tapchanger Control using mounting screws and 24-pin connector
- Provides direct mechanical replacement of the existing control using the same two hinge pins
- Provides built-in CT shorting protection when the M-2001 Series Digital Tapchanger Control is removed

M-2354C Adapter Panel – Specification

The M-2354C is an adapter panel which, when combined with the M-2001 Series Digital Tapchanger Control, provides convenient direct replacement of McGraw-Edison 550 BHS LTC transformer controls. The M-2354C consists of a front panel, and mounts into the control cabinet. The hinge hardware, knob, and the mounting hardware *must be saved* from the original control.

Interface

External connections are made via a wiring harness that connects from a fifteen-position terminal block to the two terminal blocks on the existing control cabinet. An additional terminal block provides access to auxiliary functions, including self-test alarm, user-programmable alarm, auto disable and manual raise/lower. An auxiliary current transformer is supplied to convert the 5 A load current into the 0.2 A used by the control.

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** button, 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.

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:

15" high x 9-1/4" wide x 4-1/8" deep (38.1 cm x 23.5 cm x 10.5 cm)

Approximate Weight: 2 lbs, 7 oz (1.11 kg)

Approximate Shipping Weight: 5 lbs, 7 oz (2.47 kg)

Approximate Weight with M-2001 Series Digital Tapchanger Control: 6 lbs, 12 oz (3.06 kg)

Approximate Shipping Weight with M-2001 Series Digital Tapchanger Control: 11 lbs, 7 oz (5.19 kg)

Warranty

The M-2354C Adapter Panel is covered by a five year warranty from date of shipment.

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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.

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1.0 Introduction

The Beckwith Electric M-2354C 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-2354C Adapter Panel, with the M-2001 Series Digital Tapchanger Control, provides a solid-state voltage control relay designed to directly replace McGraw-Edison 550 BHS LTC transformer 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 $\pm 0.3\%$ when tested in accordance with the ANSI/IEEE C57.15.9-1999 standard over a temperature range of -30°C to $+65^{\circ}\text{C}$. The control accuracy is $\pm 0.5\%$ when tested over the full operational temperature range of -40°C to $+85^{\circ}\text{C}$.
- 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.
- **AUTO/OFF/MANUAL** switch allows manual operation of the control.
- 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.
- **VOLTAGE SOURCE** switch disconnects the voltage transformer input and connects the **MOTOR PWR IN** and **VOLTAGE IN** binding posts to the voltage input and motor circuit.

▲ 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.

With the **VOLTAGE SOURCE** switch in the **EXT** position, the sensing and motor power circuits are connected to the **VOLTAGE IN** and **MOTOR PWR IN** binding posts on the front panel. 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.

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.

- **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 3](#) for J12 location).

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- **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.
- **RAISE** and **LOWER** band edge LEDs on the M-2001 Series Digital Tapchanger Control indicate when the input voltage is outside the voltage band.
- **NEUTRAL LIGHT** illuminates when the regulator is in the neutral tap position.
- **DRAG HANDS RESET** pushbutton resets the tapchanger position indicator drag hands.

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-2354C are shown in [Figure 1](#), [Figure 2](#) and [Figure 3](#). 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 will be reduced by the M-0169A auxiliary current transformer supplied to 0.2 A "full scale."

The external connections for the M-2354C are made to the wire harness which is connected to the 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-2354C, connections for the external dry contact may be made between TB1-7 and TB2-28 as shown in [Figure 1](#). 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-2354C are shown in [Figure 1](#), [Figure 2](#) and [Figure 3](#).

Lightning Protection

▲ CAUTION: For proper protection against system surges, chassis ground (M-2001 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.

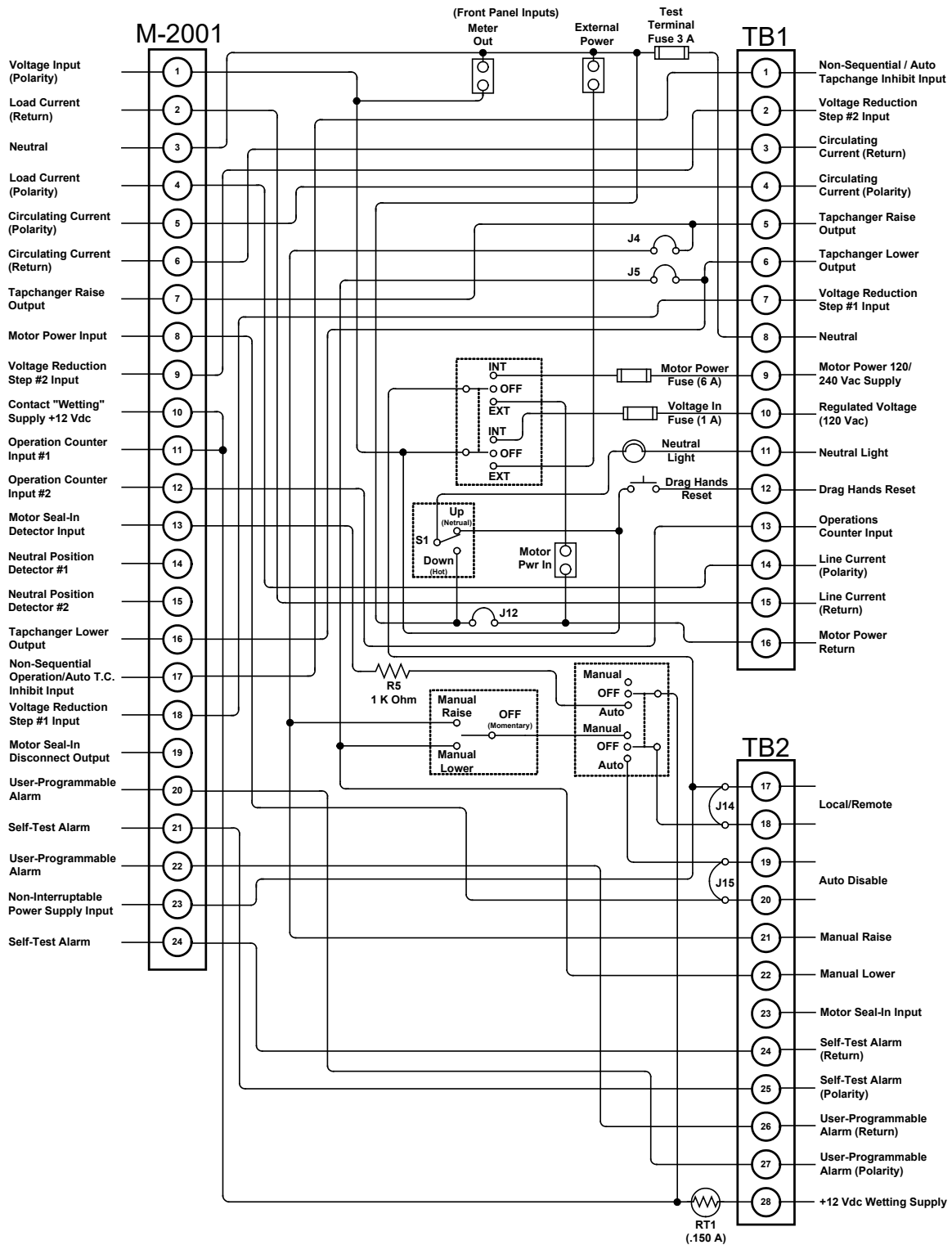
Neutral Light Circuit

The M-2354C is prepared for use with regulators which use a neutral light. This McGraw-Edison product does not use the Neutral Light terminal at TB1-11.

Non-Sequential Operation

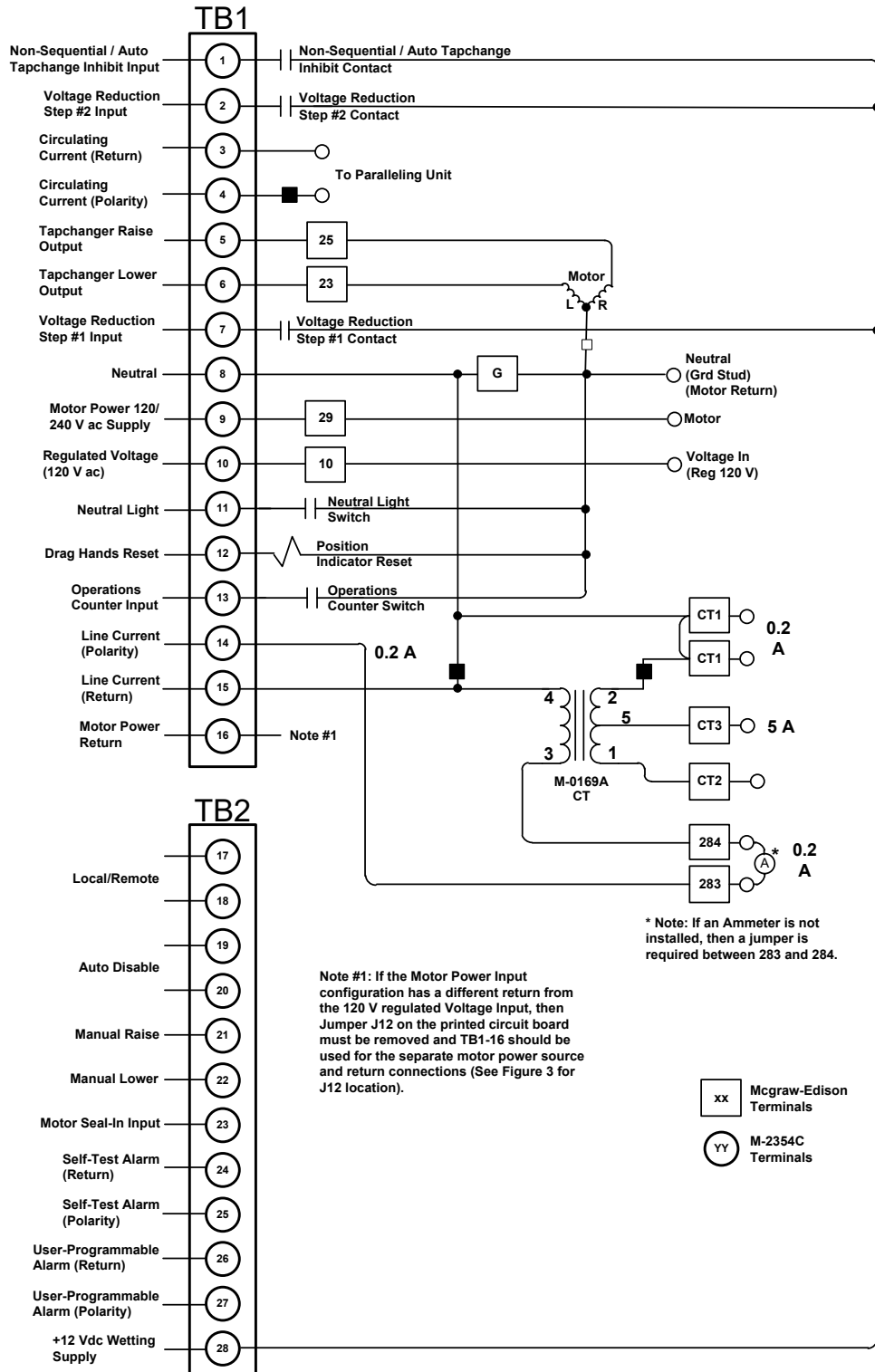
▲ CAUTION: Voltage applied through dry contacts to actuate non-sequential input *must* be + 12 Vdc obtained from pin TB2-28 of the M-2354C Adapter Panel.

The operation of the M-2354C can be interrupted during tapchanger operation by applying the "wetting" voltage of terminal TB2-28 to TB1-1 (timer reset for non-sequential operation input) on the printed circuit board through an external contact. This causes the output to de-energize and reinitialize the time delay circuit when the reset signal is removed. This function can be used to cause the LTC transformer, if so equipped, to wait for the unit to time out between tapchanges.



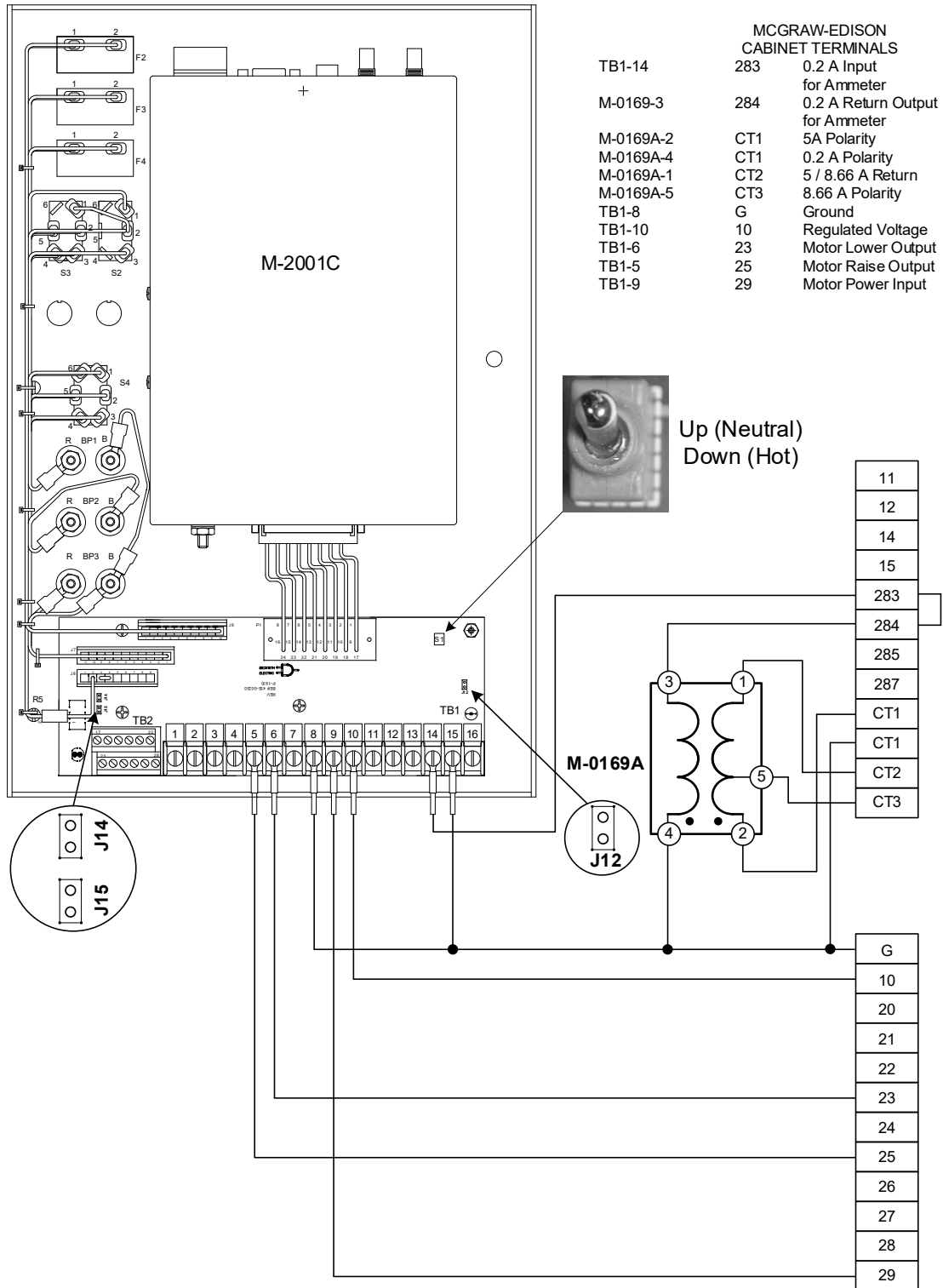
WARNING: In no case should the line current circuit be interrupted with the regulator or transformer energized. Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

Figure 1 M-2001 and M-2354C Typical Connections



WARNING: Open CT secondary will result in high voltage at CT terminals. Death, severe injury or damage to equipment can occur. Do not operate with CT secondary open. Short circuit or apply burden at CT secondary during operation.

Figure 2 External Connections



WARNING: Open CT secondary will result in high voltage at CT terminals. Death, severe injury or damage to equipment can occur. Do not operate with CT secondary open. Short circuit or apply burden at CT secondary during operation.

Figure 3 M-2354C Wiring Harness and External Connections

Automatic Disable Input

To disable automatic operation of the M-2354C, remove Jumper #15 (See [Figure 3](#), 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.

Operations Counter Input

▲ CAUTION: Do not apply any voltage to this terminal.

An operations count is registered by momentarily grounding TB1-13 through an external dry contact from the load tapchanger. The input is level-sensitive. Make sure that any "wetting" voltages are removed from the counter contacts before installing the M-2354C Adapter Panel/M-2001 Tapchanger Control.

Local/Remote Input

Removing Jumper #14 (See [Figure 3](#), for location) prohibits M-2001 operation by disabling the automatic raise and lower outputs and also by disabling the M-2354C 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-2354C adapter panel.

On the M-2354C, 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 1](#), External Connections. Voltage reduction amounts are set within the M-2001 Series Digital Tapchanger Control software.

Paralleling

See **M-2001C Instruction Book, Section 4.9, Parallel Operation.**

Operations Counter Input

▲ CAUTION: Do not apply any voltage to this terminal.

An operations count is registered by momentarily grounding TB1-13 through an external dry contact from the load tapchanger. The input is level-sensitive. Make sure that any "wetting" voltages are removed from the counter contacts before installing the M-2354C Adapter Panel/M-2001 Tapchanger Control.

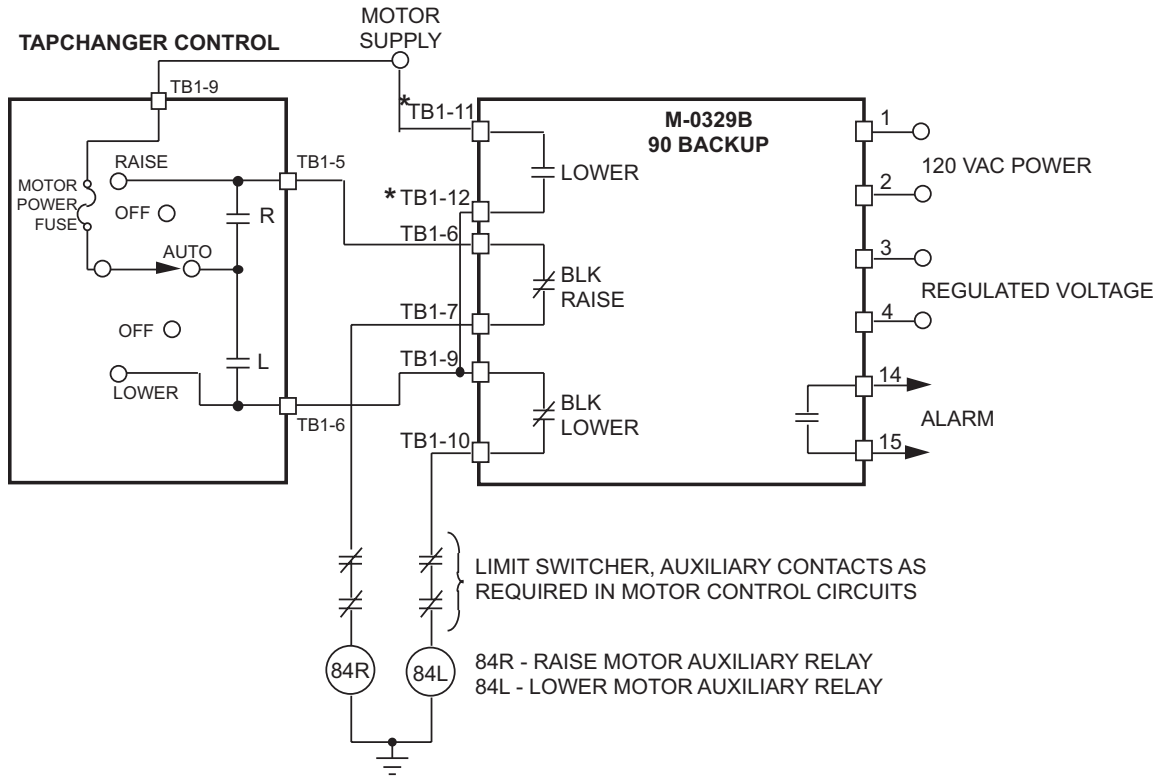
Multiple Reduction Setpoint: Multiplier Range	Apply "Wetting to Voltage" from TB2-28 to Terminal #
Voltage Reduction Setpoint #1: 0 to 1	TB1-7
Voltage Reduction Setpoint #2: 0 to 1	TB1-2
Voltage Reduction Setpoint #3: 0 to 1	TB1-7 and TB1-2

Table 1 Multi-Step Voltage Reduction External Connections

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 4](#) illustrates a typical interconnection of the two devices with motor auxiliary relays.



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.

Figure 4 Tapchanger Control and LTC Backup Control Interconnections

3.0 Installation

The M-2354C Adapter Panel is equipped with predrilled holes to allow easy mounting to the existing McGraw-Edison frame. Refer to [Figure 5](#) for outline dimensions and general orientation of adapter panel components.

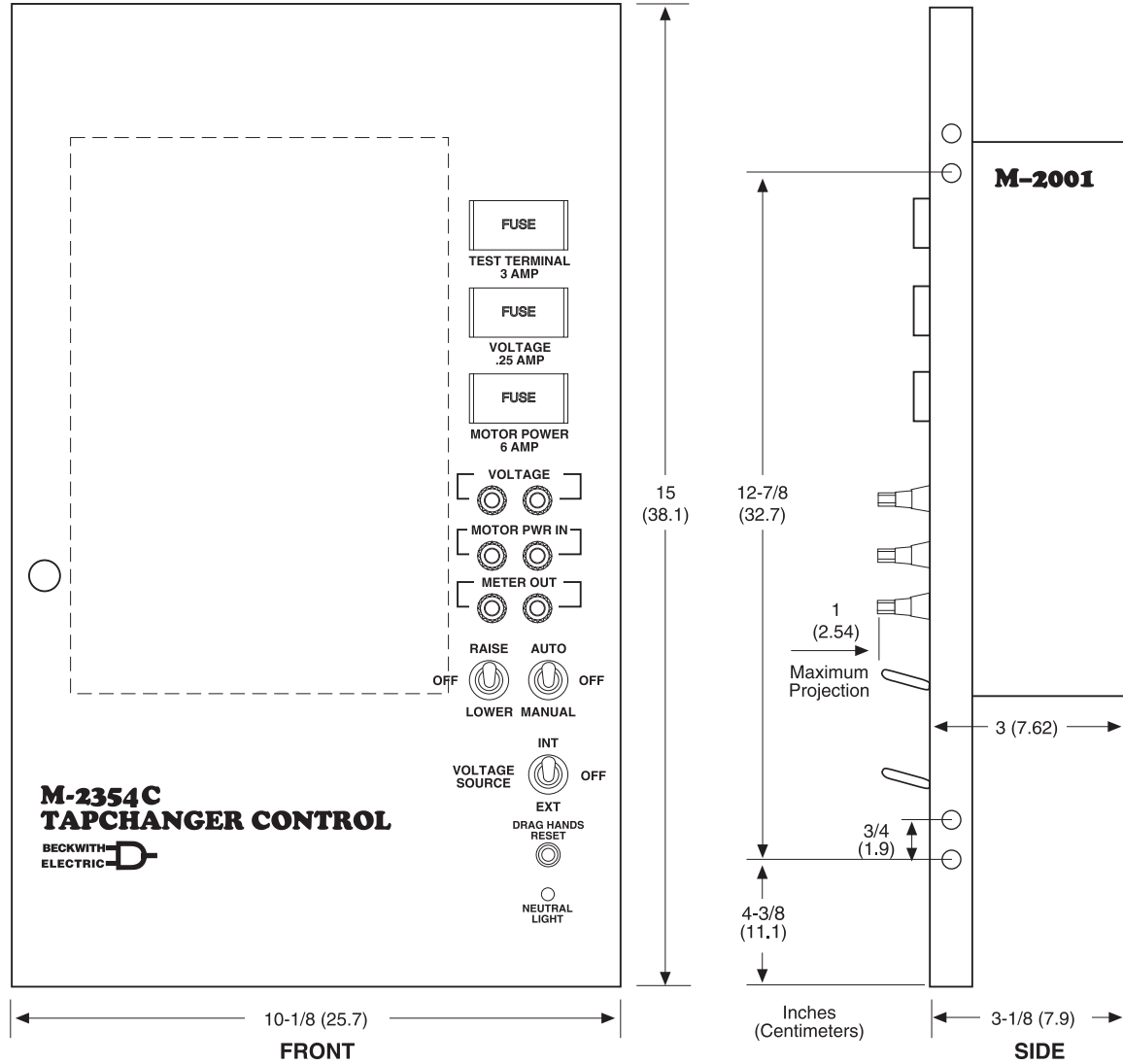


Figure 5 Front Panel Outline Dimensions

3.1 Removal of the McGraw-Edison Control

Refer to [Figure 6](#) below.

1. Loosen the wing nut on the sliding hinge.
2. Unscrew the knob on the control panel and swing the panel outward.
3. Remove the knob and save for future use.

● **WARNING: Open CT secondary will result in high voltage at CT terminals. Death, severe injury or damage to equipment can occur. Do not operate with CT secondary open. Short circuit or apply burden at CT secondary during operation.**

4. Short the 5 A load current transformer by placing jumpers between each of the two CT1's and CT2, and a jumper between CT2 and CT3.
Alternatively, the CT can be shorted before it reaches the control.
5. De-energize the transformer or remove voltage from terminals 10 and 29.

■ **NOTE:** The connections from the transformer are routed to the inside of the terminal blocks; do not remove the terminations

6. Remove the wire connections on the outside of the two terminal blocks.

■ **NOTE:** The hinge hardware, knob and the transformer mounting hardware *must be saved* from the original control.

7. Remove the mounting hardware for the small 6-position terminal block on the right side wall of the existing mounting bracket. This terminal block will be removed later.
8. Remove all connections to RCT-1, RCT-2 and APT; then remove the mounting hardware of those components. The panel, the 6-position terminal block and the three transformers are still wired together and therefore will be removed at one time.
9. Remove the swing panel by removing the hinge from panel. Save the hinge hardware since it will be used to attach the M-2354C Adapter Panel.

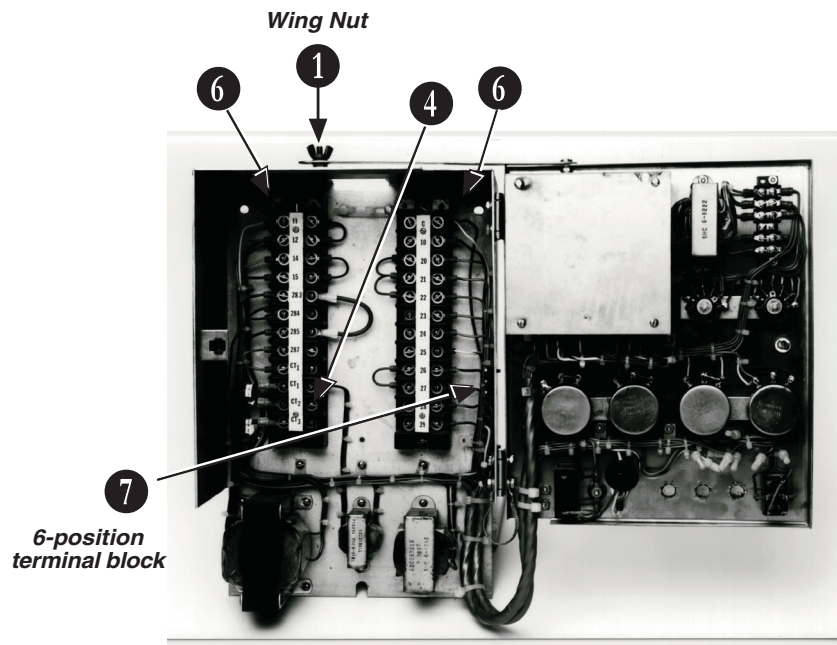


Figure 6 McGraw-Edison Control in Cabinet

3.2 Installing the M-2354C/M-2001

1. Mount the M-2001 to the M-2354C 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 7](#)). Check location of the key before plugging connector into the M-2001.

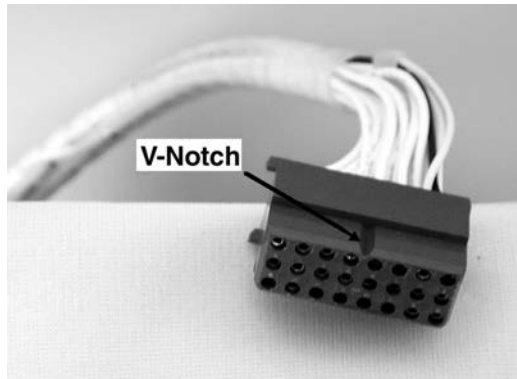


Figure 7 M-2001 Harness Connector

2. Plug the blue connector of the M-2354C harness into the bottom of the M-2001. If desired, bench testing may be performed at this time as described in [Section 5.0](#), Bench Test.

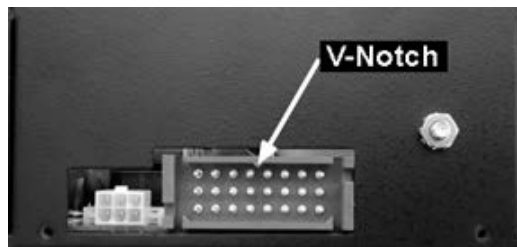


Figure 8 M-2001 V-Notch Orientation

3. Mount the M-2354C Adapter Panel (with the M-2001 Series Digital Tapchanger Control) onto the hinges in the mounting bracket ([Figure 9](#)).
4. Mount the knob saved from the existing control.
5. Mount the M-0169A Auxiliary Current Transformer with its mounting bracket where RCT-1 and RCT-2 were mounted using the mounting hardware saved earlier.
6. Connect the M-2354C's wiring harnesses to the two terminal blocks. Make all wiring connections; refer to [Figure 1](#), [Figure 2](#) and [Figure 3](#).

● **WARNING: Open CT secondary will result in high voltage at CT terminals. Death, severe injury or damage to equipment can occur. Do not operate with CT secondary open. Short circuit or apply burden at CT secondary during operation.**

7. Re-energize the transformer or reapply voltage to terminals 10 and 29.
8. Remove CT1 and CT2 shorting jumpers.
9. Swing the adapter panel closed and turn knob to latch securely.

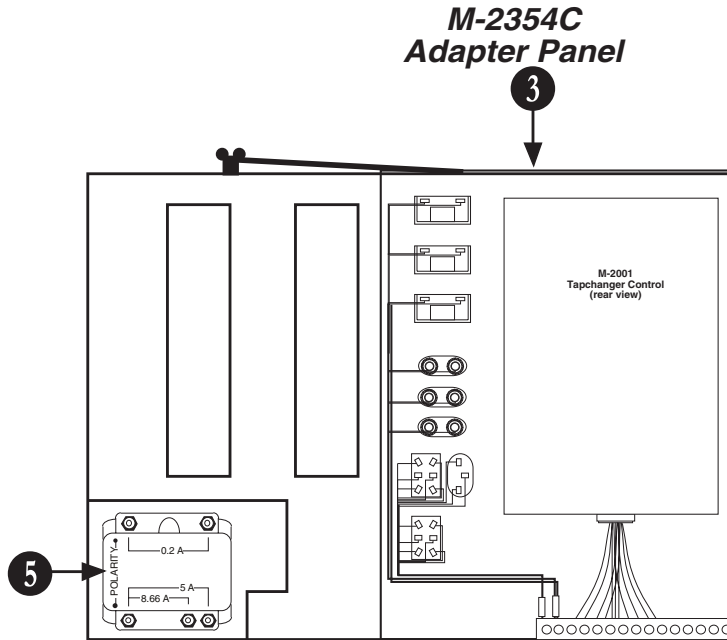


Figure 9 M-2354C Adapter Panel and M-2001 Tapchanger Control in Cabinet

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-2354C)

■ **NOTE:** This test assumes that the M-2001 Tapchanger Control is connected to the M-2354C Adapter Panel.

Test Equipment

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

● **WARNING:** The current input to the M-2001 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 $\pm 0.2\%$ of reading
- Accurate Stop watch

Setup

1. Make electrical connections as shown in [Figure 10](#), M-2354C Test Procedure External Connections.

■ **NOTE:** Refer to the **M-2001 Instruction Book, Appendix A**, Figures A-1 through A-13, 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:

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

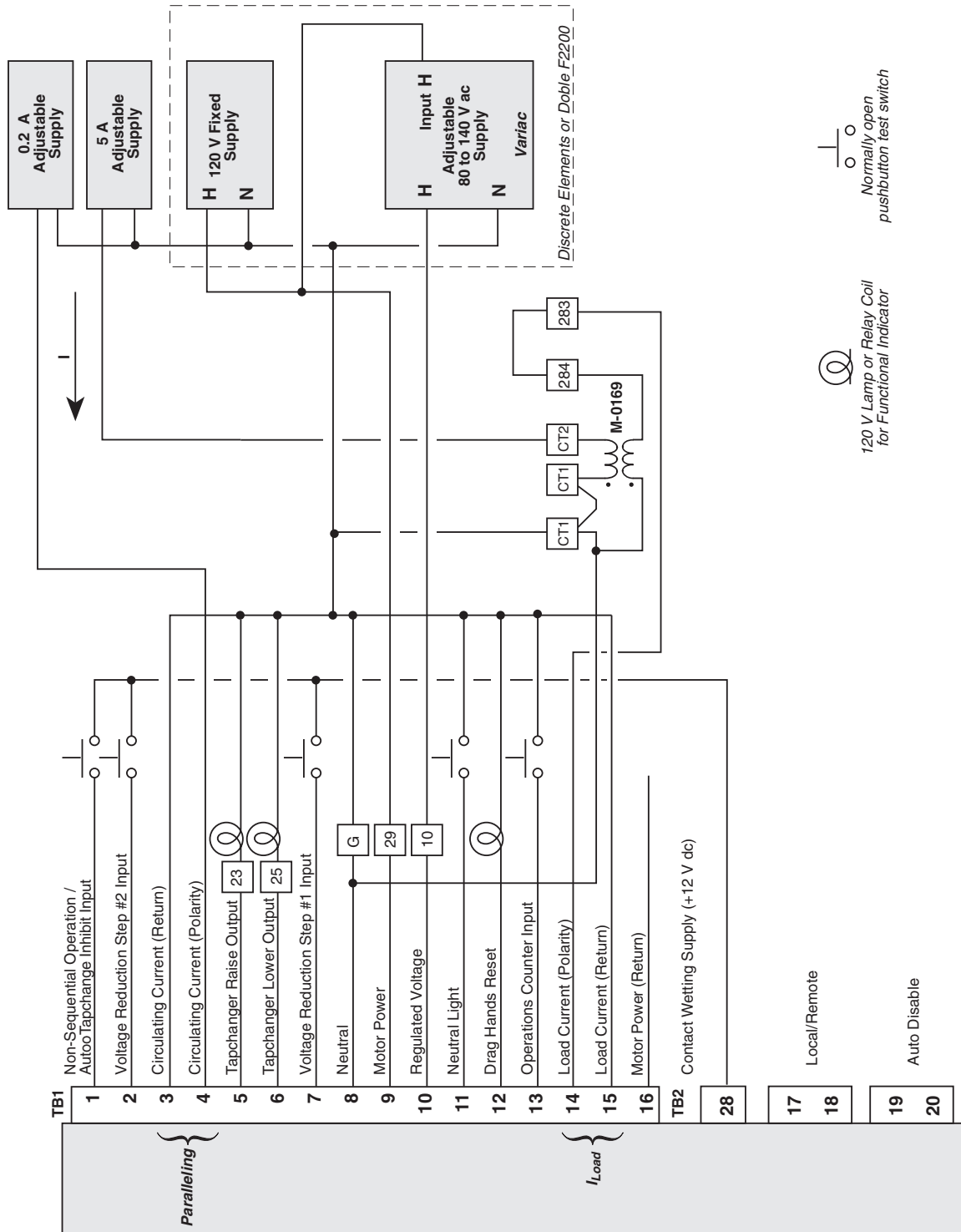


Figure 10 M-2354C Test Procedure External Connection

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. The **LOWER** LED should illuminate.
4. Decrease voltage to 118.8. The **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 121.0V.
7. Stop timing when the lamp connected to the **LOWER** output illuminates (should be approximately 5 seconds).

Resistance

1. Apply 2.5 A in-phase current to CT2 (5 A) (load current-polarity) and CT1 (load current-return) to the adapter panel's wire harness.
2. Set **LDC Resistance** to 24.0 V. The **RAISE** LED should illuminate.
3. Increase input voltage to 132.0 Vac. The **RAISE** and **LOWER** LEDs should be extinguished.
4. Set **LDC Resistance** to -24.0 V. The **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 2.5 A 90° leading current to CT2 (5 A) (load current-polarity) and CT1 (load current-return) to the adapter panel's wire harness.
2. Set **LDC Reactance** to 24.0 V. The **LOWER** LED should illuminate.
3. Decrease input voltage to 108.0 Vac. Both **RAISE** and **LOWER** LEDs should be extinguished.
4. Set **LDC Reactance** to -24.0 V. The **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.
7. Turn off current.

Paralleling

1. Apply 100.0 mA 90° leading current to TB1-4 (line current-return) and TB1-3 (circulating current-return) of the adapter panel.
2. The **LOWER** LED should illuminate.
3. Decrease voltage to 108.0 Vac. Both **RAISE** and **LOWER** LEDs should be extinguished.
4. Turn off current.

Voltage Source Switch

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

Drag Hands Reset

1. Connect a lamp or ac relay from TB1-12 (drag hands reset) to TB1-8 (neutral) of the adapter panel.
2. Depress the **DRAG HAND RESET** switch. The connected lamp or ac relay should operate.

Counter/Neutral Light/Tap Position

1. Set the M-2001 Series Digital 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. Place a jumper between TB1-11 (neutral light) and TB1-8 (neutral).
6. Set the Neutral Light Switch S1, located on the adapter panel printed-circuit board, to the toggle down position.
7. The neutral light on the adapter panel should illuminate and the tap position should return to "0 Neutral."
8. Remove the jumper.

Block Raise/Block Lower/Deadband

1. Set Block Raise to 126.0 V.
2. Set Block Lower to 114.0 V.
3. Set the M-2001 Series Digital Tapchanger Control to display the **Bias Voltage** screen.
4. Press **ENTER**.
5. Increase voltage to 126.5 V. The **BR** should be displayed on the screen.
6. Increase voltage to 128.5 V. The **BR** is replaced by **FL** on the screen.
7. Decrease voltage to 113.5 V. The **BL** is displayed on the screen.

—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 10 (motor power) and 29 (regulated voltage) of adapter panel's wire harness.
2. Connect neutral to G (neutral).
3. Verify local voltage \approx input voltage ± 0.3 V.
4. Apply 2.5 A in-phase current to CT2 (5 A) (load current-polarity) and CT1 (load current-return) of the adapter panel.
5. Verify **Control Load** $I \approx 100$ mA and **Power Factor** $\approx 1.0 \pm 0.02$.
6. Apply 100.0 mA 90° leading current to TB1-4 (circulating current-polarity) and TB1-3 (circulating current-return) of the adapter panel.
7. Verify **Control Circ** $I \approx 100.0$ mA ± 2 mA.
8. 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. Utilize the **UP** and **DOWN** pushbuttons to initiate **RAISE** and **LOWER** outputs.

—In-Service Test Complete—

Return unit to desired settings

5.3 M-2354C 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 29 and 10 which are located on the adapter panel printed circuit board.
3. Remove any voltage applied to 29 externally.
4. Using a voltmeter, ensure that the voltage applied to 10 is nominal 120 Vac with respect to G (neutral).
5. Apply power to 10 (hot) and G (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 29 (hot) and G (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-2354C for current checkout as illustrated in [Figure 11](#).

●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 283 and 284.
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. Place a jumper between 283 and 284.
7. Remove the shorting device across the load current input. 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.

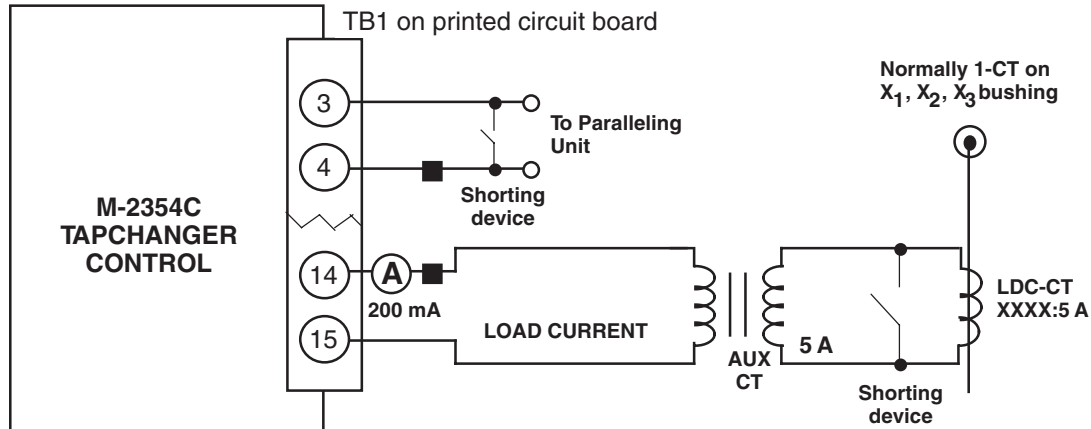


Figure 11 Setup for Current Checkout Procedure

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.

Seller makes no warranties expressed or implied other than those set out above. Seller specifically excludes the implied warranties of merchantability and fitness for a particular purpose. There are no warranties which extend beyond the description contained herein. In no event shall Seller be liable for consequential, exemplary, or punitive damages of whatever nature.

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.

It is agreed that when the equipment furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site, and all premises used for such operations.

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