Application Guide

M-2278 Adapter Panel

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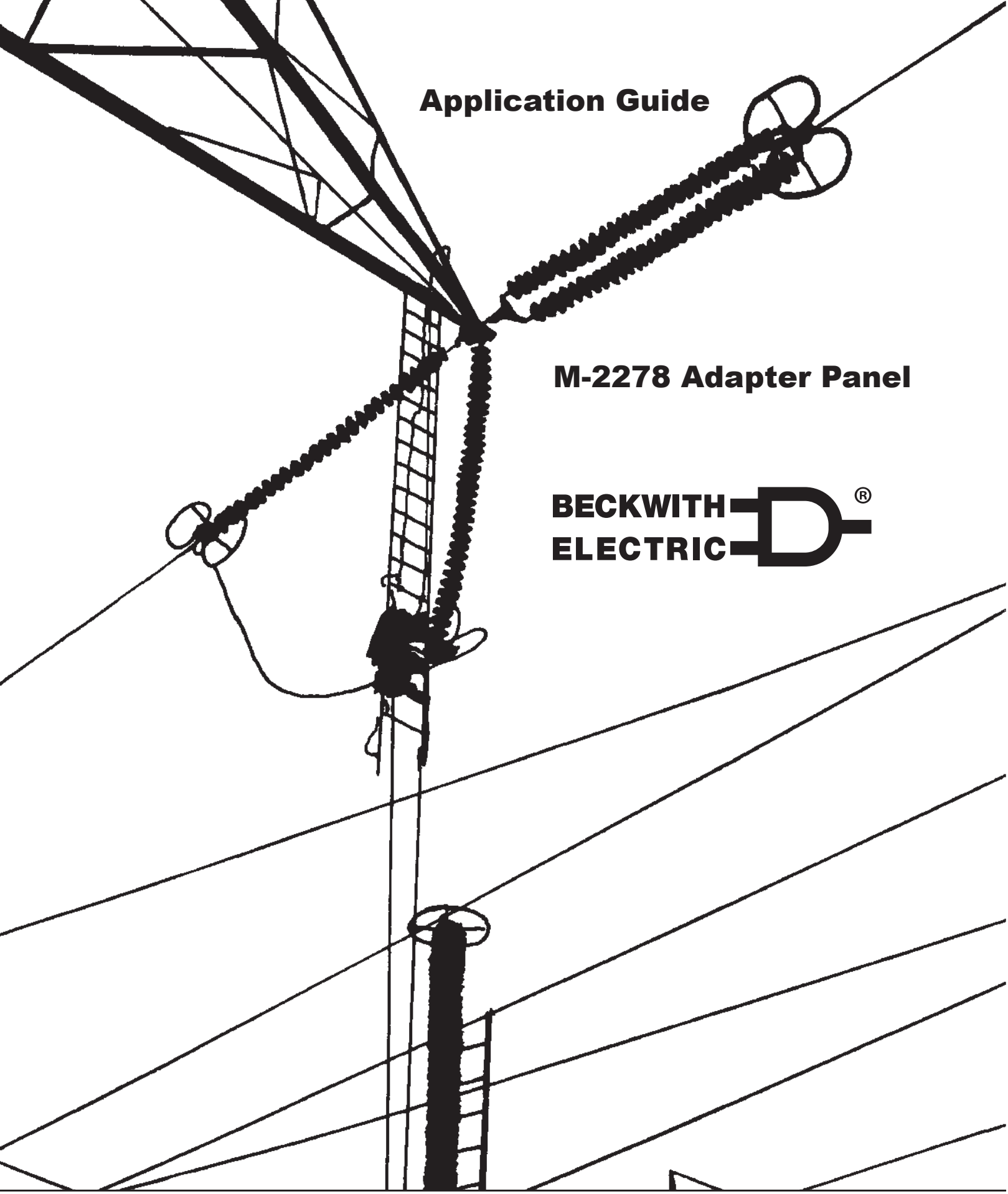

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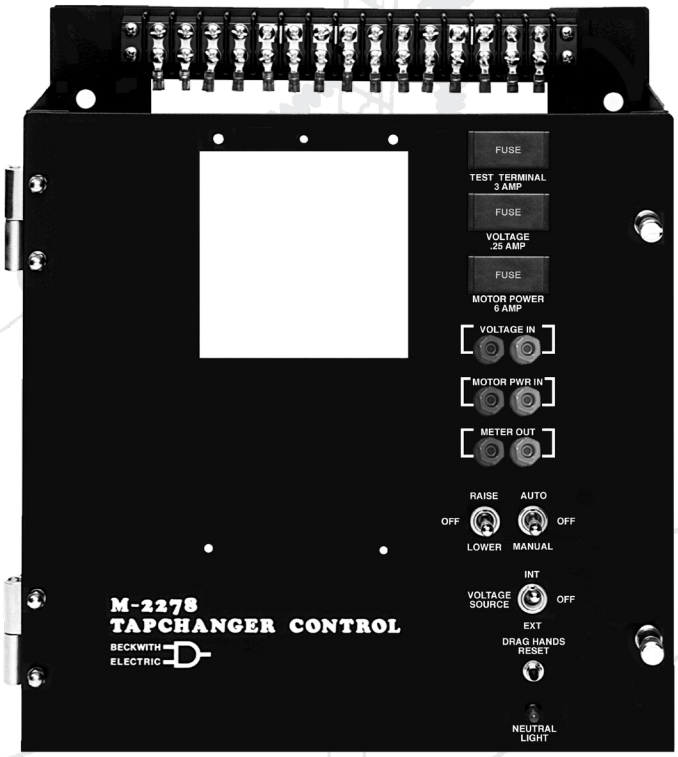
Adapter Panel M-2278

Adapts M-2001 Series Digital Tapchanger Control as a Replacement for Allis-Chalmers Surface-Mount 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 Allis-Chalmers surface-mount LTC transformer controls
- Provides built-in CT shorting protection when the M-2001 Series Digital Tapchanger Control is removed

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The M-2278 is an adapter panel which, when combined with the M-2001 Series Digital Tapchanger Control, provides convenient direct replacement for Allis-Chalmers surface-mount LTC transformer controls. The M-2278 is designed to mount against a flat surface using four screws and includes a front door hinge for easy replacement of the control panel.

Interface

External connections are made to a terminal block located on the top of the rear panel of the M-2278. Additional connections may be made to two terminal blocks located on the printed circuit board of the adapter panel. These terminal blocks 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 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

Mounting: 11" high x 8" wide (27.9 cm x 20.3 cm) 4-hole pattern for surface mounting

Size: 13-7/8" high x 12-7/8" wide x 4-1/8" deep (35.2 cm x 32.7 cm x 10.5 cm)

Approximate Weight: 6 lbs, 3 oz (2.8 kg)

Approximate Shipping Weight: 8 lbs, 3 oz (3.7 kg)

Approximate Weight with M-2001 Series Digital Tapchanger Control: 10 lbs, 8 oz (4.8 kg)

Approximate Shipping Weight with M-2001 Series Digital Tapchanger Control: 14 lbs, 3 oz (6.44 kg)

Warranty

The M-2278 Adapter Panel is covered by a five year warranty from date of shipment.

Specification subject to change without notice.

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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-2278 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-2278 Adapter Panel, with the M-2001 Series Digital Tapchanger Control, provides a solid-state voltage control relay designed to replace Allis-Chalmers surface-mount LTC transformer controls. The combination of the Tapchanger Control and Adapter Panel includes the following features:

1. Voltage waveform sampling and digital processing circuitry ensure accurate rms voltage sensing in the presence of distortion on the input voltage and current.
2. Accuracy exceeds the ANSI/IEEE C57.15-1986 Class 1 specification over the temperature range of -40° C to +80° C.
3. 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.
4. 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.
5. Easily tested by use of the following:
   a. **VOLTAGE SOURCE** switch disconnects the voltage transformer input and connects the **MOTOR PWR IN** and **VOLTAGE IN** binding posts to the motor circuits and voltage input.
   b. **VOLTAGE IN** binding posts on the front panel allow application of a 120 V rms nominal voltage to the unit for test procedures.
   c. **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.
   d. **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.
   e. **RAISE** and **LOWER** band edge LEDs on the M-2001 Series Digital Tapchanger Control indicate when the input voltage is outside the voltage band.
6. **NEUTRAL LIGHT** illuminates when the regulator is in the neutral tap position. The **NEUTRAL LIGHT** is active only when used with regulators which provide a circuit for this purpose.
7. **DRAG HANDS RESET** pushbutton switch resets the tapchanger position indicator drag hands on the regulator or LTC transformer.
8. **AUTO/OFF/MANUAL** switch allows manual operation of the control.

2.0 Installation

Remove the old control from the cabinet. The M-2278 mounts against a flat surface using four screws at the back of the side rails that match the original mounting of the Allis-Chalmers control. Refer to Figure 1 for outline dimensions; refer to Figure 2 for the hole drill dimensions of the M-2278, if needed.

Installation of the M-2001 Series Digital Tapchanger Control

Mount the M-2001 Series Digital Tapchanger Control to the back of the M-2278 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.

Installation of the M-2278 Adapter Panel
Mount the M-2278 Adapter Panel (with the M-2001 Series Digital Tapchanger Control) onto the hinges in the control cabinet. External connections are made to the terminal block at the top of the adapter panel (TB3). The terminal numbers do not match the Allis-Chalmers terminal block, but are approximately in the same position. Figures 3-1, 3-2 and 3-3 show the M-2278 external connections with the corresponding Allis-Chalmers terminal numbers.

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.

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.

Load current must be reduced by an appropriate auxiliary current transformer to 0.2 A "full scale" before connecting to the M-2278 current inputs. The Beckwith Electric M-0121 (5.0 A to 0.2 A) or M-0169 (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-0169 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-2278 are made to terminal block TB3 located at the top of the adapter panel. 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. For example, if SCADA is being used to control the voltage reduction step #1 function in the M-2278, connections for the external dry contact may be made between TB1-7 and TB2-27 as shown in Figure 3-1. 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 TB2-27. The wiring harness and external connections for the M-2278 are shown in Figure 3-3.

3.1 Features

Neutral Light Circuit
The M-2278 is prepared for use with regulators which provide for use of a neutral light. Particular manufacturers' designs may require either powering or grounding of the neutral light circuit for operation. Please refer to Section 4.0, **Adjustment**, for this procedure. Allis-Chalmers transformer controls do not make use of this feature.

Non-Sequential Operation
The operation of the M-2278 can be interrupted during tapchanger operation by momentarily applying the "wetting" voltage of terminal TB2-27 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 TB2-27 of the M-2278 Adapter Panel. If an M-0278 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-0278. Carefully examine the contacts of these functions to remove 120 Vac wetting voltages.

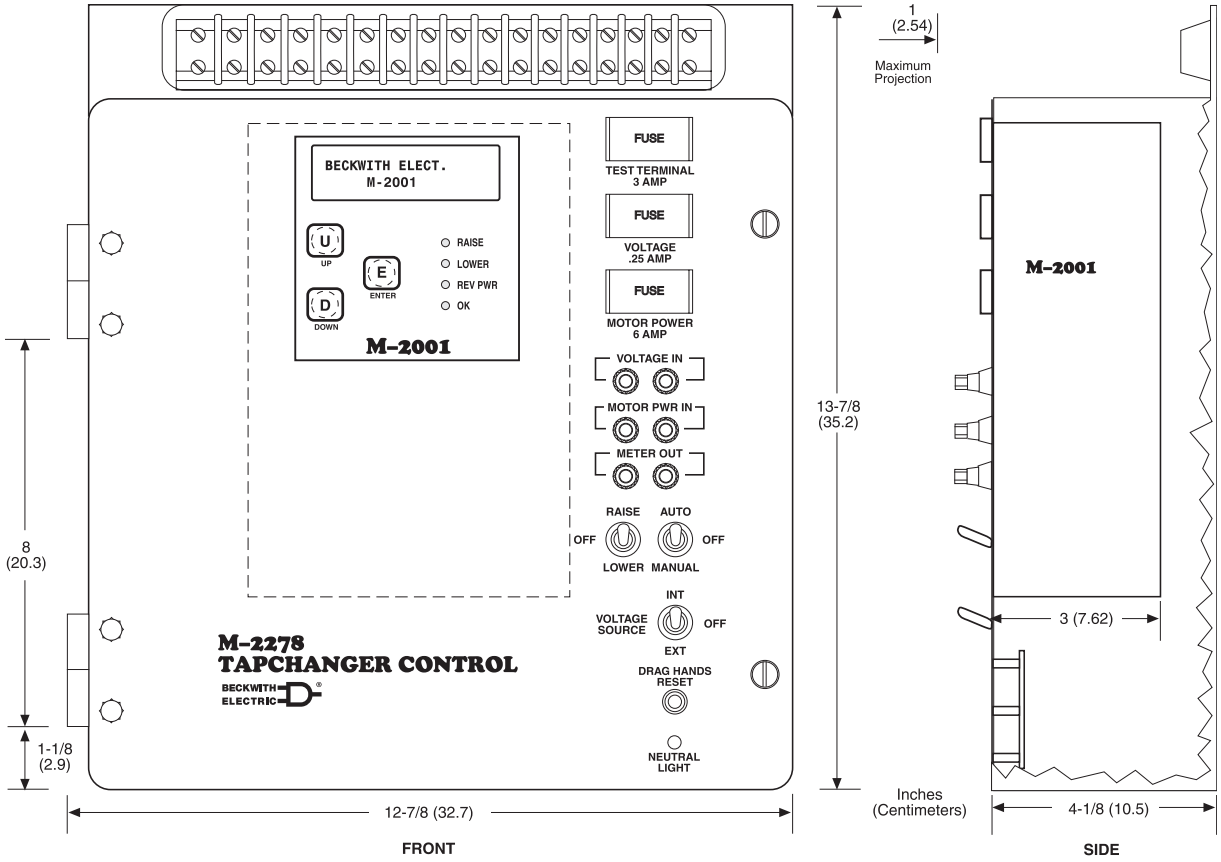


Figure 1 Outline Dimensions

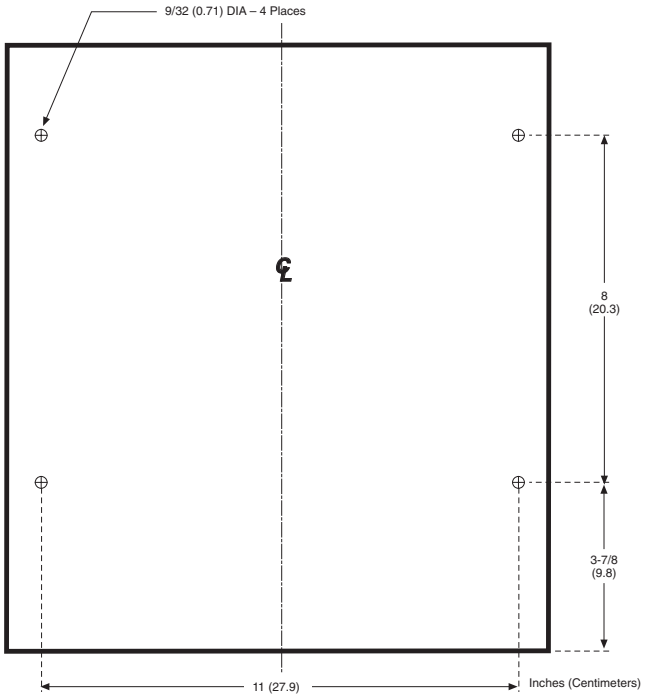
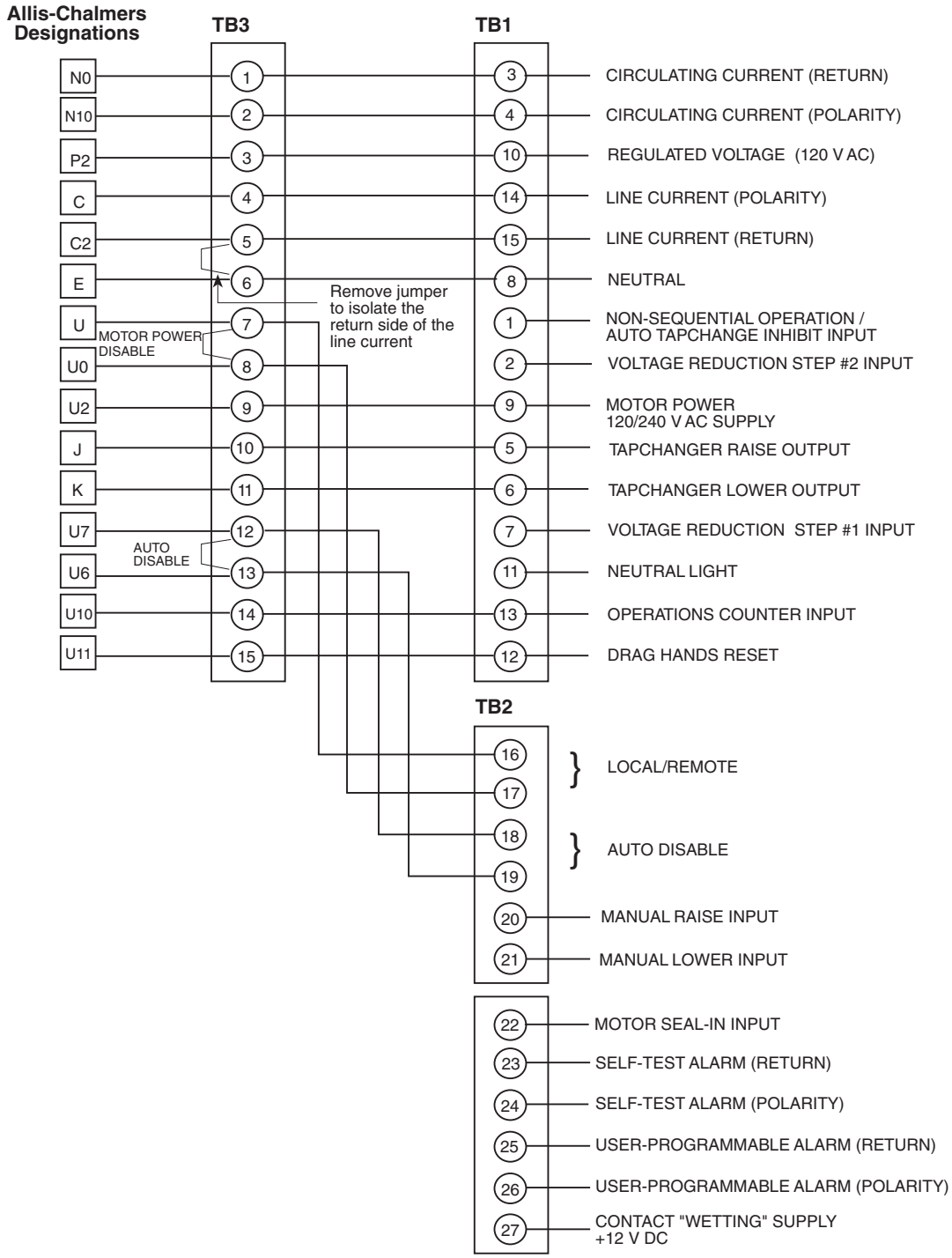


Figure 2 M-2278 Hole Drill Dimensions



■**NOTE:** External connections are made to TB3 located at the top of the adapter panel. Auxiliary external connections may be made to TB1 and TB2 as needed.

⬢**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

Auto Disable Input

To disable automatic operation of the M-2278, remove the jumper between TB3-12 and TB3-13. If SCADA is used to enable and disable this function, a contact rated at 6 A minimum should be connected between the terminals.

Auto disable may also be accomplished by closing a contact between pin TB1-1 and TB2-27.

Local/Remote Input

Removing the jumper between TB3-7 and TB3-8 prohibits operation by disabling the M-2001 Series Digital Tapchanger Control's automatic raise and lower outputs and also by disabling the M-2278 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

On the M-2278, TB1-7 and TB1-2 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 Series Digital Tapchanger Control software.

▲**CAUTION:** Voltage applied through dry contacts to actuate Voltage Reduction Steps 1, 2, and 3 *must* be nominal +12 Vdc obtained from pin TB2-27 of the M-2278 Adapter Panel. If an M-0278 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-0278. Carefully examine the contacts of these functions to remove 120 V ac wetting voltages.

Paralleling

The tapchanger controls are equipped for use in systems requiring the paralleling of two or more regulators or LTC transformers. The system operates by the circulating current method when used in conjunction with Beckwith Electric M-0115 Paralleling Balancing Modules. The M-0115 provides the minimum components required to parallel a regulator or LTC transformer, with a minimum of wires used for interconnection. With this scheme, a regulator or transformer can be switched out for maintenance, and the remaining unit(s) will operate properly (in parallel, if more than two are being used). The M-0115 also ensures that proper line drop compensation will be maintained, whether the units are operating in parallel or alone. Refer to the M-0115 Instruction Book for complete application information.

The user is cautioned that proper paralleling operation requires that attention be given to the characteristics of the regulators or transformers, the system impedances and the controls. For best parallel operation, the regulators or transformers should be as nearly identical as practical. This means that the kVA rating, turns ratio, percent voltage change per tapchange step, and the impedance (self or with series reactors) should be nominally the same. The characteristics of the controls should be similar as well, since problems can occur when controls from different manufacturers are being paralleled. For example, if the paralleling input burden of a control from a different manufacturer is different from that of the Beckwith Tapchanger Control, an incorrect compensation will result.

Ideally, the Tapchanger Control should be paralleled with another control manufactured by Beckwith Electric whose paralleling input burden is the same. Beckwith Electric does not guarantee satisfaction if the Tapchanger Control is being paralleled with another control with incompatible characteristics.

Voltage Reduction Setpoint: Multiplier Range	Apply "Wetting Voltage" from TB2-27 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

For further information on this topic, obtain Beckwith Electric Application Notes #11, "*Introduction to Paralleling of LTC Transformers by the Circulating Current Method*," and #13, "*Advanced Paralleling of LTC Transformers by the Circulating Current Method*."

WARNING: When paralleling regulators without sufficient series impedance, such as transformer leakage reactance or reactors, a dangerous amount of circulating current will appear if the regulators are on different tap positions. Death or severe electrical shock can occur. One series reactor per regulator is required in this application. Consult Beckwith Electric for further details.

Operations Counter Input
An operations count is registered by momentarily grounding TB3-14 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-2278 Adapter Panel/M-2001 Tapchanger Control.

▲ **CAUTION:** Do not apply either +12 Vdc or 120 Vac to this terminal.

Connections for Allis-Chalmers LTC Transformers
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-2278 is shown in Figure 3-2. 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.

3.2 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 3-4 shows the typical interconnection of the two devices with motor auxiliary relays.

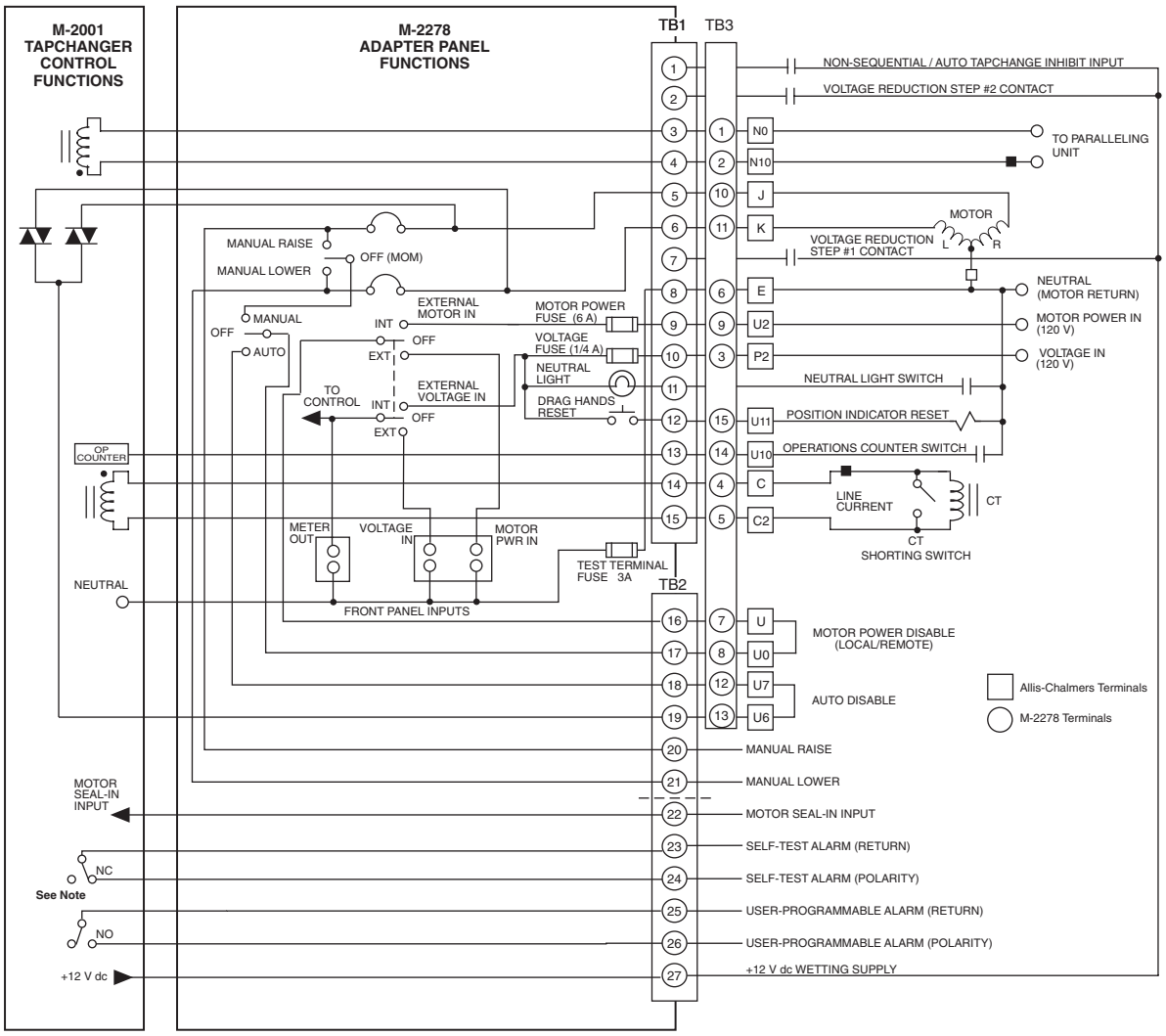
The M-0329 Instruction Book is available on request and gives added details. Please refer to the M-0329 Instruction Book for complete ordering information.

4.0 Adjustment

Neutral Light Circuit Operation
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 left 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) to the toggle right position. The operator may simply experiment with this switch until the proper position is found for the installation.

4.1 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*."



■**NOTE:** The self-test alarm and user-programmable alarm contacts are shown in the de-energized state (no voltage applied); the contacts close when the alarm is recognized.

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 4 M-2001 and M-2278 Typical Connections

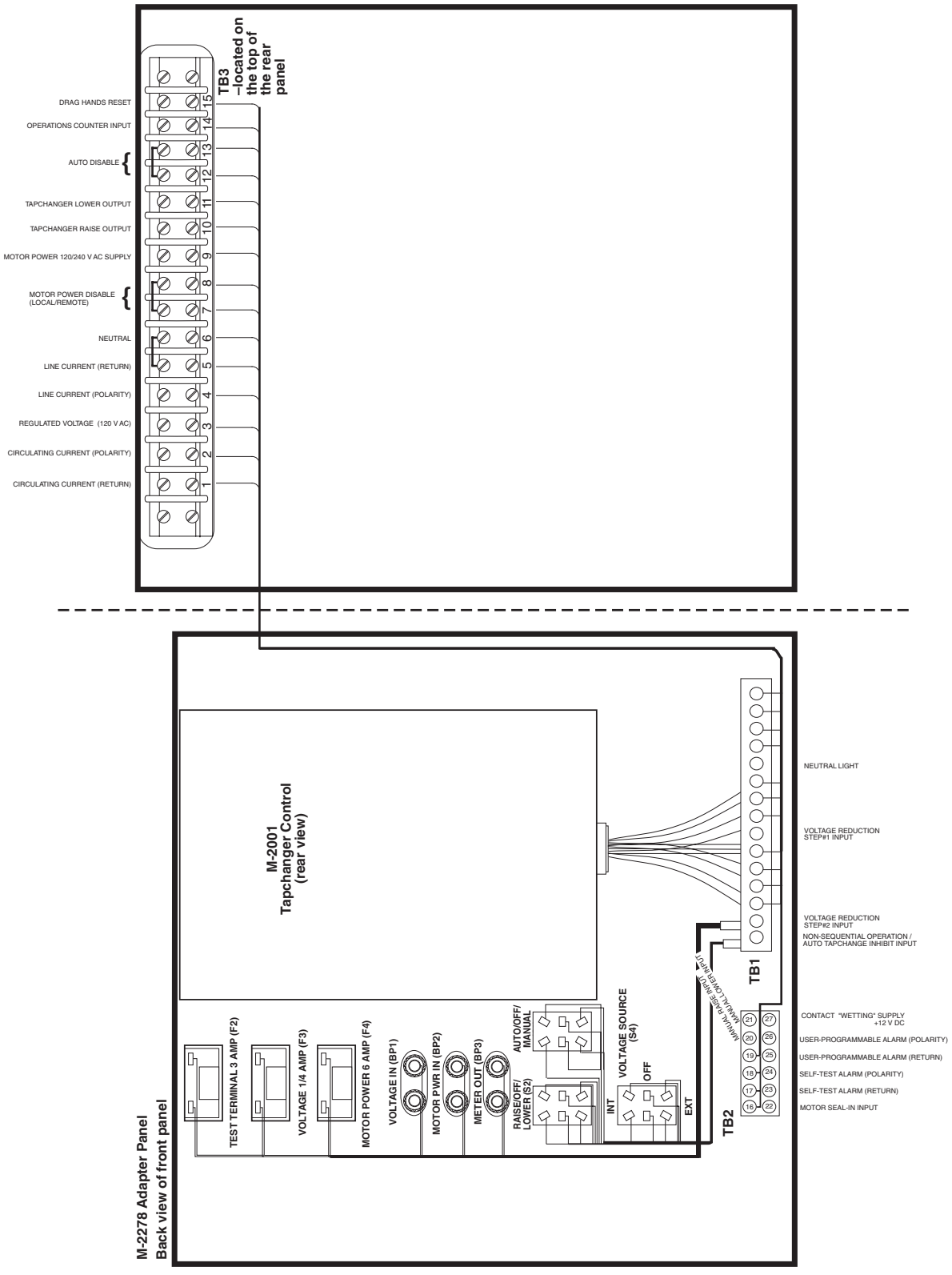
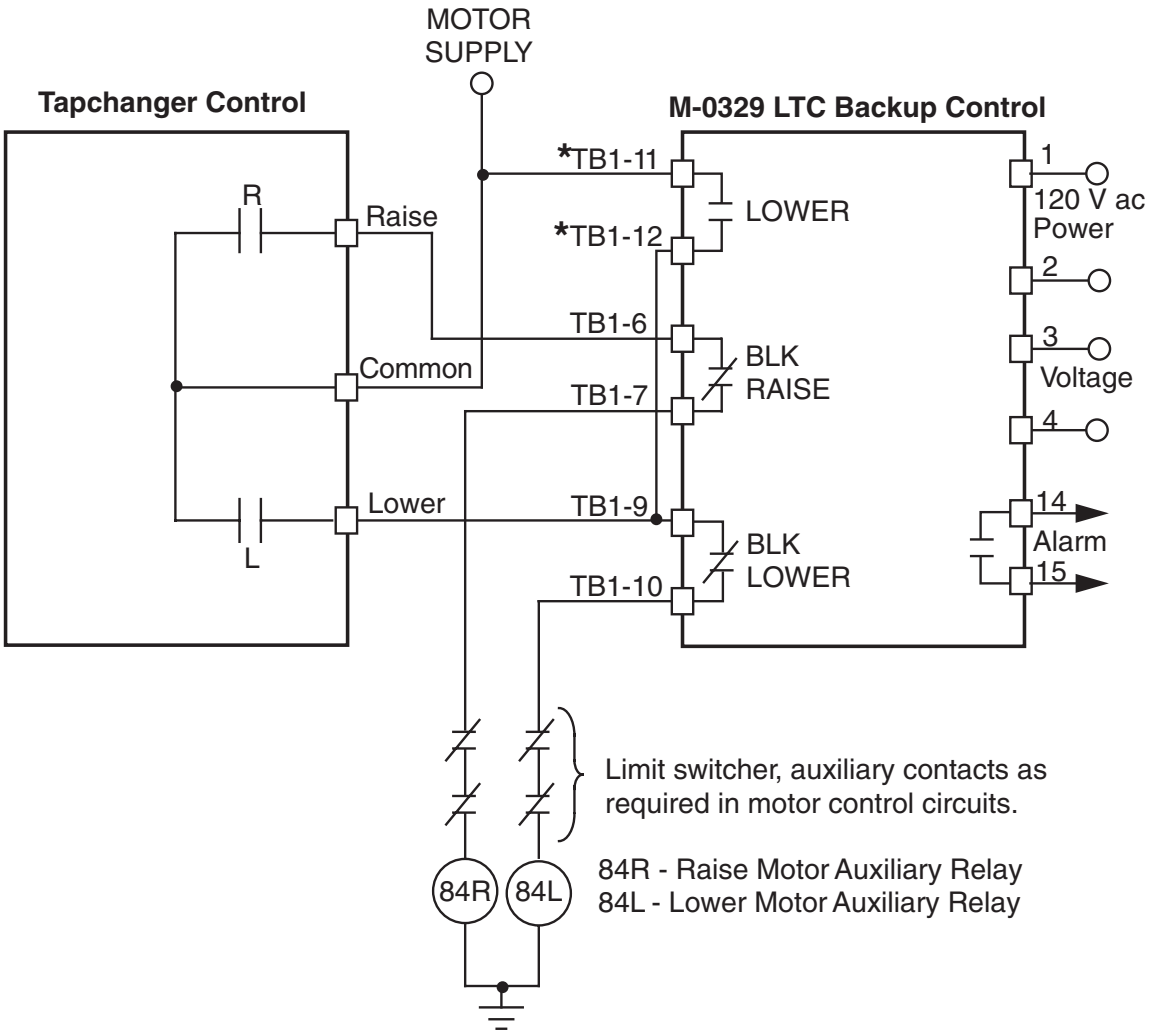


Figure 5 M-2278 Wiring Harness and External Connections



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

Figure 6 Tapchanger Control and LTC Backup Control Interconnections

4.2 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 Test Procedures

Equipment Required

- 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

Set-up Procedure

1. Make the electrical connections as shown in Figure 5-1.

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

2. Initial settings

5.1 Bench Test

■ **NOTE:** This test assumes that the M-2001 Tapchanger Control is connected to the M-2278 Adapter Panel.

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

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

Resistance

1. Apply 100.0 mA in-phase current to TB3-4 (load current-polarity) and TB3-5 (load current-return) of the adapter panel. (Set S_1 to LDC and S_2 to I_R.)
2. Set LDC Resistance to 24.0 V; **RAISE** LED should light.
3. Increase input voltage to 132.0 Vac; **RAISE** and **LOWER** LEDs should be extinguished.
4. Set LDC Resistance to -24.0 V; **LOWER** LED should light.
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 TB3-4 (load current-polarity) and TB3-5 (load current-return) of the adapter panel. (Set S_1 to LDC and S_2 to I_L.)
2. Set LDC Reactance to 24.0 V; **LOWER** LED should light.
3. Decrease input voltage to 108.0 Vac; **RAISE** and **LOWER** LEDs should be extinguished.
4. Set LDC Reactance to -24.0 V; **RAISE** LED should light.
5. Increase input voltage to 132.0 Vac; both **RAISE** and **LOWER** LEDs should be extinguished.
6. Set LDC Reactance to 0.0 V.

Paralleling

1. Apply 100.0 mA 90° leading current to TB3-2 (circulating current-polarity) and TB3-1 (circulating current-return) of the adapter panel.
2. **LOWER** LED should light.
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 TB3-15 (drag hands reset) to TB3-6 (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 Series Digital Tapchanger Control to display the Operations Count screen.
2. Verify the counter operation by connecting a switch between TB3-14 (operations counter input) and TB3-6 (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 TB3-14 (operations counter input) and TB3-6 (neutral).
4. The tap position should change.
5. Jumper TB1-11 (neutral light) to TB3-6 (neutral).
6. Set the neutral switch S1, located on the adapter panel printed-circuit board, to the toggle right position.
7. The neutral light on the adapter panel should light and the tap position should return to “0 Neutral.”
8. Remove the jumper.

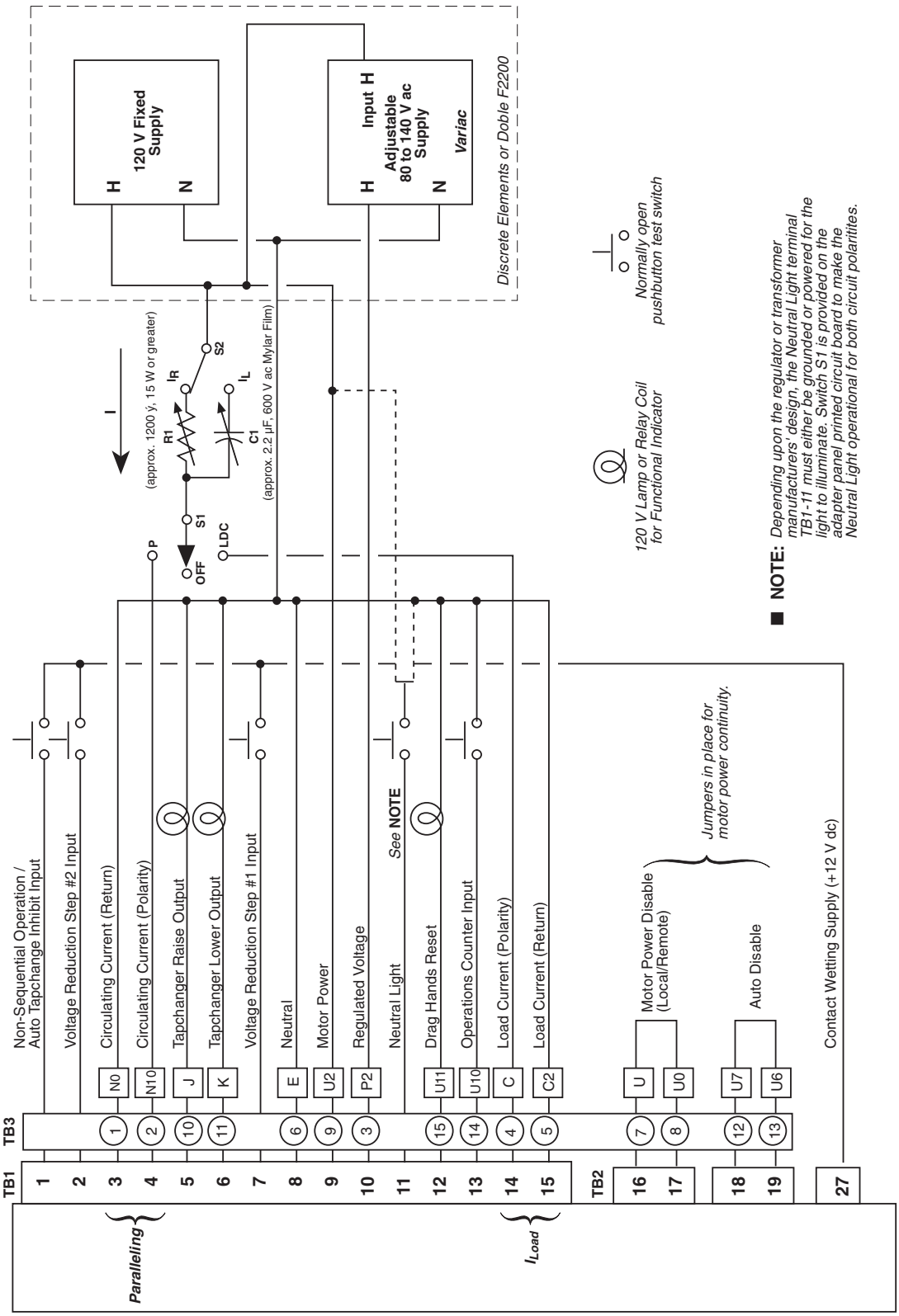


Figure 7 M-2278 Test Procedure External Connections

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; **BR** should appear on the screen.
6. Increase voltage to 128.5 V; **BR** goes off and **FL** appears on the screen.
7. Decrease voltage to 113.5 V; **BL** appears on the screen.

—Bench Test Complete—

5.2 M-2001 Checkout Procedure

■**NOTE:** This test of the M-2001 assumes that the unit remains connected to the M-2278 Adapter Panel.

Basic Operational Test

1. Apply 120.0 Vac to TB3-9 (motor power) and TB3-3 (regulated voltage) of the adapter panel.
2. Connect neutral to TB3-6 (neutral).
3. Verify local voltage ≈ input voltage ±0.3 V.
4. Apply 100.0 mA in-phase current to TB3-4 (load current-polarity) and TB3-5 (load current-return) of the adapter panel. Verify **Control Load** I ≈ 100 mA and **Power Factor** ≈ 1.0 ±0.02.
5. Apply 100.0 mA 90° leading current to TB3-2 (circulating current-polarity) and TB3-1 (circulating current-return) of the adapter panel.
6. Verify **Control Circ** I ≈ 100.0 mA ±2 mA.
7. Verify **UP**, **DOWN** and **ENTER** buttons work.

—Checkout Procedure Complete—

5.3 In-Service Test

1. Set the M-2001 Series Digital 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—

Return unit to desired settings

6.0 Checkout Procedure

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

6.1 Power

1. Remove any external connection between TB3-9 and TB3-3 which are located on the adapter panel printed circuit board. Also remove any voltage applied to TB3-9 externally. Using a voltmeter, make sure that the voltage applied to TB3-3 is nominal 120 Vac with respect to TB3-6 (neutral). Apply power to TB3-3 (hot) and TB3-6 (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. Units returned with only a blown fuse are not covered by warranty, and a nominal repair charge will be made for replacement of the fuse. Please check the fuse before returning the unit for repair, in order to avoid unnecessary repair charges.

3. Apply motor power to TB3-9 (hot) and TB3-6 (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 Field Checkout Procedure as found in the M-2001 Status & Setpoint Review Guide of the M-2001 Series Digital Tapchanger Control Instruction Book for test/operation procedures.

5. As shown in Figure 8, temporarily place a shorting device across the LDC-CT secondary to short the line drop compensator circuit, and place another shorting device across TB3-1 and TB3-2 to short the circulating current paralleling input, for the load current check. Insert an ammeter between the polarity input and TB3-4. 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.

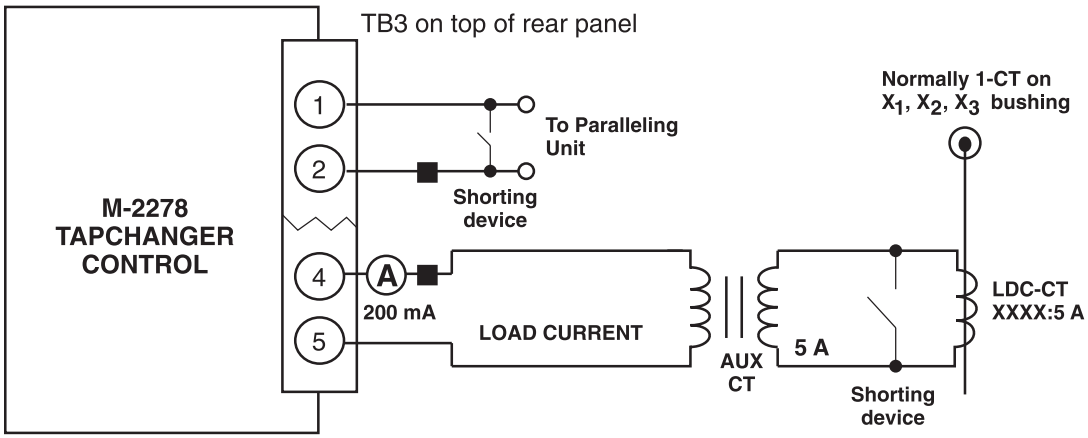


Figure 8 Setup for Current Checkout Procedure

6.2 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.

7.0 Maintenance

Due to the nature of the circuitry in the M-2001 Series Digital Tapchanger Control, field repair is not recommended. All units are fully calibrated at the factory prior to shipment; there is no need to recalibrate a unit prior to initial installation. In the event that a unit does not operate properly, it should be established that the problem is caused by a malfunction of the Tapchanger Control and not caused by an external fault or wiring error. Check for blown fuses on the Adapter Panel. If the Tapchanger Control is still not operating properly, set the **AUTO/OFF/MANUAL** switch on the Adapter Panel to **MANUAL**. Once this is accomplished, the Tapchanger Control can be disconnected and returned to Beckwith Electric. Pack the unit carefully (in the original carton if possible), assuring that there is adequate packing material to protect the contents.

■ **NOTE:** Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the user. The warranty is void if the value of the unit is invoiced to Beckwith Electric at the time of return or if the unit is returned with transportation charges collect.

If under warranty, units will be repaired rapidly and returned at no cost and with return transportation paid if the fault is found to be due to workmanship or failure of material. If a unit is under warranty and express shipment for return of the repaired unit is requested, shipping charges will be billed at the current rate. If the fault is due to abuse or misuse, or if the unit is out of warranty, a modest charge will be made. Repair can normally be expected to take two weeks, plus shipping time. If faster service is required, it should be requested at the time of return.

■ **NOTE:** Adapter panels returned with only a blown fuse are not covered by warranty and a nominal repair charge will be made for replacement of the fuse. Please check the fuses before returning the adapter panel for repair in order to avoid unnecessary repair charges.

To help in analyzing the problem, a complete description of the malfunction and conditions leading to the failure should be included with the unit.

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Legal Information

Patent

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

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

Warranty

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

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 afore-mentioned 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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