Application Guide

M-2050
Surface Mounting Kit

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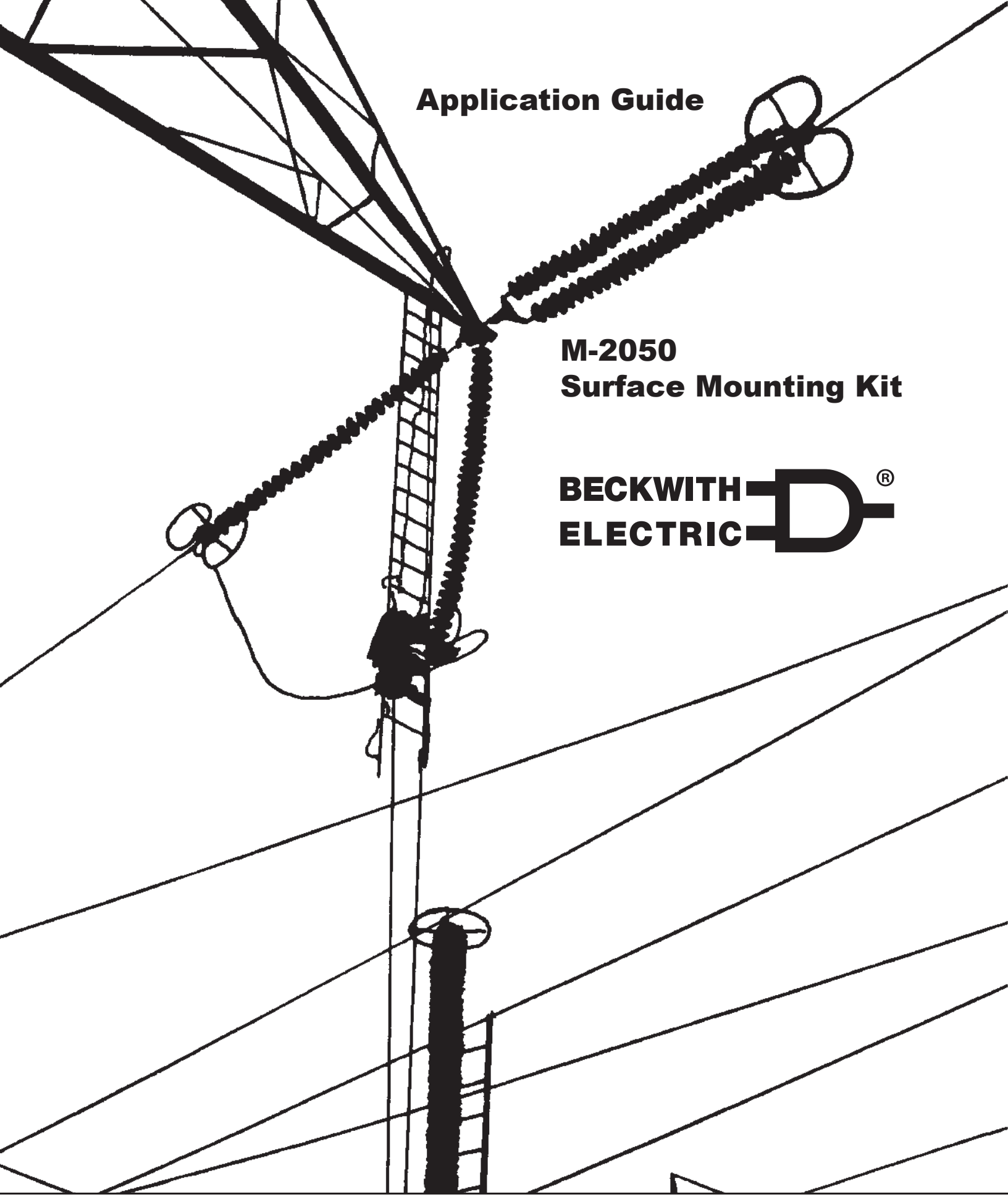

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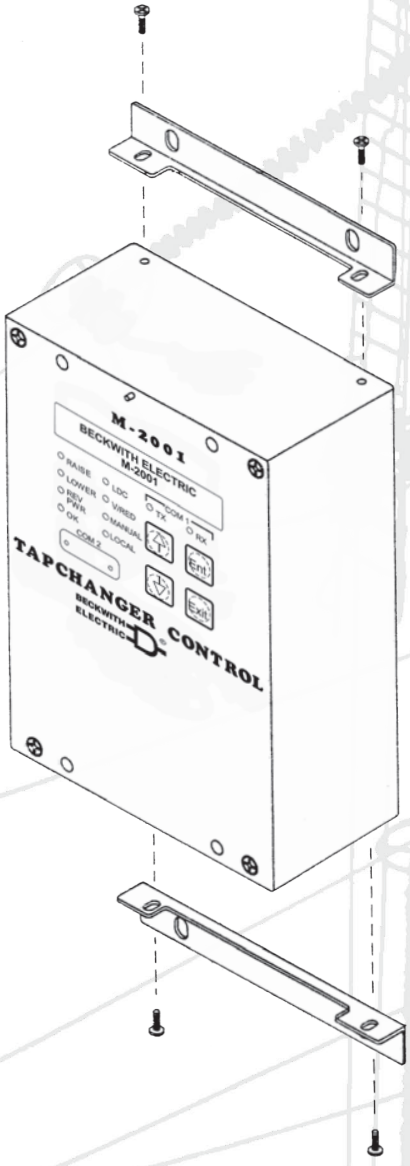
CONTROLS

Surface Mounting Kit M-2050

Provides Surface Mounting of the M-2001 Series Digital Tapchanger Controls for applications which do not require features of adapter panels



- **Connects easily to the M-2001 Series Digital Tapchanger Control using two right angle mounting brackets, four screws and a 24-pin connector with a six-foot pigtail on each pin**
- **Provides mounting onto any flat surface at least 5.8" wide and 10" high**

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The M-2050 is an adapter kit which permits surface mounting of the M-2001 Series Digital Tapchanger Controls on any flat surface at least 5.8" wide x 10.0" high. It consists of two right angle mounting brackets that bolt to the rear of the top and bottom of the M-2001 using four .25" screws. Also included is a 24-pin, in-line female connector with a six-foot pigtail on each pin to facilitate connection of the M-2001 in original equipment manufacturers' applications. The M-2050 does not include features available on adapter panels, such as mechanical configurations and wiring connections for direct replacement, or front panel switches, fuses or test points.

Interface

External connections are made to the wires of the 24-pin connector assembly. The 24-pin connector plugs into the bottom of the M-2001 and provides standard functions, such as motor power input, voltage input, voltage reduction and tapchanger raise and lower, along with auxiliary functions, such as self-test alarm, user-programmable alarm and operations counter. Refer to the applicable M-2001 Series Instruction Book for pin assignments.

Installation

1. Utilizing the four screws provided in the drawstring bag, mount the two right-angle mounting brackets to the M-2001 Digital Tapchanger Control (refer to Figure 1, M-2050 Mounting).

■**NOTE:** When locating Digital Tapchanger Control, allow for adequate clearance above for RS-232, RS-485 and fiber-optic ports, and below for the 24-pin connector plug.

2. Drill mounting holes as indicated in Figure 2, Outline and Hole Drill Dimensions.
3. Install the M-2050 Surface Mounting Kit (with M-2001 Digital Tapchanger Control) on to the flat surface.
4. Refer to the applicable M-2001 Series Instruction Book for connection and commissioning details.

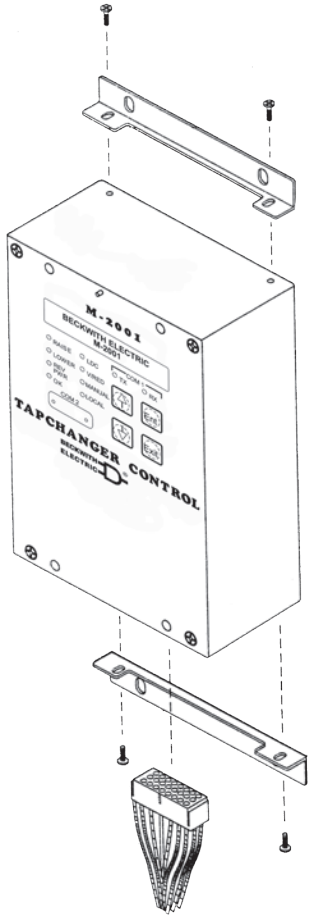

Figure 1 M-2050 Mounting

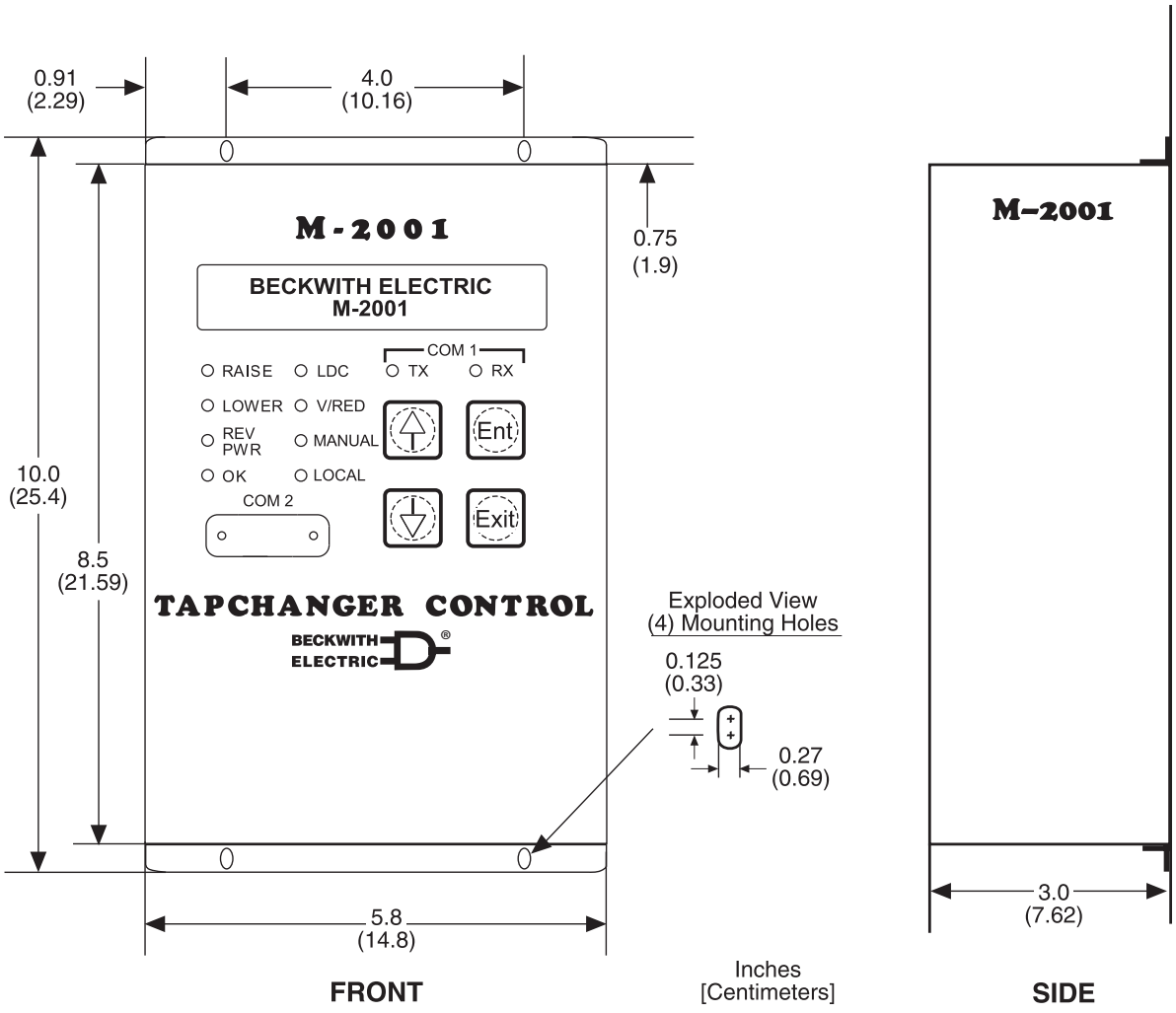

Figure 2 Outline and Hole Drill Dimensions

Physical

Size with M-2001 Tapchanger Control:

Overall dimensions are 10" high x 5.8" wide x 3" deep (25.4 cm x 14.8 cm x 7.6 cm)

Approximate Weight: 1 lb (0.45 kg)

Approximate Shipping Weight: 2 lbs (0.91 kg)

Approximate Weight with M-2001 Series Digital Tapchanger Control: 4 lbs, 11 oz (2.13 kg)

Warranty

The M-2050 Surface Mounting Kit is covered by a five year warranty from date of shipment.

Specification subject to change without notice.

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M-2050-SP-05MC1 10/23

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.

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1.0 Introduction

The Beckwith Electric M-2050 Surface Mounting Kit is used in conjunction with the M-2001 Tapchanger Control which 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-2050 Surface Mounting Kit, with the M-2001 Tapchanger Control, provides a solid-state voltage control relay intended for applications involving the control of tapchanging transformers and regulators. The Mounting Kit and M-2001 Tapchanger Control include the following features:

- Voltage waveform sampling and digital processing circuitry to ensure accurate voltage sensing.
- 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, for all terminals to ground. Input and output circuits are electrically isolated from each other, from other circuits and from ground.

2.0 Installation

The M-2050 is a surface mounting kit that provides mounting on any flat surface at least 5-13/16" wide x 10" high. Refer to Figure 1 for mounting of the M-2050; refer to Figure 2 for outline and hole drill dimensions.

Installation of the M-2001 Tapchanger Control

Mount the two right-angle mounting brackets to the M-2001 Tapchanger Control using the four screws provided. The four screws are shipped in a drawstring bag. Drill the mounting holes onto the panel surface as shown in Figure 2. Insert the 24-pin plug included in the mounting kit into the connector at the base of the M-2001. Then install the M-2050 Surface Mounting Kit (with the M-2001 Tapchanger Control) onto the flat surface.

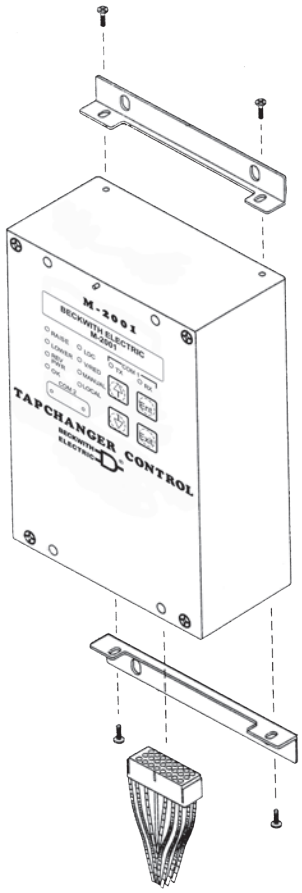


Figure 1 M-2050 Mounting

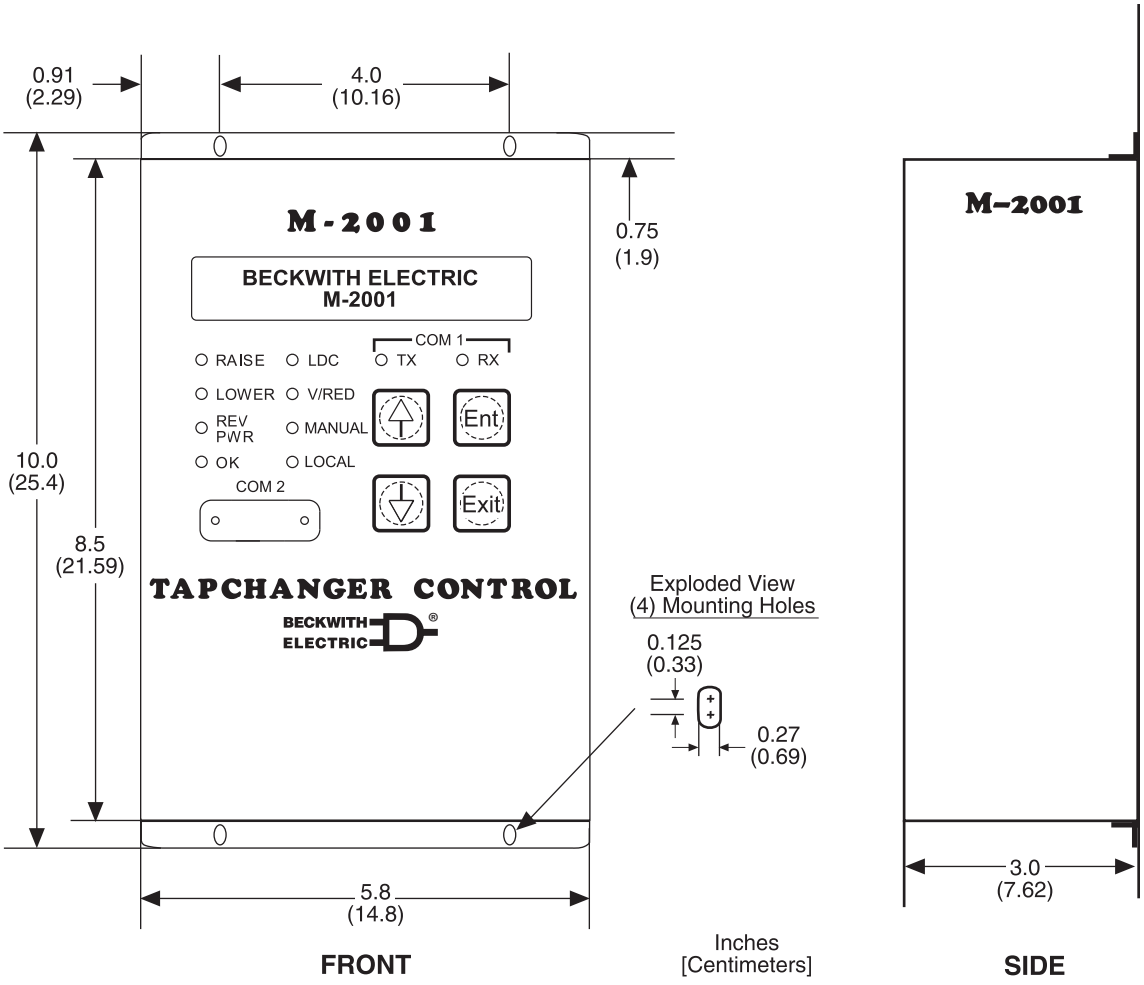


Figure 2 Outline and Hole Drill Dimensions

2.1 Lightning Protection

It has been determined that transient voltages in excess of 1500 Vac rms can exist on the "ground" lead normally tied to TB1-3 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.

3.0 Application

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. Refer to the applicable M-2001 Tapchanger Control Instruction Book for more information.

▲**CAUTION:** Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 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 Transformers can be used to reduce Load Current to 0.2 A "Full Scale". 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, obtain Beckwith Electric Application Note #17, "Basic Considerations for the Application of LTC Transformers and Associated Controls."

The external connections for the M-2001 are made to the 24-pin connector, P2, at its base. For example, if SCADA is being used to control the Voltage Reduction Step #1 function, connections for the external dry contact may be made between Pin 10 and Pin 18 as shown in Figure 3. 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 Pin 10. The external connections for the M-2050 are shown in Figure 3.

3.1 Features

▲**CAUTION:** Voltage applied through dry contacts to actuate non-sequential input *must* be nominal +12 Vdc obtained from Pin 10 of the M-2001 Tapchanger Control.

Non-Sequential Operation

The operation of the M-2001 can be interrupted during tapchanger operation by applying the "wetting" voltage of Pin 10 to Pin 17 (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.

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 10 of the M-2001 Tapchanger Control.

On the M-2001, Pin 9 and Pin 18 on connector P2 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. Refer to the applicable M-2001 Tapchanger Control Instruction Book.

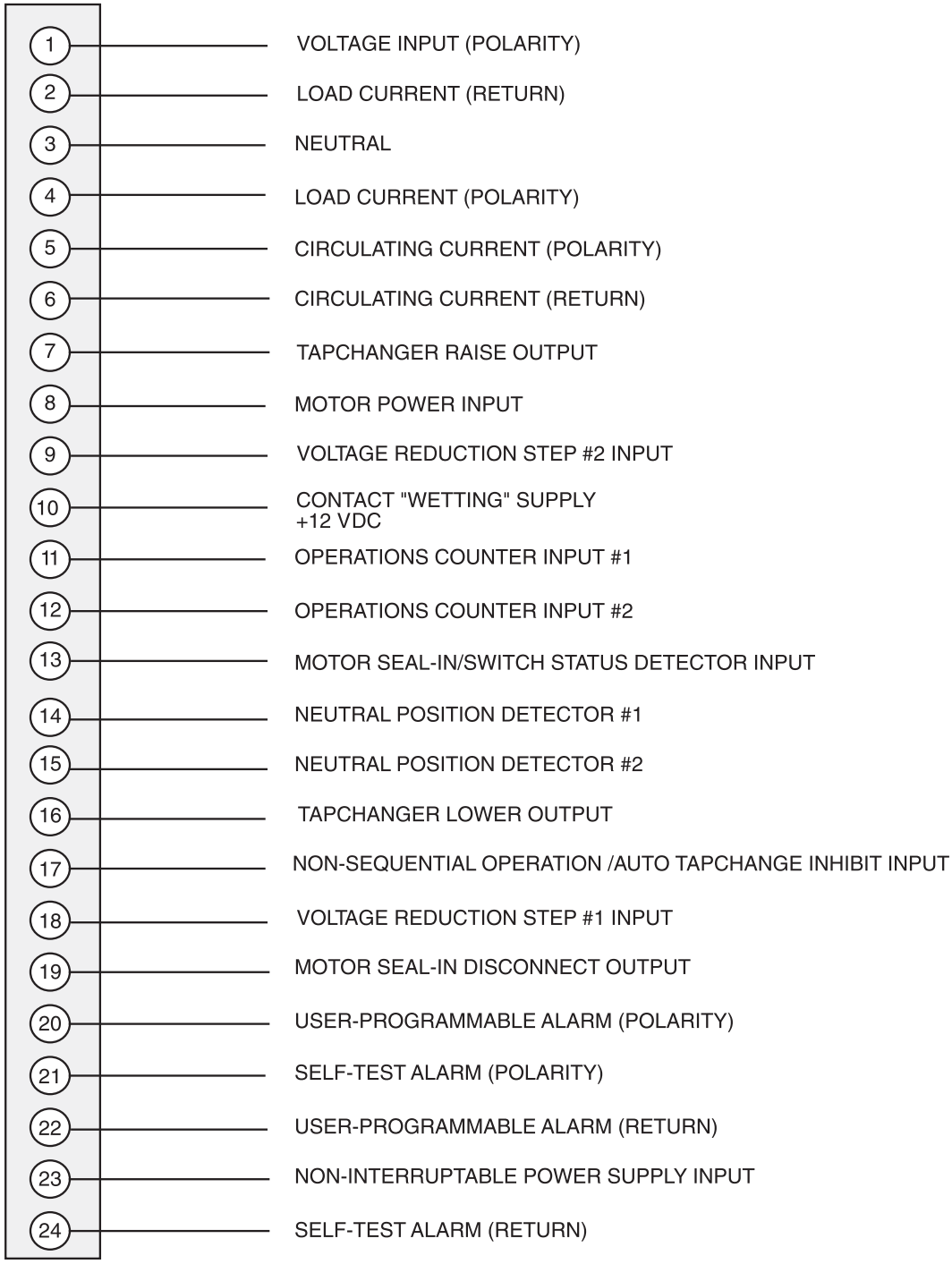
Voltage Reduction Setpoint: Multiplier Range	Apply "Wetting Voltage" from Pin 10 to Pin #
Voltage Reduction Setpoint #1: 0 to 10%	Pin 18
Voltage Reduction Setpoint #2: 0 to 10%	Pin 9
Voltage Reduction Setpoint #3: 0 to 10%	Pins 18 and 9

Table 1 Multi-Step Voltage Reduction External Connections

Paralleling

For detailed information, refer to the LTC Transformer Control System Comprehensive System Manual, available on our website www.beckwithelectric.com. This Comprehensive System Manual centralizes Paralleling information, necessary components and basic connection diagrams from several Beckwith Electric Instruction Books, Specifications, and Application Guides. This document, along with the M-2001 Instruction Book provides the information necessary to install an M-2001 in any of several paralleling schemes without needing to reference multiple publications.

24-Pin Connector



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

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.

Connector Pin Assignments

▲CAUTION: These binary inputs must be "wetted" by connection to Pin 10 only–a nominal 12 Vdc source. If the contacts are connected to a 120 Vac source, it will result in damage to the control.

The external connections for the control are shown in Figure 3.

The communication ports provide remote access to the tapchanger control using the M-2029A TapTalk® Communications Software.

Pin 1 Voltage Input

This input accepts nominal 120 Vac, 60 Hz (or 50 Hz as ordered) to operate the control's power supply and voltage sensing input. The acceptable voltage range for proper control operation is from 90–140 Vac.

Power consumption is less than 8 VA. The input voltage is referenced to line neutral (Pin 3).

Control users may encounter situations where actuating the Drag Hands Reset pushbutton on one of any of our adapter panels results in the loss of a Voltage Sense fuse. The Drag Hands reset solenoid is power from the circuit that powers the control, and provides the control with sensing voltage. Initially, a 1/4 Ampere fuse was used in this circuit, and most recently a 1 Ampere fuse was substituted to prevent further loss of the fuse. This phenomenon is due to the fact that, as solenoids age, they may become sticky due to mechanical misalignment, hardened grease, or shortened windings.

The adapter panels include a one ampere fuse in the voltage sense circuit. This value should be adequate for all but the most extreme problems. When a Drag Hands Reset Solenoid that consistently blows a one amp fuse is encountered, it is recommended that the customer either remove the solenoid for cleaning and adjustment, or replace it completely.

▲CAUTION: Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

Pin 2 Load Current Return

This is the non-polarity input to the load current measuring transformer. The companion polarity input is Pin 4. The line current transformer input is isolated from other pins.

Pin 3 Neutral

This is the return for the Voltage Input (Pin 1), and nominal +12 Vdc "wetting" voltage (Pin 10).

▲CAUTION: Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

Pin 4 Load Current Polarity

The line current input range is 0–640 mA (200 mA continuous) with 200 mA representing the 1.0 per-unit value. The measured current value is used for line drop compensation and metering calculation.

▲CAUTION: The current input to the M-2001C is rated at 0.48 A continuous and 4.0 A for 1 second.

▲CAUTION: Circulating current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

Pin 5 Circulating Current Polarity

The circulating current transformer measures a relative reactive current flow between transformers in parallel configuration. Maximum anticipated current input is 200 mA.

▲CAUTION: The current input to the M-2001C is rated at 0.48 A continuous and 4.0 A for 1 second.

▲**CAUTION:** Circulating current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

Pin 6 Circulating Current Return

This is the return path for Pin 5. The circulating current transformer input is isolated from other pins.

Pin 7 Tapchanger Raise

This switched output connects the tapchanger raise winding to the source of motor power. When the control calls for a raise, it is capable of switching up to 6 A at 120/240 Vac.

Pin 8 Motor Power Input

The source for powering the tapchanger motor is connected here. It may have a maximum voltage of 240 Vac.

Pin 9 Voltage Reduction Step #2

This digital input is typically enabled by connecting it to the nominal +12 Vdc wetting source (Pin 10), through an external Form "a" dry contact. The amount of voltage reduction implemented is determined by the setting.

Pin 10 +12 Vdc Wetting Voltage

This is the output of an unregulated dc power supply internal to the control. It is referenced to neutral and can supply up to 100 mA. It is used for powering the digital inputs of the control through external relays. Depending on the voltage supplied to Pin 1 and loading, its output can vary from +10 to +18 Vdc. It is not fused in the control.

Pins 11 & 12 Operations Counter Inputs 1 and 2

▲**CAUTION:** When "Input Selection 1" configuration is set to "Seal-In," the Counter Input is used as the Switch Status Input and the Seal-In Input will cause the counter to increment.

This digital input registers the counter contact closure. The pins are isolated from neutral to permit placing the external contact in series with either the wetting voltage or neutral. The operation count will increment when Pin 12 is grounded via the transformer or regulator dry operation count switch.

This contact is needed for using the intertap time delay. Once the contact is opened, the intertap time delay will begin counting down.

Pin 13 Input 1 – Motor Seal-In/Switch Status Input

When the **Input Selection (1)** screen in the **Configuration** menu is set to **Seal-In Input**, this input will operate as a seal-in input and Counter Input. In this configuration, the digital input is referenced to line neutral, but is unique in that it is configured to accept only the output of the motor seal-in current detection transformer, from the B-0553 motor seal-in printed circuit board subassembly. The B-0553 is a supplemental circuit board used in the appropriate adapter panels.

When the **Input Selection (1)** screen in the **Configuration** menu is set to **Switch Status Input**, this input will only 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 ON/OFF. The status can be read through the seal-in/switch status data point in the communications protocols.

Pins 14 & 15 Neutral Position Detector Inputs 1 and 2/Delta Var II Disable Input

■**NOTE:** This input will only perform one function, either the Neutral Detect or the Delta Var 2 Disable Input

This digital input registers neutral position switch closures on regulators. The pins are isolated from neutral to permit placement of the external contact in series with either the wetting voltage or neutral. Normally the wetting supply (Pin 10) will be connected to Pin 14.

When using the Delta Var 2 paralleling method, this input becomes the disable input for Delta Var 2. This is used to keep the paralleled devices from running to their limits (max raise or lower) if they have been unparalleled for maintenance, etc.

Pin 16 Tapchanger Lower Output

This switched output connects the tapchanger lower winding to the source of motor power. When the control calls for a lower, it is capable of switching up to 6 A at 120/240 Vac.

Pin 17 Input 2 - Non-Sequential Operation/Auto Tapchange Inhibit/Block SCADA

Non-Sequential Operation

When the **Input Selection (2)** screen (in the **Configuration** menu) is set to **NONSEQ INPUT**, non-sequential operation is invoked by momentarily connecting this input to the nominal +12 Vdc wetting source (Pin 10) through an external Form "a" dry contact. When this function is enabled, the tapchanger control times out with the Time Delay setting between every tapchange.

Auto Tapchange Inhibit

When the Input Selection (2) screen (in the Configuration menu) is set to NONSEQ INPUT, auto tapchange inhibit is invoked by closing and maintaining a Form "a" dry contact connected to this input and to the nominal +12 Vdc wetting source (Pin 10). As long as this contact is closed, the tapchanger will not time out, thereby prohibiting raise and lower commands.

SCADA Cutout Input

When the Input Selection (2) screen (in the Configuration menu) is set to SCADA CUTOUT INPUT, all writes using SCADA will be blocked when the non-sequential input is present. Any read operations using SCADA will still be allowed regardless of the input state. When the "SCADA Blk Input" input mode is selected, all non-sequential input functions will be disabled.

Pin 18 Voltage Reduction Step #1

This digital input is typically enabled by connecting it to the nominal +12 Vdc wetting source (Pin 10) through an external Form "a" dry contact. The amount of voltage reduction implemented is determined by the setting.

> ■**NOTE:** Enabling both voltage reduction Step #1 and Step #2 inputs simultaneously will result in the level of voltage reduction as specified on the voltage reduction Step #3 screen of the control.

Pin 19 Motor Seal-In Disconnect Output

This output connects to the B-0553 motor seal-in printed circuit board subassembly. When the seal-in detector input is actuated, this output drives a triac on the B-0553 motor seal-in printed circuit board subassembly to temporarily disconnect the motor power to the control. The B-0553 is a supplemental circuit board used in the appropriate adapter panels.

Pins 20 & 22 User-Programmable Alarm

This pair of terminals is a Form "a" alarm relay contact rated for 3 A at 120 Vac, or 100 mA at 120 Vdc. This alarm indicates when any of eight programmable alarm conditions are detected. Refer to the Appendix, Figure A-8 or A-10.

Pins 21 and 24 Self-Test Alarm

> ■**NOTE:** If the M-2001C is configured for the SCAMP pushbutton Auto/Manual Switch type, then the Self-Test Alarm relay is NOT available.

This pair of terminals is a held-open Form "b" alarm relay contact rated for 6 A at 120 Vac, or 100 mA at 120 Vdc. Failure of the power supply or the microcontroller results in loss of power to the alarm relay, allowing the contact to close.

Pin 23 Non-Interruptible Power Supply Input

This input is normally connected to Pin 8, the motor power input. The power to Pin 8 is interrupted by the motor seal-in process of the B-0553 motor seal-in printed circuit board. The purpose of Pin 23 is to provide continuous power to the raise and lower keep-track detection circuits. It should be connected ahead of any motor power interruption (for example, auto/manual, local/remote) of the seal-in circuitry to maintain keep-track raise and lower operation. The motor seal-in function is used in the following adapter panels: M-2109, M-2324 and M-2355.

3.2 Using the M-0329 LTC Backup Control with the M-2001

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.

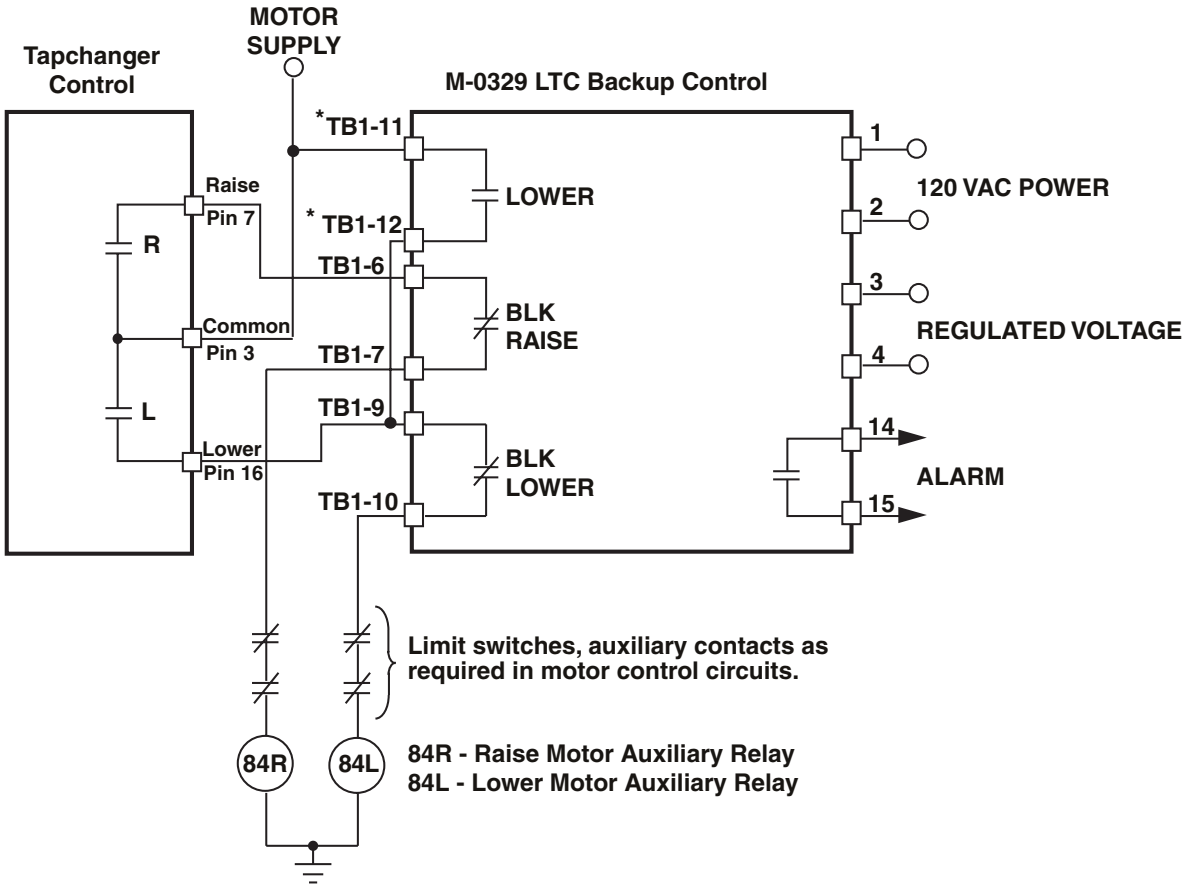
The M-0329 Instruction Book is available on request and gives added details. Please refer to the M-0329 Instruction Book for complete ordering information.

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.



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

Figure 4 Tapchanger Control and LTC Backup Control Interconnections

4.0 Adjustment

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."

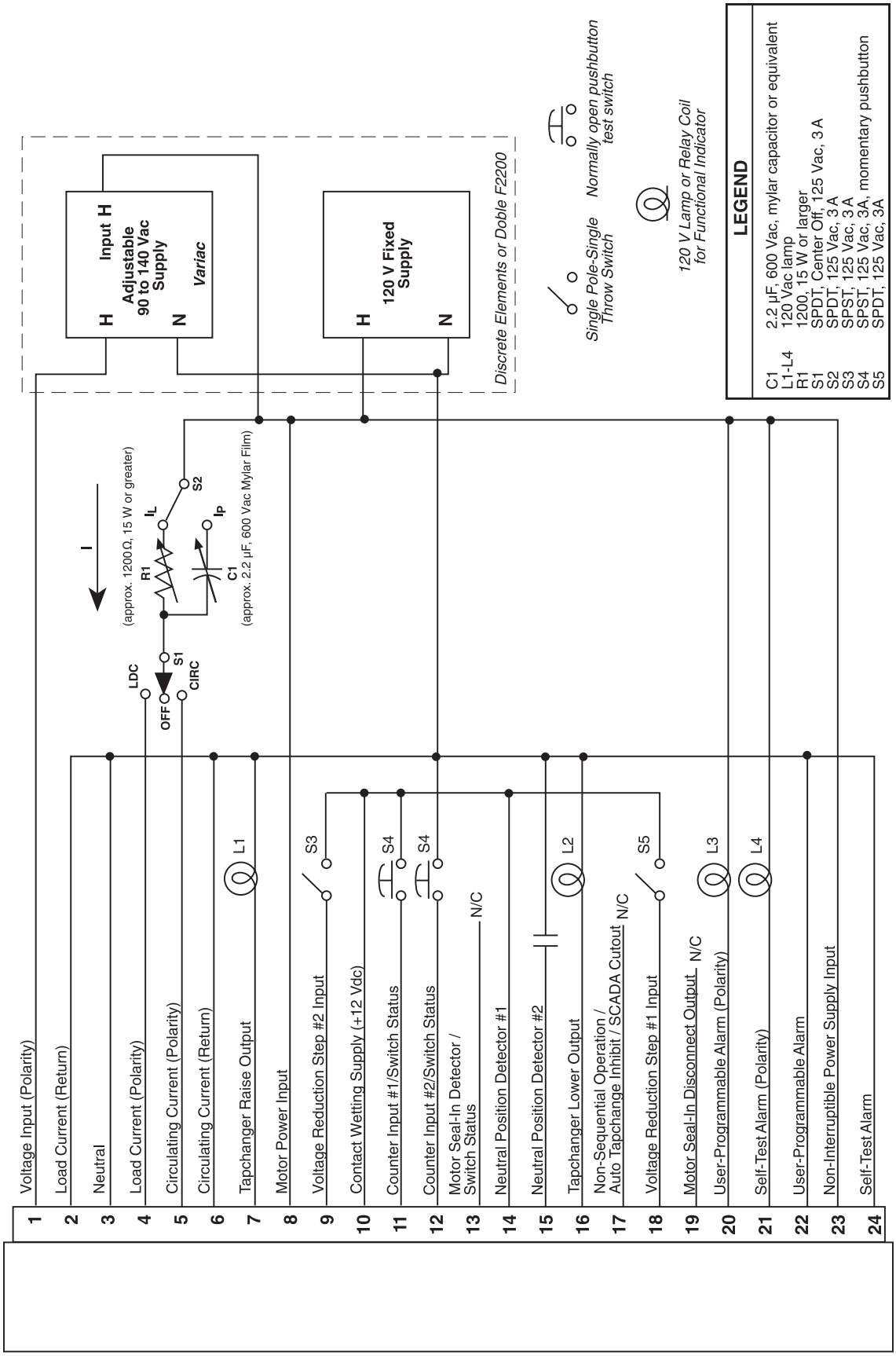


Figure 5 External Connections for Test Procedure

5.0 Set-up Procedure

Equipment List

▲**CAUTION:** The current input to the M-2001C is rated at 0.48 A continuous and 4.0 A for 1 second.

- 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 ±0.2% of reading
- Accurate stop watch

Procedure

1. Make electrical connections as shown in Figure 5, External Connections for Test Procedure.

■**NOTE:** Refer to the applicable M-2001 Instruction Book, Appendix A, 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 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

5.1 Bench Test

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

1. Apply 120 Vac from power source.The display of the M-2001C will automatically advance to the Local Voltage screen.
2. Increase voltage to 121.2. The **LOWER** LED should illuminate.
3. Decrease voltage to 118.8. The **RAISE** LED should illuminate.
4. Set the input voltage to 120.0 Vac. Wait for **RAISE** and **LOWER** LEDs to extinguish.
5. Increase voltage to 122.0 Vac, then start timing when voltage passes 121.0 V.
6. Stop timing when the lamp connected to the **LOWER** output illuminates (should be approximately 5 seconds).

Resistance

▲**CAUTION:** Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

1. Apply a 100.0 mA in-phase current to Pin 4 (load current-polarity) and Pin 2 (load current-return) of the P2 connector.
2. Set S_1 to LDC and S_2 to I_L.
3. Set LDC Resistance to 24.0 V. The **RAISE** LED should illuminate.
4. Increase the input voltage to 132.0 Vac. The **RAISE** and **LOWER** LEDs should be extinguished.
5. Set the LDC Resistance to -24.0 V. The **LOWER** LED should light.
6. Decrease the input voltage to 108.0 Vac. Both **RAISE** and **LOWER** LEDs should extinguish.
7. Set the LDC Resistance to 0.0 V.
8. Decrease the input voltage to 120 Vac.

Reactance

▲ **CAUTION:** Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

1. Apply 100.0 mA 90° leading current to Pin 4 (load current-polarity) and Pin 2 (load current-return) of the P2 connector.
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 the 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 the LDC Reactance to 0.0 V.
8. Decrease the input voltage to 120 Vac.

Voltage Reduction

1. Set Voltage Reduction Step #1 to 2.5% (default setting).
2. Close S_5 to enable Voltage Reduction Step #1. The **LOWER** LED should illuminate.
3. Decrease the voltage to 117.0 Vac. The **LOWER** LED should be extinguished.
4. Open S_5 and decrease the input voltage to 120.0 V.
5. Set Voltage Reduction Step #2 to 5% (default setting).
6. Close S_3 to enable Voltage Reduction step #2. The **LOWER** LED should illuminate.
7. Decrease voltage to 114.0 Vac. The **LOWER** LED should extinguish.
8. Open S_3 and decrease the input voltage to 120.0 Vac.

Paralleling

▲ **CAUTION:** Circulating current must be reduced by an appropriate circulating current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

1. Apply 100.0 mA 90° leading current to Pin 5 (circulating current-polarity) and Pin 6 (circulating current-return) of the P2 connector.
2. Set S_1 to CIRC and S_2 to I_P. The **LOWER** LED should illuminate.
3. Decrease the voltage to 108.0 Vac. Both **RAISE** and **LOWER** LEDs should be extinguished.
4. Set S_1 to OFF.

Counter

1. Set the M-2001C Tapchanger Control to display the Operations Count screen for the Total Operations Counter.
2. Verify counter operation by depressing S4 wired to Pin 11 and Pin 12 (counter in).
3. The operations counter should increment.

Block Raise/Block Lower/Deadband

1. Set Block Raise to 126.0 V.

2. Set Block Lower to 114.0 V.
3. Set the unit to display the Bias Voltage screen.
4. Press **ENT**.
5. Increase voltage to 126.5 V. BR should be displayed on the screen.
6. Increase voltage to 128.5 V. FL is displayed on the screen.
7. Decrease voltage to 113.5 V. BL is displayed on the screen.

—Bench Test Complete—

5.2 Check-out Procedure

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

Applying Power

1. Remove any external connection between Pin 1 (voltage input) and Pin 8 (motor power input).
2. Using a voltmeter, ensure that the voltage applied to Pin 1 is nominal 120 Vac with respect to Pin 3 (neutral).

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

3. Apply motor auxiliary voltage to Pin 8 (motor power input) and Pin 3 (neutral).
4. Verify that the motor runs in the proper direction when conditions of sensed voltage result in activation of Raise and Lower outputs.

⬢**WARNING: In no case should the load current circuit be interrupted with the regulator or transformer energized.**

⬢**WARNING: Do not remove auxiliary current transformers without shorting the current inputs. Death or severe electrical shock can occur.**

5. As shown in Figure 6, Setup for Current Checkout Procedures, temporarily place a shorting device across the LDC-CT secondary to short the line drop compensator circuit, and place another shorting device to short the circulating current paralleling output, for the load current check.
6. Insert an ammeter between the polarity input and Pin 4.
7. 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.

▲**CAUTION:** The current input to the control is rated at 0.48 A continuous and 4.0 A for 1 second.

8. Replace the shorting device across the load current input and remove the ammeter.
9. 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.

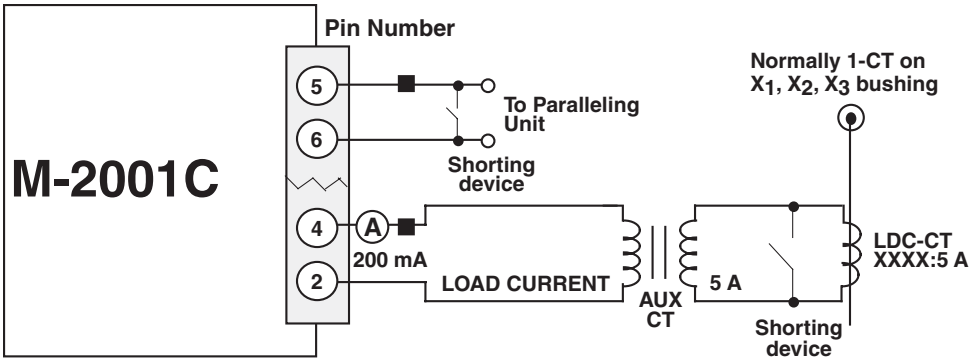


Figure 6 Setup for Current Checkout Procedure

5.3 Operational Test

1. Set VT Ratio Correction = 0 V; CT/VT phasing = 0° from the appropriate screen in the software.
2. Return to the Local Voltage screen.
3. Apply 120.0 Vac to Pin 1 (hot) and Pin 3 (neutral) of the adapter panel.
4. Verify local voltage = input voltage ±0.3 V.

▲**CAUTION:** Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

5. Apply 100.0 mA in-phase current to Pin 4 (load current-polarity) and Pin 2 (load current-return).
6. Verify Control Load I =100 mA and Power Factor =1.0 ±0.02 from the appropriate software screens.

▲**CAUTION:** Circulating current must be reduced by an appropriate circulating current transformer to 0.2 A "full scale" before connecting to the M-2001 current inputs.

7. Apply 100.0 mA 90° leading current to Pin 5 (circulating current-polarity) and Pin 6 (circulating current-return).
8. Verify Control Circ I = 100.0 mA ±2 mA.
9. Verify the ↑ , ↓ and **ENT** pushbuttons function properly.
10. De-energize the current source.

—Checkout Procedure Complete—

5.4 In-Service Test

1. Set the M-2001C Tapchanger Control to display the Bias Voltage screen.
2. Press **ENT**.
3. Use the ↑ and ↓ pushbuttons to cause **RAISE** and **LOWER** outputs.
   If either output is blocked, verify that the unit is not at the maximum tap position.
4. Press **ENT** to return to the Local Voltage screen.

—In-Service Test Complete—

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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