



# Application Guide

**M-2270B  
Adapter Panel**

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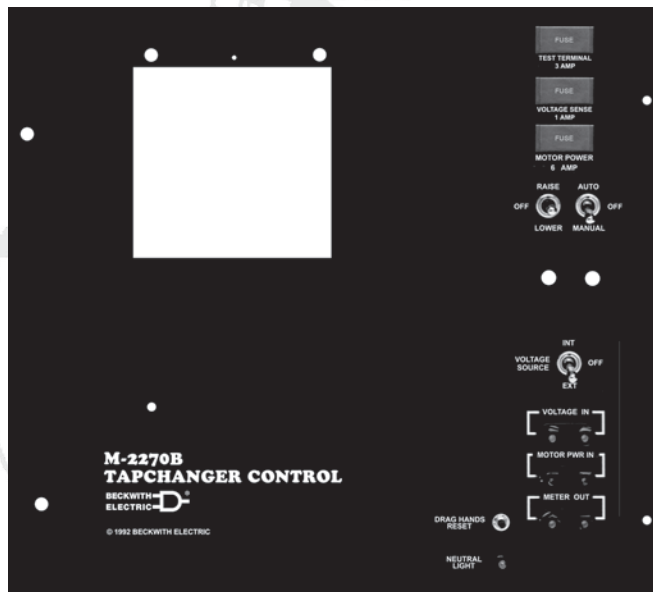
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# Adapter Panel M-2270B

**Adapts M-2001 Series Digital Tapchanger Control  
s a General Replacement for Transformer  
and Regulator Controls**



- Provides mounting adaptable to several different configurations
- Provides built-in CT shorting protection when the M-2001 Series Digital Tapchanger Control is removed
- Optional SCADA Cutout (Local/Remote) switch allows Local Blocking of SCADA commands (for use with SCADA enabled M-2001C controls)
- Optional SCAMP™ (SCADA Controlled Auto/Manual Pushbutton) replaces AUTO/OFF/MANUAL toggle switch
- Optional 2 Level Local Voltage Reduction switch
- Optional 19" Rack Mount Adapter Panel Kit

## M-2270B Adapter Panel

The M-2270B is an adapter panel which, when combined with the M-2001 Series Digital Tapchanger Control, can be customized to fit as a replacement for a variety of manufacturers' LTC transformers and regulator controls.

## Interface

External connections are made to two terminal blocks located on the rear of the adapter panel. The second terminal block provides access to 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** button, and **NEUTRAL LIGHT** are standard.

**NEUTRAL LIGHT** will light to indicate that the regulator is in the neutral position when used with regulators which provide a circuit for this purpose.

## Options

**SCADA CUTOFF** switch allows Local blocking of SCADA commands (for use with SCADA enabled M-2001C controls). Use of the SCADA Cutout Switch with the M-2001C, requires a M-2001C Control with firmware version D-0146V08.01.22 or later installed.

**SCAMPTM** (SCADA Controlled Auto/Manual Pushbutton) allows the Auto/Manual state on the adapter panel to be changed by a SCADA command. Use of the SCAMP pushbutton with the M-2001C, requires a M-2001C Control with firmware version D-0146V08.05.XX or later installed.

**Voltage Reduction** switch allows 2 levels of Voltage Reduction to be selected.

**19" Rack Mount Adapter Panel Kit (B-1569)** allows mounting the M-2270B and M-2001 series control in a 19", 8U rack application.

## 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:** 12-1/4" high x 12-1/2" wide x 4-1/8" deep (31.1 cm x 31.8 cm x 10.5 cm).

## **M-2270B Adapter Panel**

**Size with 19" Rack Mount Adapter Panel and M-2001 Series Digital Tapchanger Control:** 13.96" high x 19" wide x 4.22" deep  
(35.46 cm x 48.26 cm x 10.72 cm).

**Approximate Weight:** 3 lbs, 5 oz (1.5 kg)

**Approximate Shipping Weight:** 6 lbs (2.7 kg)

**Approximate Weight with Optional 19" Rack Mount Adapter Panel:** 4 lbs, 8 oz (2 kg)

**Approximate Shipping Weight with Optional 19" Rack Mount Adapter Panel:** 8 lbs, 8 oz (3.9 kg)

**Approximate Weight with M-2001 Series Digital Tapchanger Control:** 12 lbs, 5 oz (5.67 kg)

**Approximate Shipping Weight with M-2001 Series Digital Tapchanger Control:** 17 lbs (7.71 kg)

## **Warranty**

The M-2270B Adapter Panel and optional 19" Rack Mount Adapter Panel are 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-2270B Adapter Panel, used in conjunction with the M-2001 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-2270B Adapter Panel, with the M-2001 Tapchanger Control, provides a solid-state voltage control relay designed to replace General Electric static LTC transformer controls and some balance beam models. 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  $-30^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$ . The control accuracy is  $\pm 0.5\%$  when tested over the full operational temperature range of  $-40^{\circ}\text{C}$  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, for 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

The **Auto/Off/Manual** toggle switch allows Local Manual control operation. The M-2001 **Input Selection 1** in the **Configuration** menu must be set to **Switch Status Input**, with the exception of Cooper Regulators. The seal-in input will operate as a switch status input. All seal-in input functions will be disabled. In this mode, the switch status on the adapter panel can be read to determine if it is in Auto or Manual. The status can be read through the seal-in/switch status data point in the communications protocols.

#### VOLTAGE SOURCE

The **VOLTAGE SOURCE** switch disconnects the voltage transformer input and connects the **MOTOR PWR IN** and **EXT POWER 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 fuse (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 **EXT POWER IN** and **MOTOR PWR IN** binding posts on the front panel. The unit can be tested using an external 120 Vac 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 selected to the **EXT** position with no source connected to the front panel voltage inputs.

#### DRAG HANDS RESET

**DRAG HANDS RESET** button 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 or 240 V 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](#) or [Figure 5](#) 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 Tapchanger Control.

## Status Indicators

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

## Fuses

The Adapter Panel includes three replaceable fuses: Test Terminal (3 A), Voltage Sense (1 A), and Motor Power (6 A).

## Optional Features

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

**SCADA CUTOUT (LOCAL/REMOTE)** switch allows the local blocking of SCADA commands. Use of the SCADA Cutout switch requires a M-2001C 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. Use of the SCAMP pushbutton switch requires a M-2001C Series Control with firmware version D-0146V08.05.XX or later installed.

**Optional 19" Rack Mount Adapter Panel:** 19" Rack Mount Adapter Panel Kit (B-1569) allows mounting the M-2270B and M-2001 series control in a 19", 8U rack application.

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## 2.0 Application

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### External Connections

Power and voltage sensing are obtained either from a common source or from independent sources having a nominal 120 Vac output. 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-2270B 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 higher burden circuits, such as are found in paralleling schemes. Outputs of the auxiliary CTs are protected against overvoltage. For further information, refer to the Comprehensive System Manual "*LTC Transformer Control System including Paralleling and Backup Control*" (available for download at [www.beckwithelectric.com](http://www.beckwithelectric.com)).

The external connections for the M-2270B are made to terminal blocks TB1 and TB2. Auxiliary external connections, if needed, are made to terminal blocks TB1 and TB2 on the printed circuit board at the base of the adapter panel. The wiring harness and external connections for the M-2270B are shown in [Figure 3](#) through [Figure 5](#).

### Neutral Light Circuit

If the Neutral Light terminal TB1-11 needs to be grounded for the light to illuminate, set switch S1 (located in the right-hand corner of the adapter panel printed circuit board) to the toggle up position. If the Neutral Light terminal TB1-11 needs to be powered for the light to illuminate, set switch S1 (located in the right-hand corner of the adapter panel printed circuit board [Figure 4](#) and [Figure 5](#)) to the toggle down position (Hot).

### Non-Sequential Operation (N/A for BASE-R or BASE-RS)

The operation of the M-2270B can be interrupted during tapchanger operation by momentarily applying the "wetting" voltage of terminal TB2-28 to TB1-1 (timer reset for non-sequential operation input) 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.

**▲ CAUTION:** Voltage applied through dry contacts to actuate non-sequential input *must* be nominal +12 Vdc obtained from pin TB2-28 of the M-2270B adapter panel. If an M-0280 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 located on the top of the rear panel of the M-0280. Carefully examine the contacts of these functions to remove 120 Vac wetting voltages.

### Automatic Disable Input

To disable automatic operation of the M-2270B, remove Jumper #15 (See [Figure 4](#) and [Figure 5](#), 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-2270B Adapter Panel/M-2001 Tapchanger Control.

### Local/Remote Input

Removing Jumper #14 (See [Figure 4](#) and [Figure 5](#), for location) prohibits M-2001 operation by disabling the automatic raise and lower outputs and also by disabling the M-2270B 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 nominal +12 Vdc obtained from pin TB2-28 of the M-2270B adapter panel. If an M-0280 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 located on the top of the rear panel of the M-0280. Carefully examine the contacts of these functions to remove 120 Vac wetting voltages.

On the M-2270B, 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](#) and [Figure 3](#). Voltage reduction amounts are set within the M-2001 Tapchanger Control software.

Voltage Reduction Setpoint: Multiplier Range	Apply "Wetting Voltage" from TB2 28 to Terminal #
Voltage Reduction Setpoint #1: 0 to 10%	TB1-7
Voltage Reduction Setpoint #2: 0 to 10%	TB1-2
Voltage Reduction Setpoint #3: 0 to 10%	TB1-7 and TB1-2

*Table 1 Multi-Step Voltage Reduction External Connections*

## Paralleling

For further information, refer to the Comprehensive System Manual *"LTC Transformer Control System including Paralleling and Backup Control"* (available for download at [www.beckwithelectric.com](http://www.beckwithelectric.com)).

## Operations Counter Input

**▲ CAUTION:** Do not apply either +12 Vdc or 120 Vac 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-2270B Adapter Panel/M-2001 Tapchanger Control.

## Connections for LTC Transformers and Regulators

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.

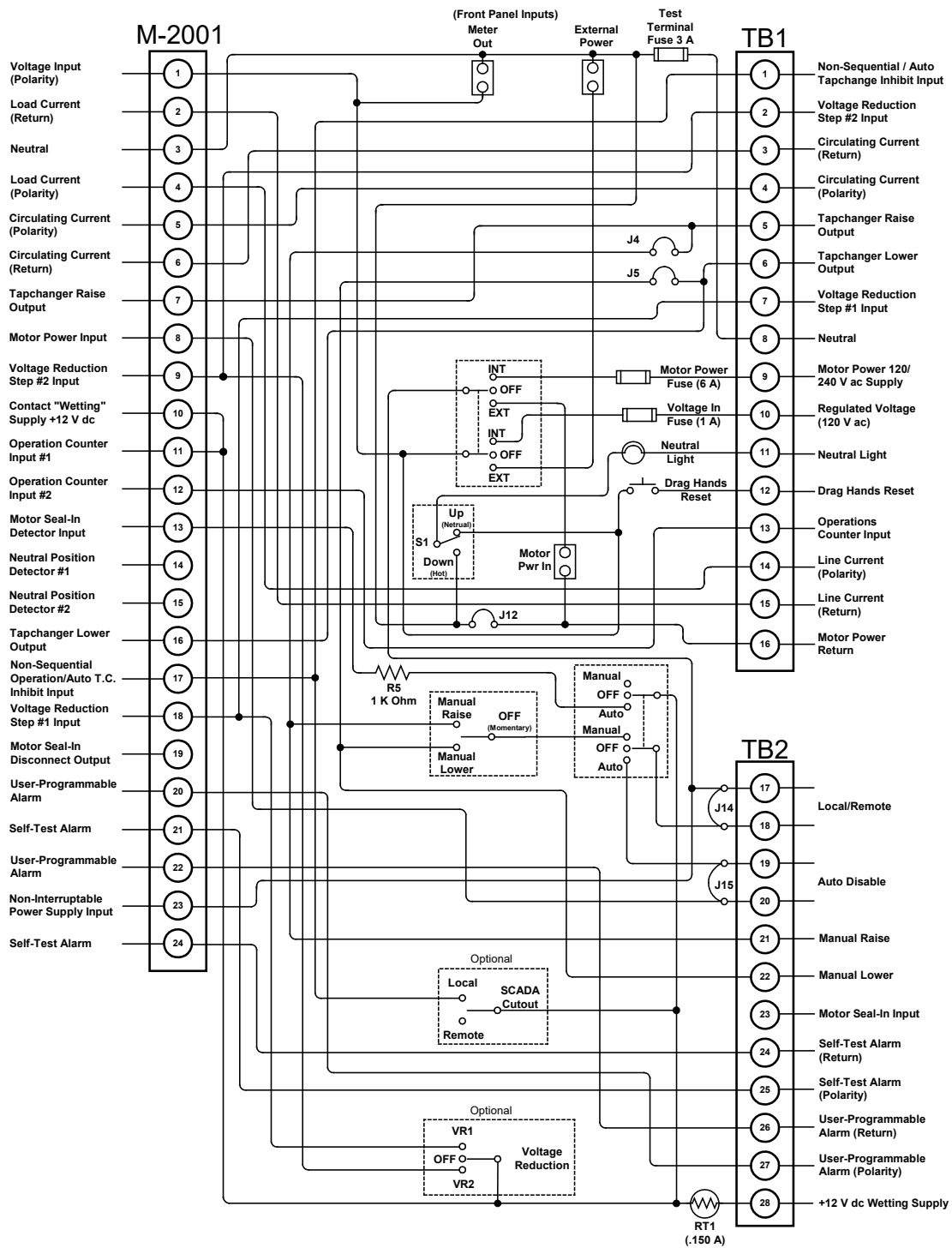
A typical connection for an M-2270B is shown in [Figure 3](#). Connections are simplified and may not show all functions required in a typical load tapchanging transformer control scheme; for example, seal-in contacts, limit switches, etc.

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

The M-0329 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-0329 LTC Backup Control is connected as a two terminal device to the voltage transformer. [Figure 4](#) shows the typical interconnection of the two devices with motor auxiliary relays.

The M-0329 Specification is available on [www.beckwithelectric.com](http://www.beckwithelectric.com) and gives additional details. Please refer to the M-0329 Specification for complete ordering information.

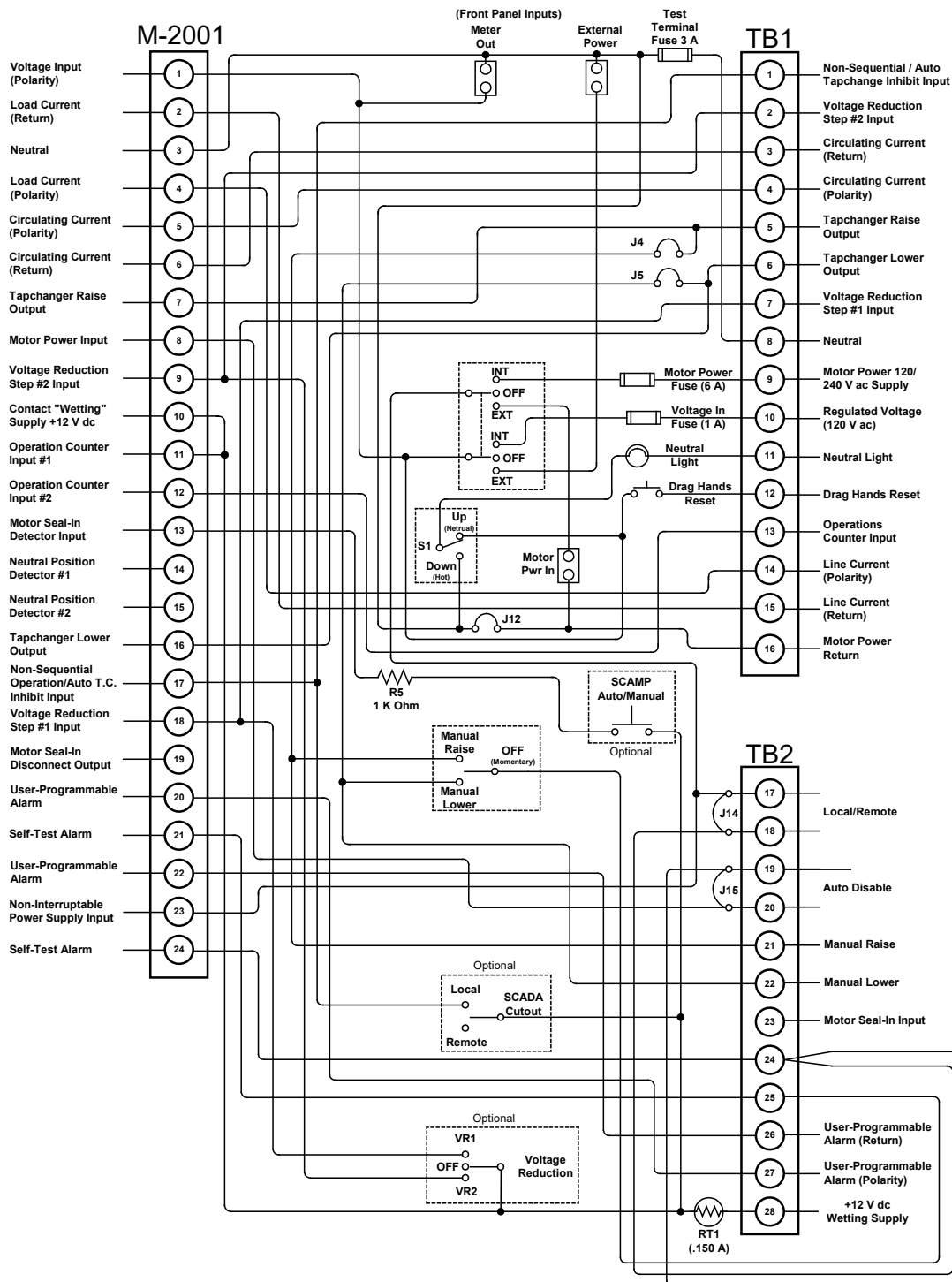


**WARNING:** In no case should the line current circuit be interrupted with the regulator or transformer energized. Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

**NOTE:** 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](#) or [Figure 5](#) for J12 location).

Figure 1 M-2001 and M-2270B Adapter Panel with Standard Auto/Off/Manual Toggle Switch and Optional Voltage Reduction and SCADA Cutout Switches



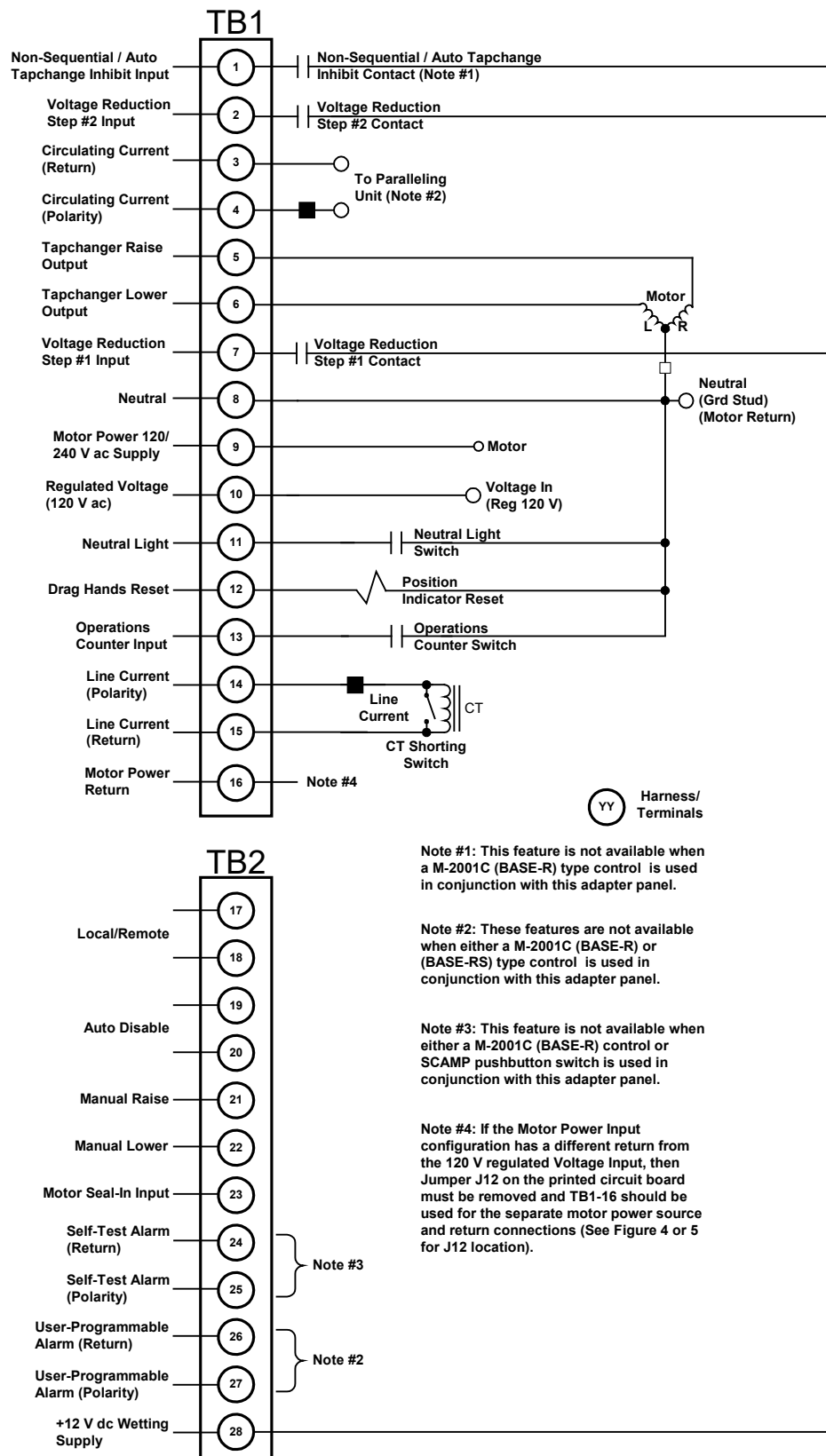


**WARNING:** In no case should the line current circuit be interrupted with the regulator or transformer energized. Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.

**NOTE:** 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](#) or [Figure 5](#) for J12 location).

Figure 2 M-2001 and M-2270B Adapter Panel with Optional SCAMP™ Auto/Manual Pushbutton, SCADA Cutout and Voltage Reduction Switches





**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 External Connections

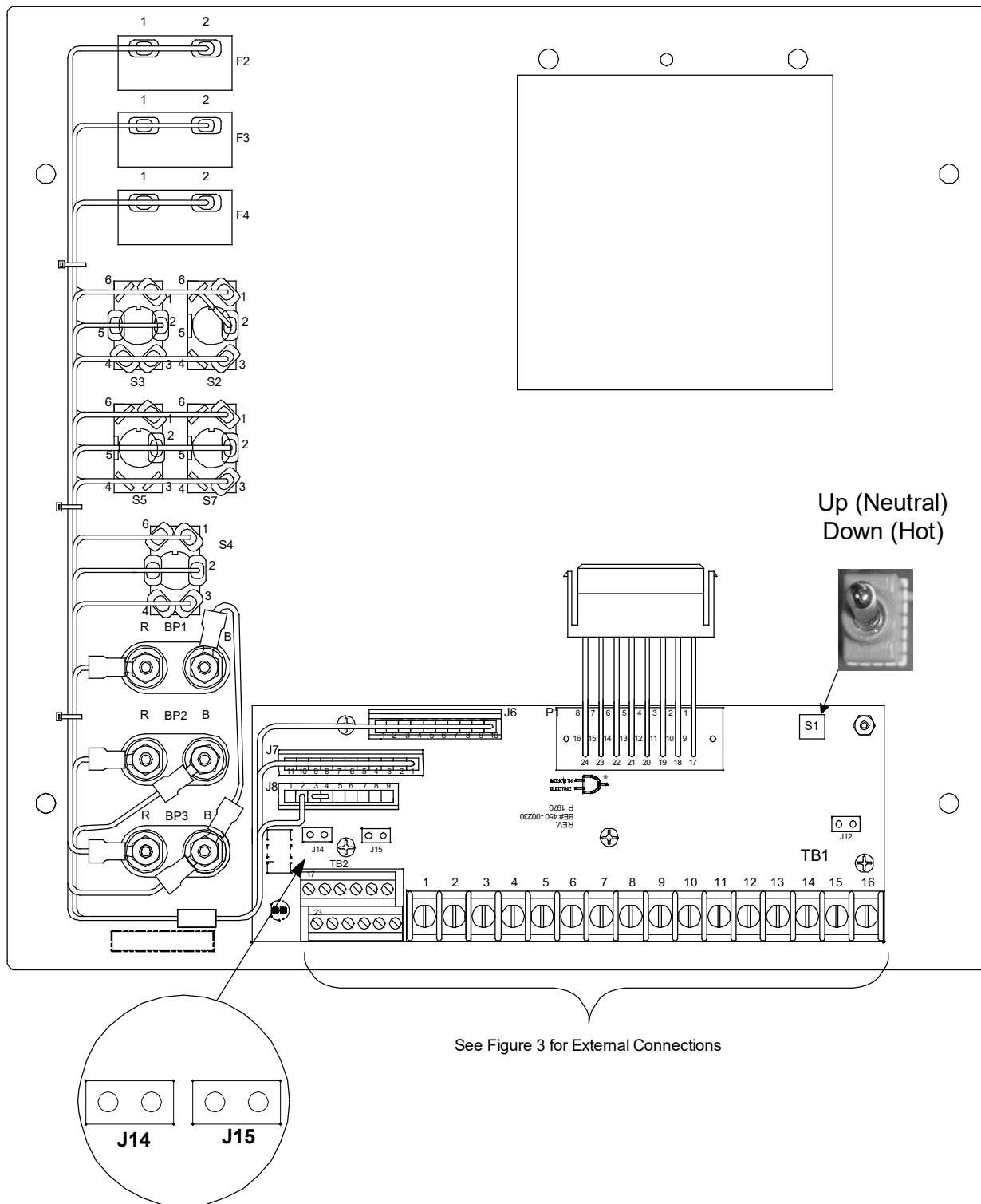
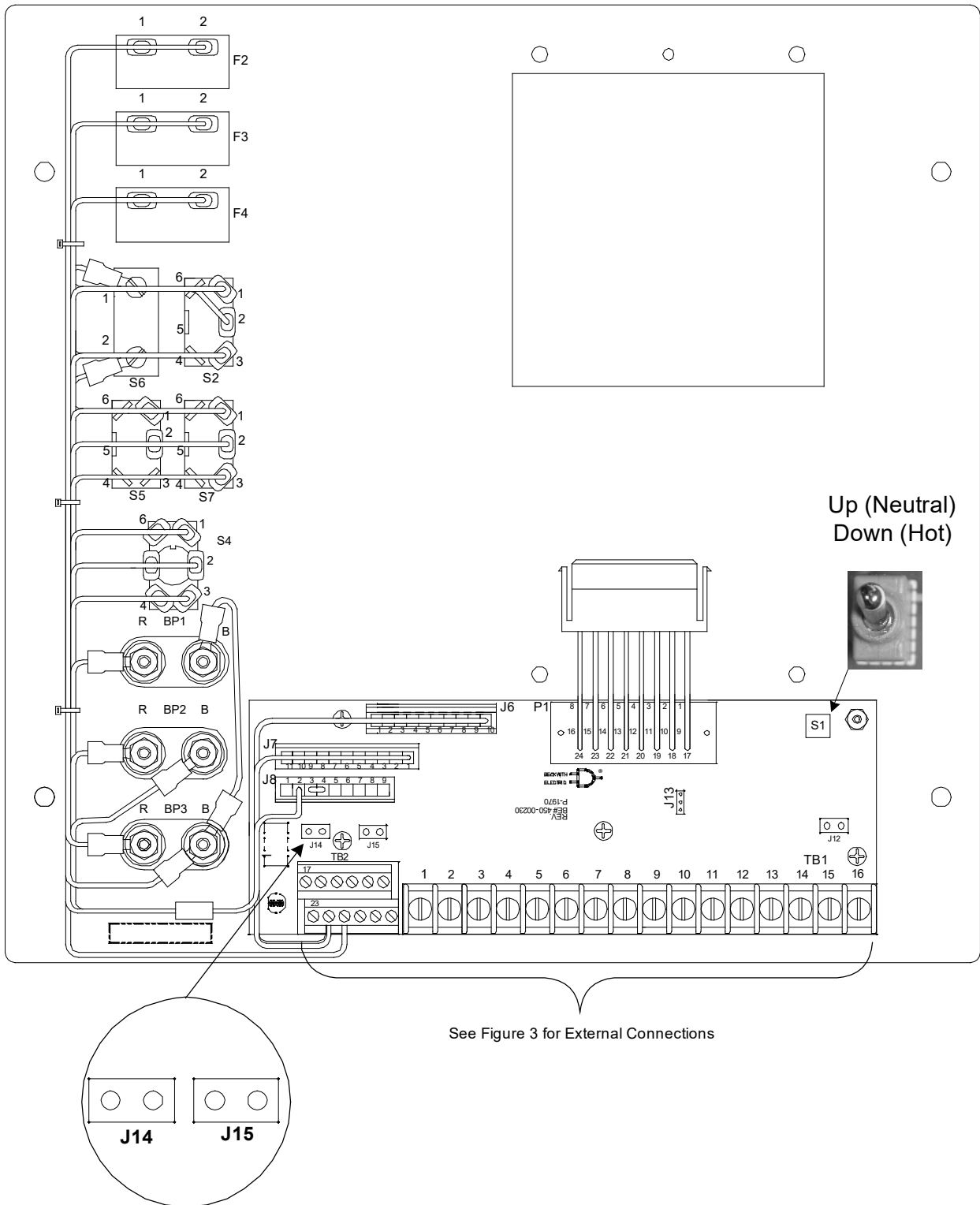
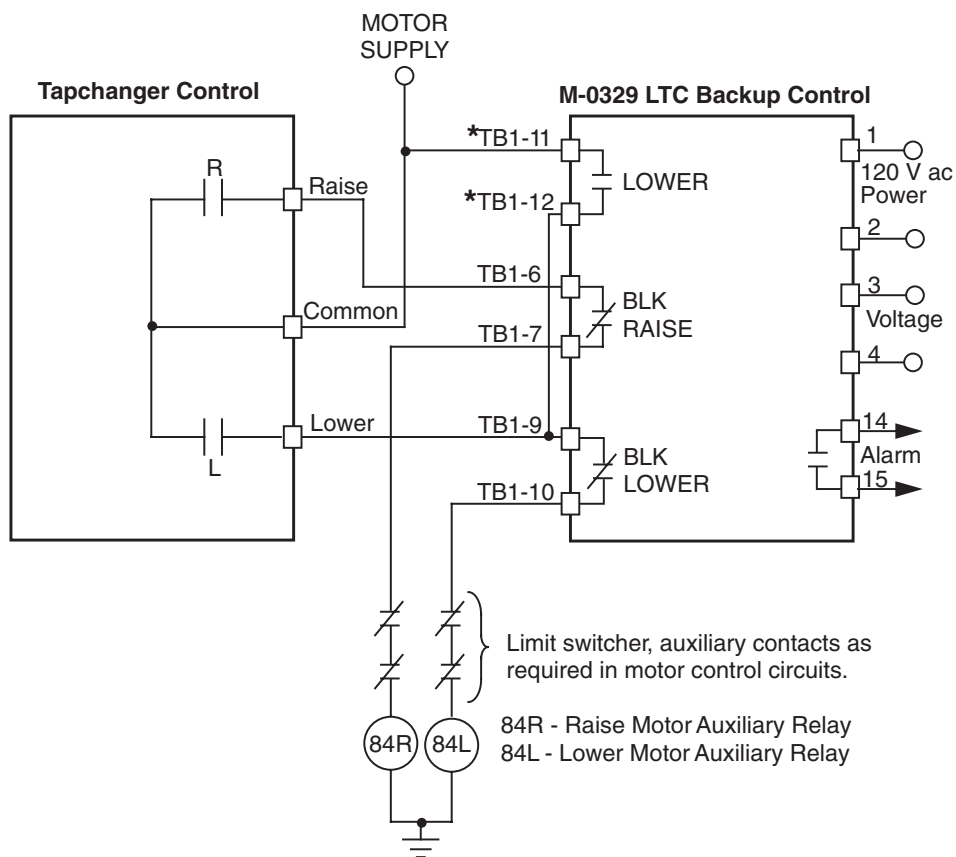


Figure 4 M-2270B Wiring Harness with Standard Auto/Off/Manual Toggle Switch, Optional Voltage Reduction and SCADA Cutout Switches



*Figure 5 M-2270B Wiring Harness with Optional SCAMP™ Auto/Manual Pushbutton, Voltage Reduction and SCADA Cutout Switches*



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

Figure 6 Tapchanger Control and LTC Backup Control Interconnections

### 3.0 Installation

The M-2270B is a flat-panel, general purpose adapter panel that is designed for surface mounting in a 10½" x 12" panel cutout. Remove the old control from the cabinet. Refer to [Figure 7](#) for outline dimensions; refer to [Figure 8](#) for panel cutout dimensions of the M-2270B.

#### Installation of the M-2001 Tapchanger Control

Mount the M-2001 Tapchanger Control to the back of the M-2270B Adapter Panel and secure with the four screws provided. The four screws are shipped in a drawstring bag which is attached to the adapter panel. Insert the plug from the adapter panel into the connector at the base of the M-2001. Then install the M-2270B Adapter Panel (with the M-2001 Tapchanger Control) into the control cabinet.

#### Installation of the M-2270B Adapter Panel

Mount the M-2270B Adapter Panel (with the M-2001 Tapchanger Control) in the control cabinet utilizing appropriate fasteners in the four mounting holes. External connections are made to the terminal block on the rear of the adapter panel (TB1). Refer to [Figure 3](#) through [Figure 5](#) for the M-2270B external connections.

#### Installation of the M-2270B Adapter Panel in the 19" Rack Mount Adapter Panel

The B-1569 19" Rack Mount Adapter Kit is available for rack mount applications. Mount the M-2270B Adapter Panel (with the M-2001 Tapchanger Control) into the 19" Rack Mount Adapter Panel using the included fasteners in the four mounting holes. Then mount the assembly into the 19" rack using the included fasteners. External connections are made to the terminal block on the rear of the adapter panel (TB1). Refer to [Figure 3](#) through [Figure 5](#) for the M-2270B external connections.

## Lightning Protection

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. 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.

**▲ CAUTION:** For proper protection against system surges, chassis ground must be connected to earth 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.

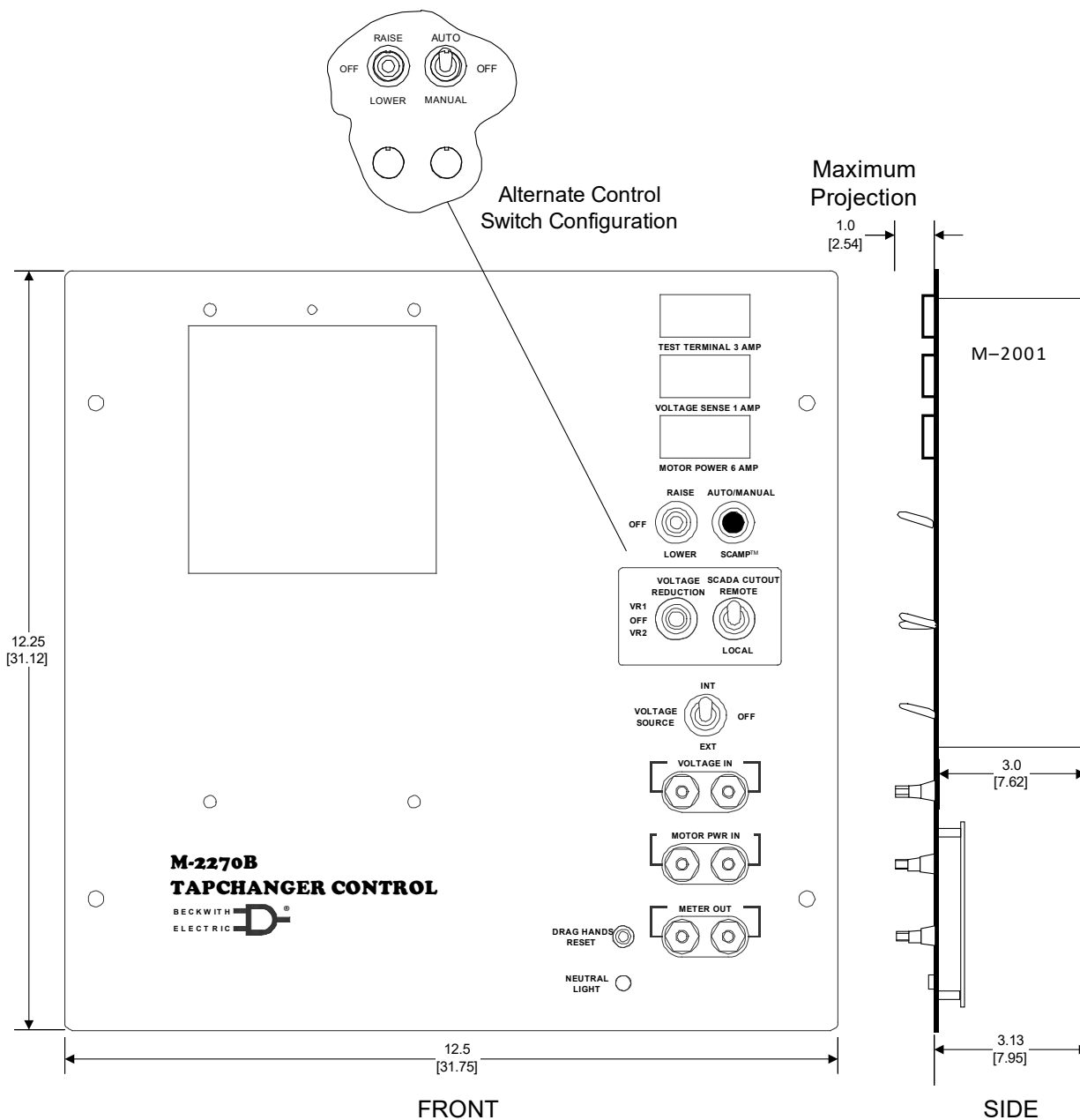


Figure 7 Outline Dimensions

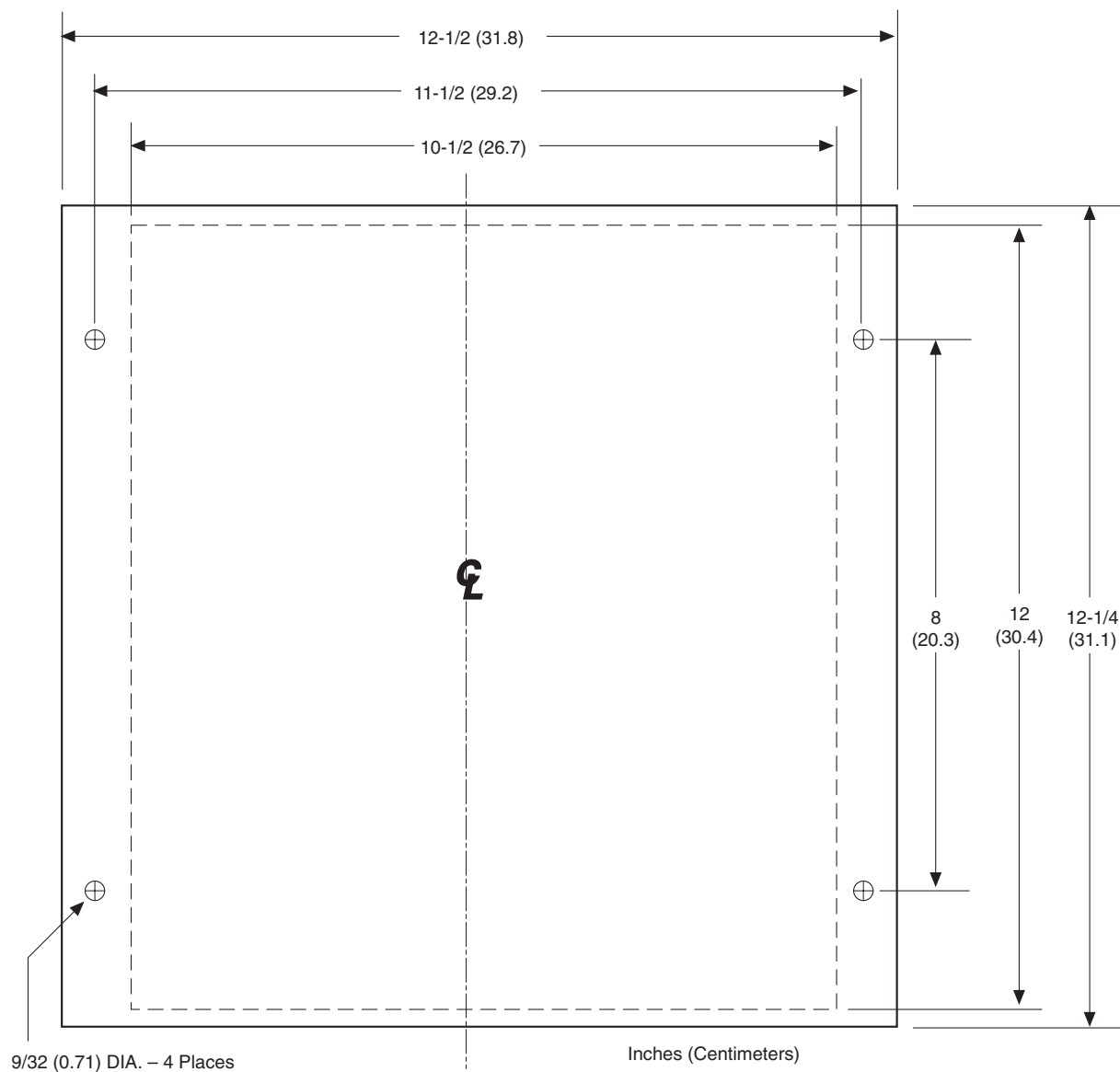


Figure 8 M-2270B Panel Cutout Dimensions

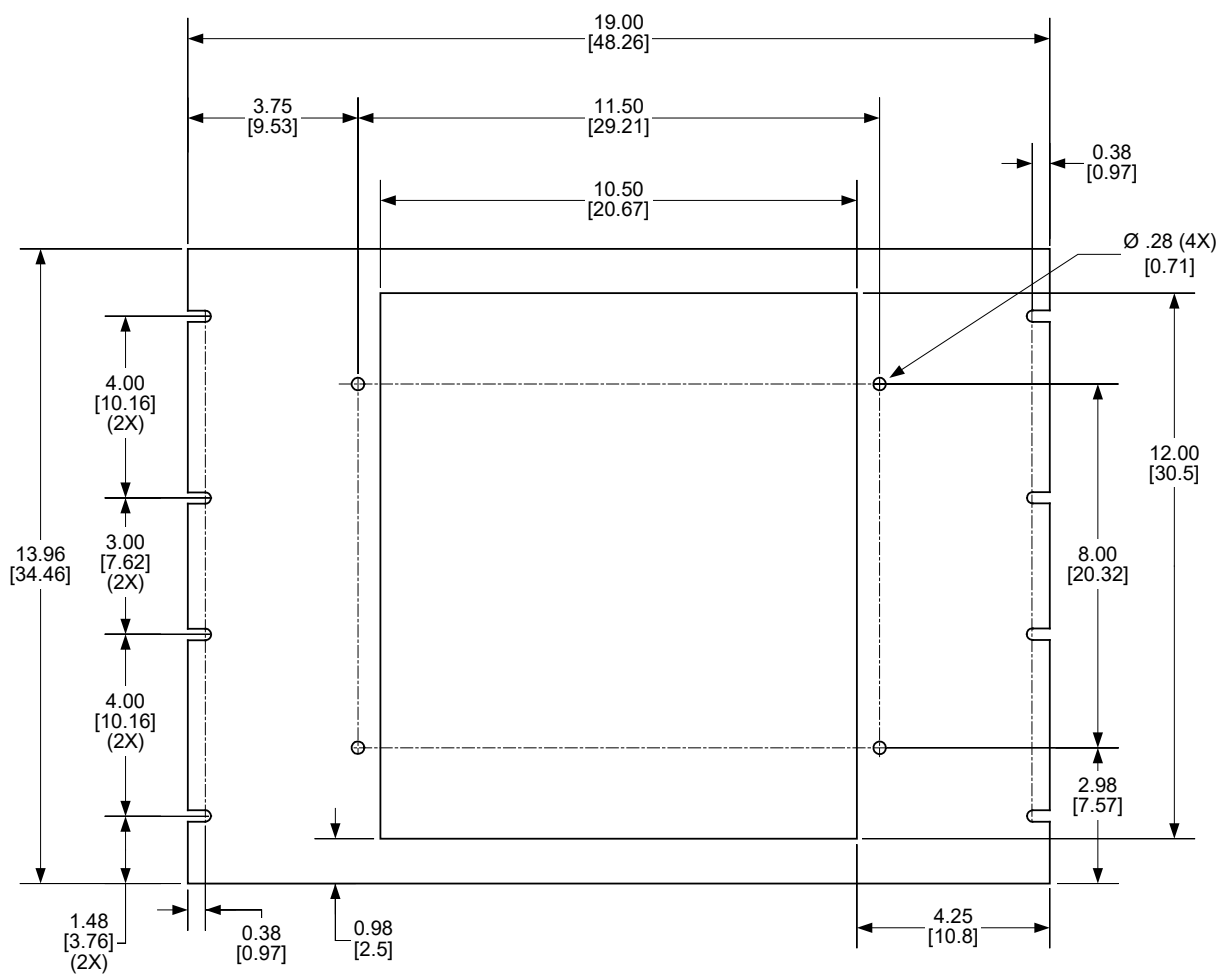


Figure 9 19" Rack Mount Adapter Panel Kit (B-1569) Dimensions

## 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, refer to the Comprehensive System Manual *"LTC Transformer Control System including Paralleling and Backup Control"* (available for download at [www.beckwithelectric.com](http://www.beckwithelectric.com)).

### 4.1 M-0329 LTC Backup Control Settings

The BANDCENTER and BANDWIDTH dials on the M-0329 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-0329 Block Raise limit should be set at the maximum voltage desired at the transformer secondary under full load.

The M-0329 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-2270B)

**NOTE:** This test assumes that the M-2001 Tapchanger Control is connected to the M-2270B Adapter Panel.

### Test Equipment

- 0–200 mA current supply with phase angle settings of 0° to +90°
- 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 the electrical connections as shown in [Figure 10](#). Refer to the applicable M-2001 Instruction Book for the locations of screens within the software.

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

2. Enter initial M-2001 settings:

Function	Initial Setting
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
Time Delay	5.0 seconds

Table 2 Initial Settings



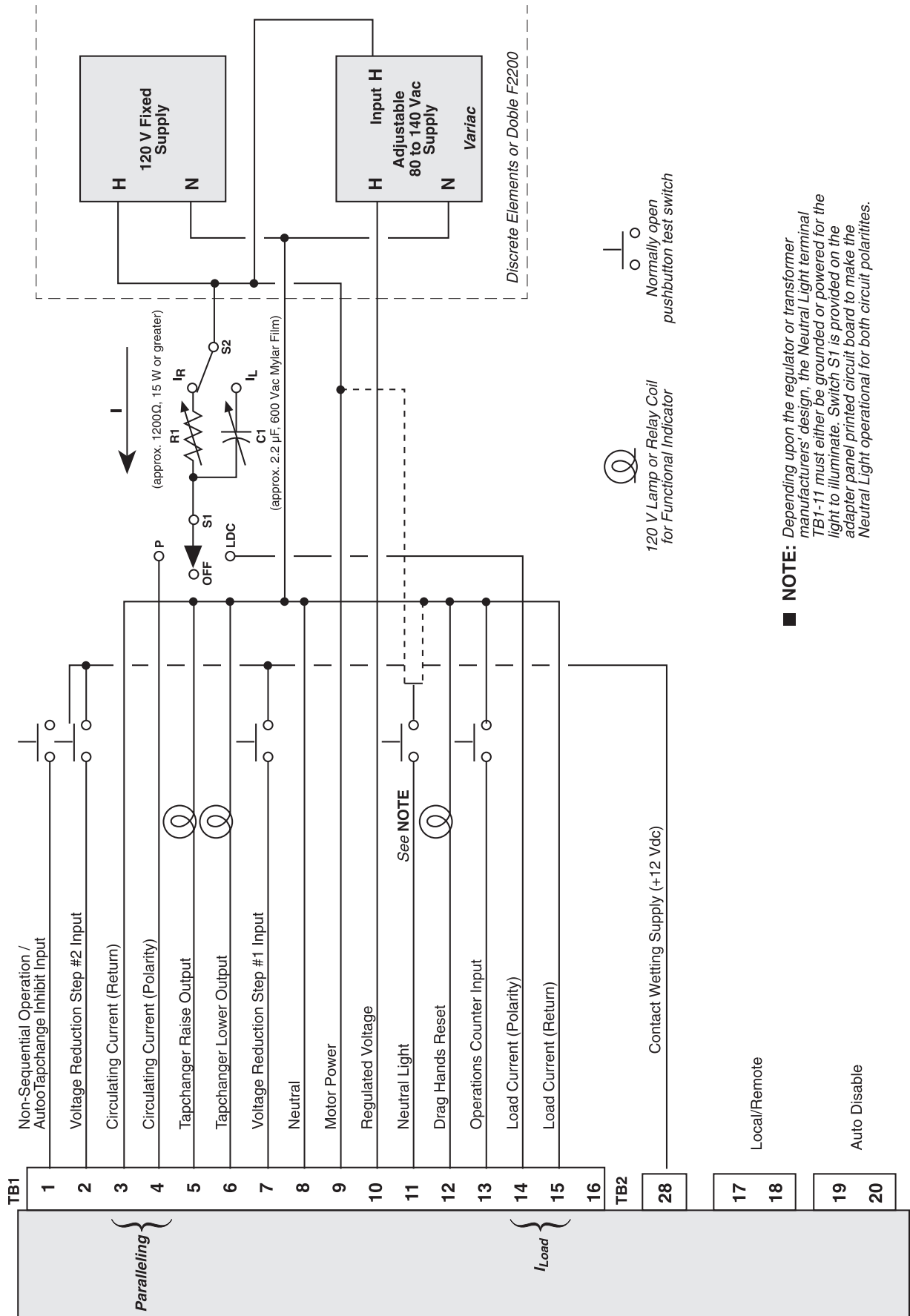


Figure 10 M-2270B Test Procedure External Connections

### Procedure

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 121.0 V.
7. Stop timing when the lamp connected to the **LOWER** output illuminates (should be approximately 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. 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 100.0 mA 90° leading current to TB1-14 (load current-polarity) and TB1-15 (load current-return) of the adapter panel.
2. Set  $S_1$  to LDC and  $S_2$  to  $I_L$ .
3. Set LDC Reactance to 24.0 V. The **LOWER** LED should illuminate.
4. Decrease input voltage to 108.0 Vac. The **RAISE** and **LOWER** LEDs should be extinguished.
5. Set LDC Reactance to -24.0 V. The **RAISE** LED should illuminate.
6. Increase input voltage to 132.0 Vac. Both **RAISE** and **LOWER** LEDs should be extinguished.
7. Set LDC Reactance to 0.0 V.

### Paralleling

1. Apply 100.0 mA 90° leading current to TB1-4 (circulating current-polarity) 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 there is no manual **Raise** or **Lower** output.
4. Attach a voltmeter to **Meter Out** terminals.
5. Verify that no voltage is present.
6. Apply 120 Vac to both the **Voltage In** and **Motor Pwr In** binding posts (Black-Neutral, Red-Hot).
7. Set the **AUTO/OFF/MANUAL** switch to **AUTO**.
8. Verify normal raise and lower operation.
9. Return the **VOLTAGE SOURCE** switch to **INT**.

### Drag Hands Reset

Verify that the **DRAG HAND RESET** switch works by connecting a lamp or ac relay from TB1-12 (drag hands reset) to TB1-8 (neutral) of the adapter panel. When the switch is pressed, the connected indicator should function.

### Counter/Neutral Light/Tap Position

1. Set the M-2001 Tapchanger Control to display the **Operations Count** screen.
2. Verify the counter operation by connecting 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 lights. Allow the delay timer to time out and then activate the switch between TB1-13 (operations counter input) and TB1-8 (neutral).
4. The tap position should change.
5. Jumper TB1-11 (neutral light) to TB1-8 (neutral).
6. Set the neutral light switch S1, located on the adapter panel printed-circuit board ([Figure 4](#) and [Figure 5](#)), to the toggle down position (Hot).
7. The neutral light on the adapter panel should light and the tap position should return to "0 Neutral."
8. 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 be displayed on the screen.
6. Increase voltage to 128.5 V. **BR** extinguishes and **FL** is displayed on the screen.
7. Decrease voltage to 113.5 V. **BL** is displayed on the screen.

—Bench Test Complete—

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## 5.1 M-2001 Checkout Procedure

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■ **NOTE:** This test of the M-2001 assumes that the unit is connected to the M-2270B adapter panel.

### Basic Operational Test

1. Apply 120.0 Vac to TB1-9 (motor power) and TB1-10 (regulated voltage) of the adapter panel.
1. Connect neutral to TB3-5 (neutral).
2. Verify local voltage  $\approx$  input voltage  $\pm 0.3$  V.
3. 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**  $\approx$  100 mA and **Power Factor**  $\approx$  1.0  $\pm 0.02$ .
4. Apply 100.0 mA 90° leading current to TB1-4 (circulating current-polarity) and TB1-3 (circulating current-return) of the adapter panel.
5. Verify **Control Circ I**  $\approx$  100.0 mA  $\pm 2$  mA.
6. Verify **Up**, **Down** and **Enter** buttons work.

—Checkout Procedure Complete—

## 5.2 In-Service Test

1. Set the M-2001 Tapchanger Control to display the **Bias Voltage** screen.
2. Press **Enter**.
3. Use **Up** and **Down** buttons to cause **RAISE** and **LOWER** outputs.

—In-Service Test Complete—

■ **NOTE:** Return unit to desired settings

## 5.3 M-2270B Checkout Procedure

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

Set the **AUTO/OFF/MANUAL SWITCH** to **OFF**. Inspect the **MOTOR POWER** and **VOLTAGE** fuses to ensure they are correctly sized and have not blown.

### Power

1. Remove any external connection between TB1-9 and TB1-10 which are located on the adapter panel printed circuit board. Also remove any voltage applied to TB1-9 externally. Using a voltmeter, make sure that the voltage applied to TB1-10 is nominal 120 Vac with respect to TB1-8 (neutral). Apply power to TB1-10 (hot) and TB1-8 (neutral).
2. Connect a voltmeter to the **METER OUT** test terminal on the front of the adapter panel. 120 Vac should be indicated.

● **WARNING:** 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. Do not connect any voltage source at the **METER OUT** test terminal.

▲ **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.

3. Apply motor power to TB1-9 (hot) and TB1-8 (neutral). Set the **AUTO/OFF/MANUAL** switch to **MANUAL** and using the **RAISE/OFF/LOWER** switch, verify that the motor runs in the proper direction when this switch is in the **RAISE** and **LOWER** positions.
4. Set the **AUTO/OFF/MANUAL SWITCH** to the **AUTO** position. Refer to the applicable M-2001 Tapchanger Control Instruction Book, "Check-out Procedure" for test/operation procedures.
5. As shown in [Figure 11](#) temporarily place a shorting device across the LDC-CT secondary to short the line drop compensator circuit, and place another shorting device across TB1-3 and TB1-4 to short the circulating current paralleling input, for the load current check. Insert an ammeter between the polarity input and TB1-14. Open the load current shorting device and with a known load on the transformer or regulator, measure the current in the load current circuit to ensure that this current is correct for 0.2 A full load.
6. Replace the shorting device across the load current input and remove the ammeter. Reconnect polarity to the unit and 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.

● **WARNING:** In no case should the load 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.

### Voltage Source Switch

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.

**▲ 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.

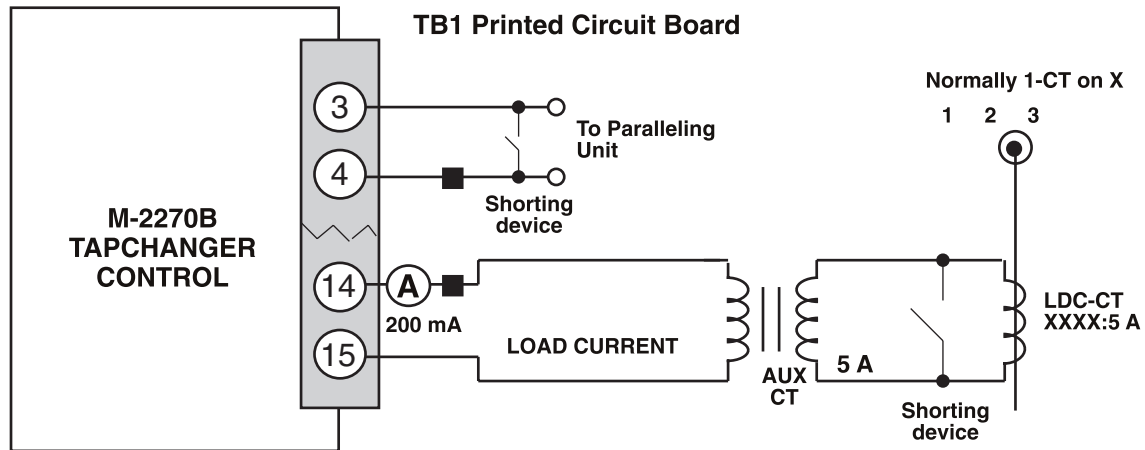


Figure 11 Setup for Current Checkout Procedure

# 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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