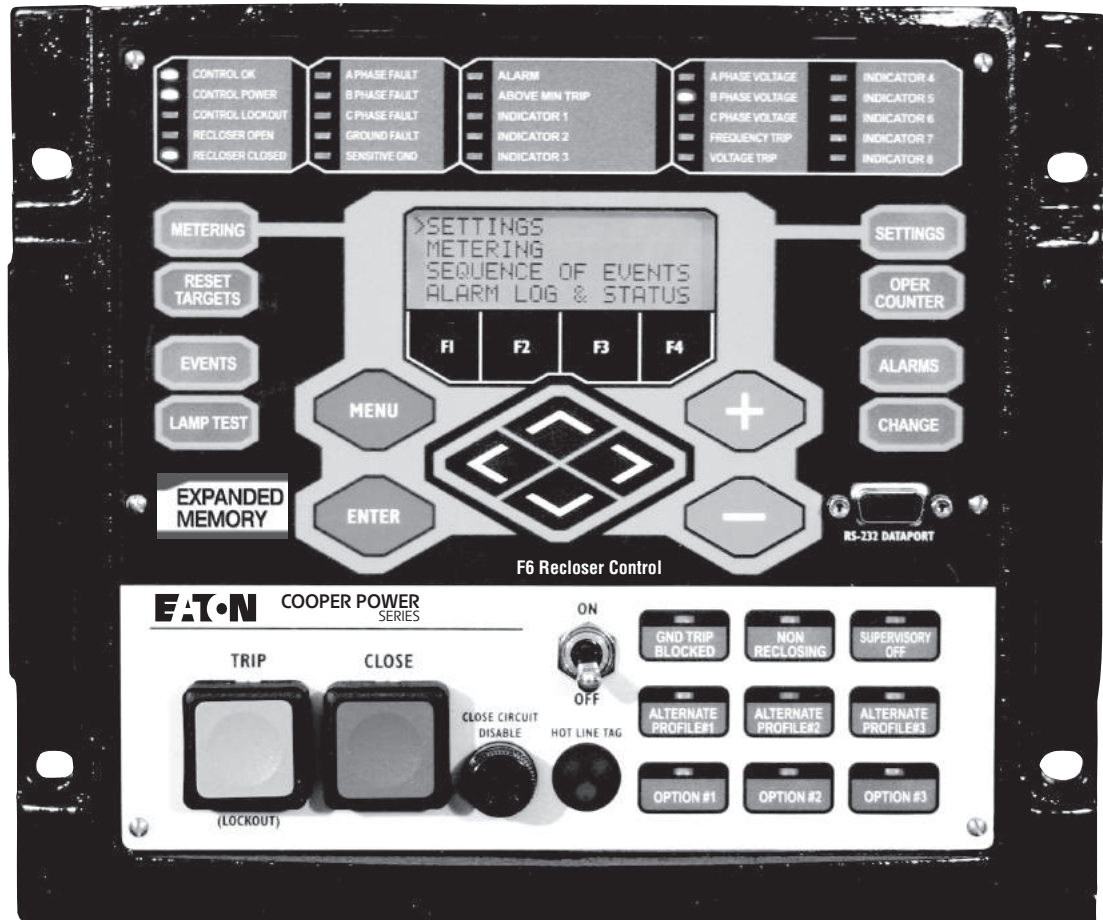


Form 6 microprocessor-based rack-mount recloser control installation and operation instructions

For type F6-R2 controls above serial number 20,000 or beginning with CP57.



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Contents

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY	II
SAFETY FOR LIFE	IV
SAFETY INFORMATION	IV
Safety instructions	iv
PRODUCT INFORMATION	1
Introduction	1
ANSI standards	1
Quality standards	1
Acceptance and initial inspection	1
Handling and storage	1
Control power	1
FORM 6 RECLOSER CONTROL DESCRIPTION	1
Description	1
Theory of operation	2
Control front panel	3
Control features	8
Communications	11
Control information	11
Control back panel	11
INSTALLATION PROCEDURE	12
Initial programming prior to installation	12
Control/recloser compatibility	12
Duty cycle monitor	13
Mounting the control	13
Grounding the control	14
Customer connections for DC power and AC voltage sensing	16
Before placing the control and the recloser into service	20
Using removable inserts	25
ACCESSORIES	27
Control cable	27
Recloser interface junction box	27
Recloser interface junction box cable	28
Discrete interface board (DIF) option accessory ..	32
Mounting kits	32
Communication board accessories	36
TESTING	38
Testing an installed control	38
Remove the control from service	39
Testing with type MET tester	39
Closing the recloser during testing	40
Return the control to service	44
ADDITIONAL INFORMATION	45
Replacement kits	45
Factory-authorized service centers	45
Factory testing and troubleshooting classes	45



Safety for life



Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally-approved safety procedures and safety instructions when working around high-voltage lines and equipment, and support our “Safety For Life” mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally-approved safety procedures when working around high- and low-voltage lines and equipment.

G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling, or maintenance can result in death, severe personal injury, and equipment damage.

G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally-approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury, and equipment damage.

G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install, or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage.

G122.2

WARNING

Overlapping zones of protection are required. Upstream protection device settings must provide adequate overcurrent protection in the event of a system or product failure. Failure to properly select appropriate upstream coordination protection can result in death, severe personal injury, and equipment damage.

G172.0

Product information

Introduction

Service Information MN280075EN provides installation and operation instructions for the Form 6 microprocessor-based rack mount recloser control above serial number 20,000 or beginning with CP57.

Refer to the following information as appropriate for your version of ProView software:

- *Service Information S280-70-4 Form 6 Recloser Control Programming Guide: ProView 4.X.X software*
- *Service Information S280-70-21 Form 6 Recloser Control Programming Guide: ProView 5.X.X software*

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment.

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or process described, nor provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, contact your Eaton representative.

ANSI standards

Eaton's Cooper Power series reclosers are designed and tested in accordance with the following ANSI standards: C37.60 and C37.85 and ANSI Guide C37.61.

Quality standards

ISO 9001-Certified Quality Management System

Acceptance and initial inspection

Each Form 6 rack mount recloser control is completely assembled, tested, and inspected at the factory. It is carefully calibrated, adjusted and in good condition when accepted by the carrier for shipment.

Upon receipt, inspect the carton for signs of damage. Unpack the control and inspect it thoroughly for damage incurred during shipment. If damage is discovered, file a claim with the carrier immediately.

Handling and storage

Be careful during handling and storage of the control to minimize the possibility of damage. If the control is to be stored for any length of time prior to installation, provide a clean, dry storage area. If storage is in a humid atmosphere, make provisions to keep the control circuitry energized.

Control power

All operating power is obtained from the substation battery bank. There are two power supply options available for the Form 6 rack mount recloser control. Examine the voltage decal on the back of the recloser control to verify the correct voltage rating.

The following power supply options are available and configured at the factory:

- 24 VDC $\pm 20\%$
Burden 14 Watts
- 40 VDC –140 VDC
Burden 14 Watts

Note: The 40 VDC – 140 VDC power supply is a universal power supply adaptable for either 48 VDC or 125 VDC substation batteries.

Refer to the **Customer connections for DC power and AC voltage sensing** section of this manual for incoming power wiring illustrations for the Form 6 rack mount recloser control.

Form 6 recloser control description

Description

The Form 6 rack mount microprocessor-based recloser control includes extensive system protection functionality, including phase, ground, and negative sequence overcurrent protection, over/underfrequency, and voltage protection, directionality, sensitive ground fault, and sync check.

Analysis tools include fault locating, event recording, TCC Editor II, Idea Workbench, and oscillography functions, including oscillography replay.

Metering functions include demand and instantaneous current on a per-phase basis, instantaneous voltage and power factor on a per-phase basis, and power (real, reactive, apparent).

The front panel LCD display is used to configure the operating settings for the control. It is also used to display metering, counter information, control parameters, reset alarms, and provide diagnostic information.

Control parameters can also be programmed via a personal computer connected to the control through the front panel RS-232 port. Control programming, interrogation, and operations are performed with Form 6 ProView interface software on a personal computer.

The interface program software includes additional functions used to create and graphically display Time Current Curves and provide Idea Workbench for configuring user-selected inputs and outputs, configurable event and alarm data, and selectable communication points for serial communication.

The control operates on 50 and 60 Hz systems.

Form 6 microprocessor-based rack-mount recloser control

The control can be configured, by the factory or by the user, for a wide variety of applications. If user requirements change, the control functions can be modified to meet the new requirements.

Theory of operation

Current sensing is provided by three current transformers located in the recloser and interfaced to the Form 6 recloser control via control wiring. This wiring also supplies Trip, Close, and Recloser status, and connects to the Recloser Interface (RIF) module to provide isolation for reliable operation. Voltages for metering are connected to the analog board via the connector terminal block, TB-2.

A functional block diagram of the Form 6 recloser control is shown in **Figure 1**. Line current flowing through the recloser is converted by the CPU module to a digital signal suitable for metering and fault current calculations. Data sampling occurs at a rate of 64 times per cycle. The CPU contains a data acquisition section that uses the acquired samples to compute the fundamental currents and voltage for use in overcurrent, under/overvoltage, and under/overfrequency protection, as well as currents and voltages for metering functions. The current for overcurrent protection is calculated on a sub-cycle basis; it includes only the fundamental and DC component.

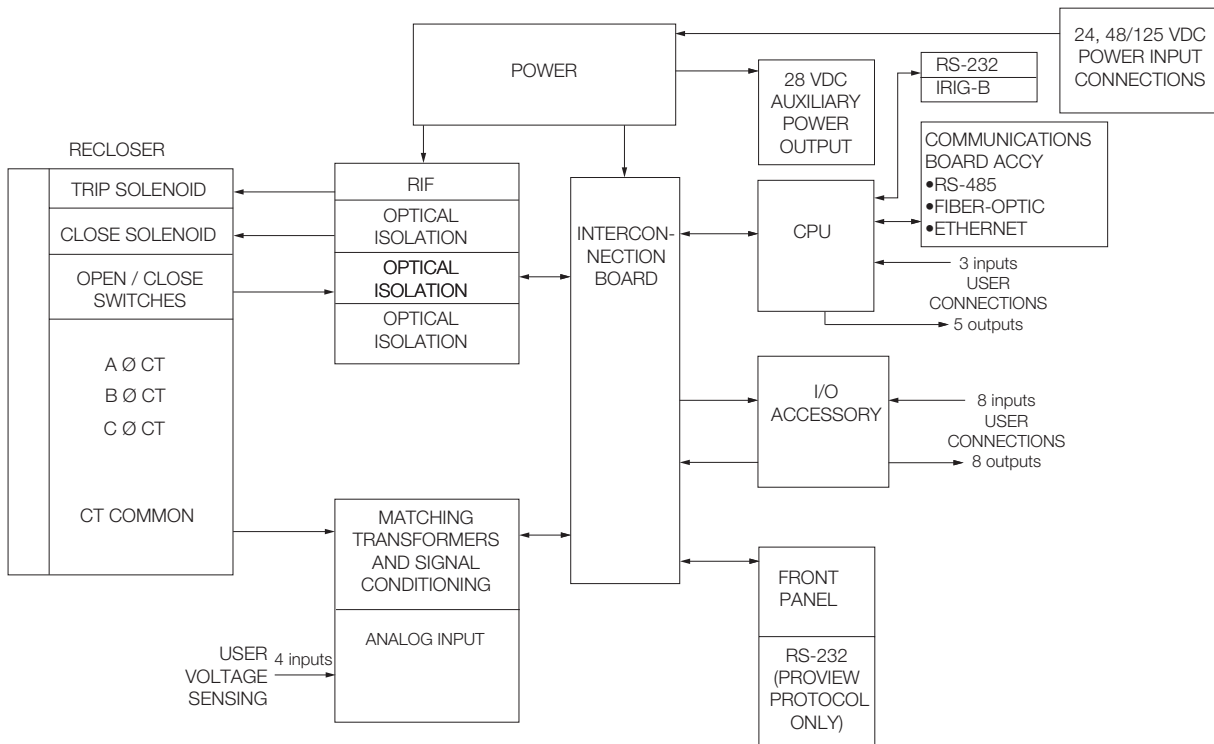


Figure 1. Form 6 rack mount recloser control operational flow diagram

When the phase or ground current exceeds its programmed minimum-trip value and associated time-current-curve (TCC) timing, the control initiates the programmed sequence of recloser tripping and reclosing operations via the CPU and RIF modules. If the fault is temporary, the control resets to the start of its operating sequence after a preset time delay. If the fault is permanent, the control performs its complete programmed sequence of reclose commands and locks out with the recloser open. Once locked out, the control must be closed via the operator panel or SCADA communications. This resets the control to the start of the operating sequence.

The following chain of events occurs for an operating sequence of two trips to lockout (one trip on TCC1, one trip on TCC2):

1. The overcurrent signal is integrated with time on the selected curve for the first trip operation (TCC1) to produce the signal which energizes the trip circuit.
2. Energizing the trip circuit connects the supply to the trip solenoid to open the recloser.
3. Upon opening, the control starts timing on the first reclosing interval-delay time.
4. Upon expiration of this reclosing interval-delay, a closing signal is issued from the control, closing the recloser, and selecting the time-current characteristics for the second trip operation (TCC2).
5. If current remains above the minimum-trip level, the recloser will trip on TCC2 and lockout the recloser.

Control front panel

The Form 6 control front panel is illustrated in **Figure 2**.

The front panel is separated into two clearly identified, color-coded sections:

- The top portion of the front panel is used for programming the control and providing LED status indication.
- The lower portion of the front operating panel is used for operating the control and recloser.

The control includes a Power Save feature that will turn off the backlit LCD display and all LEDs (except Hot Line Tag) if no front panel keypad is pressed within ten minutes. Pressing the LAMP TEST key will re-activate the display and LEDs.

Note: The Power Save feature is a ProView interface software default setting. This feature can be disabled via the ProView interface software.

The control includes a Reset Menu feature that will cause the LCD display to revert to the root menu after ten minutes of inactivity.

Note: The ten minute timer and MMI Reset Menu is a ProView interface software default setting. The menu selection and timer can be changed via the ProView interface software.

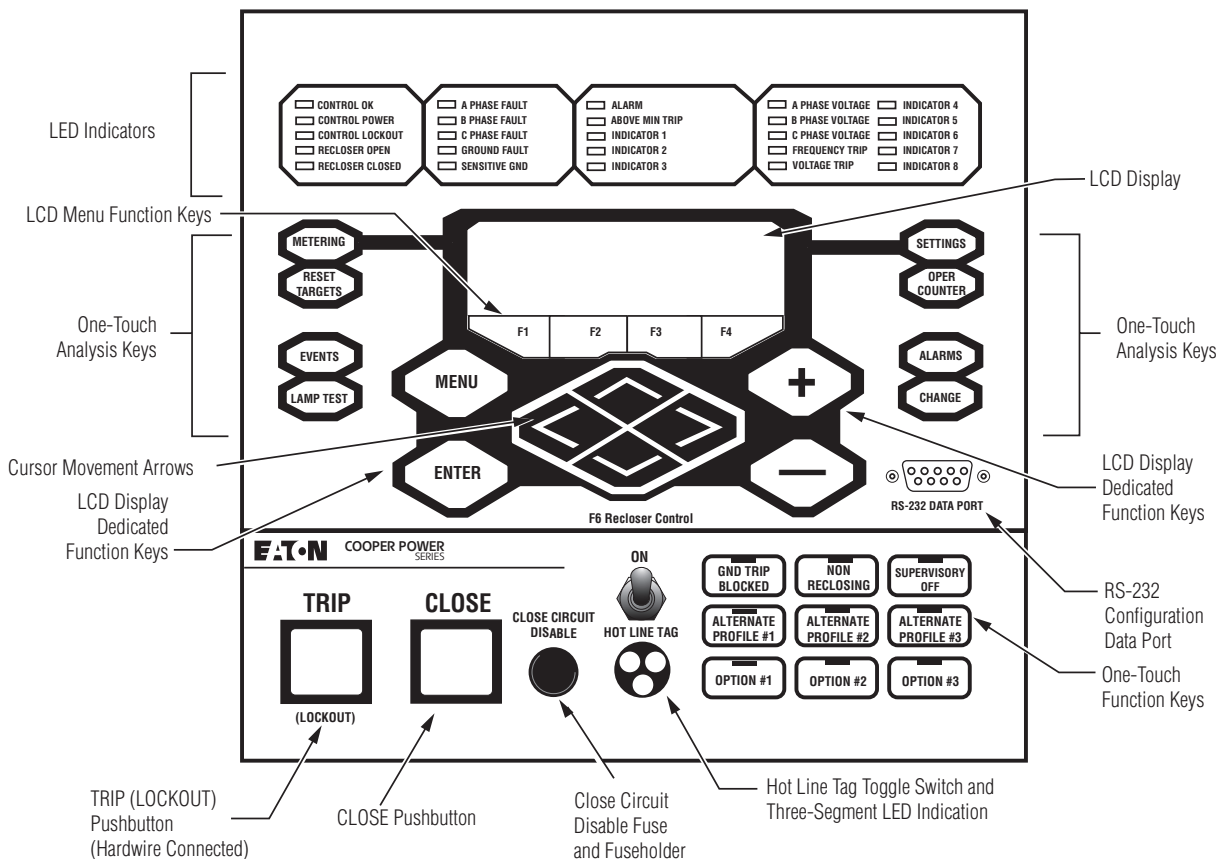


Figure 2. Form 6 recloser control front panel

Form 6 microprocessor-based rack-mount recloser control

Front panel text messaging

The LCD messages are accessed from the front panel by following the Text Messages menu path. This menu displays any active user-configured text messages.

Up to fourteen user-configurable text messages can be programmed via the Idea Workbench. Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for information on programming the text messages.

These text messages appear on the front panel LCD and can be programmed to appear for alarm or other conditions.

Text messages displayed on the front panel are limited to four lines of 20 characters each (including spaces). Text messages can also be accessed by pressing the LAMP TEST one-touch analysis key on the front panel.

Programming panel

The Programming panel has the following sections:

One-touch analysis keys

There are eight analysis keys (**Figure 3**) that allow one-button access to a variety of control and monitoring functions that appear in the LCD display. Pressing these buttons causes the following information to display or function to occur:

Note: When pressing a membrane pushbutton, always press and hold for 0.5 seconds to ensure the button press is recognized by the device.

METERING: Displays the systems instantaneous metering values for current and voltage on the LCD display.

RESET TARGETS: Resets the fault target indicators on the operator panel.

EVENTS: Displays the last 25 events from the Sequence of Events log.

LAMP TEST: All operator panel LEDs are illuminated for verification of proper connection and operating status of all indicator lights. All status indicators will then return to their previous state. While in the LAMP TEST mode, the control response to operator panel keys is disabled, except for the TRIP (LOCKOUT), CLOSE, and HOT LINE TAG switches.

SETTINGS: Displays recloser settings on the LCD display.

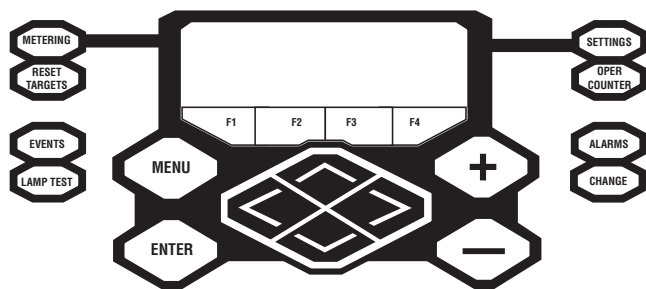


Figure 3. Analysis keys, LCD display, LCD menu function keys, and cursor movement arrows

OPER COUNTER: Displays the total number of trip operations and target counters for each A, B, and C Phase; Ground, and Sensitive Ground on the LCD display.

ALARMS: Provides status information on the LCD display for all recloser alarms.

CHANGE: Allows the user to change the state of the control functions on the operator panel function keys.

Note: The CHANGE mode is a ten second period in which one function setting can be changed. If no change is made in that time, the control returns to the current setting.

LCD Display

The LCD Display is a backlit 4-line, 20-character display that provides extensive distribution system, recloser, and control status information using a minimum of eight navigation keypads (**Figure 3**).

Note: The LCD display panel contrast is field-adjustable to allow for various mounting heights and applications. Press the MENU key and then press the (+) or (-) key to increase or decrease the contrast.

The four LCD navigation buttons are as follows:

- MENU Identifies the LCD Display menu options.
- ENTER Selects a menu option.
- + Increases value selection.
- Decreases value selection.

The four LCD menu function keys activate specific menu commands. When a command appears in the LCD display directly above one of the four LCD menu function keys, the user can press the key to accept/select the command.

The four LCD menu function keys are as follows:

F1 F2 F3 F4

The four cursor movement arrows allow movement in the following directions:

- ◀ Moves the cursor left.
- ▶ Moves the cursor right.
- ▲ Moves the cursor up one line.
- ▼ Moves the cursor down one line.

Status indicator LEDs

The status indicator LEDs (**Figure 4**) in the Programming section of the Operator Panel give instant information on the control and recloser status:

All of the default status indicators LEDs (except for CONTROL OK, CONTROL POWER, and ALARM) can be reconfigured via the Idea Workbench. Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

The label inserts can be user-customized. Refer to **Using removable inserts** section of this manual for additional information.

CONTROL OK: The green LED indicates the control is operating normally and not in an alarm state.

The CONTROL OK LED will not be illuminated during these alarms (indicated by the red ALARM LED and displayed in the alarm status log):

- RAM Failure: This alarm indicates a failed RAM memory test.
- ROM Failure: This alarm indicates a failed ROM memory test.
- Power Supply Mal[function]: This alarm indicates internal control operation power was outside of its operating tolerance for more than 20 seconds. This alarm resets when the internal control operation power returns to operation within its normal tolerances.

CONTROL POWER: The green LED indicates there is adequate VTC voltage to trip the recloser. This LED does not indicate the presence of AC or battery power.

CONTROL LOCKOUT: The green LED indicates the control is in a locked out state, i.e. a reclosing sequence is not in progress. This LED does not indicate that the recloser is open.

RECLOSER OPEN: The green LED indicates the recloser is in the open position.

RECLOSER CLOSED: The red LED indicates the recloser is in the closed position.

Note: There are several conditions that will cause the alternate blinking of the CONTROL LOCKOUT, RECLOSER OPEN, and RECLOSER CLOSED LEDs: Failure to Trip, Failure to Close, Interrupter Malfunction, and 52a/b Disagreement.

The LED blinking pattern for these conditions is the CONTROL LOCKOUT green LED and RECLOSER CLOSED red LED alternating with the RECLOSER OPEN green LED.

In addition to the above LED blinking pattern, the red ALARM LED will also be illuminated for these alarms: Failure to Trip, Failure to Close, and Interrupter Malfunction.

A PHASE FAULT, B PHASE FAULT, C PHASE FAULT: The red LEDs indicate A, B, and/or C phase current was either the maximum phase current or within 20% of the maximum when a trip signal was issued.

GROUND FAULT, SENSITIVE GROUND FAULT: The red LEDs indicate that a Ground and/or Sensitive Earth Fault

tripping function was asserted at the time the trip signal was asserted.

ALARM: The red LED indicates an alarm has been issued. Review the alarm status and log on the LCD display for the specific alarm.

Note: If a Battery Alarm occurs, de-select the Pole Mounted Control checkbox in the ProView application software Configure>System Configuration dialog box. Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

ABOVE MINIMUM TRIP: The red LED indicates the current exceeds the level set for minimum trip.

FREQUENCY TRIP: Indicates the recloser tripped due to an under or over frequency condition.

VOLTAGE TRIP: Indicates the recloser tripped due to an under or over voltage condition.

A PHASE VOLTAGE, B PHASE VOLTAGE, C PHASE VOLTAGE: The red LED indicates a presence of voltage on the respective phases. The Single-Phase Undervoltage Pickup setting controls the voltage indication for the front panel LEDs as defined in the Voltage setting dialog box for the active setting profile. Refer to **Settings - Voltage** in the **Schemes** section of *S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide*.

INDICATOR 1, INDICATOR 2, INDICATOR 3, INDICATOR 4, INDICATOR 5, INDICATOR 6, INDICATOR 7, INDICATOR 8: Customizable LEDs that are used with functions programmed through the Idea Workbench. The LED indicators do not have active default values. The LEDs are illuminated when the status configured via the Idea Workbench is present.

Operating panel

The Operating section includes the following sections:

RS-232 configuration data port

The RS-232 connector (shown in **Figure 2**) on the front operating panel allows direct connection to a personal computer without any special cables or connectors. This port is used only for configuring the control with ProView application software. All settings, metering, events, and oscillography data are available from this port. The port is Data Communication Equipment (DCE) wired for direct connection to a personal computer.

A 9-pin RS-232 cable (Catalog Number KME5-66) to connect from the PC to the RS-232 data port is available as an accessory.

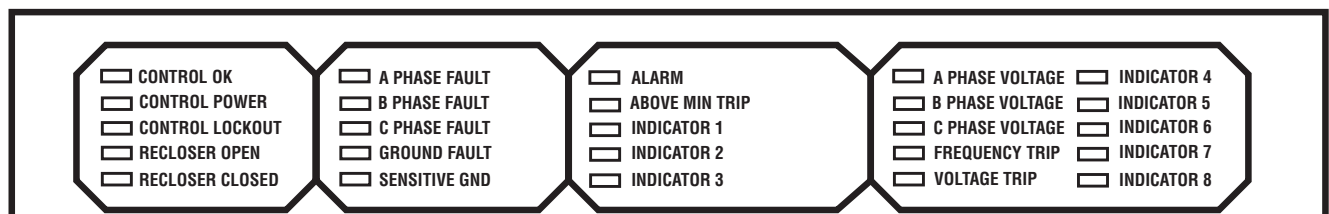


Figure 4. Status indicator LEDs

HOT LINE TAG ON/OFF Toggle Switch and LED Indicator

⚠ WARNING

Hazardous voltage. Do not use Hot Line Tag as a substitute for a visible disconnect. Always establish a visible disconnect prior to performing any work requiring a de-energized line. Failure to comply may cause death, severe personal injury, or equipment damage.

T276.0

Hot Line Tag is provided for live-line work applications. All closing operations are disabled when the Hot Line Tag feature is activated.

IMPORTANT

Hot Line Tag activation does not cause the recloser to trip open. It only prevents the recloser from closing.

IMPORTANT

Hot Line Tag is intended solely for live-line work applications, such as maintenance, repairs or improvements to the distribution system, that occur while the line remains energized.

Hot Line Tag prevents all closing attempts from the control and shifts protection to one trip-to-lockout on the composite curve of the Hot Line Tag definite time and the TCC1 curve (whichever is faster). Hot Line Tag takes precedence over Cold Load Pickup, Non-Reclosing, and Fast Trips Disabled.

Hot Line Tag is activated from either the operator panel toggle switch, serial communications, or a discrete SCADA function. All sources must be off to de-activate Hot Line Tag.

To activate the function from the operator panel, flip toggle switch up to the ON position. See **Figure 5**. The LED indicator illuminates when the function is active.

The Hot Line Tag function may only be reset by the source which initiates it. For example, if Hot Line Tag is activated at the operator panel, the reset function is only possible at the operator panel, and not via SCADA command.

Close circuit disable

Close Circuit Disable (**Figure 5**) is a removable fuse that, when removed from the front operating panel, disables the close circuit from the control to the recloser. Removing the cartridge from the control disables all electrical closing of the recloser and provides a physical disconnect to the recloser closing circuit. As a result, the control cannot perform a close operation. This disconnect overrides all close functions and makes a remote or manual close operation impossible.

Note: When the Close Circuit Disable fuse is removed, the trip circuit remains active and will trip per the programmed time current curve for a faulted condition.

IMPORTANT

If the CLOSE button is pressed after the Close Circuit Disable fuse is removed, do not reinstall the fuse until after the ALARM LED illuminates (within approximately five seconds) to indicate CLOSE MALFUNCTION. Re-installing the Close Circuit Disable fuse prior to the CLOSE MALFUNCTION ALARM indication will cause the control to close the recloser.

TRIP (Lockout) pushbutton

The TRIP pushbutton (**Figure 5**) provides front-panel access to trip (lockout) the recloser. When pressed, the TRIP pushbutton opens the recloser and locks out the control. The TRIP pushbutton operates independent of the microprocessor and is directly connected to the trip coil circuitry in the recloser.

Note: In the event of microprocessor failure, the trip circuit can operate independent of the main microprocessor.

CLOSE pushbutton

When pressed, the CLOSE pushbutton (**Figure 5**) returns the control to the initial or home sequence position, closing the recloser. The control is ready for the start of a new trip/close sequence.

Note: The Close Malfunction alarm must be reset before Closing will be allowed.

Note: Pressing the CLOSE pushbutton from the Lockout position initiates Cold Load Pickup (CLPU) protection, if the feature is enabled.

The user does have the ability to block COLD LOAD PICKUP through the LCD menu or by configuring one of the Option one-touch function keys via the Idea Workbench feature in ProView.

If the recloser is closed, pushing and holding the CLOSE pushbutton does not activate the Cold Load Pickup feature. See **Cold Load Pickup** in the **Control Features** section of this manual.

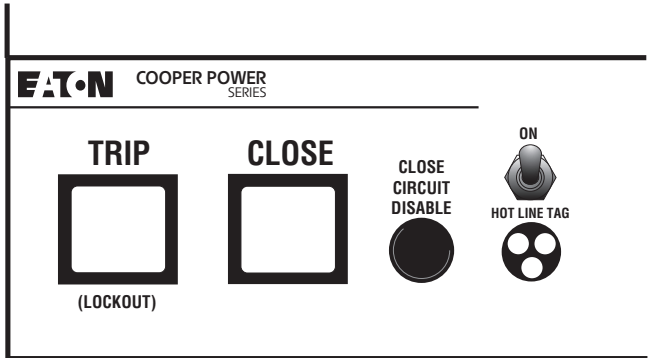


Figure 5. TRIP (Lockout) pushbutton; CLOSE pushbutton; Close Circuit Disable removable fuse; and Hot Line Tag switch and Hot Line Tag red indicator LEDs

One-touch function keys

Quick access to frequently operated Form 6 control features is provided with nine function key pushbuttons on the control operator panel.

The Form 6 control operator panel one-touch function keys are illustrated in **Figure 6**.

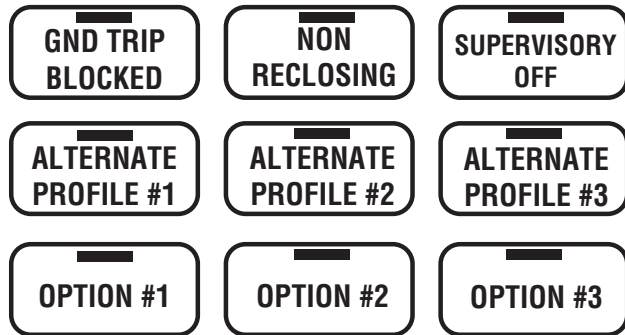


Figure 6. Operator panel function keys

Red LEDs located on each function key indicate the status of the function, regardless of local or remote activation. For example, if Ground Trip Blocked is activated from a SCADA signal, the red indicator will illuminate even though it was not activated from the operator panel.

Operator panel function key activation or de-activation requires the operator to first press the CHANGE key to enter the CHANGE mode. A function must then be selected or de-selected within ten seconds to activate or de-activate the function. Once selected, the control returns to normal operation until prompted for another change request. This prevents accidental changing of functions or features.

Note: Only one function can be changed per each CHANGE mode activation.

GND TRIP BLOCKED

The Ground Trip Blocked function blocks all ground sensing in the control for the active profile. This red indicator is illuminated when Ground Trip Block is activated from the serial port, I/O, the interface software, or locally (via the front panel) causing the control to block all ground sensing.

NON RECLOSING

The control is operating in a non-reclosing mode when the NON RECLOSING red indicator is illuminated. Non-reclosing mode disables any automatic reclosing operations. Non-reclosing does not alter the active TCC. Activation is possible from the SCADA port, I/O, the interface software, or locally (via the front panel).

SUPERVISORY OFF

When the SUPERVISORY OFF red indicator is illuminated, supervisory commands are blocked. Supervisory functions

through the back panel serial communication ports and the discrete I/O are blocked. Serial communications through the front panel RS-232 port remain active independent of the status of the SUPERVISORY OFF switch. Activation of this function key is restricted to the operator panel and is accomplished by pressing the CHANGE key and then pressing the SUPERVISORY OFF key. Operational data and metering information are available while the control is in the SUPERVISORY OFF position. The TRIP and CLOSE pushbuttons and Hot Line Tag are active independent of the SUPERVISORY OFF function.

ALTERNATE PROFILE #1, #2, AND #3

The Form 6 control has four separate protection profiles; a Normal profile, and Alternate Profiles 1, 2, and 3. Each profile changes all protection parameters for the control. Except for the normal profile, each has an indication and selection key. When the operator panel display lights are active and none of the three indicators are on, the normal profile is active. Only one profile can be active.

To select an alternate profile, press the CHANGE key and then press the desired alternate profile.

To return to the normal profile, press the CHANGE key and then press the active alternate profile to deselect it. These functions can also be completed remotely via communications interfaces.

IMPORTANT

Unused alternate profiles should be programmed with the same settings as one of the applicable profiles. Default settings on unused alternate profiles can cause unnecessary outages if they are below normal system requirements.

IMPORTANT

Check minimum trip values prior to changing an alternate profile to avoid misoperation of the control under load conditions.

OPTION #1, OPTION #2, AND OPTION #3

The OPTION #1, OPTION #2, and OPTION #3 function keys must be programmed via the ProView Idea Workbench software.

The OPTION LEDs are illuminated when the options configured via the Idea Workbench are selected. Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

These OPTION keys provide a momentary signal. For instance, these keys can be programmed to toggle control status, protective functions, or a momentary input pulse.

The OPTION #1, OPTION #2, and OPTION #3 function keys are intentionally not defaulted to any function. The functions are assigned to each OPTION key via the Idea Workbench application.

Form 6 microprocessor-based rack-mount recloser control

Control features

The Form 6 recloser control offers numerous standard features and accessories that allow the user the utmost flexibility applying the recloser control.

Control security

The Form 6 recloser control has multiple customer-programmable security codes to limit control programming and viewing function access to authorized personnel. The front panel Human-Machine Interface (HMI) includes a user-selected security code to access the settings. Plus, the ProView interface software has its own security levels for multiple-user access.

Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

Protection profiles

Four protection profiles capable of fully specifying control operation are standard in the control. Each protection profile includes the following as a minimum:

- Overcurrent Protection
- Over/Undervoltage Protection
- Over/Underfrequency Protection
- Directional Protection
- Hot Line Tag Functionality
- Sync Check
- Sensitive Earth Fault Protection
- Sequence Coordination
- Operation Settings

Time current curves

Time-current curves are available for numerous functions, including fast and delayed operations for phase, ground, and negative sequence protection. Each time-current is selected from a defined fifty curves which can be further customized by the user. The time-current curves are also selected from a graphical TCC Editor II to visualize any modifications prior to configuring the control.

The time-current curves include the following modifications for phase, ground, and negative sequence protection:

- Time Multiplier with a range of 0.1 to 25 in .1 increments.
- Time Adder with a range of 0 to 30 seconds in .01 second increments.
- Minimum Response Time with a range of 0.1 to 1 seconds in .001 second increments.
- High Current Trip multiplier with a range of 1 to 32 multipliers in increments of 0.1.

- High Current Trip Time Delay with a range of 0.01 to .150 seconds in .001 second increments.
- Time Dial Reset co-efficient with a range of .1 to 30 seconds in 1 second increments.

Sequence coordination

Sequence Coordination eliminates nuisance tripping through trip coordination. It allows the control to step through selected operations in the operating sequence without tripping. The number of Sequence Coordination advances is programmable from one to three operations to provide trip coordination with a downline recloser. This feature is independently selectable for each protection profile.

Cold load pickup

The control includes a Cold Load Pickup feature to prevent the control from tripping while energizing non-fault system loads. This feature has independently programmable minimum trip value time-current curve, reclose interval, and number of independent operations to lockout for each protection profile. Cold Load Pickup also includes TCC Multipliers, TCC Adders, Minimum Response Time, Time Dial Reset, and High Current Lockout. Also, direct values, not multiples of minimum trip, are provided for high current lockout.

Fast trips disabled

The control includes a Fast Trips Disabled feature to modify protection, so that all trip operations use the programmed TCC2. This feature is independently selectable for each protection profile. All trip operations will time on TCC2. Typically, TCC1 is fast and TCC2 is delayed. So, as an example, the control will change its sequence from 2 fast and 2 delayed operations to 2 operations on TCC2 when Fast Trips Disabled is active.

High current lockout

The High Current Lockout feature will automatically lockout the control on the selected operation when current exceeds a programmable level. The active trip numbers for the lockout is selectable for phase, ground, and negative sequence. This feature is independently selectable for each protection profile.

Sensitive ground/earth fault operation

The control has a Sensitive Ground/Earth Fault Trip feature that provides tripping of the recloser after a programmable, definite time for ground currents below normal ground minimum trip levels. The feature has programmable operations to lockout and reclose intervals independent of the ground settings. This feature is independently selectable for each protection profile.

Metering

The control provides instantaneous and/or demand metering with programmable integration intervals for the following functions:

- Real and reactive power for each phase and total, including directional, on an individual phase basis.
- Demand currents on a per phase basis.
- Instantaneous currents, including ground current.
- Instantaneous voltage on a per phase basis.
- Instantaneous frequency.
- Positive, negative, and zero sequence voltages.
- Instantaneous power factor on a per phase basis.
- Metering settings to include demand interval, and alarm thresholds for current, single-phase kW, three-phase kW, single-phase kvar, and three-phase kvar.

Event recorder

The Form 6 control contains capabilities to perform Sequence of Events time-stamping for up to 33 event types. Sixteen additional inputs can be user-defined through the Idea Workbench.

Factory-defined event types include:

- Overcurrent Protection Trip
- External Trip
- Non-Reclose Trip
- External Close
- Lockout
- Reset

The Event Recorder maintains a minimum of 90 event records. The last 25 events are viewable on the front panel LCD display. Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

Recloser duty monitor

The Form 6 recloser control software is equipped with a Recloser Interrupting Duty Monitor. The Duty Monitor accumulates the summation of $I^{1.5}$ for all interrupted currents on each interrupter. This feature permits programmable entries to preset the duty of an existing recloser. The recloser duty monitor displays interrupting duty in percent of duty used. If the duty cycle monitor exceeds 100%, the recloser should be examined for maintenance.

Discrete SCADA communications

The control provides five configurable output status contacts and three configurable input control contacts as standard. Each status contact is configurable using graphical interface software to combine status functionality along with Boolean

algebra. Default output status contacts are: Lockout, Recloser Open, Recloser Closed, Ground Trip Block, and Hot Line Tag. One output status contact is a solid state output (SS1) with a pickup time no longer than two milliseconds.

The control also provides a minimum of three configurable input control contacts. Each control contact is configurable using ProView application software. Contacts accept a whetting voltage range of 9 VDC - 290 VDC, 7 VAC - 265 VAC. Each digital input is configured for either a momentary, maintained, or maintained with precedence contact. Default input control contacts are: Supervisory Trip and Lockout, Supervisory Close, and Remote Trip and Lockout.

A Discrete Interface Board is also available as an accessory to provide an additional eight output status contacts and eight input control contacts. The expansion I/O board is completely user-configurable.

TCC Editor II

Coordination and actual time current modifications are available with a graphic interactive TCC Editor or similar graphical software.

The TCC Editor II includes a complete database of standard recloser industry time current curves (TCC), both ANSI and IEC types, along with the ability to customize the TCCs with multipliers, constant time adders, or minimum response time adders. Also, the user is able to derive their own specific TCC through data point entry. Each modified time current curve can be identified with a user-customized name and is selectable for configuring the control. The grid and format for presenting the TCCs has a user-adjustable scale, including the option of presenting multiple TCCs in various user-configured colors.

Oscillography

Oscillography is provided to present current and voltage waveforms, along with protection element and recloser response status changes. Filtered and unfiltered data are provided for viewing.

The recorded values are super-imposed on the protection scheme, and the state or value at any point in the scheme is displayed. The user has the capability to move through the event and watch the response of every function. All analog signals, digital inputs, and contact outputs are monitored. Analog oscillography is displayed at 16 samples per cycle.

Oscillographic data is recorded to analyze multiple events during a permanent fault or other event type. The oscillographic data shows two cycles before the trigger point and eight cycles after the trigger point (default).

Note: The configuration settings are programmable.

Oscillography automatically initiates trigger points for the following functions:

- Above Minimum Trip for Phase, Ground, and Sensitive Ground Fault
- Single and Three-Phase Overvoltage
- Single and Three-Phase Undervoltage

Form 6 microprocessor-based rack-mount recloser control

- Over and Underfrequency
- Trip Signal Issued
- Close Signal Issued

Removable inserts

Removable inserts are included with the control design for customization of specific protection requirements. Inserts are available for the status indicator LEDs, the operator panel function keys, and the analysis keys. The removable inserts are designed for use without adhesives, labelmakers, or temporary labels. Refer to **Using removable inserts** section in this manual for more information.

An electronic label template is included on the ProView application software CD and can be accessed through the following default address: C: / Program Files / Cooper / ProviewXX / Form6 / Form 6 Inserts.doc

Idea workbench

The Idea Workbench provides access to various inputs, intermediate variables, and internal Form 6 alarms, status, and targets to allow user-customization of the Form 6 recloser control to meet specific and unique applications. Idea Workbench also gives the user the ability to perform logical functions with these variables by using a simple graphical user interface. Use of Idea Workbench is not a requirement for operation.

Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional Idea Workbench information.

Over/underfrequency protection

The control includes two-stage operation for both underfrequency and overfrequency protection. A fixed time delay ranging from 0 to 100 seconds in .001 second increments is available for both over and underfrequency. A frequency restoration function, enabled or disabled by the user, is provided to allow the recloser to automatically close should frequency return to within configured settings for a user-settable time. Over/Underfrequency Protection is included as part of each protection profile.

Over/undervoltage protection

The control includes single-phase and three-phase undervoltage tripping. The control also includes three-phase overvoltage tripping. Both over and undervoltage functions include a single-phase and three-phase pick-up setting; a single-phase and three-phase time delay setting ranging from 0 to 100 seconds.

Directional

Directional functionality is included to maintain system coordination from multiple sources, as well as circuit reconfiguration for each profile. Directional applies to

phase, ground, and negative sequence protection, selected independently. A maximum torque angle has a range of 0 – 90 degrees.

Fault location

The control includes an impedance-based fault locator based upon the Takagi algorithm¹. Load-compensated impedance calculation is used for calculating the distance. Positive and zero sequence is configured in ohms, and the fault locator line length is configured in kilometers/miles.

¹T. Takagi, Y. Yamakoshi, J. Baba, K. Uemura, T. Sakaguchi, "A New Algorithm of an Accurate Fault Location for EHV/ UHV Transmission Lines: Part I - Fourier Transformation Method"; IEEE Trans. on PAS, Vol. PAS-100, No. 3, March 1981, pp 1316-1323.

Sync check

Sync Check is a permissive system used to qualify any close signal to the mechanism when enabled via the sync check settings. Sync check allows for closing for any combination of dead/live bus/line, and to perform anticipatory closing for a live bus/live line condition by calculating slip and anticipating the mechanism closing delay. In addition to the anticipatory close calculation, the sync check system performs verification of line and bus voltage magnitudes and frequencies to determine that they are within pre-determined ranges, and that the angular difference between the two systems is also within the pre-determined range. For a live/live close, where there is no slip between the systems, the sync check system allows permissive closing after the two systems are within frequency and voltage limits, and the angular difference between the systems has been within the allowable limits for a pre-determined time.

Sync Check functionality includes the following applications: Hot Line/Hot Bus Closing; Dead Line/Hot Bus Closing; Hot Line/Dead Bus Closing; and Dead Line/Dead Bus Closing.

Sync Check Parameters include the following configurable settings: Voltage Angle; Mechanism Operating Delay; Static Angle Delay; Dead Threshold; Live Threshold; Positive Sequence Dead Threshold; Upper Voltage Limit; Lower Voltage Limit; Lower Frequency Limit; Upper Frequency Limit; and Fail to Close Timer.

Data profiler

A fully-configurable data profiler is available which allows the user to collect information by sampling data at selectable intervals. These time-stamped values can then be viewed to determine weekly load profiles, daily harmonic disturbances or hourly voltage fluctuations. The number of days of information the data profiler can provide depends upon configuration parameters.

Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

Manual close delay

Manual Close Delay provides a delay from the time that the manual CLOSE button is pushed to the time the manual close operation is performed.

The delay is programmable from 0 to 60 seconds in 1 second increments. A programmed delay value can be overridden for immediate closing by pressing the CLOSE button a second time.

An active Manual Close Delay can be canceled by pressing the TRIP/LOCKOUT button.

The default setting has the feature disabled (0 seconds). A countdown on the front panel LCD screen indicates Manual Close Delay is active.

Communications

Communication ports

The Form 6 control has two back panel communication ports and a front panel configuration data port.

The front panel configuration data port is described in the **Operating Panel** section of this manual.

There is one standard 9-pin RS-232 and one optional communication port (RS-485, serial fiber, Ethernet wire or fiber or both) on the back operator panel, as well as a standard IRIG-B port for user time-syncing. See **Figure 7**.

Communication protocols

Four communication protocols are available for the Form 6 recloser control:

- Modbus
- DNP3
- 2179
- IEC870-5-101

One communication protocol can be selected for either the back panel RS-232 or the optional communication port.

All four protocols are selected and configured by the user with the ProView Communications Workbench application software.

Ethernet communications

- ProView over TCP/IP
- DNP3 over TCP/IP

Ethernet connection allows for network application of the Form 6 control for both DNP3 and ProView protocols. In addition, the front panel data port can simultaneously communicate ProView to the PC.

Ethernet configuration is accomplished via ProView interface software. Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide, Section 4: Schemes, Communicating with the Form 6 Control*, for Ethernet Configuration information.

When a communication protocol is selected for the optional communication boards (serial fiber or the RS-485 serial port), the RS-232 serial port is defaulted to ProView interface software protocol.

DNP3 is factory-defaulted to the RS-232 port.

When a communication protocol is selected for the RS-232 serial port, the optional RS-485 or serial fiber optic board is not active.

The RS-485 or fiber optic serial ports do not support ProView interface software protocol.

The user can simultaneously communicate to the Form 6 control using both the front panel data port and the appropriate back panel serial communication port (provided the back panel RS-232 port or the Ethernet optional communications board is not configured to be ProView protocol).

Control information

Control information includes firmware identification by catalog number and name, date code, and ProView release number. Control information is available through the Settings menu on the front panel (**Figure 3**).

Control back panel

The control back panel (**Figure 7**) is easily accessible when the control is mounted in a standard 19" rack.

Note: It is not necessary to remove the control from the standard 19" rack to access the wiring to the power supply and recloser.

Form 6 microprocessor-based rack-mount recloser control

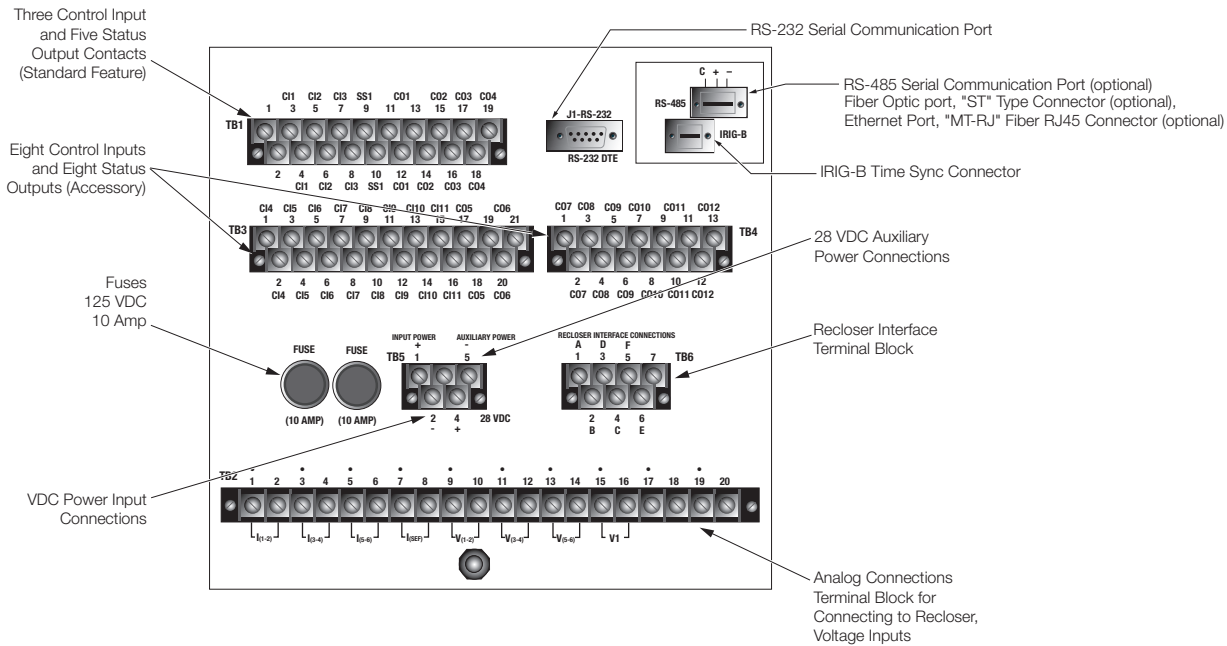


Figure 7. Rack mount control back panel

Installation procedure

Initial programming prior to installation

CAUTION

Equipment misoperation. Do not connect this control to an energized recloser until all control settings have been properly programmed and verified. Refer to the programming information for this control. Failure to comply can result in control and recloser misoperation, equipment damage, and personal injury.

G110.3

IMPORTANT

Equipment misoperation. Check minimum trip values prior to changing an alternate profile. Failure to do so may cause misoperation of the recloser under load conditions.

T280.1

IMPORTANT

Program all protection profiles. Unused alternate profiles should be programmed with the same settings as one of the applicable profiles. Default settings on unused alternate profiles can cause unnecessary outages if they are below normal system requirements.

The control must be programmed with all necessary operating settings, all alternate profiles, and parameters prior to operation with an energized recloser.

Note: Initial programming of the control is the responsibility of a qualified technician or engineer familiar with control functions and programming parameters required for the specific recloser installation.

The control must be programmed with the Form 6 ProView interface software. Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

Control/recloser compatibility

The Form 6 rack mount recloser control is adaptable to the following Eaton Cooper Power series reclosers:

WE*, WVE27, WVE38X, VWE, VWVE27, VWVE38X, VSA12, VSA16, VSA20, VSA12B, VSA20A, VSO12, VSO16, Auxiliary-Powered NOVA reclosers.

*This control is not compatible with Form 1 Type WE reclosers below s/n 300 and RE reclosers below s/n 400.

IMPORTANT

All Auxiliary-Powered NOVA reclosers require power at the input power receptacle for tripping and closing.

A new control cable is required to connect the Form 6 rack mount recloser control to these reclosers. Refer to **Table 3** in the **Recloser connections/control cable** Section of the **Customer connections for DC power and AC voltage sensing** section of this manual.

Reclosers manufactured prior to June 1989 are equipped with Type A bushing current transformers. These reclosers were designed for use with Form 2, Form 3, and Form 3A controls. Because the Form 6 recloser control is designed for use with reclosers equipped with Type B current-sensing Transformers, reclosers retrofitted with Form 6 recloser controls should be retrofitted with Type B current transformers. All reclosers manufactured since 1989 are equipped with Type B (1000:1, 1000/500:1, or 2000:1) sensing CTs.

Reclosers equipped with Type B sensing CTs are compatible with all Eaton Cooper Power series recloser controls (Form 2, Form 3, Form 3A, Form 4A, Form 4C, FXA, FXB, Form 5, Form 5 LS/UDP, and Form 6 recloser controls), and are identified with the following label prominently displayed on the recloser sleet hood or the front of the operator cabinet:

IMPORTANT

**RECLOSER IS EQUIPPED WITH TYPE B SENSING CTs.
RECLOSER DOES NOT HAVE A BATTERY CHARGER.**

The Form 6 recloser control can be used with the old-style Type A CTs; however, the event recorder and duty cycle monitor will have limited accuracy for currents above 5000 Amps.

Retrofit kits with the new Type B sensing CTs are available to upgrade existing families of reclosers for operation with Form 6 recloser controls. For additional information, contact your Eaton representative.

For identification, **Table 1** lists the serial number breaks between old-style Type A and the new-style Type B sensing CTs. Below this serial number, the recloser is equipped with the Type A CTs.

Note: For reclosers shipped prior to June 1989 and not listed below, contact your Eaton representative with the recloser type and serial number for verification of Type A or B bushing current transformers.

Table 1. Serial number break for reclosers with Type A sensing CTs

Recloser	Below serial number
RXE	5831
RVE	5894
WE	11199
WVE	3695
VWE	7199
VWVE27	7208
VWVE38	1204

All VSA reclosers are equipped with Type A Sensing CTs. All VSML reclosers are equipped with Type A Sensing CTs. All VSA12, VSA12B, VSA16, VSA20, VSA20A, and VSA20B reclosers are equipped with Type B Sensing CTs. All VWVE38X and VWE38X reclosers are equipped with Type B Sensing CTs.

Duty cycle monitor

The Duty Cycle Monitor provides the following duty cycle information:

- Measures and records duty for each individual phase in non-volatile memory.
- The recloser duty is measured and stored on the basis of *Current^{1.5} x Number of Operations for Each Phase* (ANSI C37.61).
- Readout is based on a percentage of total duty cycle for each phase.
- Duty record can be adjusted or reset if recloser is changed-out, serviced, etc.

Using **Table 2**, select the appropriate recloser interrupting duty cycle factor and enter that value via the ProView interface software.

Table 2. Duty cycle factor

Recloser type	Interrupting rating (rms sym Amps)	100% Duty cycle factor*
RXE, RVE	6,000	97
WE	12,000 @ 4.8 kV	257
WE	10,000 @ 14.4 kV	196
VWE		
VWVE27	12,000	1045
VWVE38X		
WVE27	8,000	140
WVE38X	8,000	140
VSA12	12,000	1045
VSA16	16,000	1608
VSA20		
VSA20A	20,000	2248
VSA20B		
VSO12	12,000	1045
VSO16	16,000	1608
Auxiliary-Powered NOVA	12,500	1111

* Duty Cycle Factor is Value x 10⁵.

Mounting the control

⚠ WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply may result in death, severe personal injury, and equipment damage.

G102.1

The Form 6 rack mount recloser control is intended to be mounted in a substation facility protected from weather elements, such as rain, snow, wind, etc. Mount the control in a convenient and accessible location that fits the above criteria. See **Figure 8** for control weight and dimensions.

Form 6 microprocessor-based rack-mount recloser control

The control is designed to be mounted in a standard 19" substation rack. There are three available mounting accessories available:

- Double rack mount accessory with two handles and one connecting plate.
- Single rack mount accessory with two handles.

- Double rack – single mount accessory with two handles and one filler plate.

Refer to **Accessories** section of this manual for accessory attachment instructions.

CONTROL WEIGHT:

7 kg (15 lbs)

Note: Weight of one Form 6 rack mount recloser control with handles attached to both sides.

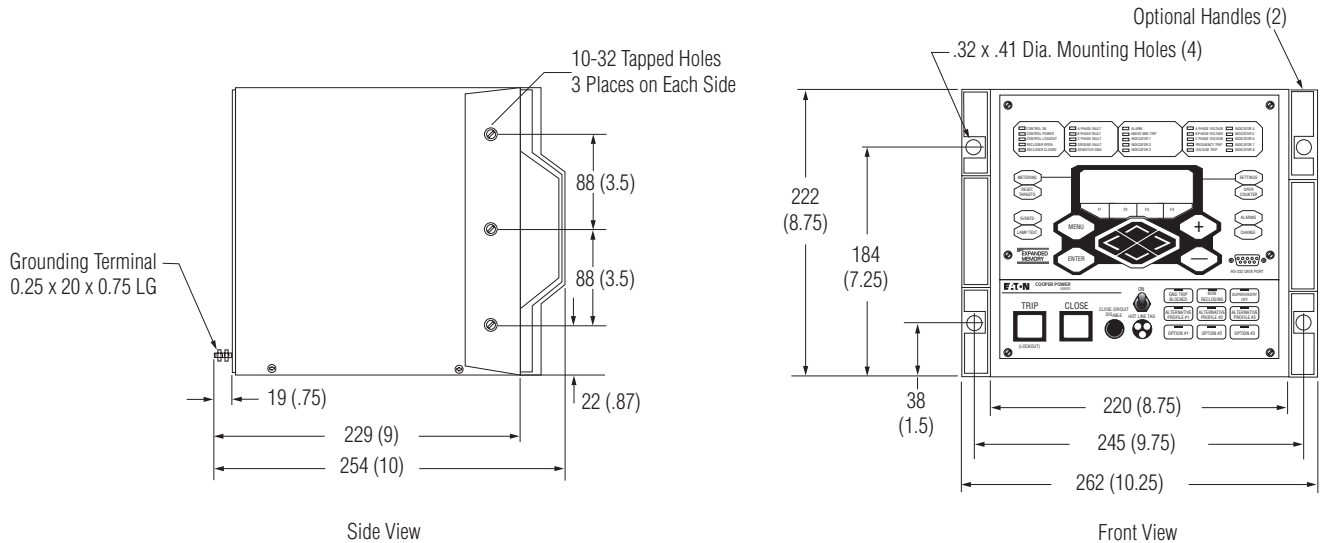


Figure 8. Form 6 rack mount recloser control weight and dimensions

Grounding the control

WARNING

Hazardous voltage. Recloser and control must be solidly grounded. Follow all locally approved procedures and safety practices when grounding this equipment. Improper grounding can result in contact with high voltage, which will cause death or severe personal injury.

G115.1

The Form 6 rack mount recloser control must be solidly grounded prior to installation or energization. Refer to **Figure 9** for grounding connections.

Note: Grounding of the mounting panel or standard 19" rack does not eliminate the control grounding requirement.

The grounding connection on the back of the control will accommodate a spade connector or ring terminal that fits on a .25 inch diameter grounding terminal stud (**Figure 10**).

Note: Control grounding must comply with all locally approved procedures and safety practices that apply in a substation or other appropriate indoor facility.

The recloser that the control will be connected to must also be properly grounded per the grounding requirements of the individual recloser. Refer to the appropriate installation and operation manual for grounding requirements.

IMPORTANT

All external wiring inputs to the Form 6 recloser control must be routed within 8 inches of their corresponding ground. During a surge, a potential of approximately 1.5 kV per foot can develop in the conductors. Differences between conductor and ground path lengths can add additional stress to the control components in the event of a power surge.

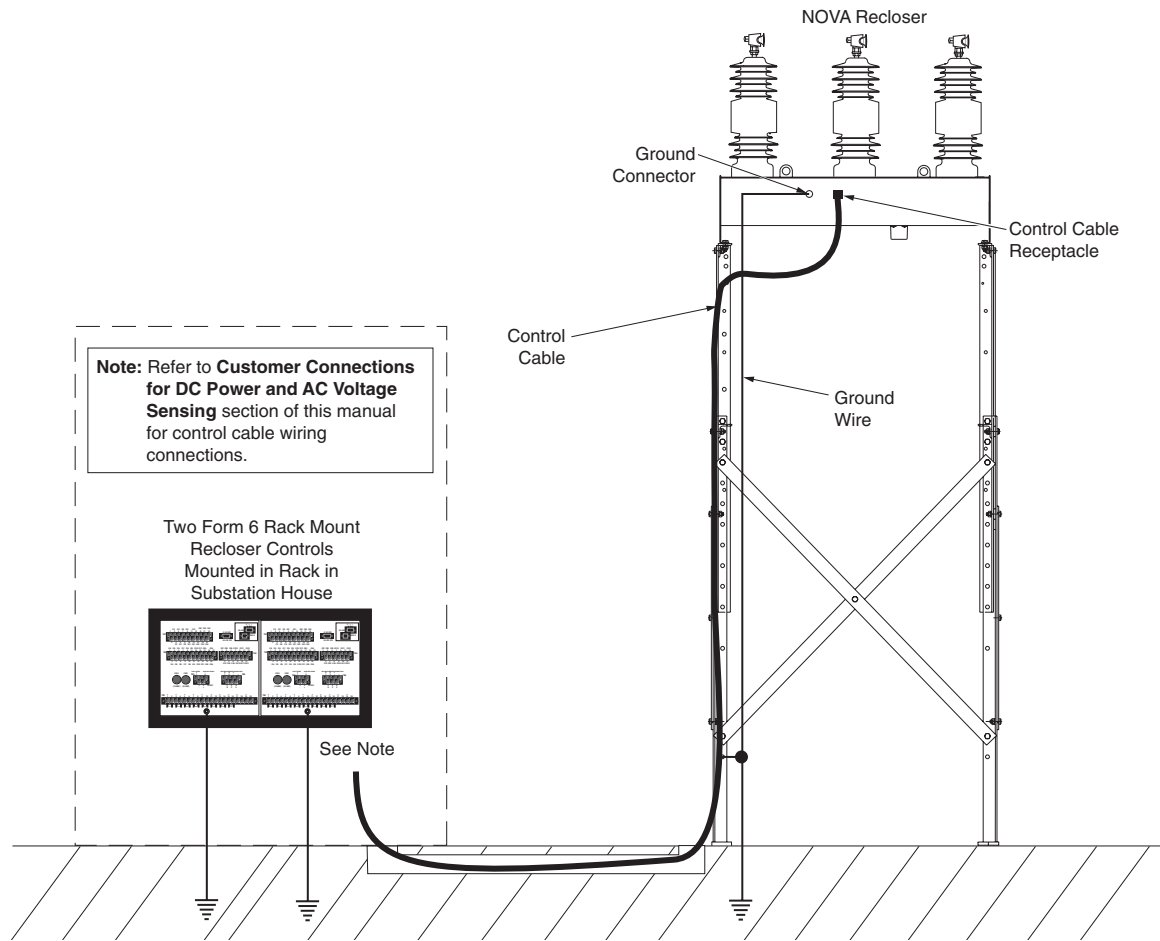
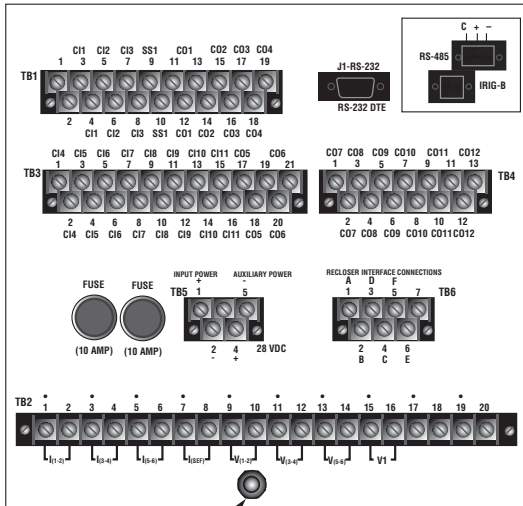


Figure 9. Grounding connections for a Form 6 rack mount control installed in a substation

Form 6 microprocessor-based rack-mount recloser control



Grounding Terminal Stud
.25 inch diameter x .75 inch length

Figure 10. Form 6 rack mount control grounding terminal identification (back panel)

Customer connections for DC power and AC voltage sensing

DC Power

Wiring connections to the Form 6 rack mount recloser control are made to the back panel (**Figure 11**). Input DC power is required to power the control.

IMPORTANT

Verify the label on the Form 6 rack mount recloser control matches the voltage of the substation supply prior to installation.

DC power is connected to terminal block TB5, terminal points 1(+) and 2(-). Battery negative is not grounded at the control as the control should be grounded as discussed in the **Grounding the Control** section.

AC Voltage sensing

Input AC power is required to provide the following functions:

- Directional Protection
- Sync Check Protection
- Voltage Protection
- Frequency Protection
- Single- or Three-Phase Voltage and Power Metering

AC voltage input connections are connected to TB2 for Wye connections only. **Figure 11** illustrates three-phase wiring connections for source side connections and single-phase wiring connections for load side connections.

Note: Three-phase wiring connections for load side connections are not available.

Figure 12 illustrates customer connections to TB2, 120 VAC Delta connection.

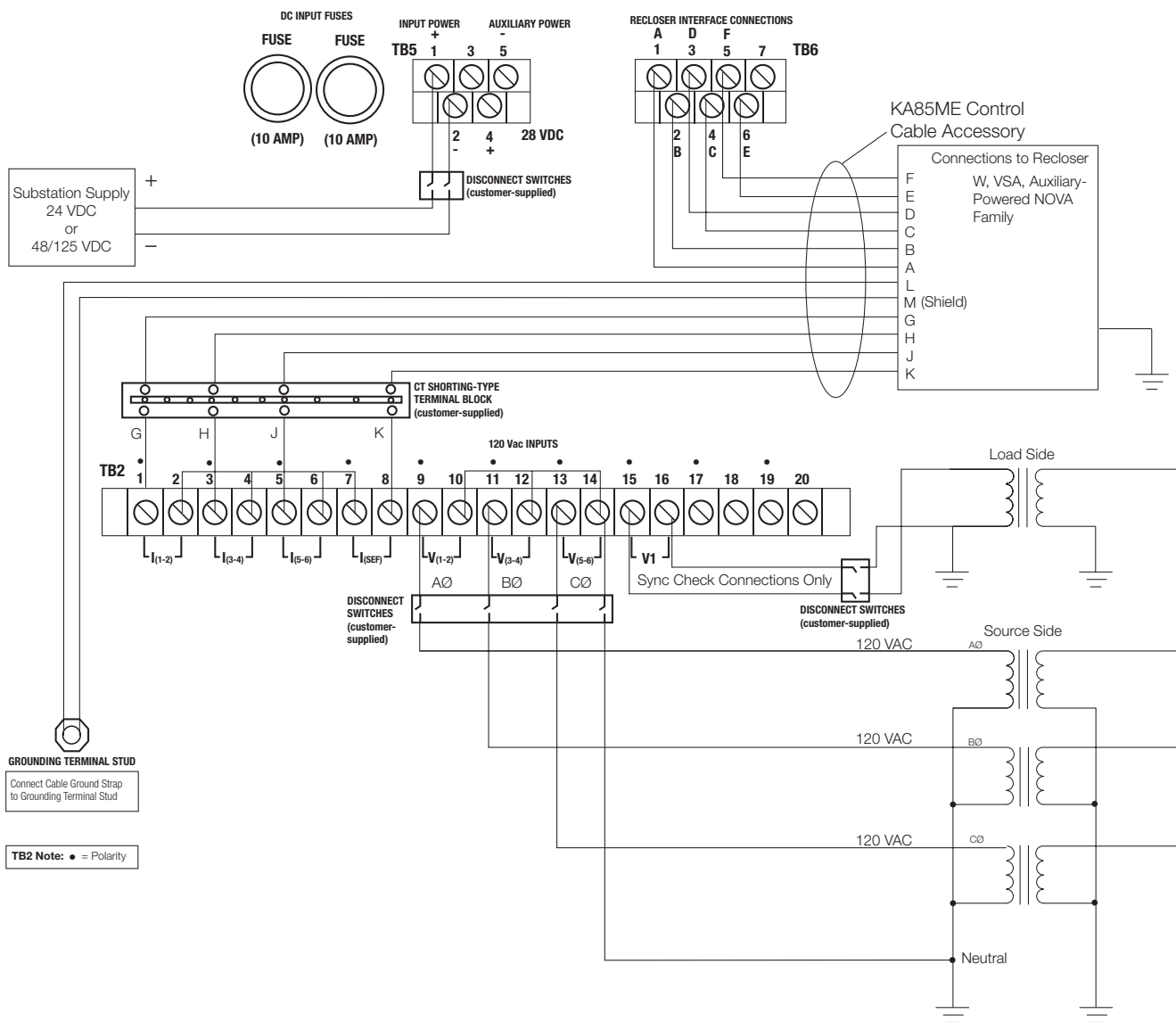


Figure 11. Three-phase transformer connection. Wye configuration only

Form 6 microprocessor-based rack-mount recloser control

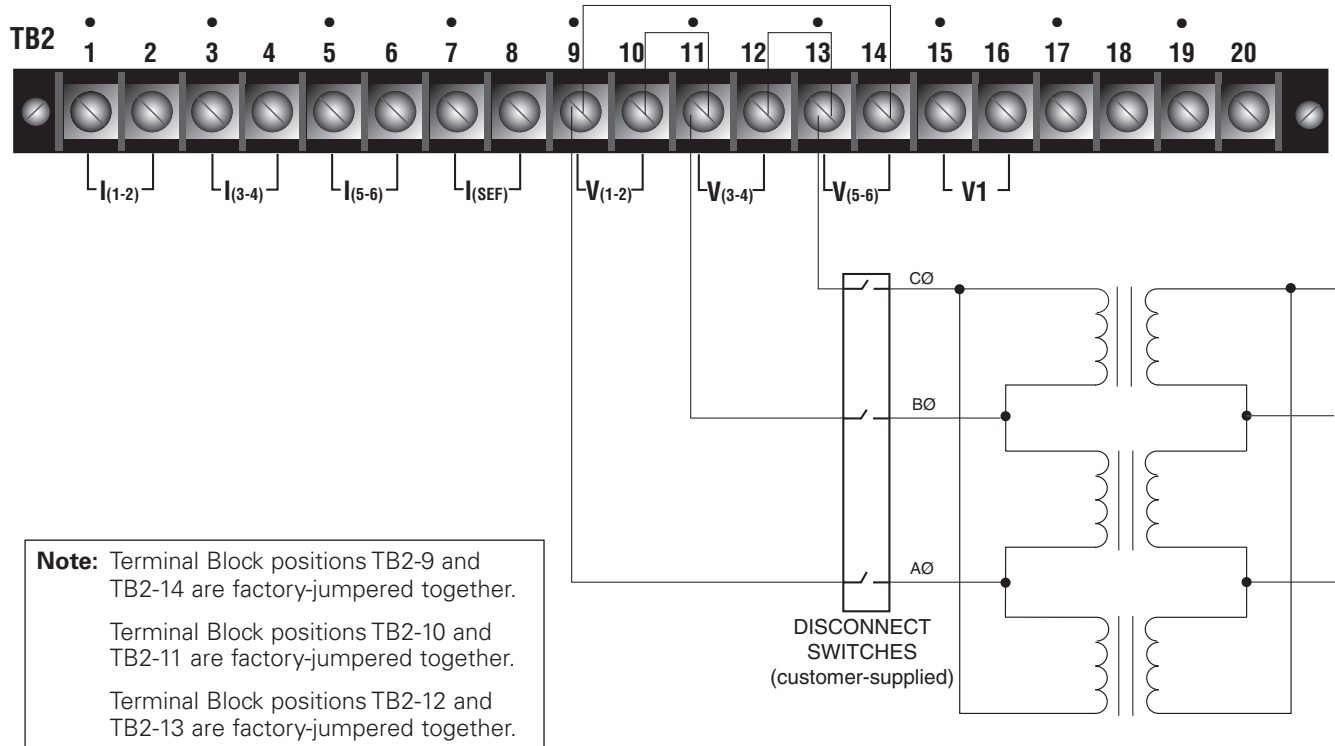


Figure 12. Customer connections to TB2, 120 VAC Delta Connection

The AC voltage inputs for both source or load side accept a voltage input of 120 VAC nominal. For single-phase source side AC voltage inputs, connections to AØ, BØ, or CØ are acceptable.

The following are not functional for single phase AC voltage input:

- Directional Protection
- Single-Phase Voltage Protection
- Three-Phase Metering
- Sync Check

Recloser connections/control cable

⚠ WARNING

Hazardous voltage. Recloser and control must be solidly grounded. Follow all approved procedures and safety practices when grounding this equipment. Improper grounding can result in contact with high voltage, which will cause death or severe personal injury. G115.1

Recloser connections are accomplished with either of these methods:

- Eaton provides a control cable accessory (KA85ME) with a connector on one end to connect to the receptacle on the recloser. The other end is hard-wired directly to the Form 6 rack mount recloser control. Several control cables are available based upon the recloser type and required distance between the recloser and control. Refer to **Table 3** for available control cable lengths.
- The user can hardwire directly to the recloser via a recloser interface junction box accessory. The interface junction box is mounted on the substation frame and connected to the receptacle on the recloser with a short cable. If the cable lengths are insufficient for the desired application, control wiring with larger gauge wire is recommended. To facilitate wiring, two types of recloser interface junction box accessories are available. Refer to **Accessories** for more information.

Connections to the Form 6 rack mount recloser control are made at terminal blocks TB2 and TB6. Terminal Block TB2 is used to connect the recloser current transformers while terminal block TB6 is used for connection of the signal and status functions. If the Eaton Cooper Power series Control Cable KA85ME is ordered, **Table 4** identifies the connection point and corresponding color wire. Also, connect the cable shield wiring to the grounding terminal stud.

Various commercial wire terminals are available for connection to the terminal blocks on the back of the Form 6 rack mount recloser control. **Table 5** identifies common terminal types suitable for connection to the Form 6 rack mount recloser control.

IMPORTANT

Disconnect switches for both AC and DC circuits and a current transformer shorting-type terminal block are necessary to isolate the Form 6 recloser control for testing and servicing.

Table 3. Available form 6 recloser rack mount control cable lengths for Eaton Cooper Power series reclosers with KA85ME control cable accessory

Recloser Type	Gauge	Length	
		Meters	Feet
WE, WVE27, WVE38X, VWE,VWVE27,VWVE38X, Auxiliary-Powered NOVA	14	3 to 61	10 to 200
VSA12, VSA12B, VSA16, VSA20, VSA20A, VSO12 VSO16	14	1.5 to 9	5 to 30

Table 4. Cable KA85ME wire color and corresponding connection point

Pin	Color	Connection Point
A	BRN/BLK	TB6-1
B	BLK/RED	TB6-2
C	ORANGE	TB6-4
D	YELLOW	TB6-3
E	BROWN	TB6-6
F	BLUE	TB6-5
G	RED/BLK	TB2-1
H	BLU/BLK	TB2-3
J	ORG/BLK	TB2-5
K	BLACK	TB2-8
L	RED	GROUNDING TERMINAL STUD
M	GROUND STRAP	GROUNDING TERMINAL STUD

Table 5. Common terminal types suitable for connection to the form 6 rack mount recloser control

Wire Size AWG	Terminal Type	Size	Model
16	Ring	#6	AMP# 320619
14	Ring	#6	AMP# 320619
12	Ring	#6	AMP# 35149
10	Ring	#6	AMP# 35149

Standard default supervisory input control and output status contacts

The standard Form 6 rack mount recloser control includes three control contact inputs and five status contact outputs. The standard default I/O terminal connections are identified in **Figure 13**. A discrete interface board accessory is available if additional I/O is required. The accessory includes eight control contact inputs and eight status outputs as identified in **Figure 14**.

All of the control inputs and status outputs are user-configurable via the Idea Workbench. To avoid configuration time, the most common control inputs and status outputs are included as default values. Refer to **Figure 13** and **Figure 14** and **Table 6**, **Table 7**, and **Table 8**. Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

NOTICE

External leads must be shielded and the shield must be grounded at both ends. Terminate each lead with a 320 VAC, 150 Joules metal oxide varistor (MOV), or equivalent, at the remote end. Attach MOVs between the leads and ground. Failure to properly shield and protect leads can result in equipment damage and/or unintentional operation.

IMPORTANT

Shielding and Surge Protection of Supervisory Cables

All supervisory operation and control monitor leads must be protected within shielded cables. Refer to **Figure 15** or **Figure 16** as appropriate.

Table 6. Operating whetting voltage and current requirements for the standard (TB1) and Accessory (TB3) discrete interface boards

Input Voltage	Nominal Current	Minimum Operating Time
9 VDC – 290 VDC, 7 VAC – 265 VAC	2.5 mA	5 milliseconds

Table 7. Ratings table for output status contacts CO1 through CO12 (TB1, TB3, and TB4) (resistive load – pickup time 8 ms, dropout 5 ms)

Input Voltage	Contact Rating
120 VAC	8 A
12 VDC	8 A
24 VDC	8 A
48 VDC	1 A
125 VDC	0.4 A

Table 8. Ratings Table for Output Status Contact SS1 (Resistive Load – pickup time 2 ms, dropout 15 ms) (TB1)

Input Voltage	Contact Rating
120 VAC	8 A
12 VDC	8 A
24 VDC	8 A
48 VDC	8 A
125 VDC	8 A

Before placing the control and the recloser into service

Prior to placing the control and recloser into service, the following installation procedures must be properly completed and verified:

CAUTION

Equipment misoperation. Do not connect this control to an energized recloser until all control settings have been properly programmed and verified. Refer to the programming information for this control. Failure to comply can result in control and recloser misoperation, equipment damage, and personal injury.

G110.3

1. Removable insert labels changed. (Not required – user-preference option.)

Note: Refer to **Using removable inserts** section in this manual for more information.

2. Control properly mounted for the installation.
3. Recloser installed according to all locally approved standards and practices.
4. AC and DC disconnect switches installed.
5. Shorting CT terminal-type block installed.
6. Control wiring between control and recloser properly connected and supported.
7. Control and recloser properly grounded in accordance with guidelines in this manual and the applicable recloser manual.
8. DC power and AC voltage sensing connected to the control.

Note: The control Power Save feature will turn off the backlit LCD display and all LEDs if no front panel keypad is pressed within ten minutes.

Note: If fuses are blown, check control power polarity. Replace fuses and re-energize control.

- All control programming entered and verified by appropriate personnel.

Note: Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

- Customer connections for remote and supervisory operation checked and completed in accordance with proper shielding and surge protection.

NOTICE

External leads must be shielded and the shield must be grounded at both ends. Terminate each lead with a 320 VAC, 150 Joules metal oxide varistor (MOV), or equivalent, at the remote end. Attach MOVs between the leads and ground. Failure to properly shield and protect leads can result in equipment damage and/or unintentional operation.

IMPORTANT

Shielding and Surge Protection of Supervisory Cables

All supervisory operation and control monitor leads must be protected within shielded cables. Refer to **Figure 15** or **Figure 16** as appropriate.

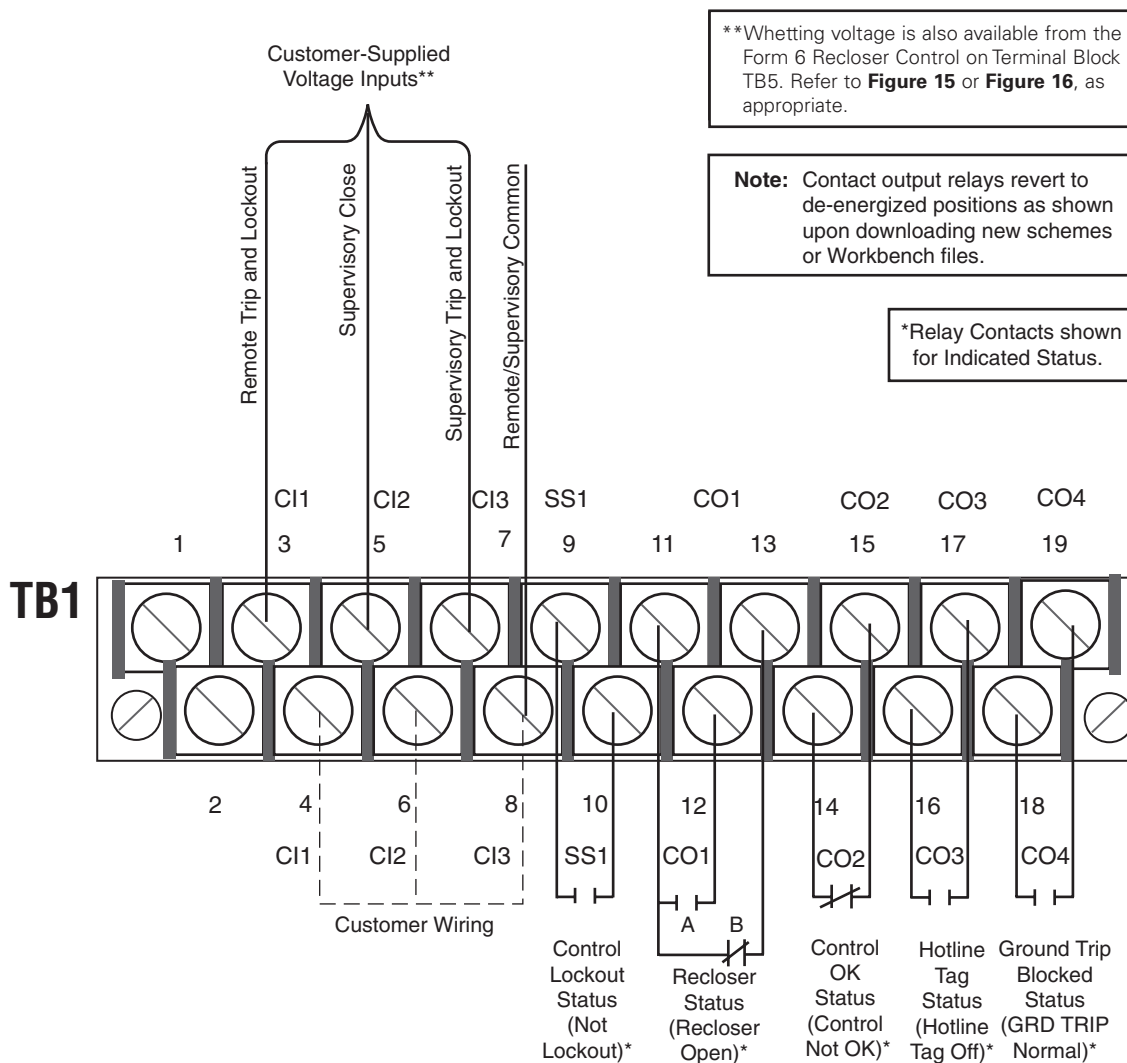


Figure 13. Form 6 recloser control standard discrete interface board and default configurations. These default contact input/outputs are completely configurable via the idea workbench

NOTICE

External leads must be shielded and the shield must be grounded at both ends. Terminate each lead with a 320 VAC, 150 Joules metal oxide varistor (MOV), or equivalent, at the remote end. Attach MOVs between the leads and ground. Failure to properly shield and protect leads can result in equipment damage and/or unintentional operation.

IMPORTANT

Shielding and Surge Protection of Supervisory Cables

All supervisory operation and control monitor leads must be protected within shielded cables. Refer to **Figure 15** or **Figure 16** as appropriate.

Whetting voltage is also available from the Form 6 Recloser Control on Terminal Block TB5. Refer to **Figure 15 or **Figure 16**, as appropriate.

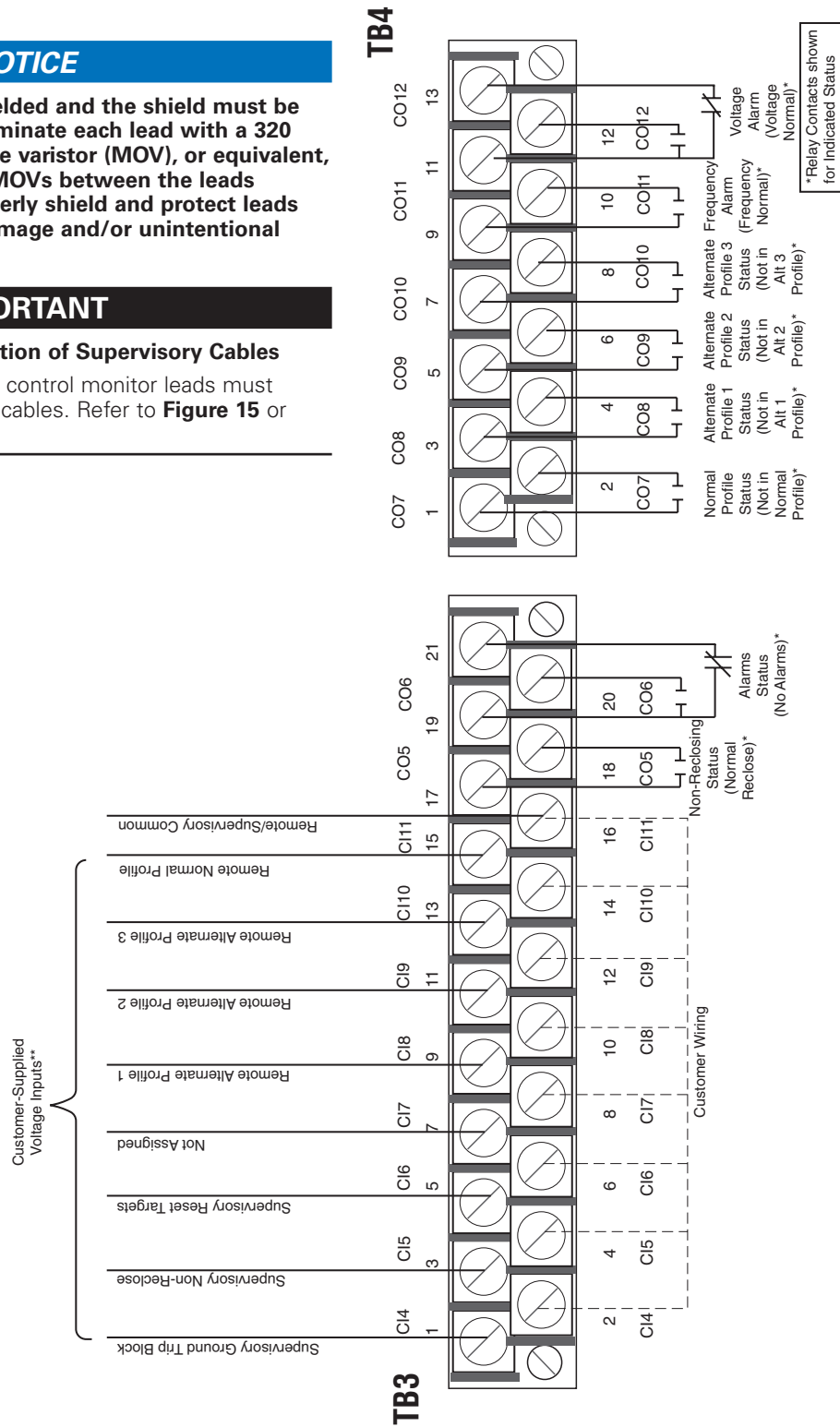


Figure 14. Form 6 recloser control discrete interface board accessory and default configurations. These default contact input/outputs are completely configurable via the idea workbench

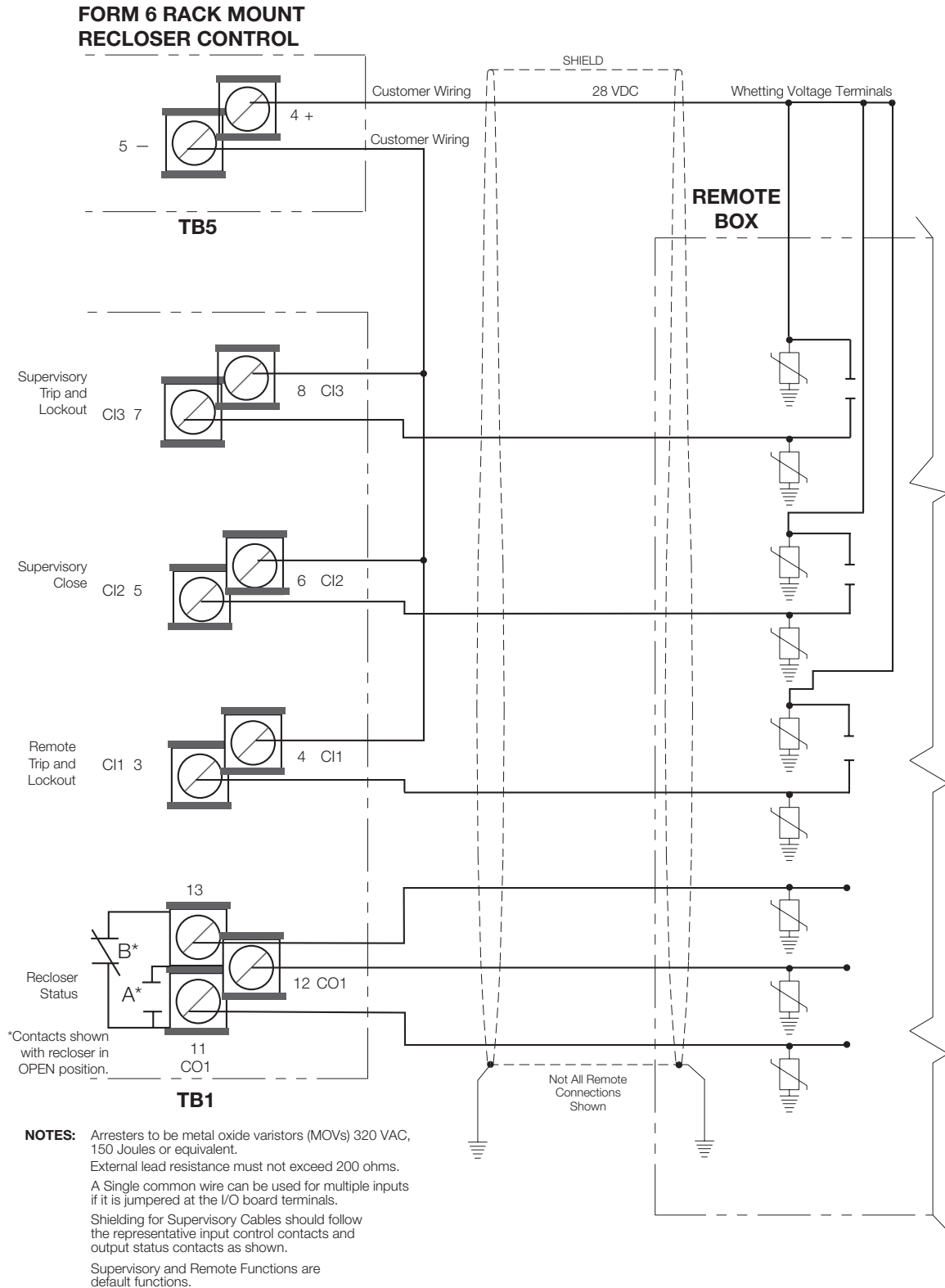


Figure 15. Shielding and surge protection for supervisory and remote cables (12-48 VDC option)

Form 6 microprocessor-based rack-mount recloser control

NOTES: Arresters to be metal oxide varistors (MOVs) 320 VAC, 150 Joules or equivalent.
 External lead resistance must not exceed 200 ohms.
 A Single common wire can be used for multiple inputs if it is jumpered at the I/O board terminals.
 Shielding for Supervisory Cables should follow the representative input control contacts and output status contacts as shown.
 Supervisory and Remote Functions are default functions.

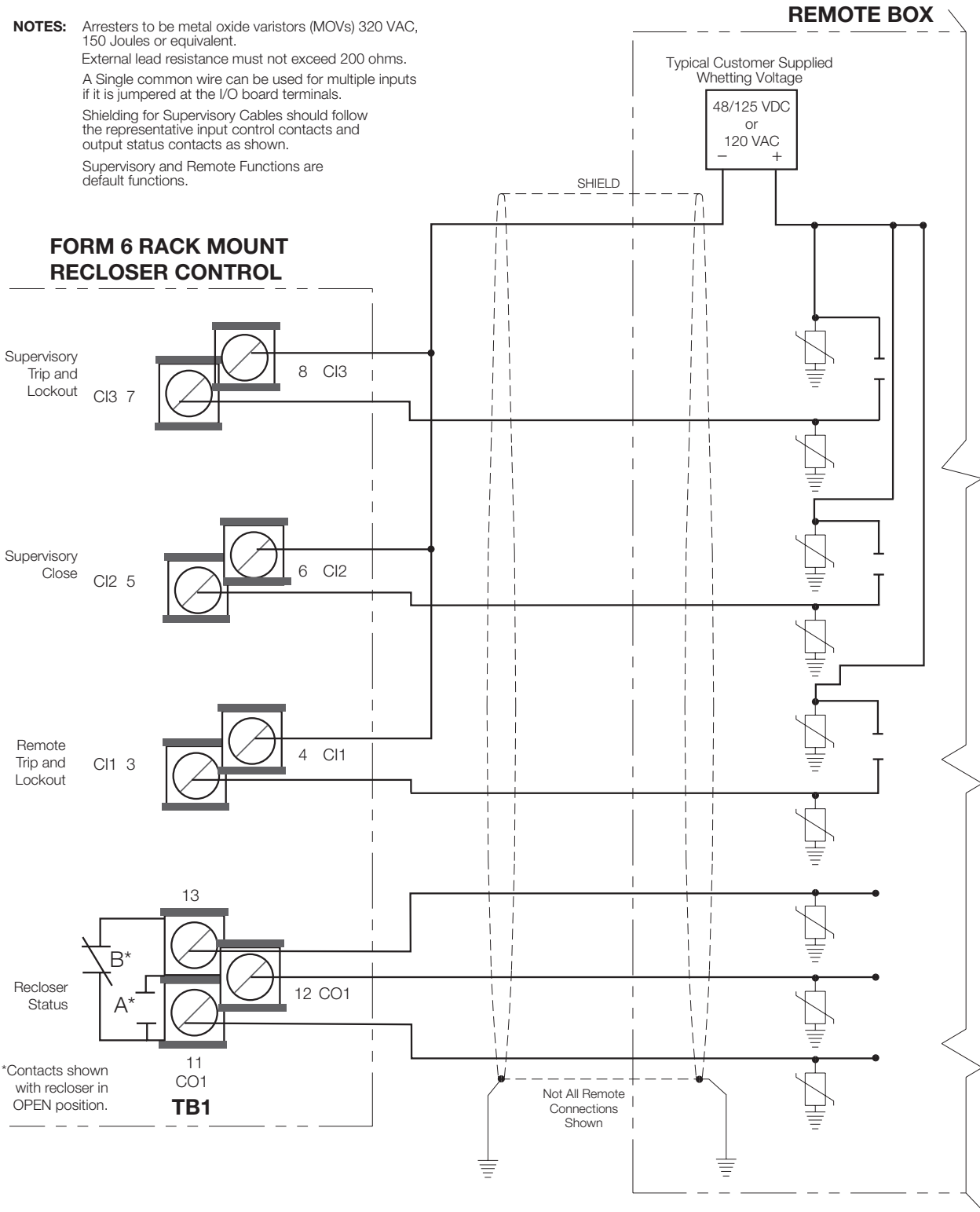


Figure 16. Shielding and surge protection for supervisory and remote cables (48-125 VDC, 120 VAC option)

Rear panel RS-232 communication port pin assignments

Table 9 indicates the pin assignments for the rear panel RS-232 communication port (Figure 17). Refer to Figure 18 for pin identification. Refer to Protocols for additional information.

Refer to the **Accessories** section of this manual for additional communication options.

Table 9. Rear panel RS-232 communication port pin assignments

Pin Number	Signal Name
1 DCD	Carrier Detect
2 RXD	Receive Data
3 TXD	Transmit Data
4 DTR	Data Terminal Ready (Not Connected)
5 GND	Signal Ground
6 DSR	Data Set Ready (Not Connected)
7 RTS	Request to Send
8 CTS	Clear to Send
9 NC	Not Used
10 (Shroud)	Chassis Ground

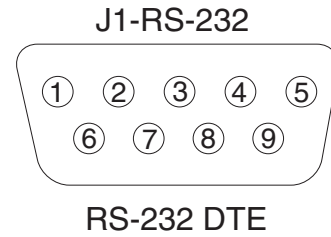


Figure 18. Rear panel rs-232 communication port pin identification

Using removable inserts

NOTICE

Control damage. De-energize both AC and DC power prior to removing or installing any internal connections or circuit boards in the control. Failure to comply can result in damage to the control.

T241.1

NOTICE

Equipment damage. Always wear a grounding wrist strap to control static electricity before handling circuit boards. Failure to use this strap may result in circuit board damage.

T253.1

The front panel inserts can be changed, if desired.

1. De-energize both AC and DC power.
2. Use a flathead or 3/32" hex key screwdriver to unscrew the six front panel screws.
3. Pull the right side of the front panel out towards the left (Figure 19).

Note: Various connecting wires will keep the panel attached to the control.

Note: It is not necessary to disconnect any wires.

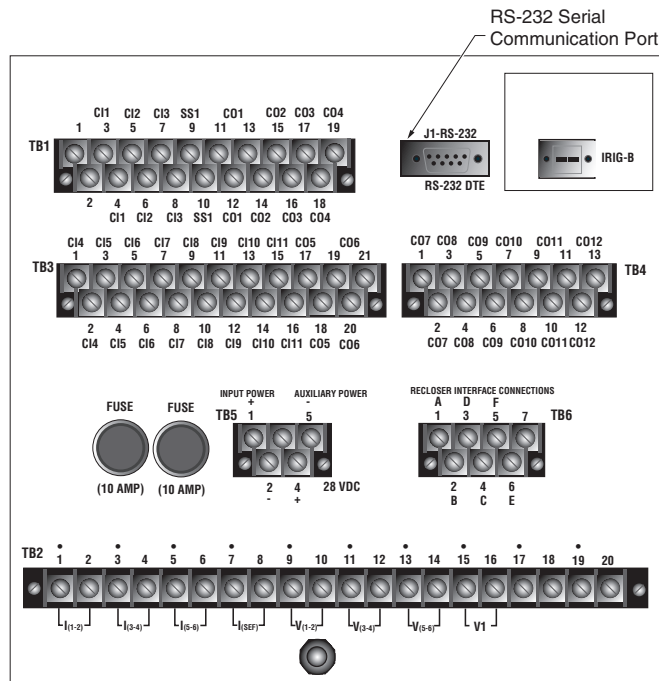


Figure 17. Form 6 recloser control rear panel RS-232 communication port

Form 6 microprocessor-based rack-mount recloser control

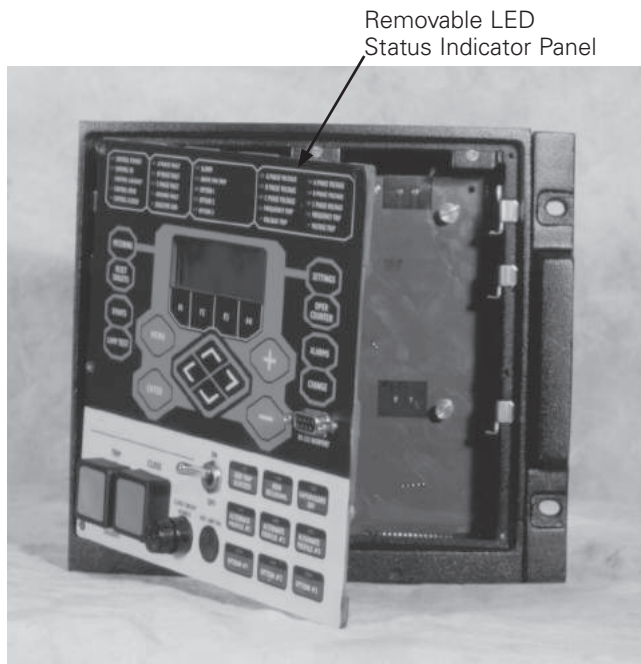


Figure 19. Open front panel. Labels are easily removed from and inserted into the top of the programming panel LED status indicator section

4. Use tweezers to gently pull out the removable insert.

Note: The insert will slide out of the right side of the operating panel (**Figure 20**).

Note: The insert will slide out of the top of the programming panel indicator section (**Figure 19**).

5. Change the existing label or slide in a new label with the name of the configured option.

An electronic label template is included on the ProView application software CD and can be accessed through the following default address:

C: / Program Files / Cooper / ProviewXX / Form 6 / Form 6 Inserts.doc

IMPORTANT

Laminate the removable inserts prior to installing. This will seal the ink/toner and avoid damage to the front panel.

6. Gently push the removable insert from right to left into the right side of the operating panel (**Figure 20**) or down into the programming panel LED indicator section (**Figure 19**).

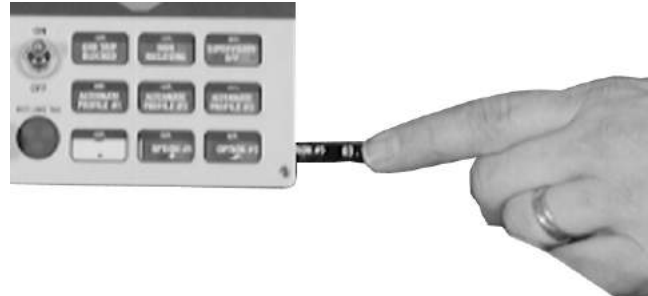


Figure 20. Labels are easily removed from and inserted into the operating panel

7. Place the front cover panel back onto the control. Using a flathead screwdriver screw the screws into the control and tighten all hardware completely.

Accessories

These accessories are available. Contact your Eaton representative for additional information.

Control cable

The control cable consists of two separate wire sizes pending the distance from the Form 6 recloser control to the selected Eaton Cooper Power series recloser. The control cable is fabricated with a connector on one end and pigtailed on the other. The connector is mated to the recloser receptacle on one end and hardwired to the control on the other end. Refer to **Table 3** in the Recloser Connection/Control Cable section of this manual for available control cable lengths.

Recloser interface junction box

The recloser interface junction box (mounted on a recloser substation frame) facilitates customer wiring from the recloser to the control. The junction box is required when the distance between the recloser and control exceeds the maximum available control cable length for the KA85ME control cable (**Table 3**).

There are two types of junction boxes available:

- KME6-1811 The recloser interface junction box cable is factory-hardwired between the recloser and the junction box. Refer to **Figure 21**, **Figure 22**, and **Figure 25**.
- KME6-1859 The recloser interface junction box cable disconnects at both ends. The junction box has a male receptacle that enables connection between the recloser and the junction box with existing control cables from other Eaton Cooper Power series controls (Form 3A, Form 4C, etc.). Refer to **Figure 23**, **Figure 24**, and **Figure 26**.

The junction box is mounted on the substation frame based upon the mounting dimensions in **Figure 21** or **Figure 23**. The junction box cabinet includes multiple diameter holes for sealing grip connections to hardwire to the control. A recloser interface junction box cable connects from the junction box to the recloser (**Figure 22** or **Figure 24**). Refer to **Figure 25** or **Figure 26** for control-to-junction box customer connection diagrams. Refer to **Table 10** for control-to-junction box cable requirements.

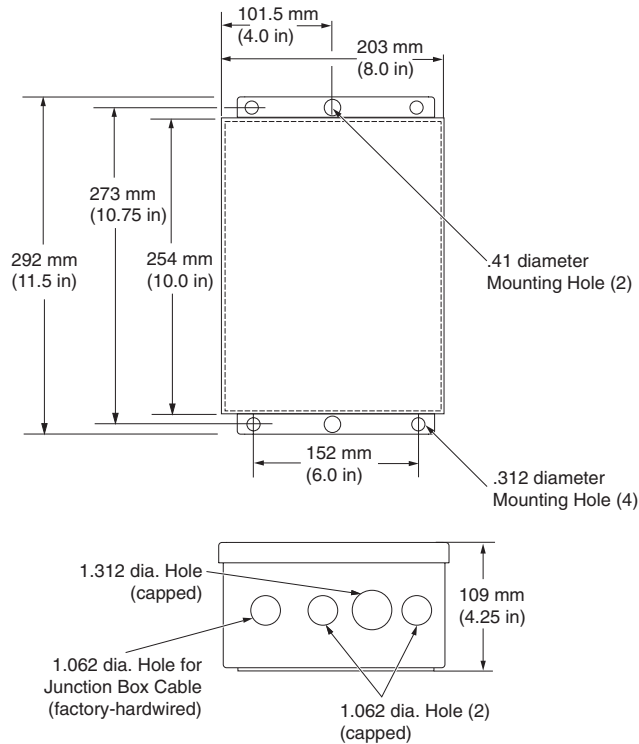


Figure 21. Form 6 recloser interface junction box KME6-1811 dimensions mm (in). (Dimensions are approximate.)

Form 6 microprocessor-based rack-mount recloser control

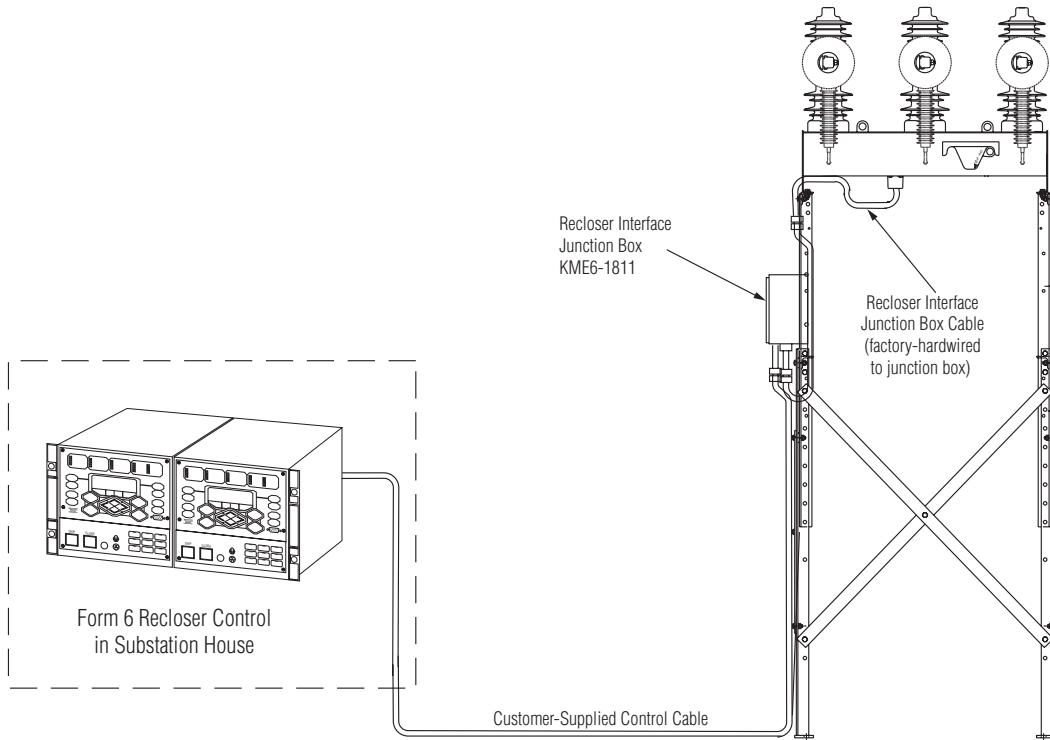


Figure 22. Form 6 recloser control connected to a recloser through a KME6-1811 recloser interface junction box

Recloser interface junction box cable

A recloser interface junction box cable for connection between the recloser and KME6-1811 junction box is available in lengths of 5 to 15 feet. This cable is factory-hardwired into the junction box. Refer to **Figure 25** for Customer Connection information.

Recloser interface junction box wiring

The recloser control has various connection options to connect the recloser. A recloser interface junction box is available for customer-supplied cable. The gauge of the cable is determined by the length needed for proper connection.

Table 10 shows the required customer-supplied cable gauge and length used on Eaton Cooper Power series three-phase electronic reclosers. **Table 11** shows the common terminal type suitable for connection to the Recloser Interface Junction Box.

Table 10. Customer-supplied cable sizes for wiring the form 6 rack mount control to the interface junction box

Recloser Type	Gauge	Length	
		Meters	Feet
WE, WVE27, WVE38X, VWE,VWVE27,VWVE38X, Auxiliary Powered NOVA	12	91	300
	10	152	500
VSA12, VSA12B, VSA16, VSA20, VSA20A, VS012, VS016	12	14	45
	10	27	90

Table 11. Common terminal type suitable for connection to the recloser interface junction box

Wire Size AWG	Terminal Type	Size	Model
12-10	Ring	#8	AMP# 8-35605-2

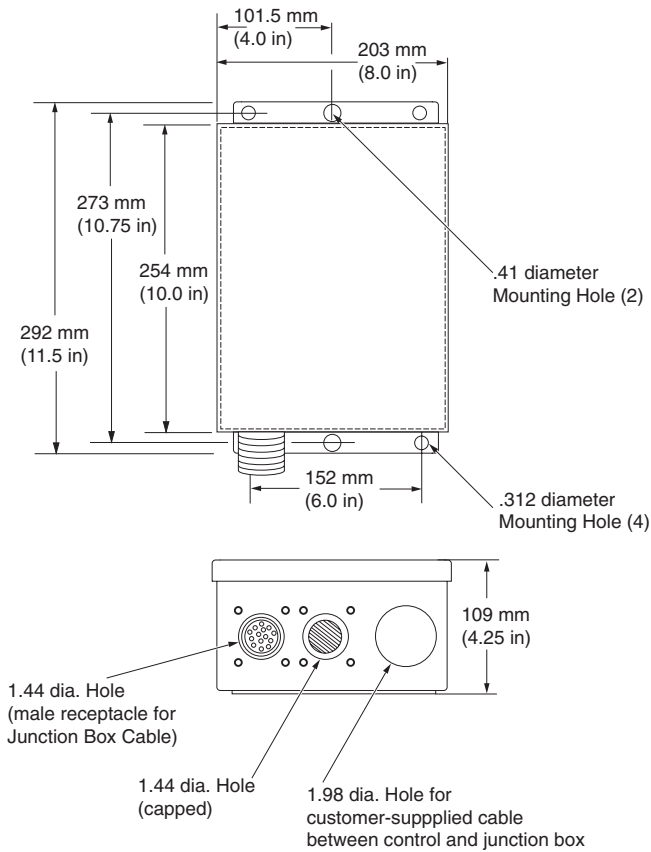


Figure 23. Form 6 recloser interface junction box KME6-1859 dimensions mm (in). (Dimensions are approximate.)

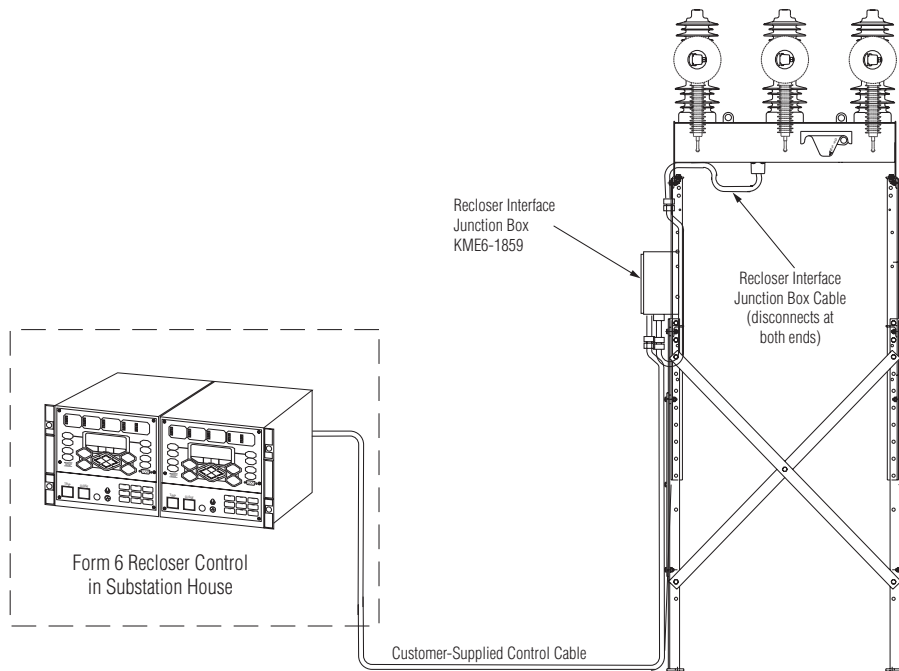


Figure 24. Form 6 recloser control connected to a recloser through a KME6-1859 recloser interface junction box

Form 6 microprocessor-based rack-mount recloser control

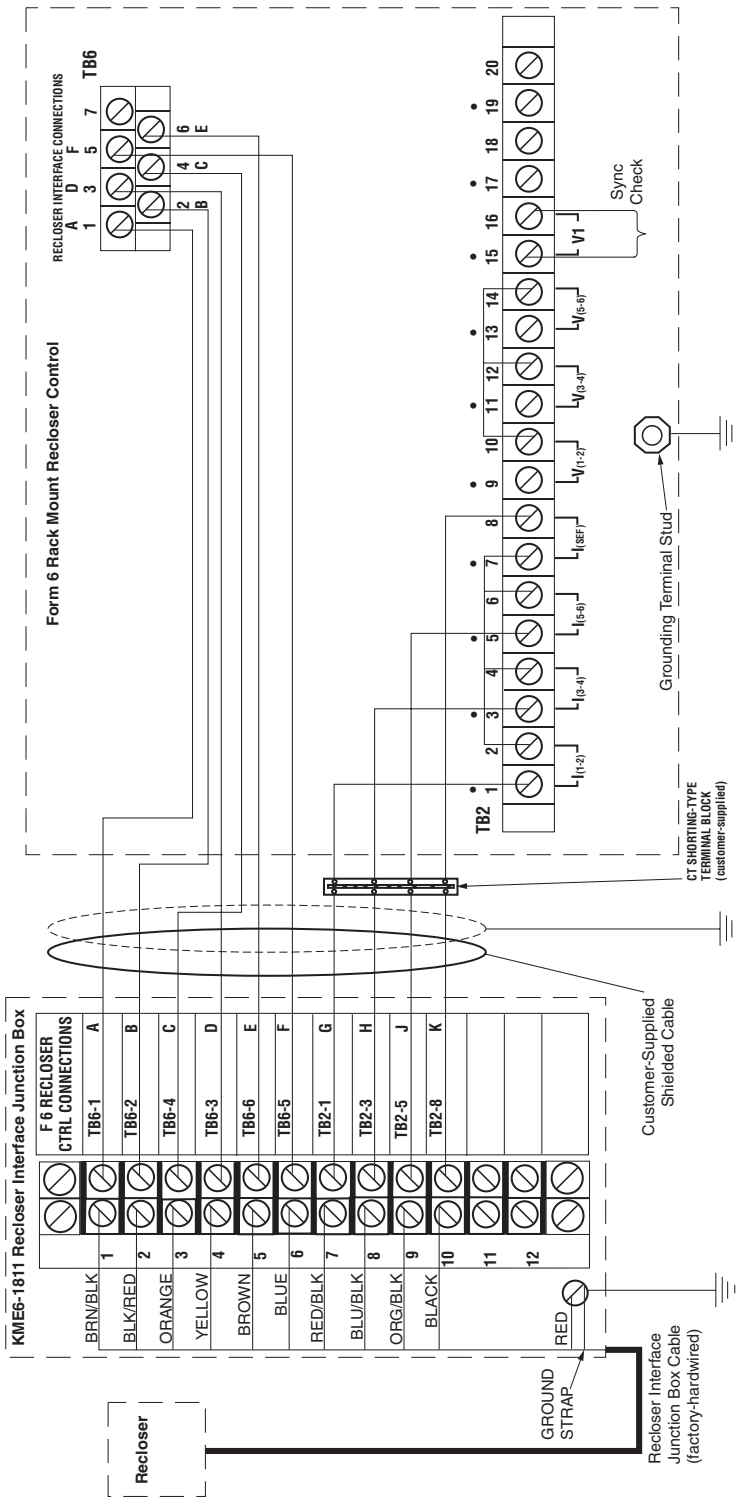


Figure 25. KME6-1811 recloser interface junction box connection diagram

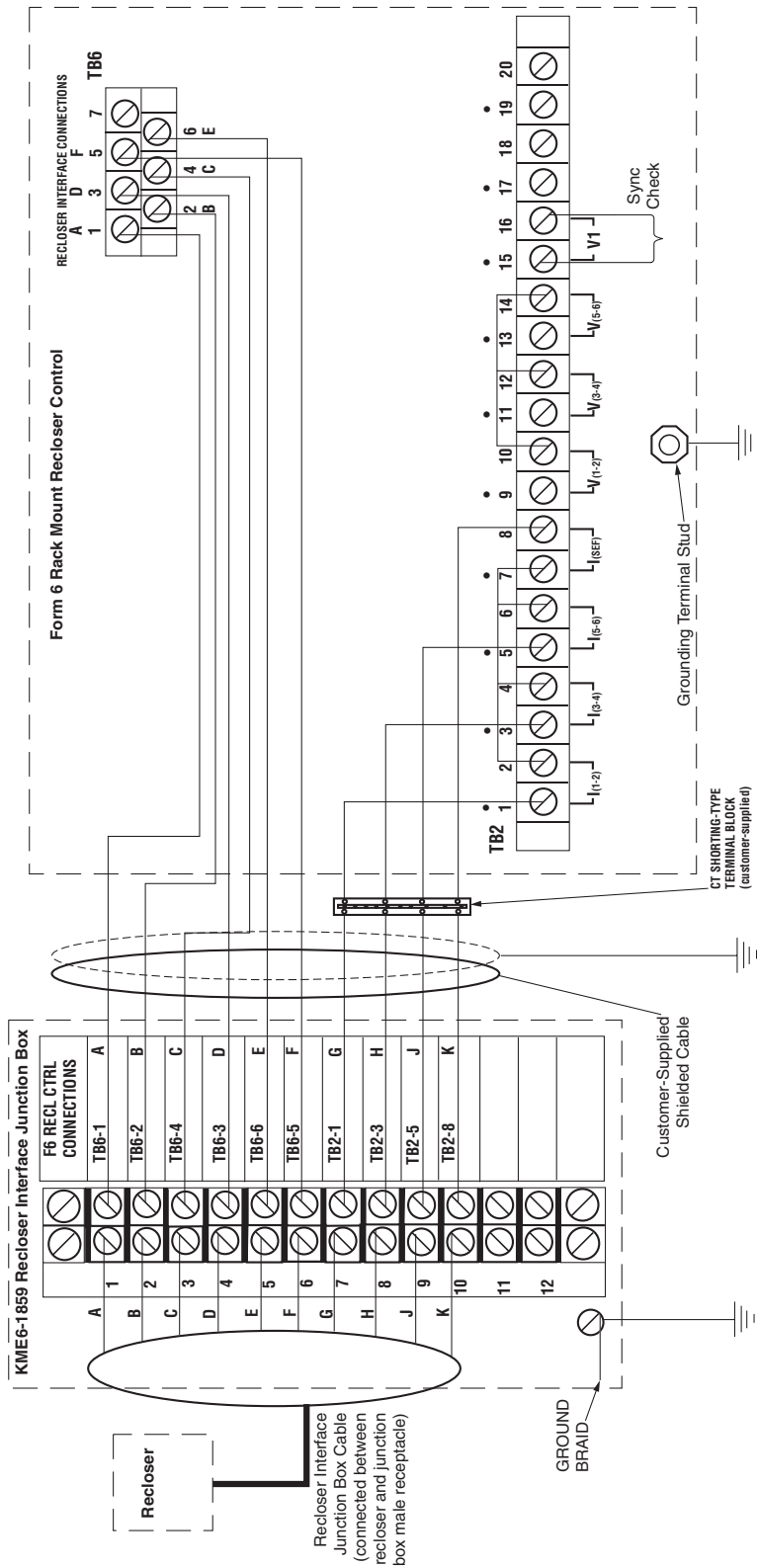


Figure 26. KME6-1859 Recloser interface junction box connection diagram

Form 6 microprocessor-based rack-mount recloser control

Discrete interface board (DIF) option accessory

A Discrete Interface Board Option accessory provides eight configurable input control contacts and eight configurable output status contacts (**Figure 27**). The ordering options include: Standard (3 inputs / 5 outputs) or Additional (8 inputs / 8 outputs).

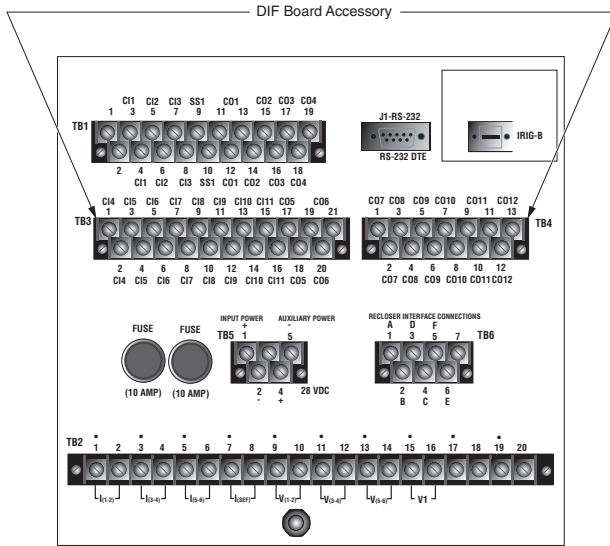


Figure 27. Form 6 recloser control discrete interface board accessory

Mounting kits

The Form 6 rack mount recloser control is designed to be mounted in a standard 19" rack. There are three mounting kits available:

- Single Rack Mount – KME6-1802 Mounting Kit includes two handles. Refer to **Single rack mount option handle attachment instructions**.
- Double Rack Mount – KME6-1803 Mounting Kit includes two handles and one connecting plate. Refer to **Double rack mount connecting plate and handle attachment instructions**.
- Single Mount w/Filler Plate – KME6-1804 Mounting Kit includes two handles and one filler plate. Refer to **Double Rack – Single Mount Handle and Filler Plate Attachment Instructions**.

Refer to *Service Information MN280078EN Form 6 Rack Mounting Kit Instructions* for additional information.

Double rack mount connecting plate and handle attachment instructions

These instructions apply to the attachment of the handles and connecting plate to the Form 6 Double Rack Mount Recloser Control.

These controls are shipped without the handles or connecting plate attached. Refer to **Figure 28** and **Figure 29** and follow this procedure to attach the handles and connecting plate and then secure the two controls together.

NOTICE

Control damage. De-energize both AC and DC power prior to removing or installing any internal connections or circuit boards in the control. Failure to comply can result in damage to the control.

T241.1

Attach control handles

1. Orient the handles and controls as illustrated in the Front View in **Figure 28**.
2. Attach one handle (Item 2) to each control (Item 1) using three #10-32 Flat Head Screws (Item 3) per handle as illustrated in **Figure 28**.
3. Completely tighten hardware. Do not torque.

Attach connecting plate

1. Remove the two middle screws from the back of each control with a Phillips head screwdriver as illustrated in **Figure 28**.
2. Place the connecting plate over the screw holes in the controls.
3. Secure the connecting plate with the previously removed screws.
4. Completely tighten hardware. Do not torque.

Table 12. Form 6 recloser control double rack mount accessory attachment parts list (Figure 28)

Item	Description	Part Number	Quantity
1	Form 6 Control		2
2	Form 6 Handle	6A00163901	2
3	#10-32 Fl Hd Screw	722915310050A	6
4	Connecting Plate	6A00169501	1
5	#10-24 Screw	813315110100A	2

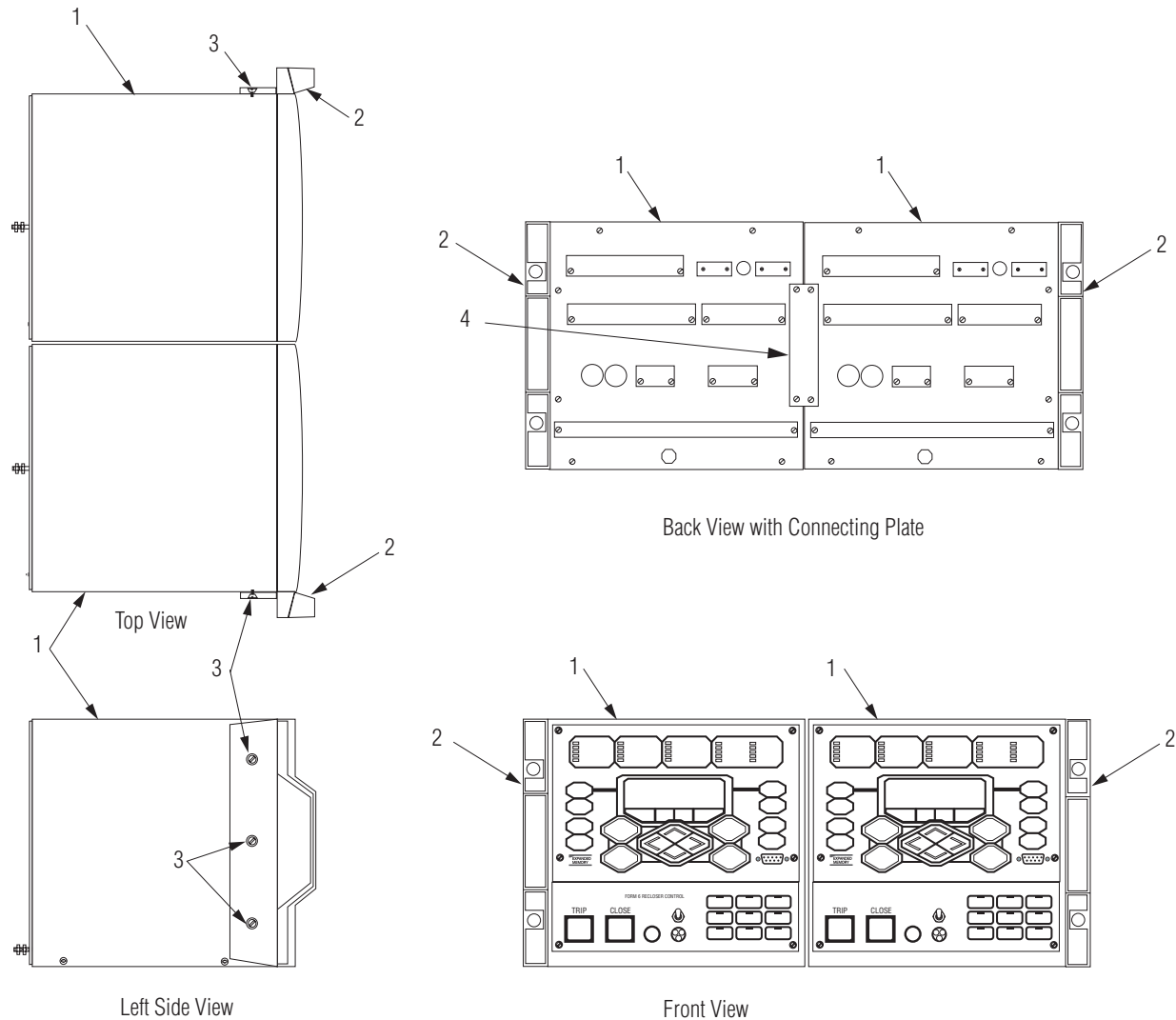


Figure 28. Form 6 double rack mount recloser control

Secure the controls together

Connecting two Form 6 rack mount recloser controls requires removing the front panel from the control (right-side) as shown in **Figure 29**.

NOTICE

Equipment damage. Always wear a grounding wrist strap to control static electricity before handling circuit boards. Failure to use this strap may result in circuit board damage.

T253.1

1. Unscrew the six screws from the control front panel until they detach from the control box.
2. Pull the right side of the right control front panel out towards the left (**Figure 29**).

Note: Various connecting wires will keep the panel attached to the control (**Figure 29**). It is not necessary to disconnect any wires.

3. Use a long flathead screwdriver to screw each #10-24 screw (Item 5, **Table 12**) right to left into the pre-threaded holes (**Figure 29**).

Note: It is not necessary to remove the front cover panel of the left control.

4. Tighten screws completely (**Figure 29**).
5. Gently place the front cover panel back onto the control.
6. Re-screw the screws back into the right control front panel and tighten all hardware completely. Do not torque.

Form 6 microprocessor-based rack-mount recloser control

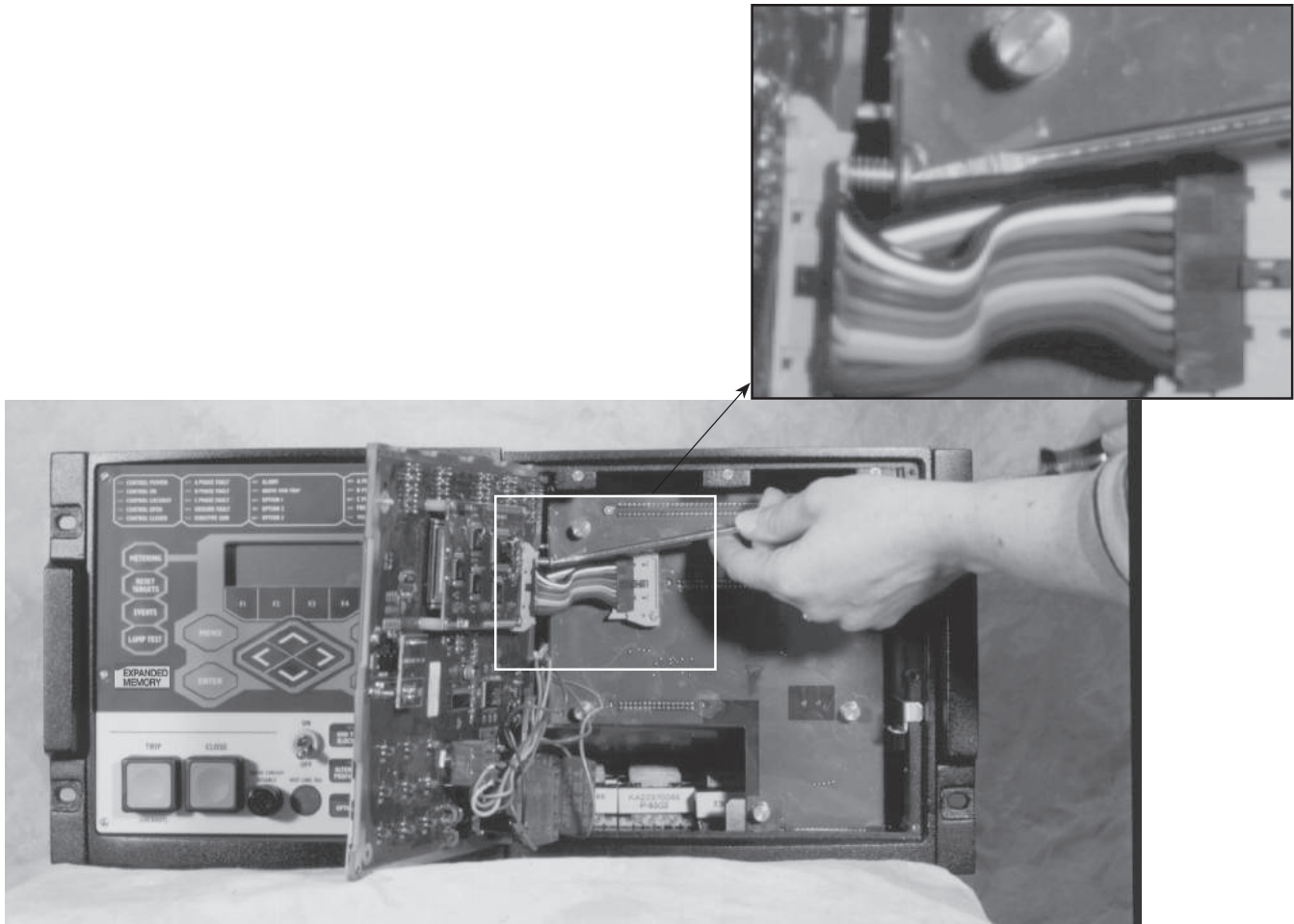


Figure 29. Connect double rack mount controls with #10-24 screws

Single rack mount option handle attachment instructions

These instructions apply to the attachment of the handles to the Form 6 Single Rack Mount Recloser Control (**Figure 30**).

The control is shipped without the handles attached. Follow this procedure to attach the handles to both sides.

1. Orient the handles as illustrated in **Figure 30**.
2. Attach the two handles (Item 2) to the control using six #10-32 Flat Head Screws (Item 3).

Note: Three screws will be used for each handle.

3. Tighten all hardware completely. Do not torque.

Table 13. Form 6 Recloser Control Single Rack Mount Accessory Handle Attachment Parts List (Figure 30)

Item	Description	Part Number	Quantity
1	Form 6 Rack Mount Control		1
2	Form 6 Handle	6A00163901	2
3	#10-32 Flat Head Screw	722915310050A	6

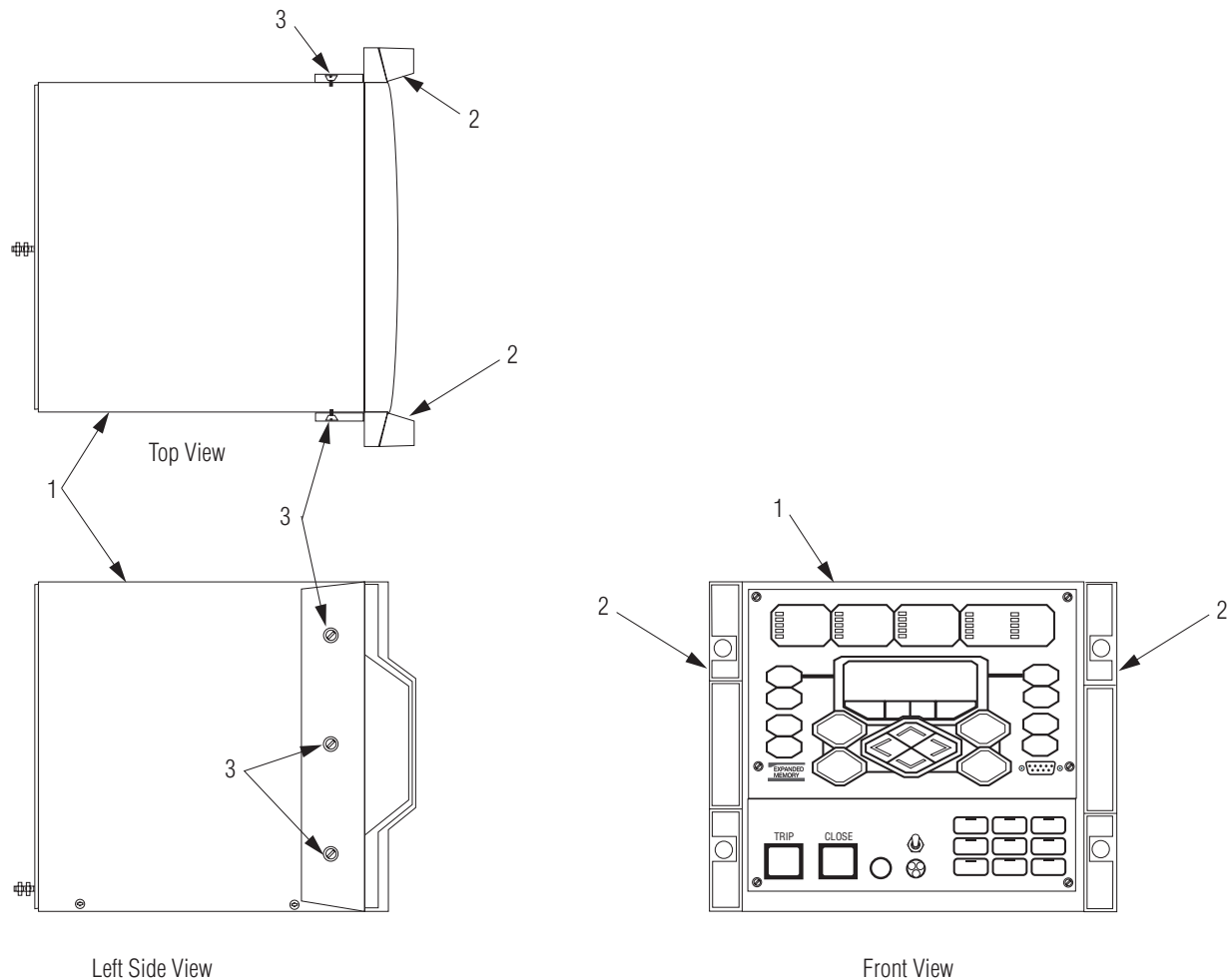


Figure 30. Form 6 single rack mount recloser control

Double Rack – Single Mount Handle and Filler Plate Attachment Instructions

These instructions apply to the attachment of two handles and one filler plate to the Form 6 Double Rack – Single Mount Recloser Control (**Figure 31**).

The control is shipped without the handles or filler plate attached. Follow this procedure to attach the handles to both sides and the filler plate to one side.

Note: The filler plate can be mounted on either side of the control.

Note: This procedure is required prior to mounting one Form 6 recloser control in the 19" rack.

Table 14. Form 6 Recloser Control Single Rack Mount Handle and Filler Plate Attachment Parts List (Figure 31)

Item	Description	Part Number	Quantity
1	Form 6 Control	(for reference)	1
2	Filler Plate	6A00166801	1
3	Form 6 Handle	6A00163901	2
4	#10-32 Fl Hd Screw	722915310050A	3
5	#10-32 Pan Hd Screw	723315310050A	5

1. Orient the handles as illustrated in the left side view in **Figure 31**.
2. Attach one handle (Item 3) with three #10-32 Flat Head Screws (Item 4) to the side of the control the filler plate is not going to be mounted to.
3. Tighten hardware completely. Do not torque.
4. Align the holes in the other handle over the pre-drilled holes on the side of the control.

Form 6 microprocessor-based rack-mount recloser control

5. Align the filler plate over the handle holes.
6. Attach the handle (Item 3) and filler plate (Item 2) to the control using five #10-32 Pan Head Screws (Item 5) (**Figure 31**).
7. Tighten all hardware completely. Do not torque.

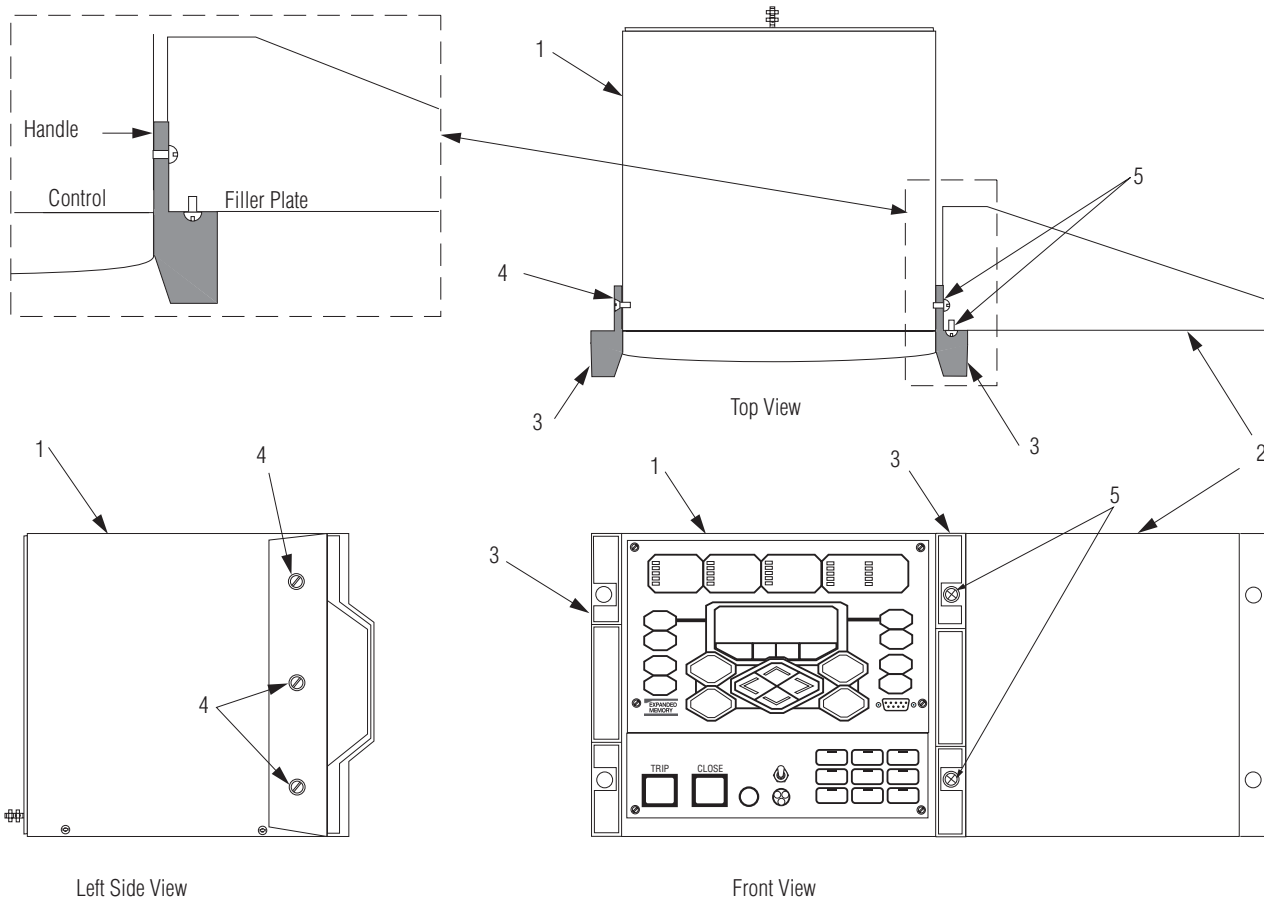


Figure 31. Form 6 double rack – single mount recloser control

Communication board accessories

The Form 6 control is equipped with a Communication Board Accessory (expansion bay) offering versatile support for modern communication media. Six distinct communication options (**Figure 32**) are available, providing two-way, real time digital communications with a remote terminal unit (RTU), wireless, telephone modem, Ethernet network, or other communication devices. The following options are available:

- No auxiliary communication card installed (standard)
- RS485 (isolated) Serial communication card
- Fiber-optic-based Serial Communication Card (ST)
- 10/100 Base-T dual Ethernet communication card (2*RJ-45)

- 100 Base-FX dual Ethernet communication card (2*MT-RJ)
- 10/100 Base-T, 100 Base-FX Ethernet communication card (RJ-45 + MT-RJ)

The expansion bay based Communication Board Accessory concept offers high versatility with respect to communication medium and protocol support. Additional accessories are being continuously developed. Contact your Eaton representative for the latest information regarding particular media and communication protocol support.

RS485 Serial communication card

The RS485 serial communication card accessory provides means for establishing asynchronous link-based digital communications with the Form 6 control. The Galvanic isolated (1000V DC) RS485 port uses a single shielded twisted pair connection and can support 32 devices in multi-drop configuration. Communication speed is controlled through software and can be set at: 1200, 2400, 4800, 9600, 19.2k, and 38.4k. Modbus can also be set at 57.6k.

Digital communications must be programmed through the Communications Workbench to ensure proper operation of the RS485 communication card accessory. Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional protocol support information.

Fiber-optic based serial communication card

The Fiber-Optic based Serial Communication Card offers means of establishing asynchronous (RS-232 like) digital communications through multi-mode fiber media. The use of the fiber-optic based serial communication card accessory can enhance communication reliability, and provides excellent electrical isolation thus protecting transmitted data from extraneous electrical interference.

An optional fiber-optic-to-RS-232D converter with DB-9 connector (Catalog Number KME6-1875-1) is available for interfacing between an optical signal and a hard-wired RS-232 signal, when required. This converter is compatible with loop (ring) and point-to-point (star) configurations.

A pair of industry standard ST type fiber-optic connectors are mounted on the back of the board enabling customer connection to a digital communication system using fiber-optic cables (customer-supplied).

The fiber-optic link has separate receive (RX) and transmit (TX) ports operating at 820nm. Typical transmission distance is 2000m with 62.5/125µm multi-mode fiber. Consult your Eaton representative for availability of long haul solutions. Link communication speed is controlled through software and can be set at: 1200, 2400, 4800, 9600, 19.2k, and 38.4k. Modbus can also be set at 57.6k.

The fiber-optic accessory must be programmed through the Communications Workbench for the appropriate protocol. Refer to *Service Information S280-70-4 (ProView 4.X.X) or S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional information.

The fiber-optic based serial accessory includes TX and RX indicating LEDs for verifying communications along with an echo/non-echo switch for supporting ring/star fiber topologies.

When operated in a ring configuration, the toggle switch must be set in the ECHO position. In this mode, the fiber-optic card will repeat (pass through) all messages received on the RX fiber, and will respond to the Master station by first echoing the incoming command and then sending the response. This arrangement is best suited for creation of low cost multi device fiber loops. For reliable communications, the fiber loop system requires that all devices in the loop remain powered at all times, thus enabling unobstructed flow of information throughout the loop.

A more resilient system can be designed by using the fiber-optic ports in a point-to-point or multiple point-to-point (star) configuration. For this mode, the toggle switch must be set in the NON-ECHO mode. The Form 6 control will respond to the Master station by sending a response only (total separation of Receive and Transmit fibers). Additional hardware (fiber-optic star coupler) is required to support the multiple point-to-point device configurations.

Ethernet communication cards

The Ethernet communication card accessory brings the Ethernet network connectivity to the Form 6 recloser control platform. It is highly flexible, offering simultaneous support for multiple sessions, device management (ProView over TCP/IP) and SCADA communications (DNP3 over TCP/IP).

By natively supporting a set of widely accepted industry standards (TCP/IP, UDP/IP, OSI) the Ethernet communication accessory ensures seamless interoperability with other network devices.

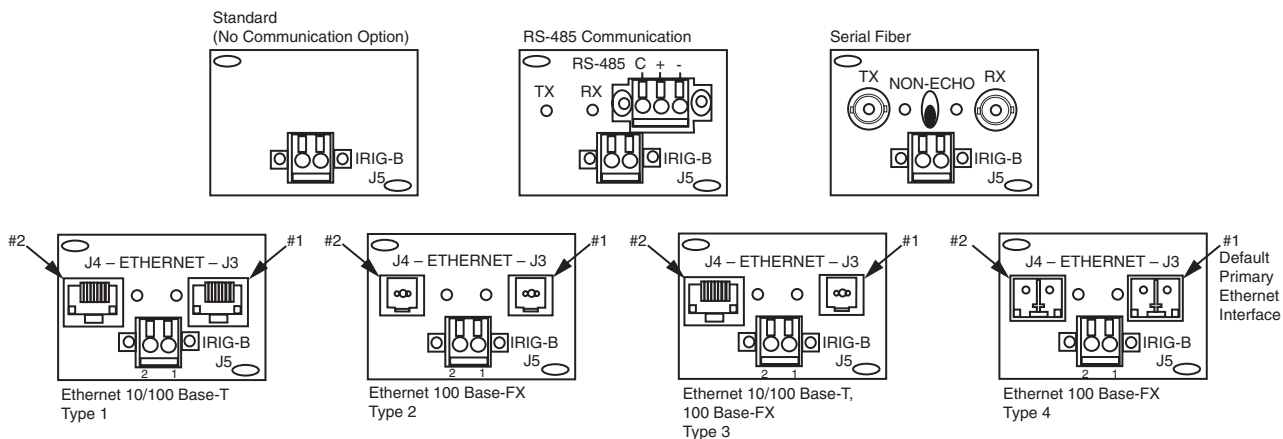


Figure 32. Back panel ethernet and communication options

Form 6 microprocessor-based rack-mount recloser control

The Ethernet communication card accessory is offered in 3 physical layer configurations (twisted pair and optical-fiber options) as shown in **Table 15**.

Table 15. Ethernet communication card configurations

Type	Card Configurations	Output Connectors	Communication Speed
1	10/100 Base-T	2 * RJ-45	10 / 100MBps (auto switching)
2	100 Base-FX (multi-mode fiber)	2 * MT-RJ	100MBps (full duplex)
3	10/100 Base-T, 100 Base-FX	RJ-45 + MT-RJ	10/100MBps and 100MBps
4	100 Base-FX, (single-mode fiber)	2 * LC	100MBps (full duplex)

Maximum link length is determined by the use of the particular physical layer implementation, and can be further constrained by the actual network configuration. In case of the 100Base-FX MT-RJ connector based implementation, maximum link length in excess of 2000m can be achieved with 62.5/125µm multi mode fiber. The fiber-optic link uses 1300nm wavelength, and can easily be interfaced to other 100Base-FX solutions (ST connector patch cord solution).

The Ethernet communication accessory card (**Figure 32**) is equipped with two physical ports configured to act as primary and standby LAN connections. Availability of the backup communication port enables creation of highly redundant Ethernet networks thus increasing the overall system reliability.

Note: Under normal network conditions, all communications will be channeled through the primary port (#1, **Figure 32**), with the standby port either logically disabled, or configured for fast automatic throw-over in case of the primary Ethernet link failure. Refer to *Service Information S280-70-4 (ProView 4.X.X)* or *S280-70-21 (ProView 5.X.X) Form 6 Control Programming Guide* for additional Ethernet accessory configuration information.

Testing

CAUTION

Equipment misoperation. Do not connect this control to an energized recloser until all control settings have been properly programmed and verified. Refer to the programming information for this control. Failure to comply can result in control and recloser misoperation, equipment damage, and personal injury.

G110.3

IMPORTANT

The Form 6 recloser control can be taken out of service for testing and placed back into service without de-energizing its recloser and interrupting the system. However, during the time the control is out of service, the recloser is inoperative.

Testing an installed control

The following tests to determine initial operation of the Form 6 recloser control can be performed while connected to an operating recloser.

Note: These are the only tests performed on an installed, operating control.

1. Verify operating status of all indicator lights by pressing the LAMP TEST key on the programming panel (**Figure 33**).
2. Check the operational values for currents, voltages, and other metering information.

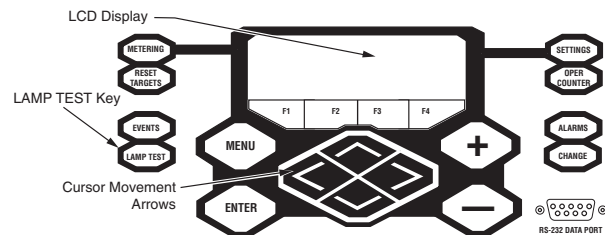


Figure 33. Lamp Test button, LCD display, and cursor movement arrows

Note: Scroll through the LCD display messages by pressing the ▲ and ▼ cursor movement arrows underneath the LCD display on the programming panel (**Figure 33**).

3. Verify the Control OK LED is illuminated on the control operator panel (**Figure 34**). This indicates the presence of DC power.

Note: The control includes a Power Save feature that will turn off the backlit LCD display and all LEDs if no front panel keypad is pressed within ten minutes. Pressing any key will reactivate the display and LEDs.

All other tests described in this **TESTING** section require the Form 6 recloser control to be removed from service, connected to a bypassed recloser, or tested at a location where the proper testing equipment is available. Refer to **Remove the control from service** for the proper procedure to remove the control from service.

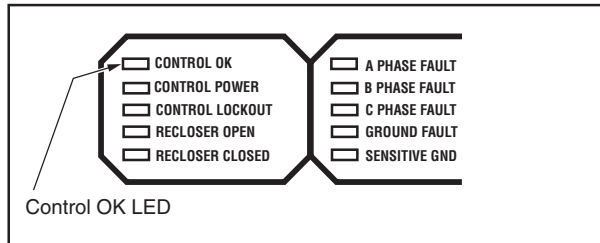


Figure 34. Control OK LED

Remove the control from service

IMPORTANT

Disconnect switches for both AC and DC circuits and a current transformer shorting-type terminal block are necessary to isolate the Form 6 recloser control for testing and servicing.

1. Enable GND TRIP BLOCKED to allow for ground trip to be disabled when re-energized.
 - A. Press the CHANGE button on the Operator Panel to enter the CHANGE mode.
 - B. Depress the GND TRIP BLOCKED button within ten seconds after entering the CHANGE mode.

Note: If the GND TRIP BLOCK button is not depressed within ten seconds, the function is not activated.

2. Remove DC power from the control using a separate disconnect switch.
3. Remove control AC sensing voltage from the control using a separate disconnect switch.

CAUTION

Hazardous voltage. Open CT secondaries can generate high voltages. Contact with CT pins of the disconnected cable can cause electric shock and may result in personal injury. Open recloser contacts and open disconnect switches before disconnecting control cable.

T204.3

4. Short CT secondaries at a separate CT shorting-type terminal block.
5. Remove any control input and status output wiring from TB1, TB3, and TB4 (**Figure 7**).
6. Disconnect any serial communications ports and IRIG-B timing connection (**Figure 7**).

7. Unscrew the mounting screw on each side of terminal block TB5 (Input Power) to disconnect and remove the terminal block from the control.

NOTICE

Equipment damage. Pin 1 retains a 24 VDC charge. Never allow conductive material (such as a screwdriver or other metal item) to touch TB6 Pin 1 to chassis. Failure to comply will damage the control.

T272.0

8. Unscrew the mounting screw on each side of terminal block TB6 (Recloser Interface Connections) to disconnect and remove the terminal block from the control (**Figure 7**).
9. Use a screwdriver to disconnect all wiring on terminal block TB2 (Voltage/Current Inputs) from the control (**Figure 7**).
10. Disconnect the ground from the control.
11. Carefully transport the control to a suitable service facility.



Figure 35. Eaton's Cooper Power series type MET electronic recloser control tester

Testing with type MET tester

The Eaton Cooper Power series Type MET Electronic Recloser Control Tester (**Figure 35**) is used for testing the following functions of the Form 6 recloser control:

- Overcurrent Timing
- Reclose Time
- Operating Sequence
- Reset Time
- Minimum Trip Current
- High Current Trip and Lockout

The MET Tester is completely self-contained, capable of performing all required checks and tests from a simple verification of operation to a complete verification of all operating parameters. Refer to Service Information

Form 6 microprocessor-based rack-mount recloser control

MN280067EN Type MET Electronic Recloser Control Tester Operating Instructions for proper setup and use of the MET Tester.

Use the wiring harness KME6-1732 accessory to connect the MET tester to the Form 6 rack mount control. Refer to **Table 16** for connection information. The wiring harness has a connector on one end for connection to the control receptacle on the MET Tester. The other end of the wiring harness has insulated locking fork terminals for connection to the Form 6 rack mount recloser control.

Table 16. Wiring Harness KME6-1732 Wire Color and Corresponding Connection Point

Pin	Color	Connection Point
A	BLACK	TB6-1
B	WHITE	TB6-2
C	RED	TB6-4
D	GREEN	TB6-3
E	ORANGE	TB6-6
F	BLUE	TB6-5
G	WHT/BLK	TB2-1
H	RED/BLK	TB2-3
J	GREEN/BLK	TB2-5
K	ORANGE/BLK	TB2-8

Closing the recloser during testing

Electrical closing – solenoid-operated reclosers

Line voltage is required for automatic recloser operation during testing of reclosers equipped with a closing solenoid (except for reclosers equipped with the low voltage closing accessory).

WARNING

Hazardous voltage. Interconnect source leads X and Y and ground solidly to the recloser tank (Figure 38). Do not connect lead Z to any other phase or mechanical ground. Dangerous voltages to ground exist on the phase connected to lead Z. Solidly ground all equipment. Failure to comply can result in severe personal injury and/or equipment damage.

T224.1

For on-line testing, bypass the recloser, open the load-side disconnects and keep the source-side disconnects closed. This will remove the recloser from service, but will keep line voltage supplied to the closing solenoid (**Figure 36**).

WARNING

Hazardous voltage. The switchgear (apparatus and control) and high-voltage transformer must be in a test cage or similar protected area to prevent accidental contact with the high-voltage parts.

Solidly ground all equipment. Failure to comply can result in death, severe personal injury, and equipment damage.

T221.5

For shop testing, the closing solenoid voltage is supplied by back-feeding a transformer with a low-side rating equal to the voltage rating of an available power source, and a high-side rating equal to the voltage rating of the recloser (**Figure 38**). A 75 kA transformer of the proper voltage rating with an impedance drop of approximately 3% is satisfactory. The AC source must have a comparable impedance drop.

A test circuit for these solenoid-closed reclosers is shown in **Figure 38**. The following equipment is required for the recommended shop testing setup:

Note: Solenoid-closed reclosers equipped with a 120- or 240- VAC low-voltage closing coil accessory can be tested as shown in **Figure 39**.

- Variable Autotransformer T1, 230 Volts, 20 Amps.
- Low-Voltage transformer T2 to simulate fault conditions.

Ratio and size will depend upon the maximum current to be used. The recloser presents a low impedance to the transformer, so secondary voltage must be only high enough to force the required current through the secondary of the transformer and the recloser.

Note: An alternative method of providing the necessary current through the transformer is shown in **Figure 37**.

- High-Voltage T3 to operate the closing solenoid.

The closing coil requirement is approximately 200 kVA during the two-to-three cycle closing operation. The solenoid coil operating voltage must be maintained at the recloser bushings during the cycle interval the closing coil is energized. This procedure is not used on reclosers equipped with the low-voltage closing accessory.

- Ammeter with a rating based on the level of test current.
- Current-actuated timer.

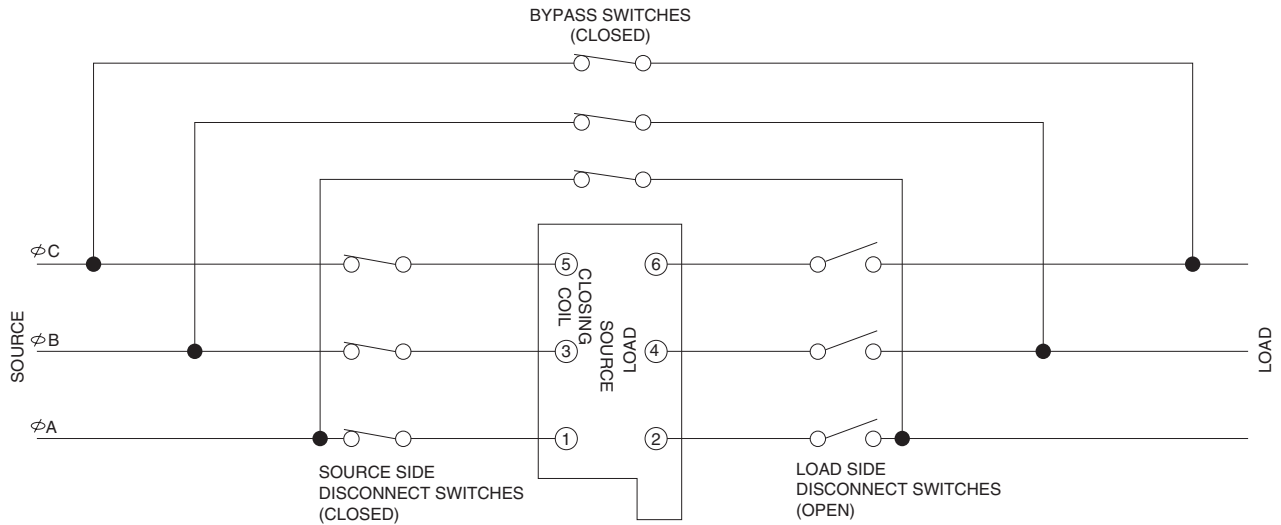


Figure 36. Closing source-side switches of a bypassed "on-line" recloser provides closing solenoid power for automatic operation during testing

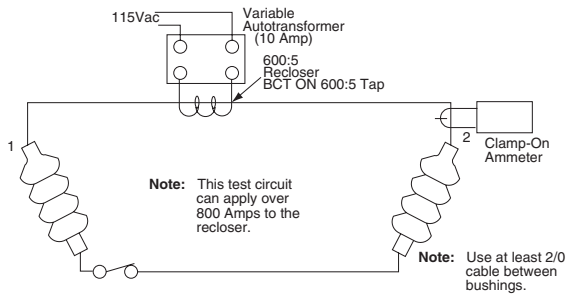


Figure 37. Alternate method of producing variable line current (substitute for t2 and w-x circuit in Figure 38 and Figure 39)

Form 6 microprocessor-based rack-mount recloser control

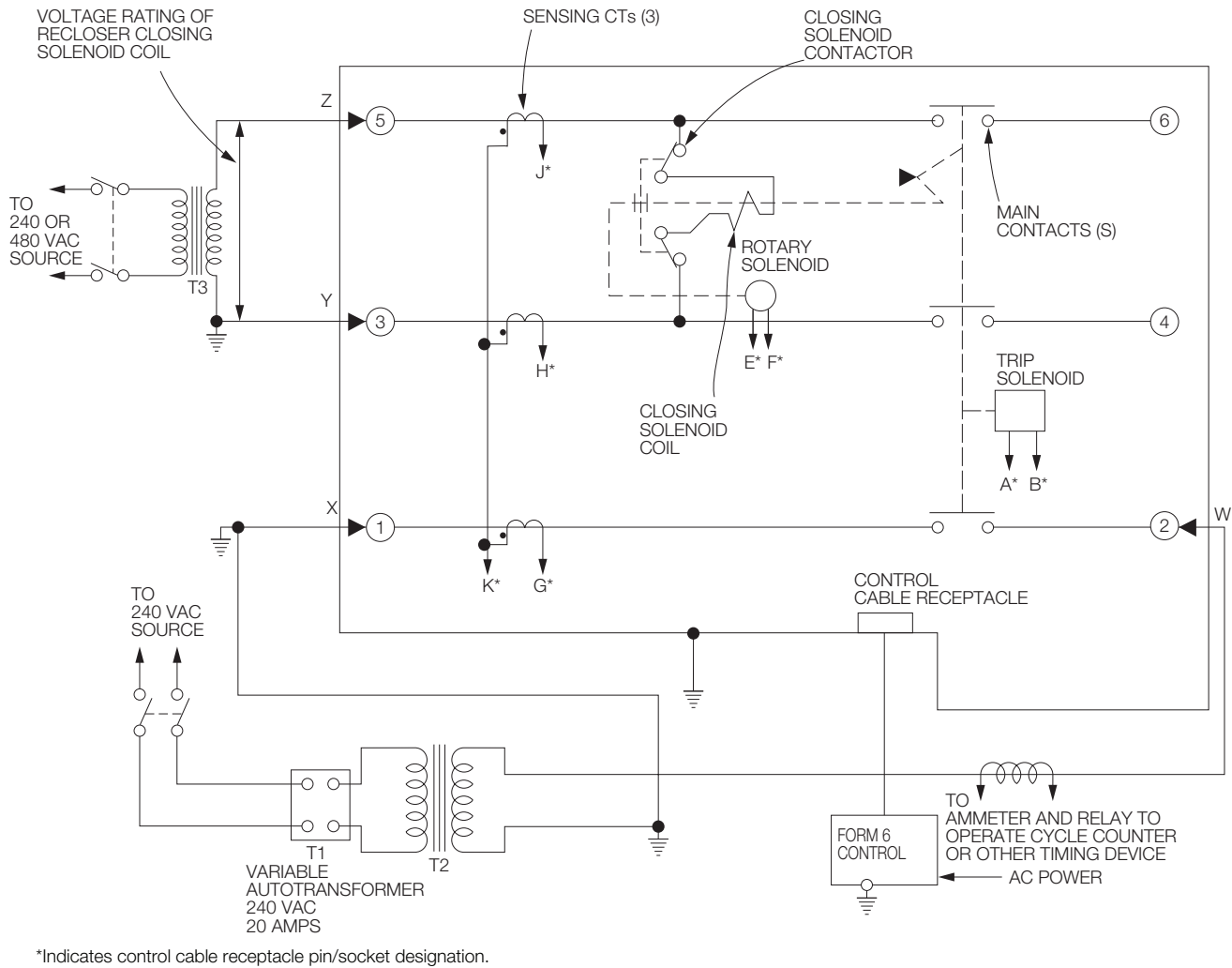


Figure 38. Suggested test circuit for high voltage “shop-testing” solenoid-closing reclosers

Electrical closing – motor-operated low voltage closing solenoid / auxiliary-powered NOVA reclosers

⚠ WARNING

Hazardous voltage. Solidly ground all equipment. Failure to comply can result in death, severe personal injury, and equipment damage.

T223.2

High-voltage is not required for reclosers utilizing a motor-operated closing mechanism, low voltage closing, or Auxiliary-Powered NOVA recloser. For information on energizing the recloser, refer to the appropriate recloser installation manual. Low voltage supply can use either 120 or 240 VAC for input power. Check the name plate on the recloser to verify the correct closing power requirements.

Figure 39 shows a test circuit for motor-operated, low-voltage solenoid-closing, and Auxiliary-Powered NOVA reclosers. Since these reclosers require only a low voltage source for closing, high-voltage transformer T3 and its protective cage is eliminated. All other equipment is the same as the test equipment shown in **Figure 38**.

Form 6 microprocessor-based rack-mount recloser control

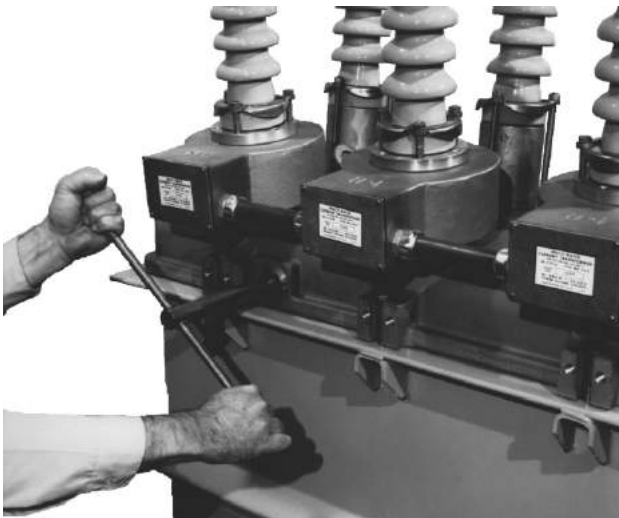


Figure 40. Using a manual closing tool to operate the recloser

Return the control to service

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury, and equipment damage.

G102.1

After the required work or testing is completed, follow this procedure to return the control to service:

CAUTION

Equipment misoperation. Do not connect this control to an energized recloser until all control settings have been properly programmed and verified. Refer to the programming information for this control. Failure to comply can result in control and recloser misoperation, equipment damage, and personal injury.

G110.3

1. Verify that all control settings are correct prior to installation.

WARNING

Hazardous voltage. Recloser and control must be solidly grounded. Follow all locally approved procedures and safety practices when grounding this equipment. Improper grounding can result in contact with high voltage, which will cause death or severe personal injury.

G115.1

2. Connect the ground to the control.

Note: Refer to **Grounding the control** section.

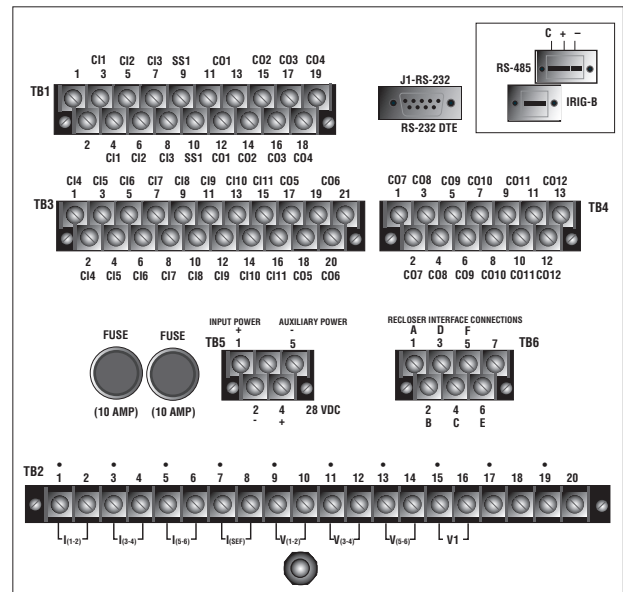


Figure 41. Back of Form 6 rack mount recloser control

3. Use a screwdriver to re-connect all wiring on terminal block TB2 (Voltage/Current Inputs) to the control (**Figure 41**).
4. Connect any serial communications ports and IRIG-B timing connection (**Figure 41**).
5. Connect terminal block TB5 to the control by screwing the mounting screw through each side of the terminal block (Input Power) and into the control (**Figure 41**).
6. Connect any control input and status output wiring to TB1, TB3, and TB4 (**Figure 41**).
7. Connect terminal block TB6 to the control by screwing the mounting screw through each side of the terminal block (Recloser Interface Connections) and into the control (**Figure 41**).
8. Connect control AC sensing voltage to the control via disconnect switches.

Note: Refer to **Customer connections for DC power and AC voltage sensing** section.

9. Connect DC power to the control via disconnect switches.

Note: Refer to **Customer connections for DC power and AC voltage sensing** section.

 **CAUTION**

Hazardous voltage. Open CT secondaries can generate high voltages. Contact with CT pins of the disconnected cable can cause electric shock and may result in personal injury. Open recloser contacts and open disconnect switches before disconnecting control cable.

T204.3

10. Reconnect CT circuit by unshorting secondaries from the CT shorting-type terminal block.
11. The recloser and control are ready for service. Once installed, remove bypass switches on the recloser.
12. Disable GND TRIP BLOCKED.
 - A. Press the CHANGE button on the Operator Panel to enter the CHANGE mode.
 - B. Depress the GND TRIP BLOCKED button within ten seconds after entering the CHANGE mode.

Note: If the GND TRIP BLOCK button is not depressed within ten seconds, the function is not activated.

Additional information

 **CAUTION**

This equipment requires routine inspection and maintenance to ensure proper operation. If it is not maintained, it can fail to operate properly. Improper operation can cause equipment damage and possible personal injury.

G105.1

Replacement kits

Replacement kits for the Form 6 recloser control are available through the factory Service Department. To order these kits, refer to the Replacement Parts price list for catalog numbers and pricing. Contact your Eaton representative for additional information and order procedures.

Factory-authorized service centers

Factory-authorized service centers are located throughout the continental United States to provide maintenance, repair and testing services for Cooper Power series controls and reclosers. For further information, contact your Eaton representative.

Factory testing and troubleshooting classes

The factory service department offers a basic testing and troubleshooting course for the Form 6 Microprocessor-Based Electronic Recloser Control. This course, taught by experienced service technicians, is held at the factory's in-house training facility. For additional information, contact your Eaton representative.

Type MET recloser control tester

A 30-minute video program KSPV7 Type *MET Electronic Recloser Control Tester Operation and Testing Procedures* is available as a supplemental training aid for service personnel.

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Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Eaton.com/cooperpowerseries

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