

Kyle Form 4C Microprocessor-Based Recloser Control Installation and Operation Instructions

Service Information
S280-77-1

For Serial Number 232001 and above



Figure 1.
Kyle® Form 4C Microprocessor-Based Recloser Control.

961066KM

Contents

Safety Information	2	Installation Procedure	14
Product Information	3	Control/Recloser Compatibility	14
Introduction	3	Mounting the Control	14
ANSI Standards	3	Control Cable	14
Quality Standards	3	Grounding the Control	15
Acceptance and Initial Inspection	3	Customer Connections for AC Power	19
Handling and Storage	3	Customer Connections for Remote and Supervisory Operation	19
Control Battery Storage and Charging	3	Shielding and Surge Protection of Supervisory Cables	19
Control Power	4	Standard Universal I/O Board	23
Initializing the Control	4	Customer Options For The Block of Close Feature ..	24
Description Of Control	5	Alternate Minimum Trip Operation	25
Control Operation	5	Non-Reclosing Operation	26
Control Front Panel	6	Ground Trip Block Operation	27
Keyboard and LCD Display	6	Accessories	28
Control Panel LCD Indicators	7	Optional Universal I/O Board	28
Data Port on Control Front Panel	7	Hot Line Tag	30
Manual Operating Controls	8	Trip On TCC2	32
Battery Meter and Test Panel	9	Sensitive Ground/Earth Fault	33
Battery Test Procedure	9	Switch Mode	34
Battery Charger Operation	9	Before Placing Control and Recloser Into Service ..	35
Battery Charging with Portable Charger	10	Testing and Troubleshooting	36
Battery Reference Information	10	Maintenance Information	47
Initial Programming Prior to Installation	10	Removal Of Control Front Panel Assembly	48
Control Security	10	Event Recorder Data Record Sheet	50
Control Back Panel	11		
Keyboard Functions	12		
Interpreting the LCD Displays	13		



SAFETY FOR LIFE



Cooper Power Systems products meet or exceed all applicable industry standards relating to product safety. 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 Cooper Power Systems 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 flash clothing, safety glasses, face shield, hard hat, rubber gloves, 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.

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 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 equipment can result in death, severe personal injury, and equipment damage.

G122.2

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.

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



PRODUCT INFORMATION

Introduction

Service Information S280-77-1 provides installation and operating instructions for the Kyle® Form 4C micro-processor-based recloser control. Refer to *Service Information S280-77-4 Form 4C Recloser Control Programming Guide* for additional information.

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 to provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your Cooper Power Systems representative.

ANSI Standards

Kyle® 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 9001:2000 Certified Quality Management System

Acceptance and Initial Inspection

Each Form 4C 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.

Note: To energize the control, apply ac power to the ac supply input terminal block located in the lower right hand corner of the back panel of the control cabinet. Refer to the **Customer Connection for AC Power** section in this manual.

Control Battery Storage and Charging

Temperature has an effect on battery life. Sealed lead acid batteries should be stored, fully-charged, at room temperature. Never store lead acid batteries at temperatures exceeding 47°C (117°F).

The 24 Vdc control battery in the Form 4C control is fully charged prior to shipment and is ready for use. In order to maintain sufficient charge to operate the control, the sealed lead acid battery should be charged after no more than three months of storage.

The battery can be kept charged by energizing the control's built-in charger with ac power applied to the customer ac supply input terminal block, located in the lower right hand corner of the control cabinet.

The battery must be fully charged before being removed from the control for long term storage. If spare batteries require charging prior to being put into service, a plug-in, bench-type, lead-acid battery charger is available, identified by the following catalog numbers:

KA43ME7001 (120 Vac)

KME4-711-1 (240 Vac)

Note: If ac power is lost to the control, the battery maintains normal control operations for a minimum of 48 hours. See **Operation Upon Loss of AC Power**.

Note: When shipped from the factory, the battery is disconnected and its output plug is taped to the cabinet. Connect the battery plug into the mating connector to complete the battery circuit.

IMPORTANT: Connect the control battery when ac power is connected to the control's ac Supply Input Terminal Block, shown in Figure 9. The battery must be disconnected prior to shipping or storing the control.

Battery Replacement

In a typical application, the life expectancy of a lead acid battery is three to five years. To determine the state of the battery, perform a bench battery test. Battery replacement is recommended after four years for lead acid batteries or if the battery fails the bench battery test. Refer to the **Battery Test Procedure** section of these instructions to identify the appropriate replacement battery and whether a battery replacement kit is necessary.

Battery Disposal

Dispose expired batteries in an environmentally responsible manner. Consult local regulations for proper battery disposal.

Control Power

The Form 4C control is factory configured for primary operation on either 120 Vac or 240 Vac (units are also available for operation on 48 Vdc and 125 Vdc) and is furnished with either a Standard Power Supply or Automation Power Supply (Figure 2).

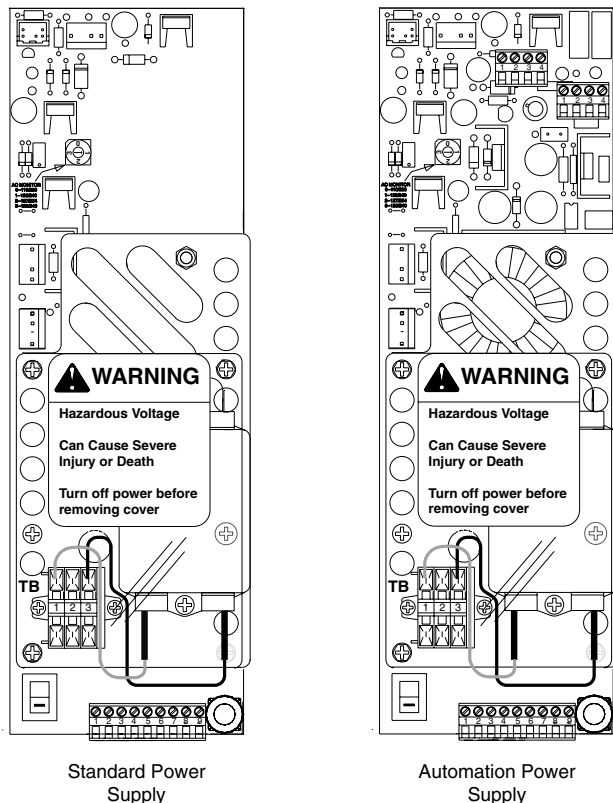


Figure 2.
Standard and Automation Power Supply Assemblies

The Standard Power Supply provides power for the Form 4C central processing unit, cabinet heater, and maintains optimum charge levels of back-up batteries. The Automation Power Supply provides the same basic functions with additional isolated 12 Vdc and 24 Vdc supply circuits, enabling powering of radio communication units, RTU's and other accessories from the Form 4C power supply board.

Both power supply assemblies are comprised of a power supply board and tandem input filter board. The Automation Power Supply with isolated 12 Vdc and 24 Vdc outputs features a thermally controlled fan in addition to the input filter. A minimum of 2.5 A of ac current is required for heater operation, current charging in bulk rate, and to keep all input/output boards energized.

In operation ac voltage is rectified to charge the power capacitor and to power the dc/dc converter that provides logic voltage to the control. A sealed 24-volt lead acid battery located in the upper portion of the control cabinet (Figure 9) is utilized to provide operating and tripping energy when ac power is temporarily lost. The control is equipped with an ac-powered, temperature-regulated battery charger.

Operation Upon Loss of AC Power

If the control is equipped with the standard 24 Vdc lead-acid battery (instead of the optional provisions for connection to a substation battery supply), the control will maintain full operation from the battery power supply for a minimum of 48 hours at 20°C (24 hours at -40°C). To prevent battery damage, the control shuts down automatically upon detection of low battery voltage below 22.7 Vdc.

Control programming settings and parameters—including event recorder, duty monitor, and demand metering data—are stored in non-volatile memory. All data is retained in the event that both ac power and battery backup power are disconnected.

The control is equipped with a power status indicator contact for remote indication of a loss of ac power or backup power supply (see the **STANDARD UNIVERSAL I/O BOARD** section of this manual).

Local indication for loss of ac power is provided by the ac Supply LCD (Figure 6) indicator on the front panel of the control. If low battery voltage is detected, the Malfun-ction LCD and Check Battery LCD indicators will be activated to provide local indication of low battery voltage.

Initializing the Control

Ac power is required to initialize or re-initialize the control each time it has been de-energized. The control clock should be reset if both ac power and battery back-up power have been disconnected. Refer to *Service Information S280-77-4 Form 4C Microprocessor-Based Recloser Control Programming Guide* for the procedure **SETTING THE CONTROL CLOCK**.

DESCRIPTION OF CONTROL

Control Operation

Line current flowing through the recloser is sensed by three internally mounted bushing-current transformers in the recloser, one for each phase. When the phase current or the zero-sequence (ground) current exceeds its programmed minimum-trip value, the Kyle Form 4C control initiates the programmed sequence of recloser-tripping and reclosing operations. If the fault is temporary, the control ceases to command recloser operations after the successful reclosure, and 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 recloser commands and locks out with the recloser open. Once locked-out, the control must be reset to the start of its operating sequence, which closes the recloser.

A functional block diagram of the Form 4C control operation is shown in Figure 3. Line current conditions are monitored continuously by three bushing-type current transformers in the recloser, one for each phase. Output of these transformers is fed to the control front end which consists of isolation transformers and a 4:1 multiplexer. The control's microprocessor samples the current and computes the RMS current for each phase and ground.

When current above the programmed minimum-trip level is detected in one or more phases, the following chain of events will occur for an operating sequence of two fast and two delayed operations:

1. The overcurrent signal is integrated with time on the selected curve for the first trip operation to produce the signal which energizes the trip circuit.

2. Energizing the trip circuit connects the battery and capacitor to the trip solenoid to open the recloser.
3. Simultaneously, the microprocessor 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.

If current remains above the minimum-trip level, the tripping and reclosing sequence (fast and delayed operation) is repeated as programmed to lockout.

If the overcurrent is cleared before the operating sequence reaches lockout, the microprocessor starts timing a reset-delay when the recloser closes into the line and current is below minimum trip.

5. When the reset-delay times out, the control is reset to the home state and is ready for another programmed operating sequence. If current rises above minimum trip prior to the reset-delay timing-out, the timer is halted and the control continues the operating sequence from where it left off and the accumulated reset-delay timing is cleared.

Ground fault tripping is separately programmable and includes minimum trip, operations to lockout, and number of operations on fast and delayed curves. Reclose and reset intervals are common for phase and ground fault operation.

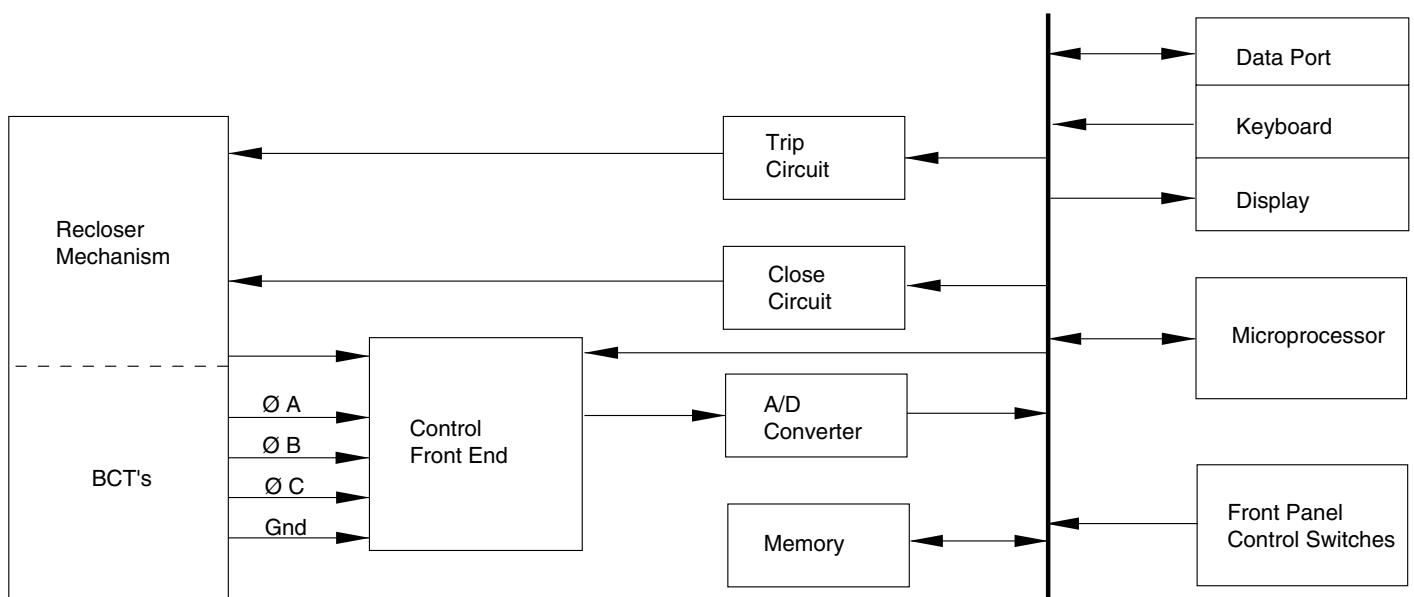


Figure 3.
Functional block diagram of Form 4C Control.

Control Front Panel

The battery meter and test panel is located at the top of the front panel of the control. The swing-out front panel contains the keyboard, LCD displays, LCD indicators, and manual operation switches of the control (Figure 4).

Manual operation and control switches are located in the lower, light gray portion of the front panel. Programming and display elements are located in the upper, dark gray portion of the front panel.

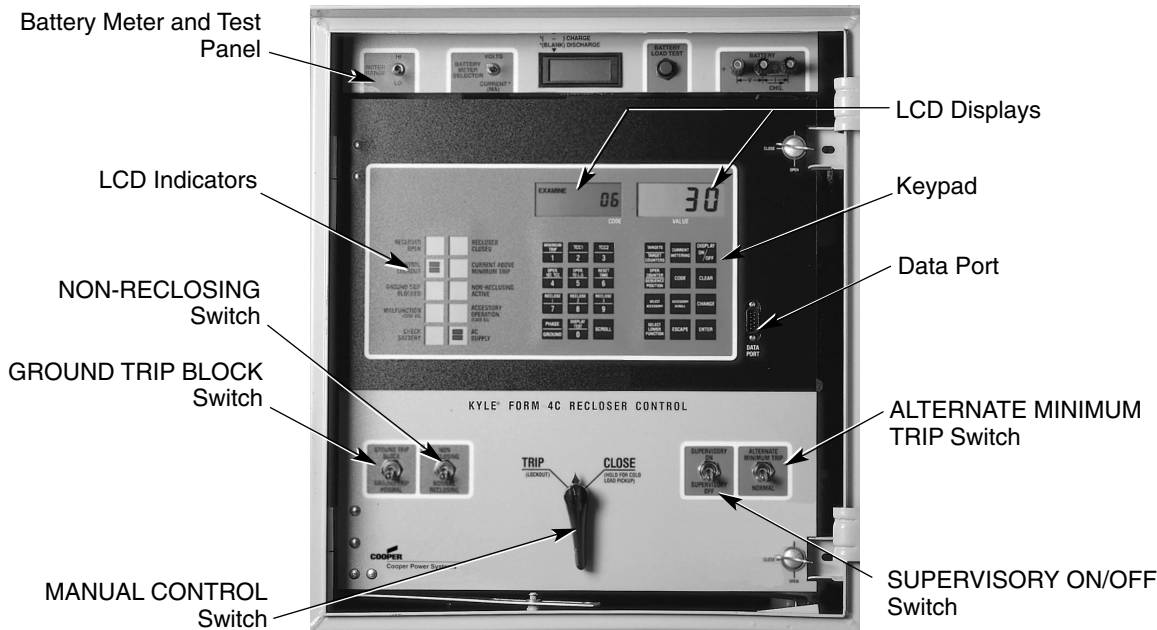
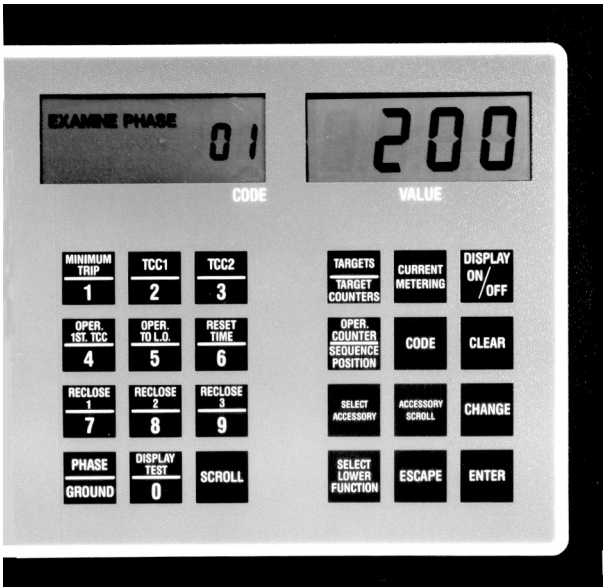


Figure 4.
Kyle Form 4C recloser control front panel.

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Keyboard and LCD Display

The Form 4C control keyboard has 24 keys and a large visible LCD display, shown in Figure 5. It is activated by pressing the DISPLAY ON/OFF key. The display will remain on until the key is pressed again, or will shut off automatically ten minutes after the last keyboard entry is made.

The dual-pad keyboard has dedicated function keys to simplify operator interrogation of the most common control parameters and functions. The functions of all keys are defined in Figure 10.

Figure 5.
Form 4C control keyboard and LCD displays.

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Control Panel LCD Indicators

Ten LCD indicators (Figure 6), located to the left of the keyboard and display, provide status information on control and recloser functions. The operation of each LCD is described as follows:

RECLOSER OPEN indicates that the recloser contacts are in the open position.

RECLOSER CLOSED indicates that the recloser contacts are in the closed position.

CONTROL LOCKOUT indicates that the control has tripped to lockout (no further automatic reclosing) sequence.

CURRENT ABOVE MINIMUM TRIP indicates that line current is above the programmed minimum trip value.

GROUND TRIP BLOCKED indicates whether or not ground trip block has been activated by either the front panel switch or via supervisory control.

NON-RECLOSING ACTIVE indicates whether or not non-reclosing has been activated either by the front panel switch or via supervisory control.

MALFUNCTION indicates when one or more of the five following malfunctions is detected:

- Failure to close from a supervisory signal.
- Low/High battery voltage (resets automatically upon restoration of normal battery voltage).
- Power down in less than 48 hours on battery power.
- Failure to close from the manual control switch.
- Internal diagnostics alarm.

Keyboard interrogation of Access Code 66 will display a malfunction code. Malfunction codes are listed on the label inside the cabinet door. To clear the Malfunction LCD display, press the CLEAR key while Code 66 is displayed.

ACCESSORY OPERATION identifies special accessory operations, where identification will aid in troubleshooting. Access Code 65 will display the code identifying the accessory:

- High-Current Lockout (Code 1)
- Remote Trip and Lockout (Code 2)
- Supervisory Trip and Lockout (Code 3)

A complete list of access codes, definitions, and parameters is located in *Service Information S280-77-4 Form 4C Microprocessor-Based Recloser Control Programming Guide*.

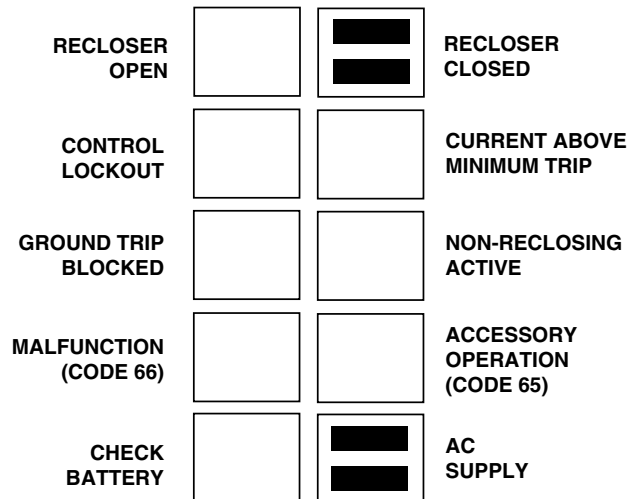


Figure 6.
Control panel LCD indicators.

CHECK BATTERY indicates that the battery voltage is low (below 23.3 volts). The control's power status indicator contact will also operate to provide remote indication of low battery voltage.

AC SUPPLY indicates the presence of ac power which is required for normal control operation.

Data Port on Control Front Panel

The Form 4C control is equipped with a data port located on the control front panel. It is used for temporary connection of a Data Reader or personal computer (with a data port-to-RS232 adapter) to the control. The data port permits the operator or technician to download all the programming information stored in the control, including operating parameters, event recorder, duty monitor, demand metering, and load profile monitor data.

The data port also provides a convenient means to upload control parameters compared to manual keyboard entry procedures at the control keyboard. See *Service Information S280-77-4 Form 4C Microprocessor-Based Recloser Control Programming Guide* for additional information.

Standard Manual Operating Controls

The lower portion of the front panel of the Form 4C control contains manual operating controls as described in Figure 7.

All available CPU firmware versions contain Ground Trip Block, Non-Reclosing, Alternate Minimum Trip, and Supervisory ON/OFF.

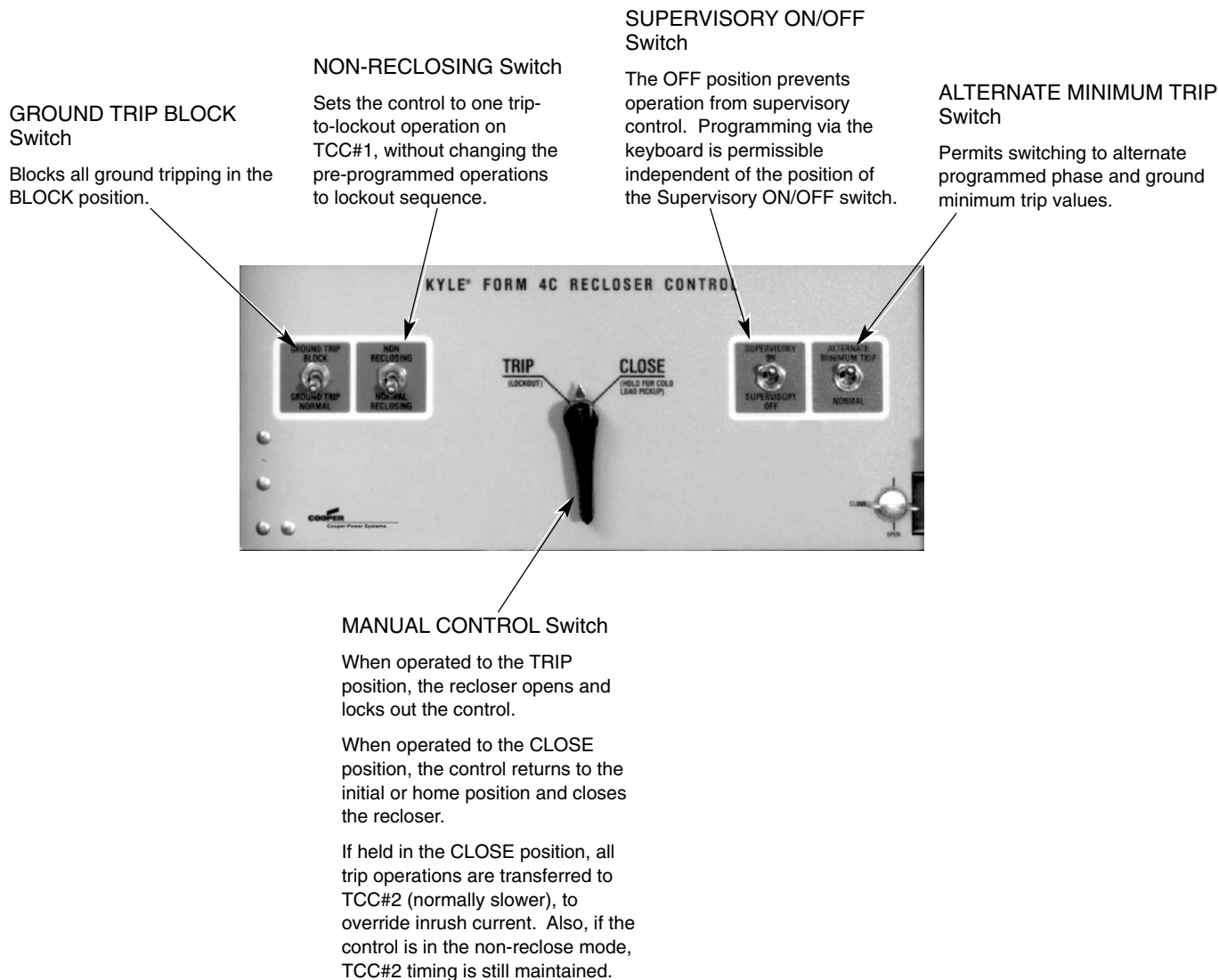


Figure 7.
Manual operating controls on the lower portion of the standard Form 4C control front panel (CPU Firmware 15.XX).

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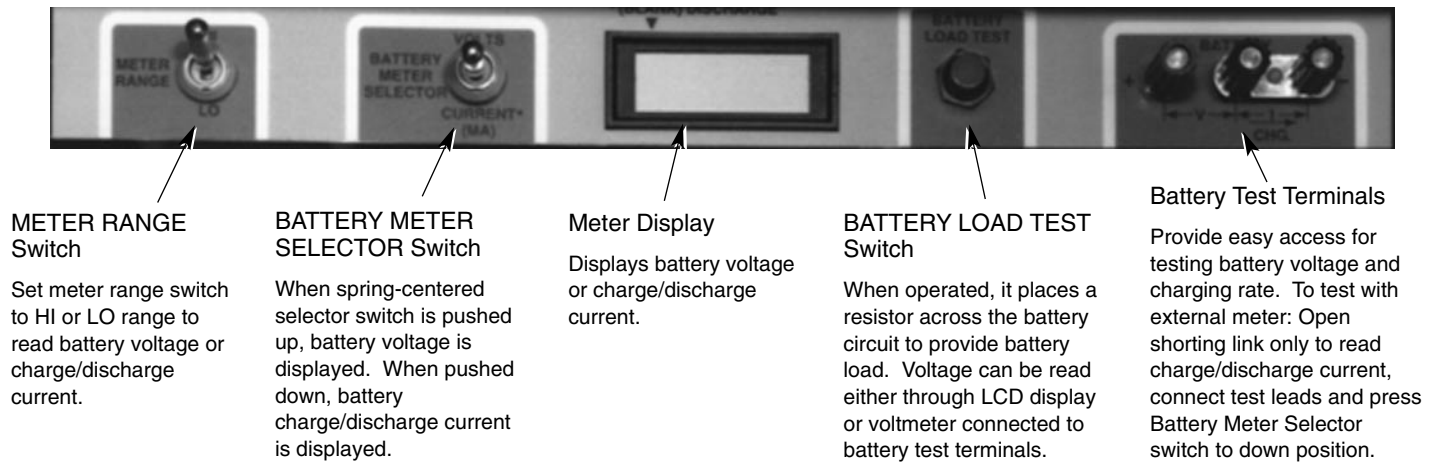


Figure 8.
Battery test panel controls and meter display.

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Battery Meter and Test Panel

Located at the top of the front panel of the control is the battery test panel (Figure 8). The battery meter and test panel contains switches, meter display and test points for checking the condition of the control's 24 Vdc lead acid battery.

Battery Test Procedure

CAUTION: Equipment damage. Shorting battery positive to battery negative at the battery test terminals on the control panel will cause damage to the control. The control will be inoperative and possible misoperation (unintentional operation) of the recloser can result. T214.1

CAUTION: Equipment damage. Do not short battery positive to mechanical ground. Failure to comply will cause damage to the control. T256.1

Follow the procedure to perform a battery test in the Form 4C control.

Control connected to AC power

Initial condition: AC power is connected to the control and battery circuit is connected.

1. Set Meter Range switch to LO.
2. Place the Battery Meter toggle switch in Volts position. Battery voltage should read 27–29 Vdc.
3. With the Battery Meter toggle switch in Volts position, press the Battery Load Test button for 5 seconds (places 5Ω load on battery). Voltage drop should not exceed 3 Vdc.
4. Set Meter Range switch to HI.
5. Place the Battery Meter toggle switch in Current position. Press the Battery Load Test button for 5 seconds. Battery charger should show charge rate of 250 to 500 mA.

Control disconnected from AC power

Initial condition: AC power is disconnected, battery circuit connected, and Meter Range switch set to LO.

1. Place Battery Meter toggle switch in the Volts position. Battery voltage should read 25–27 Vdc. If the battery voltage is less than 23 Vdc, recharge the battery prior to performing Step 2.
2. With the Battery Meter toggle switch in the Volts position, press the Battery Load Test button for 5 seconds, this places a 5Ω load on the battery. Voltage drop should not exceed 3 Vdc.

Battery Charger Operation

The Form 4C control battery charger is divided into two parts; a trickle rate (1-5 mA) that is always on, and a voltage-dependent charger that supplies battery charge current up to 450 mA.

The trickle-charge or voltage-dependent charge mode will determine the total charge current. The first time through the cycle the charger will operate in the following sequence:

1. When battery voltage is below approximately 21 Vdc only the trickle rate is enabled.
2. When battery voltage rises above 21 Vdc, the charger will go into a bulk rate charge mode current of 450 mA maximum. The charge current will decrease gradually until the battery reaches approximately 27.2 Vdc.
3. When battery voltage reaches 27.2 Vdc, the charger reverts to the trickle rate. As the battery voltage falls below the float voltage the charger will supply anywhere from the trickle current up to 450 mA until the battery is fully charged.
4. In a normal steady-state mode, when the battery is fully charged (27.2 Vdc @ 25°C), there will only be a trickle current supplied to the battery.

Battery Charging with Portable Charger

If it is not possible to charge the battery with the control's built-in charger, a KA43ME7001 (120 Vac) portable bench type battery charger is available. Refer to *S280-79-14 KA43ME7001 Portable Lead Acid Battery Charger Instructions* for additional information.

CAUTION: Recloser misoperation. The control must be removed from service before disconnecting the control battery. Removing the control battery from an in-service control may cause recloser misoperation (unintentional operation). Failure to comply can result in equipment damage or personal injury.

T213.4

IMPORTANT: Do not attempt to charge a lead acid battery below 19 Vdc with the KA43ME7001 charger. Attempting to do so will damage the charger.

Charge the battery with a KA43ME7001 (120 Vac) portable charger as applicable:

1. Remove the control from service. Refer to **Remove the Control from Service** procedure within the **Testing and Troubleshooting** section of this manual.
2. Remove the battery from the control and carefully transport it to a suitable service facility.
3. Connect the battery directly to the KA43ME7001 charger. The charger continuously monitors the battery voltage.

Note: A red LED indicator on the body of the charger illuminates when charging.

The red LED blinks to indicate the battery has reached a full charge. This process can take up to 24 hours.

Battery Reference Information

Battery: Hawker Cyclon

Catalog Part #: KME4-215

Voltage: 24 Vdc

Type: Lead Acid

Amp/Hour: 8

Bench Test

Load Condition

for 5 seconds: 5Ω, 55 Watt

Acceptable

Voltage Drop at

End of Test Load: 3V or Less

Initial Programming Prior to Installation

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

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

Initial programming of the Form 4C control is the responsibility of a qualified technician or engineer who is familiar with the functions of the control and the programming parameters required for the specific recloser installation. The control can be programmed from the keyboard, data port, or a digital communications accessory.

Service Information S280-77-4 Form 4C Microprocessor-Based Recloser Control Programming Guide lists all access codes, program settings, and detailed operating descriptions of the code parameters. All control program settings, parameter descriptions, and programming access codes are also listed on the control information label located inside the cabinet door.

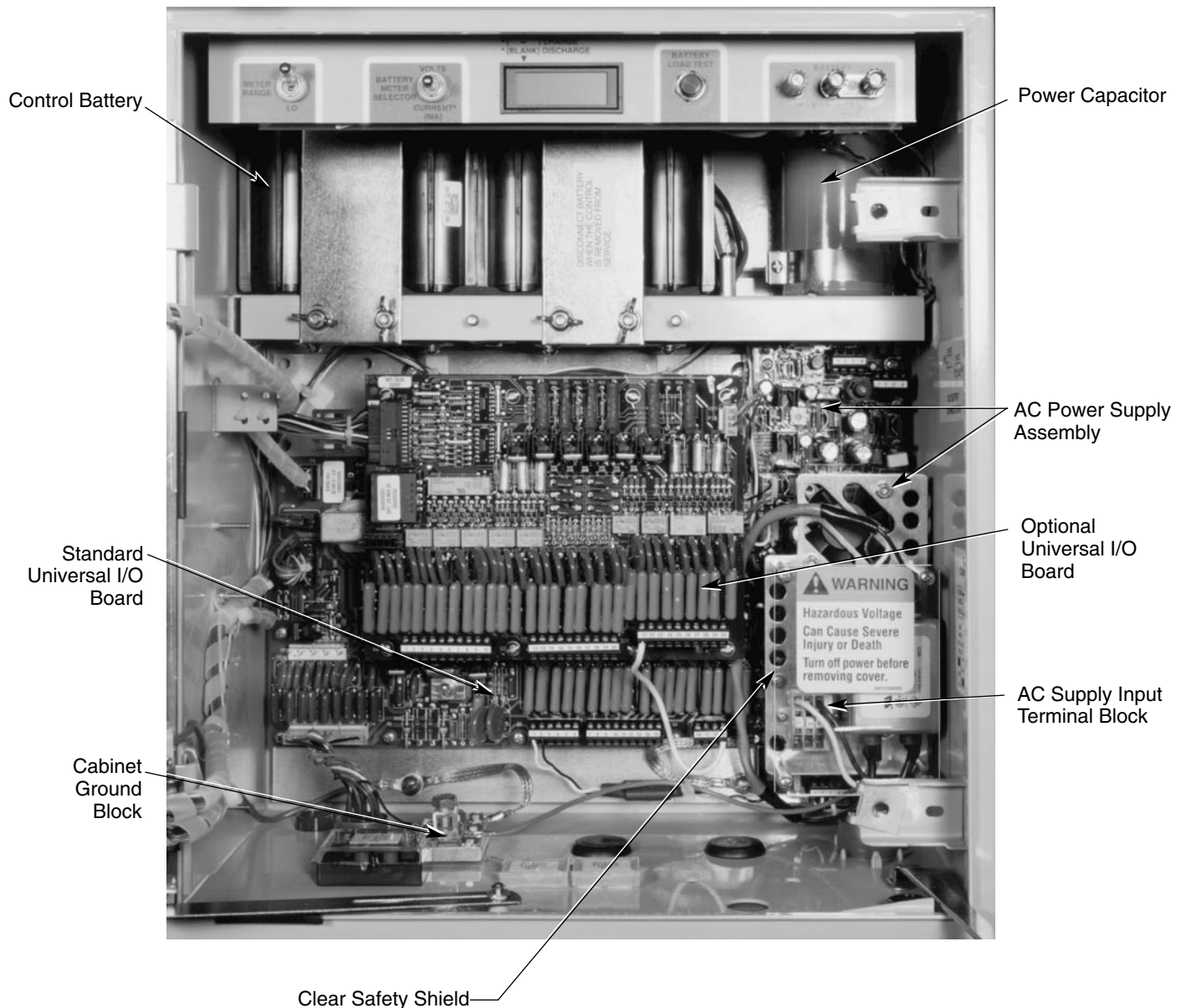
Control Security

The Form 4C control has a security system which limits access to only those control functions appropriate to the operator's responsibilities, and requires the keyboard entry of a four-digit security code. It prohibits unauthorized access to programming and operating parameters. Interrogation of the control to display operating parameters and read-only functions of the control does not require entering a security code.

Service Information S280-77-4 Programming Guide lists all control program settings along with their keyboard access codes, and the security level required to make programming changes.

Control Back Panel

The control battery, cabinet heater, power supply, Standard Universal I/O board, and Optional Universal I/O board, are located inside the control cabinet on the back panel of the control as shown in Figure 9.



WARNING: Hazardous Voltage. Turn off power before removing safety shield. Failure to do so can result in contact with high voltage which will cause death or severe personal injury.

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Figure 9.
Inside back panel of Form 4C control shown with Automation Power Supply.

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Keyboard Functions

Prior to interrogation and programming, the operator should be familiar with the control's keyboard. Figure 10 shows each key and its description and operation.

<div>MINIMUM TRIP</div> <div>1</div> <p>Interrogates or programs minimum trip (Phase and Ground)</p> <p>"1" numeric value</p>	<div>TCC 1</div> <div>2</div> <p>Interrogates or programs 1st TCC (Phase and Ground)</p> <p>"2" numeric value</p>	<div>TCC 2</div> <div>3</div> <p>Interrogates or programs 2nd TCC (Phase and Ground)</p> <p>"3" numeric value</p>	<div>TARGETS</div> <div>TARGET COUNTERS</div> <p>Displays fault target information.</p> <p>Displays cumulative total of fault current trip operations for each phase and ground. (Used with SELECT LOWER FUNCTION key)</p>	<div>CURRENT METERING</div> <p>Displays Phase and Ground load current and demand meter readings.</p>	<div>DISPLAY ON</div> <div>OFF</div> <p>Turns keyboard and display ON and OFF.</p>
<div>OPER 1ST.TCC</div> <div>4</div> <p>Interrogates or programs number of trip operations on 1st TCC (Phase and Ground)</p> <p>"4" numeric value</p>	<div>OPER. TO L.O.</div> <div>5</div> <p>Interrogates or programs number of operations to lock-out (Phase and Ground)</p> <p>"5" numeric value</p>	<div>RESET TIME</div> <div>6</div> <p>Interrogates or programs reset after successful reclose delay time.</p> <p>"6" numeric value</p>	<div>OPER. COUNTER</div> <div>SEQUENCE POSITION</div> <p>Displays total number of control trip operations.</p> <p>Displays control operating sequence position. (Used with SELECT LOWER FUNCTION key)</p>	<div>CODE</div> <p>Provides direct entry of access codes</p>	<div>CLEAR</div> <p>Clears pending keyboard entries; resets targets, counters and demand drag hand.</p>
<div>RECLOSE 1</div> <div>7</div> <p>Interrogates or programs reclosing time after 1st trip operation.</p> <p>"7" numeric value</p>	<div>RECLOSE 2</div> <div>8</div> <p>Interrogates or programs reclosing time after 2nd trip operation.</p> <p>"8" numeric value</p>	<div>RECLOSE 3</div> <div>9</div> <p>Interrogates or programs reclosing time after 3rd trip operation.</p> <p>"9" numeric value</p>	<div>SELECT ACCESSORY</div> <p>Displays status of individual control features with programmable values.</p>	<div>ACCESSORY SCROLL</div> <p>Displays individual parameters of programmable control features and accessories.</p>	<div>CHANGE</div> <p>Initiates change to programmed parameter.</p>
<div>PHASE</div> <div>GROUND</div> <p>Toggles between Phase and Ground Display</p>	<div>DISPLAY TEST</div> <div>0</div> <p>Checks LCD operation by displaying all numeric segments and messages.</p> <p>"0" numeric value</p>	<div>SCROLL</div> <p>Permits display of the programmed values of most common control operating features.</p>	<div>SELECT LOWER FUNCTION</div> <p>Provides access to Target Counters and Sequence Position</p>	<div>ESCAPE</div> <p>Escape key ignores recent keystroke and returns to ready (rdY) prompt.</p>	<div>ENTER</div> <p>Enters changed parameter into program.</p>

Figure 10.
Keyboard functions.

Interpreting the LCD Displays

During interrogation and programming, the LCD displays provide a readout of all keyboard operations (Figure 11). The left display shows the program access code entered and indicates whether the control is in the **EXAMINE**, **SCROLL**, or **CHANGE** mode. **PHASE** or **GROUND** will appear if the parameter has a phase or ground value. The right display will show a parameter value up to four digits.

EXAMINE indicates that the displayed access code is being interrogated.

SCROLL indicates the **SCROLL** key can be used to obtain additional information.

CHANGE indicates the displayed access code is being changed.

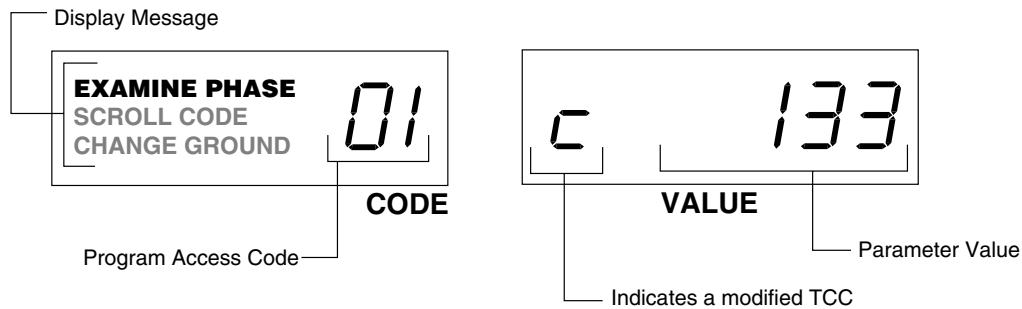


Figure 11.
Interpreting the LCD display.

INSTALLATION PROCEDURE

Control / Recloser Compatibility

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 4C control is designed for use with reclosers equipped with Type B current-sensing transformers, reclosers retrofitted with Form 4C controls should also be retrofitted with Type B current transformers at the next maintenance interval. All reclosers manufactured since 1989 are equipped with Type B (1000:1, 1000/500:1, or 2000:1) sensing CT's.

Reclosers equipped with Type B sensing CT's are compatible with all Kyle recloser controls (Form 2, Form 3, Form 3A, Form 4A and Form 4C controls), and are identified with the following label prominently displayed on the recloser sleet hood or the front of the operator cabinet:

NOTICE
<p>RECLOSER IS EQUIPPED WITH TYPE B SENSING CT'S.</p> <p>RECLOSER DOES NOT HAVE A BATTERY CHARGER.</p>

The Form 4C control can be used with the old-style Type A CT's; 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 CT's are available to upgrade existing families of reclosers for operation with Form 4C controls. For additional information, contact your Cooper Power Systems representative.

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

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

Mounting the Control

The Form 4C recloser control should be mounted at a convenient, accessible location.

- For pole-mounted installation, a hole and keyway in the control mounting bracket accommodates a 5/8" bolt.
- For substation installation, brackets are available as an accessory for mounting the control to a substation frame.

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
<p>All VSA reclosers are equipped with Type A Sensing CTs.</p> <p>All VSML reclosers are equipped with Type A Sensing CTs.</p> <p>All VSA12, VSA12B, VSA16, VSA20, VSA20A, and VSA20B reclosers are equipped with Type B Sensing CTs.</p>	

Limits on control cable length are determined by the maximum distance between the control and recloser: Solenoid-operated, motor-operated and NOVA™ reclosers have different maximum distances.

- Up to 35* feet for motor-operated reclosers (VSA12, VSA12B, VSA16, VSA20, VSA20A, VSO12, VSO16).
- Up to 125* feet for solenoid-operated reclosers (VWE, VWVE27, VWVE38X, WE, WVE27, WVE38X).
- Up to 125* feet for NOVA™ reclosers (auxiliary-powered NOVA, control-powered NOVA).

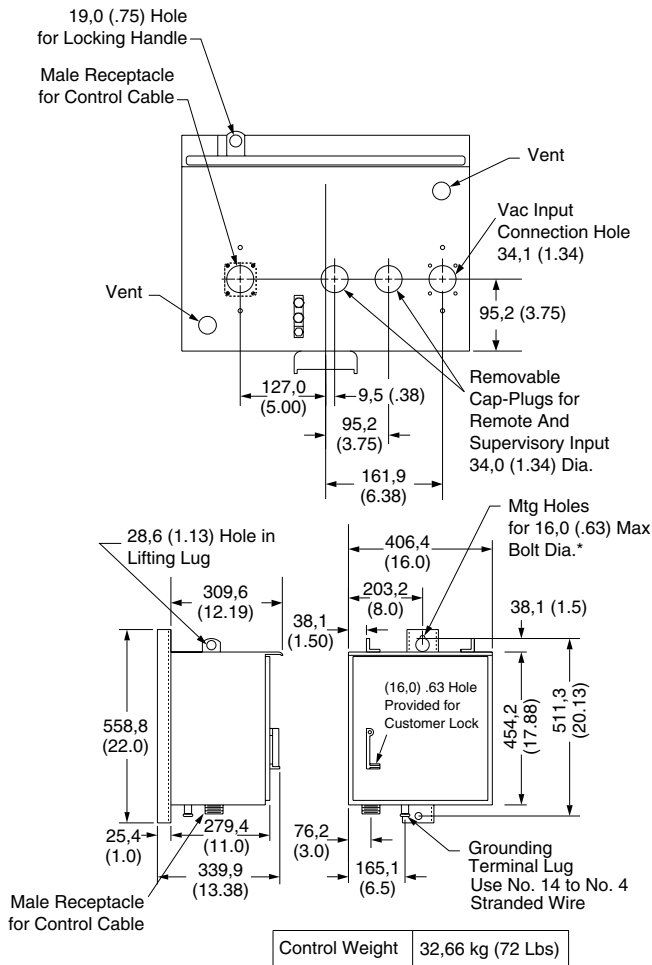
* Consult your Cooper Power Systems representative if longer cable lengths are required.

Outline, mounting, and knockout dimensions for single- and double-size control cabinets are shown in Figures 12 and 13.

Control Cable

The control cable is fabricated with connectors which mate with the female receptacle of the recloser on one end, and the male receptacle of the control on the other end.

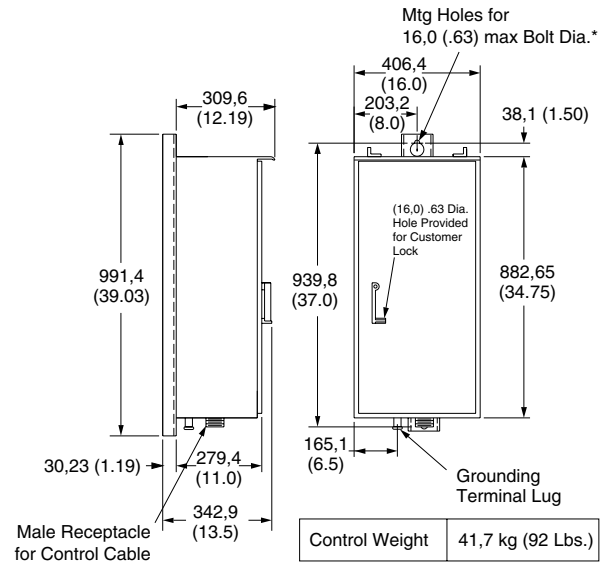
Note: The control cable must be supported along its length to prevent repeated movement due to wind or other outside forces which can damage the cable.



* Customer provided hardware

NOTE: Unless otherwise specified, all dimensions are mm (inches).

Figure 12.
Single-size cabinet mounting dimensions.



* Customer provided hardware

NOTE: Unless otherwise specified, all dimensions are mm (inches).

Figure 13.
Double-size cabinet mounting 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 control cabinet must be grounded. A grounding connector on the underside of the cabinet will accommodate No. 14 solid through No. 4 stranded conductors. Suggested methods for grounding the control and recloser are shown in Figures 14, 15 and 16.

It is important for effective surge protection that all control and power conductors for the Form 4C be routed parallel to a corresponding ground path. For example, the ac power supply for the control should be parallel to and equal in length to the transformer ground path. The control cable should be parallel to and routed close to the recloser ground path.

IMPORTANT: All external inputs to the Form 4C 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.

Grounding: 4-wire Multi-Grounded, Impedance Grounded, 3-wire Ungrounded with Local Supply Transformer

Installation of the control must include the following:

- Protection of the recloser bushings and the supplying transformer with lightning arresters
- Grounding of the recloser head
- Grounding of the transformer tank
- Grounding of the control cabinet
- Grounding of the SCADA equipment (if present)

For 4-wire Multi-Grounded Systems

IMPORTANT: In pole-mounted applications, a ground connection must be made between the recloser, transformer, recloser control, and SCADA equipment for proper protection of the equipment. The pole ground conductor size (current carrying capacity) should be the same or greater than the primary overhead conductor.

For 3-wire Ungrounded and Impedance Grounded Systems

The use of a grounding mat may be required depending upon the local safety regulations defining the permissible step and touch potential levels. Consult local regulations for proper grounding procedures.

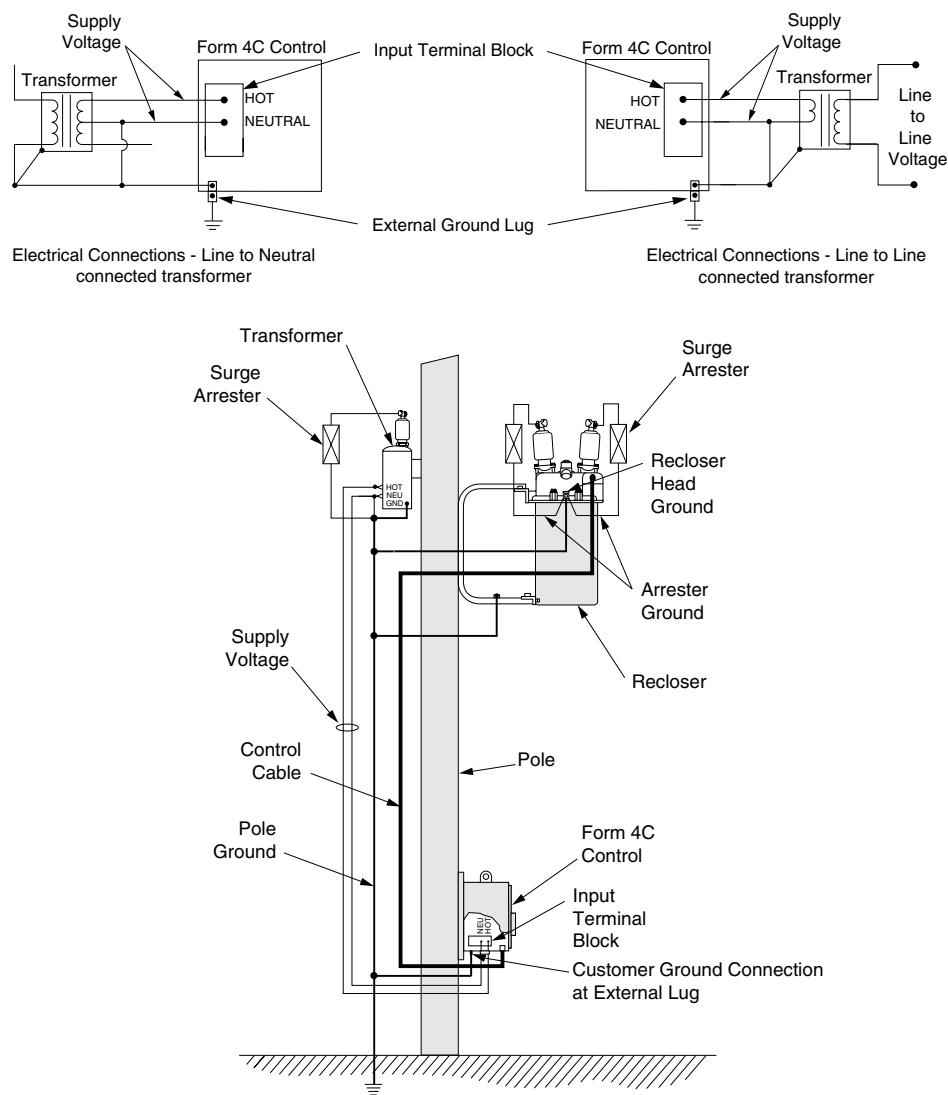


Figure 14. Recommended grounding method for Form 4C Control installed on 4-wire multi-grounded, impedance grounded, or 3-wire ungrounded systems with local supply transformer.

Grounding: 4-wire Multi-grounded, Impedance Grounded, 3-wire Ungrounded with Remote Supply Voltage Transformer

Installation of the control must include the following:

- Protection of the recloser bushings and the supplying transformer with lightning arresters
- Grounding of the recloser head
- Grounding of the transformer tank
- Grounding of the control cabinet
- Grounding of the SCADA equipment (if present)

IMPORTANT: In pole-mounted applications, a ground connection must be made between the recloser, transformer, recloser control, and SCADA equipment for proper protection of the equipment. The pole ground conductor size (current carrying capacity) should be the same or greater than the primary overhead conductor.

IMPORTANT: All external inputs to the Form 4C 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.

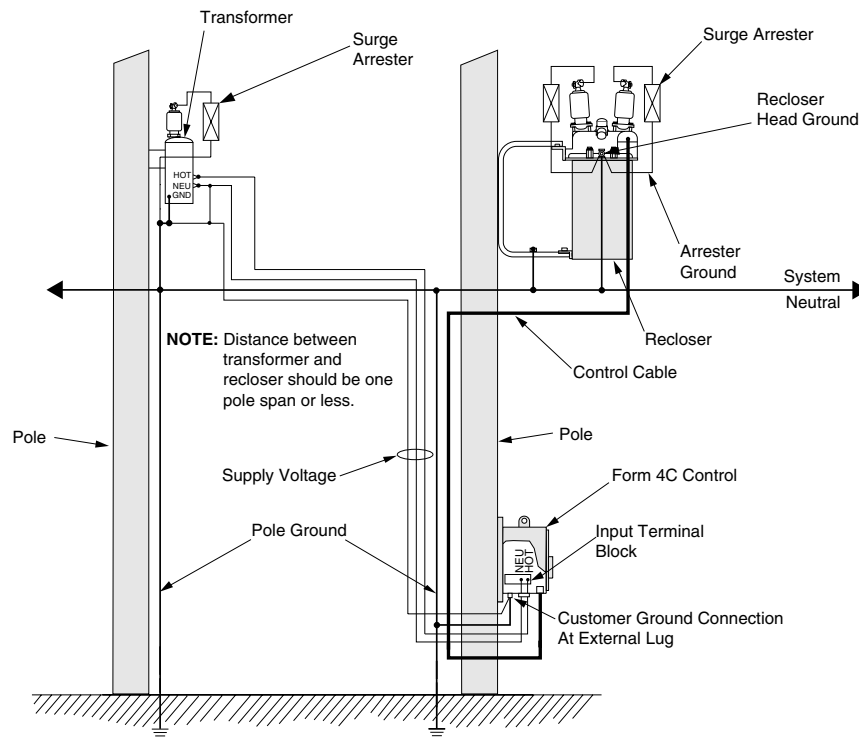
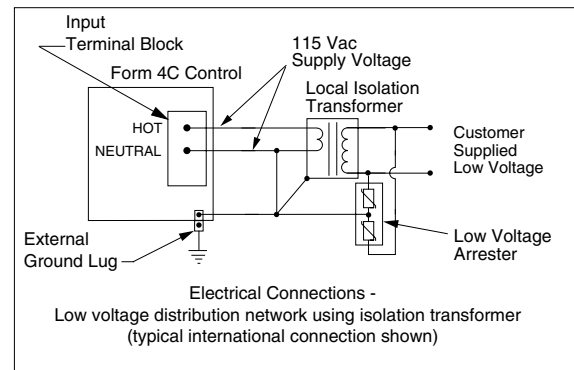
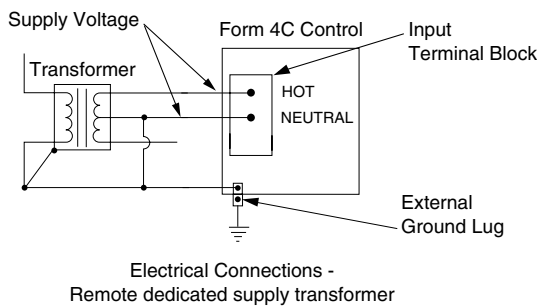


Figure 15. Recommended grounding method for Form 4C Control installed on 4-wire multi-grounded, impedance grounded, or 3-wire ungrounded systems with remote supply voltage transformer.

Grounding: 3-wire Uni-Grounded

Installation of the control must include the following:

- Protection of the recloser bushings and the supplying transformer with lightning arresters
- Grounding of the recloser head
- Grounding of the transformer tank
- Grounding of the control cabinet
- Grounding of the SCADA equipment (if present)

WARNING: Hazardous Voltage. Use locally approved operator safety procedures for proper insulation when maintaining this equipment. High Voltage step and touch potential is characteristic in uni-ground systems. Failure to comply can cause death or severe personal injury.

T262.0

CAUTION: Exported Potential. Do not make direct electrical connections to remote devices. All SCADA equipment must be mounted locally or connected using the fiber-optic or radio communication accessory. Direct connections to remote devices can produce exported potential causing equipment damage or personal injury.

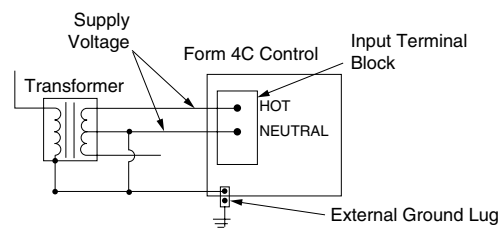
T263.0

CAUTION: Hazardous Voltage. Do not use a shared low voltage network to power the control unless specifically designed to withstand maximum ground potential rise. Ground faults on a high voltage network can create a rise in ground potential.

T264.0

IMPORTANT: In pole-mounted applications, a ground connection must be made between the recloser, transformer, recloser control, and SCADA equipment for proper protection of the equipment. The pole ground conductor size (current carrying capacity) should be the same or greater than the primary overhead conductor.

IMPORTANT: All external inputs to the Form 4C 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.



Electrical Connections - Line to Neutral connected transformer

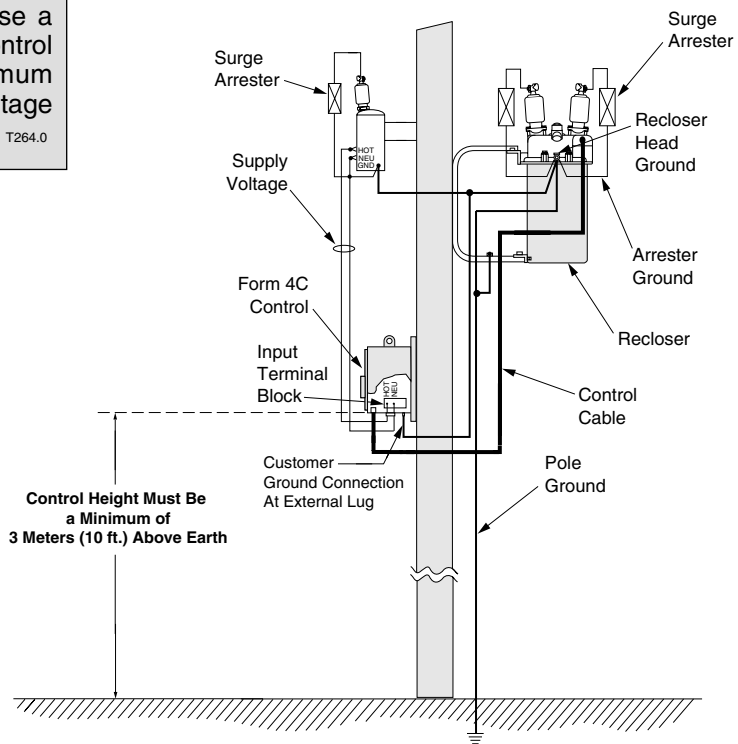


Figure 16.
Recommended grounding method for Form 4C Control installed on a 3-wire uni-grounded system.



Customer Connections for AC Power

All Form 4C controls not supplied with a dc-dc supply adapter require customer-supplied ac power for operation. Ac voltage of 120/240 Vac@50/60 Hz is required for proper operation of the power supply and control. Power to the control is provided via the ac power supply which is factory configured for either 120 or 240 volt operation. The maximum operating current requirement for the control is approximately 2.5 amps.

Customer furnished ac power leads are brought into the control through a knockout hole in the bottom right side of the control cabinet. Input leads are terminated at the ac input terminal block TB (see Figure 9) of the power supply located behind the plastic safety shield in the lower right-hand corner of the back panel of the control cabinet.

The ac power supply input terminal (Figure 17) enables connection of either 120 Vac or 240 Vac source voltage. Power supply input voltage selector switch SW-1(Figure 17) allows selection of either 115 or 230 Vac input voltages.

Selector switch SW2 (Figure 17) establishes the threshold voltage used to monitor and detect the loss of AC line voltage. The threshold reference is approximately 80% of the selected nominal voltage. Selectable values of 110/220, 120/240 and 127/254 Vac enables monitoring of local values common to most domestic and international nominal voltages.

Refer to Figure 17 and 18 for connection diagrams. Ground the control cabinet to the pole through the external cabinet ground lug (Figure 12).

Note: It is not necessary to use shielded cable if the ac supply path is running next to the transformer ground path.

CAUTION: Equipment damage. Do not drill connection holes into the top of the cabinet. Connection holes in the top of the cabinet will allow moisture to seep into the control and damage the components or cause control misoperation. Failure to comply will void the control's factory warranty.

T249.0

Customer Connections for Remote and Supervisory Operation

Figure 18 shows customer connections for the 19-position Standard Universal I/O terminal block and for the 30-position Optional Universal I/O block. The terminal block connectors will accommodate conductor leads up to 12 AWG maximum. External lead resistance must not exceed 200 ohms.

IMPORTANT

Shielding and Surge Protection of Supervisory Cables

All supervisory operation and control monitor leads must be protected within shielded cables. For 120 Vac control power, the input voltage COMMON wire must be grounded at the source and connected to the Standard Universal I/O Terminal Block at Terminal 18 or 19. A single common wire can be used for multiple inputs if it is jumpered at the I/O board terminals. The cable shield must be grounded at the Form 4C control only, see Figure 19.

All remote operation and monitor leads must be protected with metal oxide varistors (MOV's) 320 Vac, 160 Joules, or equivalent (Figure 19).

CAUTION: Equipment damage; misoperation. External leads must be shielded and the shield must be grounded at both ends. Terminate each lead with a 320 Vac, 160 Joules metal oxide resistor (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.

G117.3

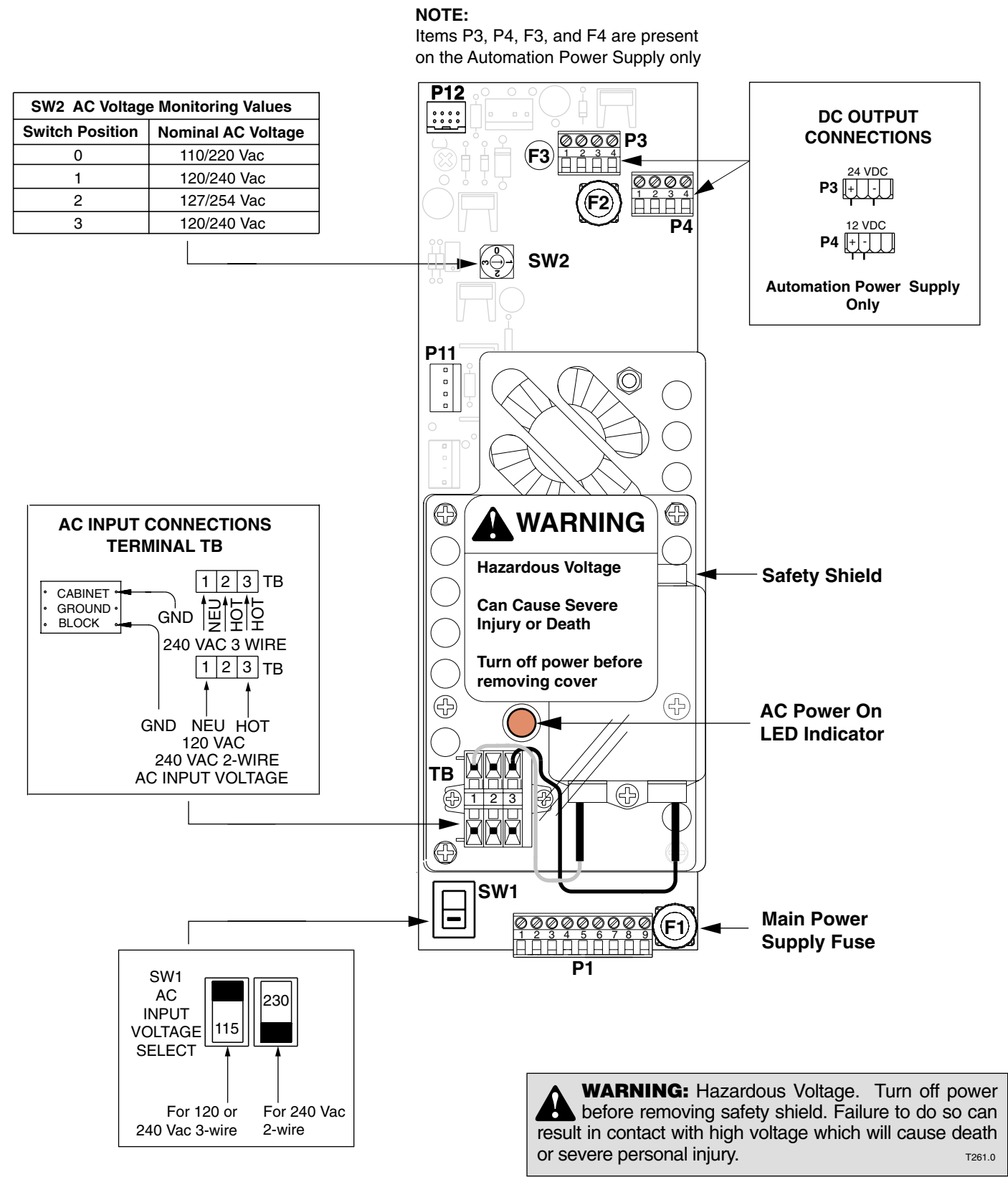
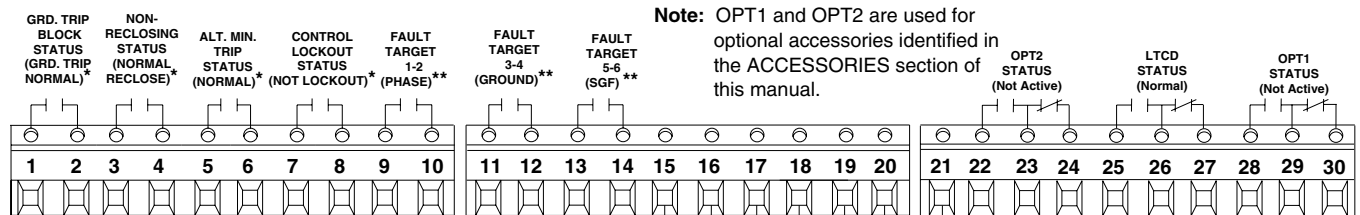
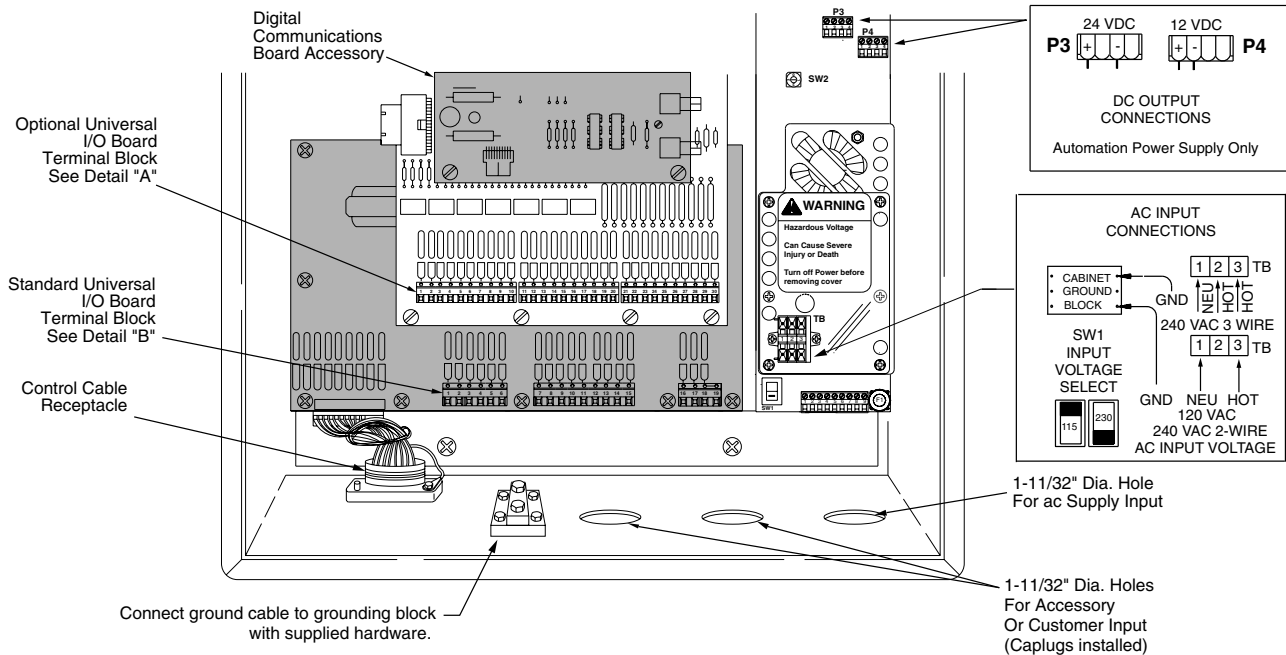


Figure 17.
Form 4C Power Supply Connections and Switch Settings

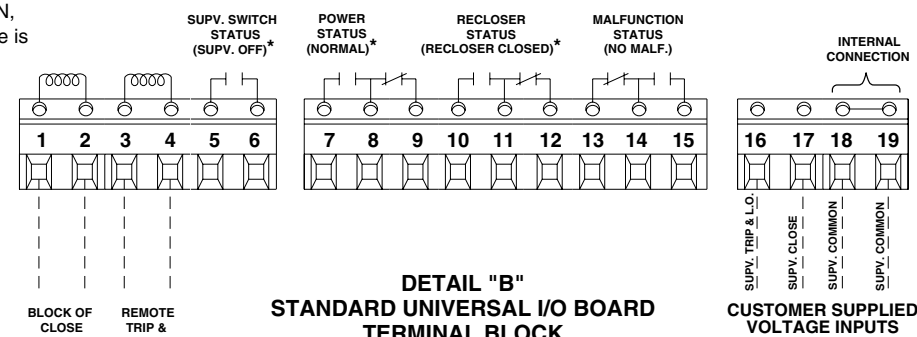


** Target Designation When Sensitive Ground/Earth Fault Is Enabled (Access Code 120)

† When SWITCH MODE firmware accessory is ON, Supervisory Non-Reclose is replaced by Supervisory Target Reset.

Note: OPT1 and OPT2 are used for optional accessories identified in the ACCESSORIES section of this manual.

Ratings Table For LTCD Status	
Input Voltage	Contact Rating
12 Vdc - 48 Vdc	4 A
125 Vdc	0.25 A
120 Vac - 240 Vac	4 A



CUSTOMER SUPPLIED VOLTAGE INPUTS

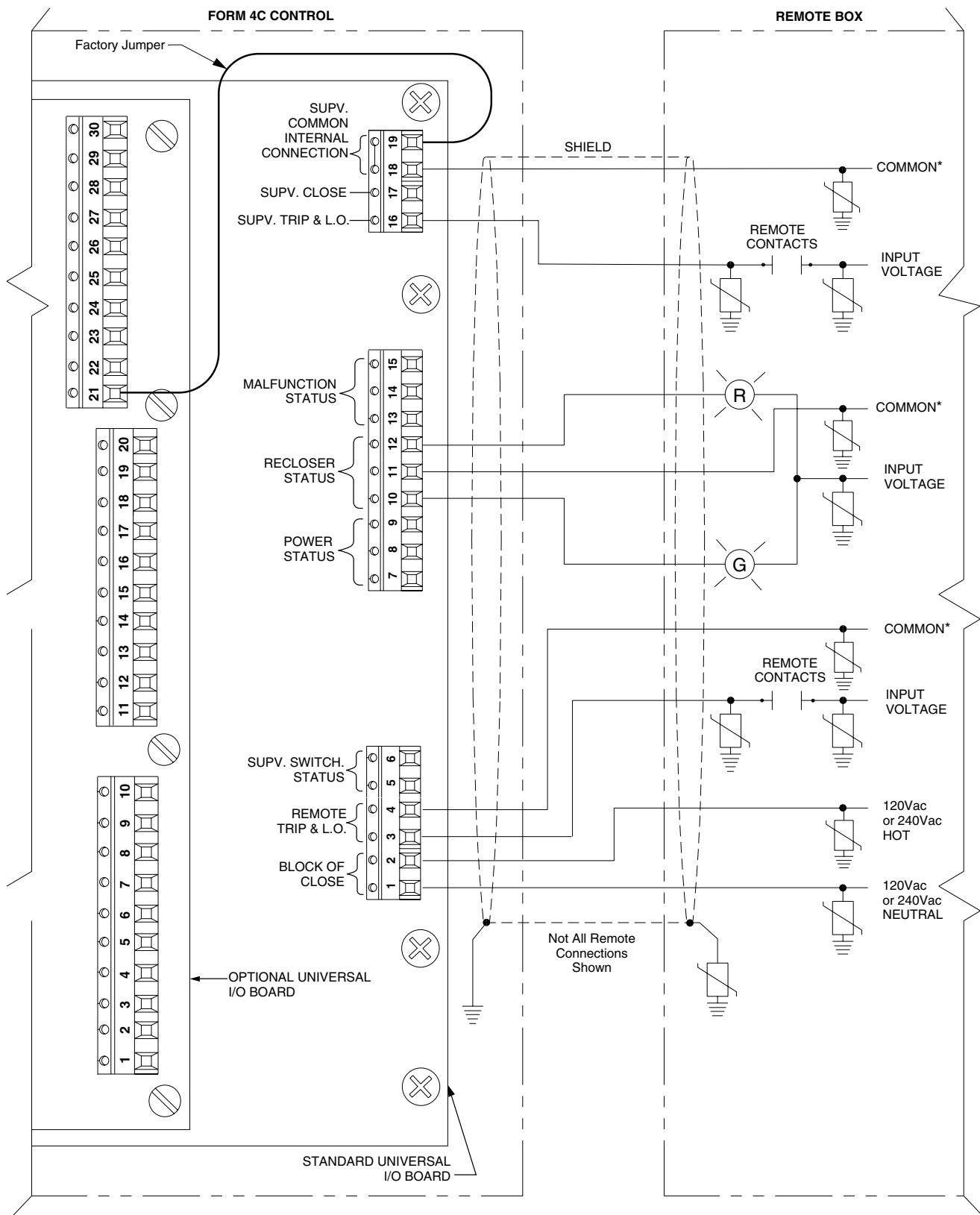
* Relay Contacts Shown For The Indicated Status

Ratings Table For Output Status Contacts	
Input Voltage	Contact Rating
120 Vac	1 A
12 Vdc	2 A
24 Vdc	2 A
48 Vdc	1 A
125 Vdc	0.6 A

Operating Current Requirements For Standard And Optional Supervisory Inputs		
Input Voltage	Nominal Current	Minimum Operating Time
12 Vdc - 125 Vdc	3 mA	0.25 seconds
120 Vac - 240 Vac		

Operating Current Requirements For Remote Trip And Lockout Input	
Input Voltage	Nominal Current
12 Vdc - 125 Vdc	3 mA
120 Vac - 240 Vac	

Figure 18.
Form 4C Control Customer Connections Diagram.



NOTES: Arresters to be metal oxide varistors (MOVs) 320 Vac, 160 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

Figure 19.
Shielding and Surge Protection for Supervisory and Remote Cables.

STANDARD UNIVERSAL I/O BOARD

The Form 4C control includes a Standard Universal I/O Board for supervisory and remote operation and indication.

The Standard Universal I/O Board requires customer provided power of 120-240 Vac or 12-125 Vdc for control operation. The Supervisory ON/OFF switch permits supervisory operation of the control. With the supervisory switch in the ON position, the supervisory close and the supervisory trip and lockout functions are operative. With the supervisory switch in the OFF position, supervisory operation is blocked. The control can be tripped or closed via the manual control switch, regardless of the position of the supervisory switch.

The supervisory switch can be in the ON or OFF position when making programming changes from the keyboard.

Customer connections to the Standard Universal I/O board are made to a 19 position terminal strip shown in Figures 18 and 19.

Block of Close

The Block of Close feature is used:

- To prevent the recloser from closing when closing power is lost.
- For supervisory dispersed generation applications.
- To disable closing functions for live-line work.
- Under any condition where the recloser must remain open even though it is under standard closing conditions.

The control will not reset while Block of Close is enabled, since reset timing begins only after reclosing, and then only if no fault current is present.

This feature is factory-installed and customer activated with a 120 or 240 Vac input. The Block of Close feature can be used to disable closing with 120 or 240 Vac applied or removed. See the **CUSTOMER OPTIONS FOR THE BLOCK OF CLOSE FEATURE** section of this manual for additional information.

Note: This feature is independent of the customer-provided power used with the Standard Universal I/O board.

Remote Trip and Lockout

Remote Trip and Lockout trips the recloser open and locks out the control. It functions independently of the position of the Supervisory ON/OFF switch and can be used for tripping from external relays and alarms.

A minimum signal duration of 0.25 second is required for the event recorder to record a supervisory trip command. The signal can be maintained to prevent closing.

Supervisory Switch Status Indicator

Supervisory Switch Status provides a closed contact when the SUPERVISORY ON/OFF switch is in the ON position.

Power Status Indicator

Power Status Indicator provides a dry contact to provide remote status indication when either of the following conditions exist:

- Low ac input (i.e.; below 90 Vac for 120 Vac).
- Low/high battery voltage (below 23.3 Vdc or above 32.4 Vdc).

Recloser Status Indicator

Recloser Status Indicator provides a dry contact that operates to indicate open or closed status of the recloser contacts.

Malfunction Indicator

Malfunction Indicator provides a dry contact to provide remote status indication when one of the following malfunctions is detected:

- Failure to close from a supervisory signal.
- Low/High battery voltage.
- Power down in less than 48 hours on battery power.
- Failure to close from the manual control switch.
- Internal diagnostics alarm.

Supervisory Trip and Lockout

Supervisory Trip and Lockout trips the recloser open and locks out the control. The control remains locked out until it is closed manually or by the supervisory close feature. A minimum signal of 0.25 second duration is required.

Supervisory Close

Supervisory Close initiates a closing signal to the recloser and modifies the operating sequence to one trip to lockout on TCC2 for a selected time interval (Access Code 12). This is known as Cold-Load pickup. After the adjustable reset time interval has elapsed, the control returns to its programmed sequence of operations. A momentary signal (minimum of 0.25 seconds duration) is required for proper operation.

To disable supervisory cold-load pickup, set Access Code 12 to zero seconds.

CUSTOMER OPTIONS FOR THE BLOCK OF CLOSE FEATURE

The Block of Close feature can be used with or without a 120 Vac or 240 Vac input. Figure 20 shows the factory wiring for the feature from the Block of Close terminals on the Standard Universal I/O Board to the AC Supply Input Terminal Block.

120 Vac Operation

Block of Close can be selected with or without 120 Vac energizing the feature (Figure 20), and is independent of the customer-provided power used with the Standard Universal I/O board.

240 Vac Operation

To use Block of Close with 240 Vac, cut jumper J4 (Figure 20). Procedures for 120 Vac and 240 Vac operation are identical.

Block of Close While De-Energized

If the control is in the *Block of Close While De-Energized* mode, a 120 Vac (or 240 Vac) power source must be connected to the feature's voltage input terminals in order for the recloser to close. Refer to Figure 20 for the factory wiring of the feature.

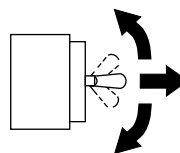
Block of Close While De-Energized is activated with the Block of Close switch in the *UP* position.

Block of Close While Energized

Block of Close While Energized is activated with the Block of Close switch in the *DOWN* position. The Block of Close terminals interrupt the closing circuit when 120 Vac (or 240 Vac) is applied.

Inactive Block of Close

The Block of Close feature is *inactive* with the Block of Close switch in the *CENTER* position.



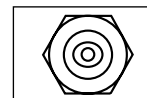
To operate the Block of Close Switch, pull the switch out and move upward or downward per application need.



Block of Close switch shown in *UP* position to activate Block of Close While *De-Energized*.



Block of Close switch shown in *DOWN* position to activate Block of Close While *Energized*.



Block of Close switch shown in *CENTER* position for *Inactive* Block of Close.

CAUTION: Equipment damage. Jumper J4 must be cut for 240 Vac operation of Block of Close. Failure to do so will damage the Standard Universal I/O Board.

T303.0

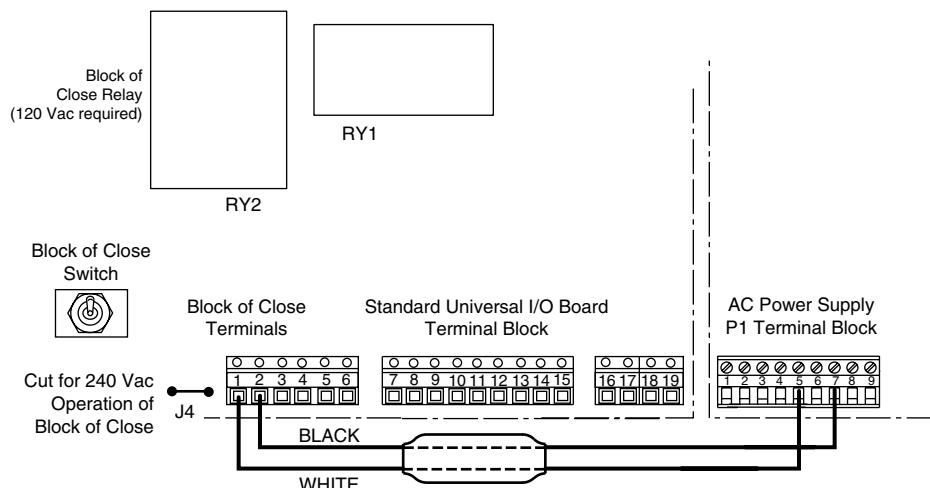


Figure 20.
Wire Connection Diagram for Block of Close feature on the Standard Universal I/O Board.

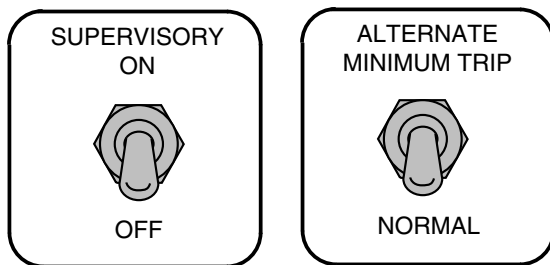
ALTERNATE MINIMUM TRIP OPERATION

(All CPU Firmware Versions)

Alternate Minimum Trip Operation vs Supervisory ON/OFF Switch Position

Alternate Minimum Trip is activated locally by the front panel toggle switch or via SCADA. Supervisory operation is dependent upon the positions of the front panel ALTERNATE MINIMUM TRIP and SUPERVISORY ON/OFF switches.

Supervisory Alternate Minimum Trip is actuated by a customer supplied signal of 12 Vdc-125 Vdc or 120 Vac-240 Vac for as long as the signal is maintained when Access Code 26 (Supervisory via Momentary Contact) is OFF. Supervisory Alternate Minimum Trip is toggled ON or OFF by successive momentary pulses when Access Code 26 is ON. Minimum pulse width duration is 0.25 second.



Tables 2 and 3 show the effect of the Supervisory ON/OFF switch and the Alternate Minimum Trip switch on standard controls and on controls equipped with the Optional Universal I/O board, which includes the supervisory alternate minimum trip contacts.

TABLE 2
Minimum Trip Operation on Controls without the Optional Universal I/O Board.

Front Panel Alternate Minimum Trip Switch Position	Front Panel Supervisory Switch Position	Minimum Trip Operation
NORMAL	ON	Normal Minimum Trip
NORMAL	OFF	Normal Minimum Trip
ALTERNATE	ON	Alternate Minimum Trip
ALTERNATE	OFF	Alternate Minimum Trip

TABLE 3
Minimum Trip Operation On Controls with the Optional Universal I/O Board.

Front Panel Alternate Minimum Trip Switch Position	Front Panel Supervisory Switch Position	Supervisory Alternate Minimum Trip Signal	Minimum Trip Operation
NORMAL	ON	NORMAL	Normal Minimum Trip
NORMAL	ON	ALTERNATE	Alternate Minimum Trip
ALTERNATE	ON	NORMAL	Alternate Minimum Trip
ALTERNATE	ON	ALTERNATE	Alternate Minimum Trip
NORMAL	OFF	NORMAL	Normal Minimum Trip
NORMAL	OFF	ALTERNATE	Normal Minimum Trip
ALTERNATE	OFF	NORMAL	Alternate Minimum Trip
ALTERNATE	OFF	ALTERNATE	Alternate Minimum Trip

NON-RECLOSING OPERATION

(All CPU Firmware Versions)

Non-Reclosing Operation vs Supervisory ON/OFF Switch Position

Non-Reclosing is activated locally by the front panel toggle switch or via SCADA. Supervisory operation is dependent upon the positions of the front panel NON-RECLOSING and SUPERVISORY ON/OFF switches.

Supervisory Non-Reclosing is actuated by a customer supplied signal of 12 Vdc-125 Vdc or 120 Vac-240 Vac for as long as the signal is maintained when Access Code 26 (Supervisory via Momentary Contact) is OFF. Supervisory Non-Reclosing is toggled ON or OFF by successive momentary pulses when Access Code 26 is ON. Minimum pulse width duration is 0.25 second.

Tables 4 and 5 show the effect of the Supervisory ON/OFF switch and the Non-Reclosing switch on standard controls and on controls equipped with the Optional Universal I/O board, which includes the supervisory non-reclosing contacts.

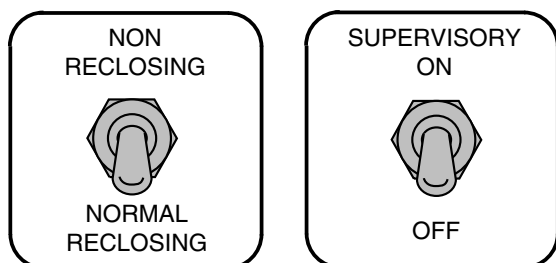


TABLE 4
Reclosing Operation on Controls without the Optional Universal I/O Board.

Front Panel Non-Reclosing Switch Position	Front Panel Supervisory Switch Position	Reclosing Operation
NORMAL RECLOSING	ON	Normal Reclosing
NORMAL RECLOSING	OFF	Normal Reclosing
NON-RECLOSING	ON	Non-Reclosing
NON-RECLOSING	OFF	Non-Reclosing

TABLE 5
Reclosing Operation On Controls with the Optional Universal I/O Board.

Front Panel Non-Reclosing Switch Position	Front Panel Supervisory Switch Position	Supervisory Non-Reclosing Signal	Reclosing Operation
NORMAL RECLOSING	ON	NORMAL RECLOSING	Normal Reclosing
NORMAL RECLOSING	ON	NON-RECLOSING	Non-Reclosing
NON-RECLOSING	ON	NORMAL RECLOSING	Non-Reclosing
NON-RECLOSING	ON	NON-RECLOSING	Non-Reclosing
NORMAL RECLOSING	OFF	NORMAL RECLOSING	Normal Reclosing
NORMAL RECLOSING	OFF	NON-RECLOSING	Normal Reclosing
NON-RECLOSING	OFF	NORMAL RECLOSING	Non-Reclosing
NON-RECLOSING	OFF	NON-RECLOSING	Non-Reclosing

GROUND TRIP BLOCK OPERATION (All CPU Firmware Versions)

Ground Trip Block Operation vs Supervisory ON/OFF Switch Position

Ground-Trip Block is activated locally by the front panel toggle switch or via SCADA. Supervisory operation is dependent upon the positions of the front panel GROUND TRIP BLOCK and SUPERVISORY ON/OFF switches.

Supervisory Ground Trip Block is actuated by a customer supplied signal of 12 Vdc-125 Vdc or 120 Vac-240 Vac for as long as the signal is maintained when Access Code 26 (Supervisory via Momentary Contact) is OFF. Supervisory ground Trip Block is toggled ON or OFF by successive momentary pulses if Access Code 26 is ON. Minimum pulse width duration is 0.25 second.

Tables 6 and 7 show the effect of the Supervisory ON/OFF switch and the Ground Trip Block switch on standard controls and on controls equipped with the Optional Universal I/O board which include the Supervisory Ground Trip contacts.

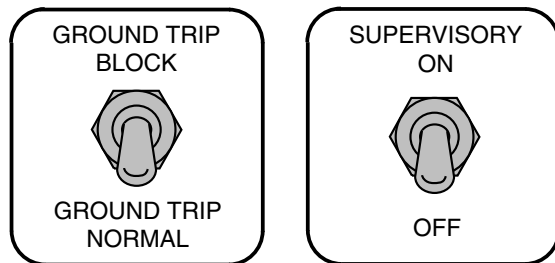


TABLE 6
Ground Trip Operation on Controls without the Optional Universal I/O Board.

Front Panel Ground Trip Block Switch Position	Front Panel Supervisory Switch Position	Ground Trip Operation
GROUND TRIP NORMAL	ON	Ground Trip Normal
GROUND TRIP NORMAL	OFF	Ground Trip Normal
GROUND TRIP BLOCK	ON	Ground Trip Block
GROUND TRIP BLOCK	OFF	Ground Trip Block

TABLE 7
Ground Trip Operation On Controls with the Optional Universal I/O Board.

Front Panel Ground Trip Block Switch Position	Front Panel Supervisory Switch Position	Supervisory Ground Trip Block Signal	Ground Trip Operation
GROUND TRIP NORMAL	ON	GROUND TRIP NORMAL	Ground Trip Normal
GROUND TRIP NORMAL	ON	GROUND TRIP BLOCK	Ground Trip Block
GROUND TRIP BLOCK	ON	GROUND TRIP NORMAL	Ground Trip Block
GROUND TRIP BLOCK	ON	GROUND TRIP BLOCK	Ground Trip Block
GROUND TRIP NORMAL	OFF	GROUND TRIP NORMAL	Ground Trip Normal
GROUND TRIP NORMAL	OFF	GROUND TRIP BLOCK	Ground Trip Normal
GROUND TRIP BLOCK	OFF	GROUND TRIP NORMAL	Ground Trip Block
GROUND TRIP BLOCK	OFF	GROUND TRIP BLOCK	Ground Trip Block

ACCESSORIES

Optional Universal I/O Board

The Optional Universal I/O Board is available for the Form 4C control to extend its supervisory operation capabilities. The Optional I/O board includes contacts to provide supervisory control and status indication of four additional control and recloser accessories, along with targets.

The supervisory control functions require customer-provided power of 120-240 Vac or 12-125 Vdc for operation and are controlled by the Supervisory ON/OFF switch.

Customer connections to the Optional Universal I/O board are made to the 30 position terminal strip shown in Figure 18, Detail A.

Supervisory status points for accessories available on CPU Firmware version 8.XX through 13.XX are located in either the OPT1 or OPT2 locations. Terminals 22 through 24 comprise OPT2 and terminals 28 through 30 comprise OPT1. Table 8 shows each accessory and its terminal location based on the CPU firmware.

Note: Terminal 19 is the contact point for supervisory command for OPT1. Terminal 20 is the contact point for supervisory command for OPT2.

TABLE 8
CPU firmware accessories.

Firmware Accessory	CPU Firmware (Access Code 72) Protocol 2179					
	8.15	9.15	10.15	11.15	12.15	13.15
Hot Line Tag	OPT2	OPT2	OPT2			
Trip On TCC2			OPT1	OPT2		OPT2
Sensitive Ground/Earth Fault ON/OFF		OPT1			OPT2	OPT1
Switch Mode	OPT1			OPT1	OPT1	

The Optional Universal I/O board also includes:

Ground Trip Block Status Indicator

The Ground Trip Block Status indicator provides a closed, dry contact to provide remote indication when the control is placed into the ground trip block mode from either the front panel Ground Trip Block switch or through supervisory control.

Non-Reclosing Status Indicator

The Non-Reclosing Status indicator provides a closed, dry contact to provide remote indication when the control is placed into the non-reclosing mode from either the front panel NON-RECLOSING switch or through supervisory control.

Alternate Minimum Trip Status Indicator

Alternate Minimum Trip Status indicator provides a closed, dry contact to provide remote indication when the control is placed into the alternate minimum trip mode from either the front panel ALTERNATE MINIMUM TRIP switch or through supervisory control.

Control Lockout Status Indicator

The Control Lockout Status indicator provides a closed, dry contact to provide remote indication of control lockout.

Remote Fault Target Indicator

Remote Fault Target Indicator provides separate dry contacts for remote indication of phase targets for bushings 1-2, 3-4 and 5-6. If Sensitive Ground/Earth Fault is ON, the contacts will indicate for phase, ground and Sensitive Ground/Earth Faults.

Supervisory Ground Trip Block

Supervisory Ground Trip Block provides supervisory operation of ground trip block by a remote momentary or maintained signal. Supervisory operation is dependent upon the positions of the front panel GROUND TRIP BLOCK and SUPERVISORY ON/OFF switches. Momentary (0.25 second minimum) or maintained signal mode is programmable using Access Code 26.

Supervisory Non-Reclosing

Supervisory Non-Reclosing provides supervisory non-reclosing input by a remote momentary or maintained signal. Supervisory operation is dependent upon front panel NON-RECLOSING and SUPERVISORY ON/OFF switch positions. Momentary (0.25 second minimum) or maintained signal mode is programmable using Access Code 26.

Supervisory Alternate Minimum Trip

Supervisory Alternate Minimum Trip provides selection of alternate programmed values for phase and ground minimum trip. This feature is activated by a remote momentary or maintained signal. Supervisory operation is dependent upon front panel ALTERNATE MINIMUM TRIP and SUPERVISORY ON/OFF switch positions. Momentary (0.25 second minimum) or maintained signal mode is programmable using Access Code 26.

Supervisory Trip

Supervisory Trip provides the ability to trip the recloser from a remote signal. Normal reclosing operations will follow. Operation is permitted only when the SUPERVISORY ON/OFF switch is ON. A momentary signal (minimum of 0.25 second) is required for proper operation.

Load Tap Change Disable (LTCD) Status Indicator

Load Tap Change Disable allows a regulator to ride through a multiple-shot recloser sequence without changing taps in an attempt to react to the recloser sequence. Load Tap Change Disable provides a Form C status contact which is activated at a trip signal and will remain active while in a reclosing sequence. The status contact resets when the control sequences to lockout or after the reset-after-reclose time delay elapses. The status contact is normally open and closes on an activated trip signal.

When a control is in SWITCH MODE (applicable to CPU Firmware version 8.XX, 11.XX, or 12.XX only), and senses an overcurrent condition, the LTCD status contact is activated as long as the overcurrent condition exists. Additionally, the LTCD status contact will remain active for the period of time programmed in Access Code 06 (Reset Time) following the overcurrent condition.

Hot Line Tag (Access Code 72)

CPU Firmware Versions 8.XX, 9.XX, and 10.XX

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 (HLT) disables and interrupts the close circuit. If the recloser is closed when HLT is activated, the recloser will trip on TCC1, with no reclosing operation permitted. Hot line Tag is activated by a momentary or maintained SCADA command, a serial command, or locally via a front panel switch. Hot Line Tag can only be reset by the source that activated it. Local activation can only be reset by the front panel switch. SCADA activation is reset via SCADA only.

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.

The Hot Line Tag indicator provides local indication and contacts for remote indication when the control is placed into the Hot Line Tag mode from either the front panel HOT LINE TAG switch, or supervisory control.

The Supervisory ON/OFF Switch has no control over Remote Hot Line Tag. Remote Hot Line Tag may be applied while the Supervisory ON/OFF switch is in either position.

Hot Line Tag is activated remotely by a customer-supplied voltage signal, dependent on Access Code 26 (Supervisory via Momentary Contacts). When Access Code 26 is OFF, Hot Line Tag is active as long as the customer-supplied voltage is present. When Access Code 26 is ON, Hot Line Tag is toggled ON or OFF by successive pulses. Minimum pulse width duration is 0.25 second. Hot Line Tag can also be activated via serial communications.

Hot Line Tag includes a CLOSE CIRCUIT DISCONNECT feature that provides visible disconnect in the close circuit. The pull-out cartridge can be removed as necessary.

On controls equipped with both Hot Line Tag and Trip On TCC2, Hot Line Tag takes precedence. This is valid independent of the Supervisory ON/OFF switch.

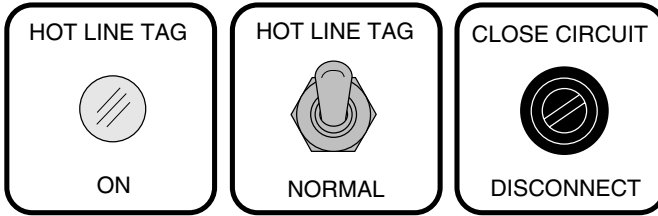
Hot Line Tag includes the following event in the event recorder:

Event Code 18: *Attempt to Close When Hot Line Tag is Active*

Table 9 shows the precedence of Hot Line Tag, Non-Reclose, and Trip On TCC2.

TABLE 9
Hot Line Tag Operation.

Front Panel Hot Line Tag Switch Position	Trip On TCC2 Signal	Non-Reclose Signal	Control Operation
NORMAL	ON	NORMAL Reclosing	All Trips on TCC2
NORMAL	ON	NON-RECLOSING	1-Trip on TCC2
NORMAL	OFF	NORMAL Reclosing	All Trips as programmed
NORMAL	OFF	NON-RECLOSING	1-Trip on TCC1
HOT LINE TAG	ON	NORMAL Reclosing	1-Trip on TCC1, closing blocked
HOT LINE TAG	ON	NON-RECLOSING	1-Trip on TCC1, closing blocked
HOT LINE TAG	OFF	NORMAL Reclosing	1-Trip on TCC1, closing blocked
HOT LINE TAG	OFF	NON-RECLOSING	1-Trip on TCC1, closing blocked

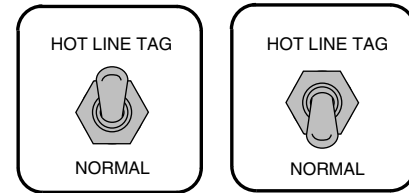


Testing the Hot Line Tag (HLT) Status Contact

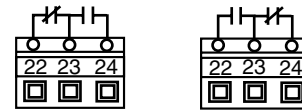
Note: Supervisory control must be disabled before testing.

1. Move the Hot Line Tag switch to the HOT LINE TAG position.
2. Connect ohmmeter probes to terminals 22 and 23. The ohmmeter must indicate a closed contact between these terminals.
3. Connect ohmmeter probes to terminals 23 and 24. The ohmmeter must indicate an open contact between these terminals.

4. Move the Hot Line Tag switch to the NORMAL position.
5. Connect the ohmmeter probes to terminals 23 and 24. The ohmmeter must indicate a closed contact between these terminals.
6. Connect the ohmmeter probes to terminals 22 and 23. The ohmmeter must indicate an open contact across these terminals.



OPT2*



*Applicable to CPU Firmware versions 8.XX, 9.XX, and 10.XX

Trip on TCC2

CPU Firmware Versions 10.XX, 11.XX, and 13.XX

Trip On TCC2 minimizes the amount of momentary outages on a distribution system by allowing an immediate change in the configuration as necessary. All trip operations occur on the TCC2 timing curve. The number of operations is based on the number of trip operations programmed on TCC2. Local indication is included on the front panel.

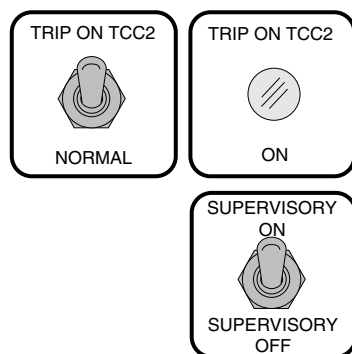
As an example, if the normal sequence on TCC1 (curve 101) is two operations, and TCC2 (curve 133) is two operations, operating the Trip On TCC2 accessory provides two trip operations on TCC2.

Trip On TCC2 does not take precedence over Hot Line Tag. Refer to the **Accessories** section on Hot Line Tag in this manual for operating relationships.

The Trip on TCC2 Status indicator provides a closed dry contact for remote indication when the control is placed into the Trip on TCC2 mode from either the front panel TRIP ON TCC2 switch or through supervisory control.

Trip On TCC2 is activated remotely by a customer-supplied voltage signal, dependent on Access Code 26 (Supervisory via Momentary Contacts). When Access Code 26 is OFF, Trip On TCC2 is active as long as the customer-supplied voltage is present. When Access Code 26 is ON, Trip On TCC2 is toggled ON and OFF by successive pulses. Minimum pulse width duration is 0.25 second. Trip On TCC2 can also be activated via serial communications.

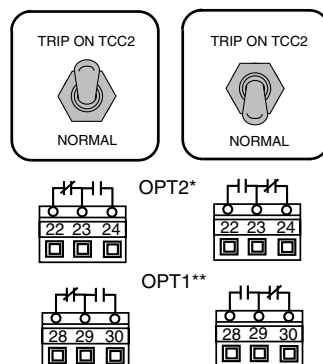
Table 10 shows the effect of the Supervisory ON/OFF switch and the Trip On TCC2 switch.



Testing the Trip on TCC2 Status Contact

Note: Supervisory control must be disabled before testing.

1. Move the Trip On TCC2 switch to the TRIP ON TCC2 position.
2. Connect ohmmeter probes to terminals (22 and 23 for OPT2 location, or terminals 28 and 29 for OPT1 location). The ohmmeter must indicate a closed contact between these terminals.
3. Connect ohmmeter probes to terminals (23 and 24 for OPT2 location, or terminals 29 and 30 for OPT1 location). The ohmmeter must indicate an open contact between these terminals.
4. Move the Trip On TCC2 switch to the NORMAL position.
5. Connect ohmmeter probes to terminals (23 and 24 for OPT2 location, or terminals 29 and 30 for OPT1 location). The ohmmeter must indicate a closed contact between these terminals.
6. Connect ohmmeter probes to terminals (22 and 23 for OPT2 location, or terminals 28 and 29 for OPT1 location). The ohmmeter must indicate an open contact between these terminals.



* Applicable to CPU Firmware versions 11.XX and 13.XX

**Applicable to CPU Firmware version 10.XX

TABLE 10
Trip On TCC2 Operation.

Front Panel Trip On TCC2 Switch Position	Front Panel Supervisory Switch Position	Supervisory Trip On TCC2 Signal	Trip On TCC2 Operation Mode
NORMAL	ON	NORMAL	Normal
NORMAL	ON	TRIP ON TCC2	Trip On TCC2
TRIP ON TCC2	ON	NORMAL	Trip On TCC2
TRIP ON TCC2	ON	TRIP ON TCC2	Trip On TCC2
NORMAL	OFF	NORMAL	Normal
NORMAL	OFF	TRIP ON TCC2	Normal
TRIP ON TCC2	OFF	NORMAL	Trip On TCC2
TRIP ON TCC2	OFF	TRIP ON TCC2	Trip On TCC2

Sensitive Ground/Earth Fault (SGF) ON/OFF

CPU Firmware Versions 9.XX, 12.XX, and 13.XX

Sensitive Ground/Earth Fault (SGF) ON/OFF provides the capability to separate the activation of sensitive ground/earth fault from normal ground sensing. If Ground Trip is activated, SGF may or may not be activated, depending on the specific application. If Ground Trip is blocked, SGF is also blocked.

Sensitive Ground/Earth Fault is activated remotely by a customer-supplied voltage signal, dependent on Access Code 26 (Supervisory via Momentary Contacts). When Access Code 26 is OFF, SGF is active as long as the customer-supplied voltage is present. When Access Code 26 is ON, SGF is toggled ON and OFF by successive pulses. Minimum pulse width duration is 0.25 second. SGF can also be activated via serial communications.

Note: Access Code 120 is an enable/disable feature for SGF. If Access Code 120 is OFF, SGF is completely disabled (blocked).

Note: Setting SGF minimum trip or SGF alternate minimum trip to 100% disables SGF, regardless of the position of the toggle switch.

Table 11 shows the effect of the Supervisory ON/OFF switch and the SGF switch.

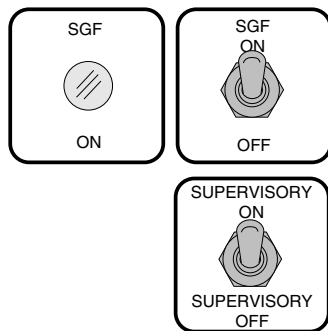


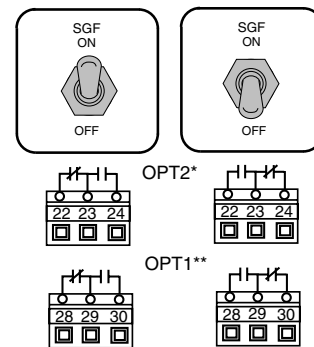
TABLE 11
Sensitive Ground/Earth Fault (SGF) ON/OFF Operation.

Front Panel SGF Switch Position	Front Panel Supervisory Switch Position	Supervisory SGF Signal	Keypad (Access Code 120)	SGF Operation Mode
ON	ON	ON	ON	ON
ON	ON	ON	OFF	OFF
ON	ON	OFF	ON	ON
ON	ON	OFF	OFF	OFF
ON	OFF	ON	ON	ON
ON	OFF	ON	OFF	OFF
ON	OFF	OFF	ON	ON
ON	OFF	OFF	OFF	OFF
OFF	ON	ON	ON	ON
OFF	ON	ON	OFF	OFF
OFF	ON	OFF	ON	OFF
OFF	ON	OFF	OFF	OFF
OFF	OFF	ON	ON	OFF
OFF	OFF	ON	OFF	OFF
OFF	OFF	OFF	ON	OFF
OFF	OFF	OFF	OFF	OFF

Testing the SGF Status Contact

Note: Supervisory control must be disabled before testing.

1. Move the SGF switch to the ON position.
2. Connect ohmmeter probes to terminals (22 and 23 for OPT2 location, or 28 and 29 for OPT1 location). The ohmmeter must indicate a closed contact between these terminals.
3. Connect ohmmeter probes to terminals (23 and 24 for OPT2 location, or 29 and 30 for OPT1 location). The ohmmeter must indicate an open contact between these terminals.
4. Move the SGF switch to the OFF position.
5. Connect ohmmeter probes to terminals (23 and 24 for OPT2 location, or 29 and 30 for OPT1 location). The ohmmeter must indicate a closed contact between these terminals.
6. Connect ohmmeter probes to terminals (22 and 23 for OPT2 location, or 28 and 29 for OPT1 location). The ohmmeter must indicate an open contact between these terminals.



* Applicable to CPU Firmware version 12.XX

**Applicable to CPU Firmware versions 9.XX and 13.XX

Switch Mode

CPU Firmware Versions 8.XX, 11.XX, and 12.XX

With the Switch Mode accessory, the Form 4C recloser control becomes a switch control providing indication of overcurrent conditions without issuing a overcurrent trip signal.

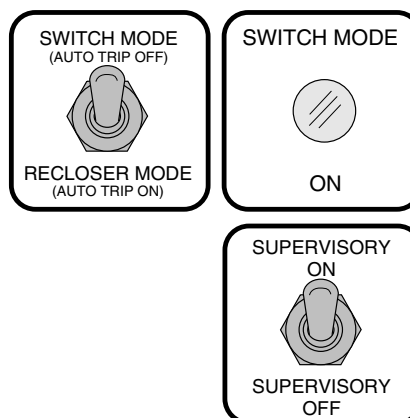
The Switch Mode accessory is a non-tripping, fault indication state initiated from the front panel as well as serial or discrete SCADA.

Switch Mode is activated remotely by a customer-supplied voltage signal, dependent on Access Code 26 (Supervisory via Momentary Contacts). When Access Code 26 is OFF, Switch Mode is active as long as the customer-supplied voltage is present. When Access Code 26 is ON, Switch Mode is toggled ON and OFF by successive pulses. Minimum pulse width duration is 0.25 second. Switch Mode can also be activated via serial communications.

The Switch Mode status indicator provides a closed dry contact for remote indication when the control is placed into the switch mode from either the front panel RECLOSER MODE/SWITCH MODE switch or through supervisory control.

Included as part of the switch mode are the following events in the event recorder:

- Event Type 14: *Fault Target Event* - Used in the Switch Mode when fault exceeds the time-current curve.
- Event Type 15: *Switch Mode* - Records the currents, date, and time when the control is set to Switch Mode.
- Event Type 16: *Recloser Mode* - Records the currents, date, and time when the control is set to Recloser Mode.



Three access codes have been developed to set both phase and ground target sensing for normal and alternate target sensing, and the selection of TCC1 and TCC2. The TCC modifiers are available in both the recloser or switch mode. Refer to Access Codes 190 through 192 in *Service Information S280-77-4, Form 4C Microprocessor-Based Recloser Control Programming Guide*.

The auto reset for the target indicators is controlled by Access Code 21 and the reset time is programmable via Access Code 6. They can also be reset via serial communications, or via the Optional Universal I/O board utilizing the Supervisory Non-Reclose contact.

The Sequence Position (Access Code 38) remains at “1” while in the Switch Mode during a target operation. The sequence position resets to zero upon reset.

Note: The Non-Reclose status output contact is disabled while the control is in the Switch Mode. The Non-Reclose function reverts to its previous state when the control is placed in the Recloser mode.

TABLE 12

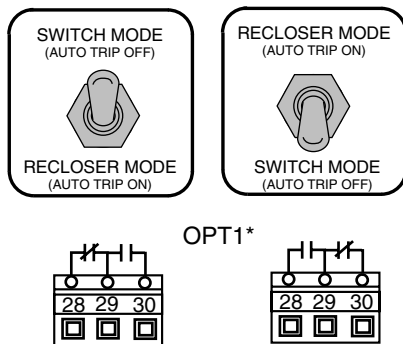
Switch Mode Operation On Controls with the Optional Universal I/O Board.

Front Panel Switch Position	Front Panel Supervisory ON/OFF Switch Position	Supervisory Position	Control Mode
RECLOSER MODE	ON	RECLOSER MODE	Recloser Mode
RECLOSER MODE	ON	SWITCH MODE	Switch Mode
SWITCH MODE	ON	RECLOSER MODE	Switch Mode
SWITCH MODE	ON	SWITCH MODE	Switch Mode
RECLOSER MODE	OFF	RECLOSER MODE	Recloser Mode
RECLOSER MODE	OFF	SWITCH MODE	Recloser Mode
SWITCH MODE	OFF	RECLOSER MODE	Switch Mode
SWITCH MODE	OFF	SWITCH MODE	Switch Mode

Testing the Switch Mode Status Contact

Note: Supervisory control must be disabled before testing.

1. Move the Switch Mode switch to the SWITCH MODE position.
2. Connect ohmmeter probes to terminals 28 and 29. The ohmmeter must indicate a closed contact between these terminals.
3. Connect ohmmeter probes to terminals 29 and 30. The ohmmeter must indicate an open contact between these terminals.
4. Move the Switch Mode switch to the RECLOSER MODE position.
5. Connect ohmmeter probes to terminals 29 and 30. The ohmmeter must indicate a closed contact between these terminals.
6. Connect ohmmeter probes to terminals 28 and 29. The ohmmeter must indicate an open contact between these terminals.



* Applicable to CPU Firmware version 8.XX, 11.XX, and 12.XX

BEFORE PLACING CONTROL AND RECLOSER INTO 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

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

1. Control properly mounted for the installation.
2. Recloser installed according to all locally approved standards and practices.
3. AC disconnect switches installed.
4. Control and recloser properly grounded in accordance with guidelines in this manual.
5. Control cable properly connected and supported.
6. Control battery connected and tested for proper operation.
7. Ac power connected to the control (ac supply LCD indicator is ON).
8. All control programming entered and verified by appropriate personnel.
9. Control clock set to the correct time. Refer to Access Code 153 in *Service Information S280-77-4 Form 4C Control Programming Guide*.
10. Customer connections for remote and supervisory operation checked and completed in accordance with shielding and surge protection instructions in this manual.

TESTING AND TROUBLESHOOTING

Testing and troubleshooting of the Kyle Type Form 4C control must be done after the control has been removed from service. This testing and troubleshooting section assists the control operator in:

- Testing the operation of the AC Supply Board and the Control Front Panel.
- Testing the operation of the Standard and Optional Universal I/O Boards
- Testing the operation of the Battery Test Panel
- Trip testing of Phases A, B, C, and Ground
- Testing Power and Malfunction Status operation

IMPORTANT: The Form 4C 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.

Level I: Testing an Installed Control

Three tests to determine initial operation of the Form 4C control can be performed while connected to an operating recloser. These are the only tests performed on an installed, operating control.

All other tests described in the **TESTING AND TROUBLESHOOTING** section require the Form 4C control be removed from service, connected to a bypassed recloser or tested at a location where the proper testing equipment is available.

Verify the Control is Energized

Open the front panel door of the control. Directly above and behind the ac Supply Input Terminal Block (see Figure 17) is an inspection port. Located behind the inspection port is an ac power-on LED indicator. Observation of the lit LED while sighting through the inspection port indicates the control is energized with ac power.

Verify Battery Operation

To test battery operation, follow the procedures described in the **Battery Test Procedure** section of this manual.

Verify LCD Display Operation

From the control front panel (Figure 5):

1. Turn the LCD display ON using the Display ON/OFF key.
2. Depress the DISPLAY TEST key. The LCD display will show numeric segments and messages.

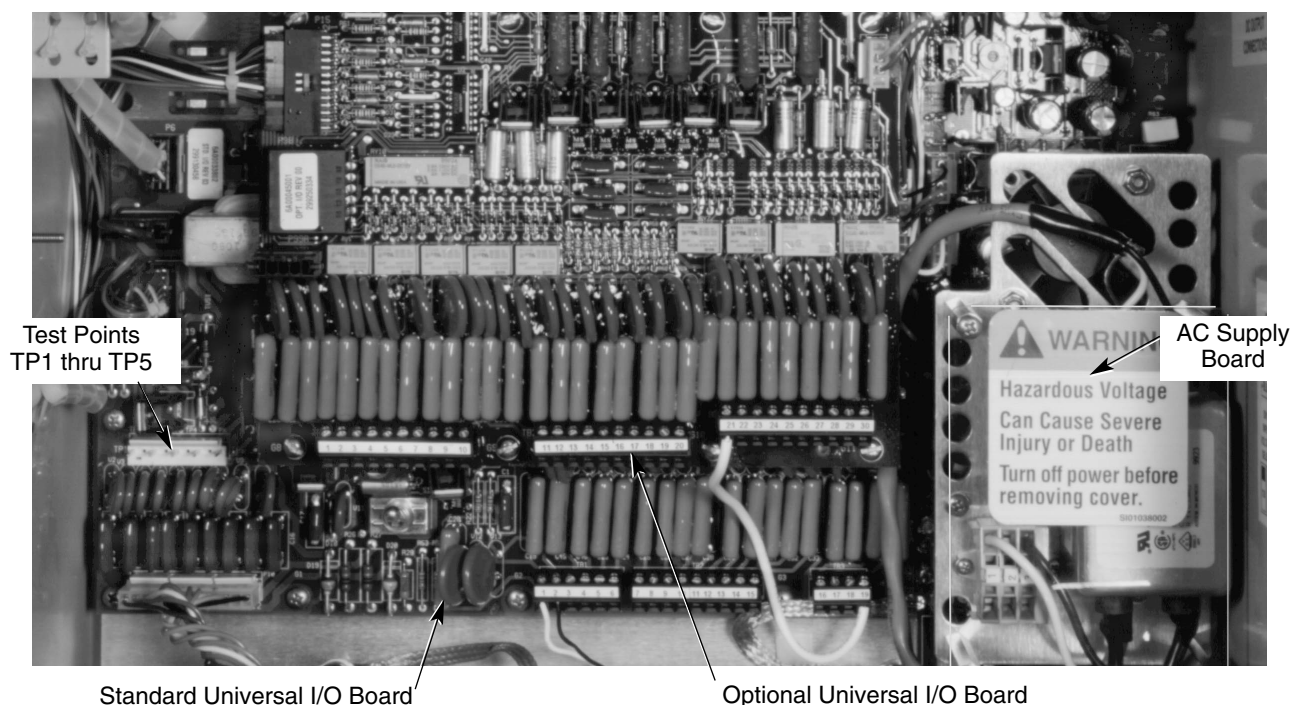


Figure 21.
Form 4C Control AC Supply Board, Standard and Accessory Supervisory Input/Output Boards

99011KM

Level II: Testing a Control Removed from Service

IMPORTANT: Disconnect switches for ac sensing and power connections are necessary to isolate the Form 4C Recloser Control for testing and servicing.

CAUTION: Recloser misoperation. The control must be removed from service prior to performing any Level II testing. Failure to comply can result in misoperation (unintentional operation) of the recloser.

T250.0

To Remove Control from Service

For all Level II testing, the following steps must be taken to remove the control from service and prevent possible recloser misoperation.

1. Switch Ground Trip Block switch to BLOCK.
2. Unplug the control battery.
3. Remove control ac sensing and power connections from the control using a separate disconnect switch.

WARNING: Hazardous voltage. If the recloser is energized while the control cable is disconnected, the CT secondaries can generate high voltages. Contact with high voltage can cause severe personal injury or death.

T204.2

CAUTION: Hazardous voltage. Cable conductors attached to NOVA reclosers will remain at 53Vdc potential after disconnection of source power to the recloser. Contact with any pins at the end of cables directly or indirectly connected to a NOVA recloser can result in personal injury or equipment damage.

T312.0

4. Disconnect control cable from the control.

Note: If the control is connected to a control-powered NOVA recloser, wait approximately 10 minutes for the 53 Vdc to dissipate from the control cable before touching the pins in the male end.

5. Disconnect the ground from the control.

On an out-of-service control, perform the following steps prior to Level II testing:

1. Ground the control cabinet using the grounding terminal lug (Figures 12 and 13).
2. Reconnect the control battery.
3. Energize the ac power to the control.

Testing with Type MET Tester

The Kyle Type MET Electronic Recloser Control Tester is used for testing the Form 4C control. The MET Tester (Figure 22) is completely self-contained, includes all necessary metering and interconnecting cables, and is capable of performing all required checks and tests from

a simple verification of operation to a complete verification of all operating parameters. Operating instructions for the Type MET Tester are contained in *Service Information S280-76-1 Type MET Electronic Recloser Control Tester Operating Instructions*.



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Figure 22.
Kyle Type MET electronic recloser control tester.

Testing Control Operation

This section describes testing the status of:

- The front panel containing the computer and display boards
- The ac supply board

The test does not specifically identify the defective component of the boards or panel. The control front panel or circuit boards must be replaced if they are found to be faulty.

Control Fails to Power-Up

If the control fails to power up, the following troubleshooting procedure will aid in determining the source of malfunction.

WARNING: Hazardous Voltage. Turn off power before removing safety shield. Failure to do so can result in contact with high voltage which will cause death or severe personal injury.

T261.0

CAUTION: 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

CAUTION: 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. Replace the main power supply 5 A fuse at F1 (see Figure 17).

If the Form 4C control still fails to power-up, either the ac power supply or the control front panel is defective. To isolate the problem, check operating power to the control. A voltage test procedure is used to determine which circuit assembly is faulty.

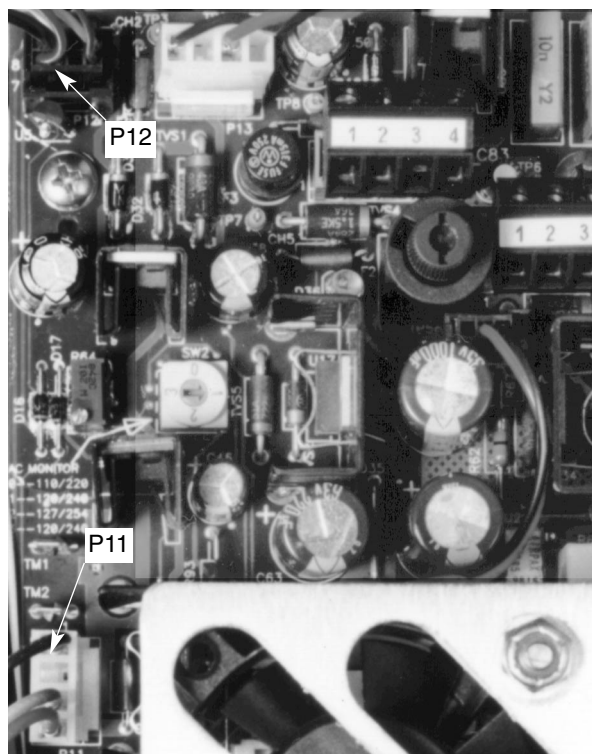


Figure 23.
Upper portion of AC Power Supply Board.
(Automation Power Supply shown).

99014KM

Terminal P11, located on the ac supply board, (Figure 23) contains three test points to verify the status of the board. The proper voltage across each of the three test points of P11 is listed below:

- Pin 1 (Black wire) Zero (battery ground point)
- Pin 3 (Blue wire) >25 Vdc
- Pin 4 (Red wire) 24.0 Vdc

To test the voltages of P11 test points:

Pin 1

1. Using a digital multimeter, place the ground probe against the aluminum plate of the back panel of the control.

Note: Keep the ground probe in contact with the aluminum plate for all three dc voltage measurements.

2. Place the positive probe into the pin 1 location (Figure 24).

If Pin 1 does not read zero, the ac supply board is defective and must be replaced.

Pin 3

3. Disconnect the control battery.
4. With the ground probe against the aluminum plate, place the positive probe into the pin 3 location.

If pin 3 does not measure approximately >25 Vdc, the ac supply board is defective and must be replaced.

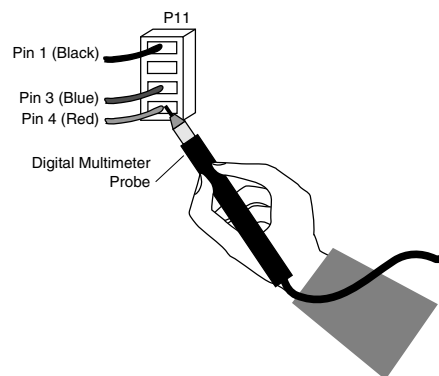


Figure 24.
Testing voltage of P11-Pin 4 on the AC Power Supply board.

Pin 4

The computer and display boards, located in the control front panel, receive dc power from terminal P11-Pin 4 (Red wire). A short circuit in the computer board can cause pin 4 to read a voltage lower than 24 Vdc.

If Pin 4 of P11 is not 24 Vdc, with the control battery disconnected, follow the instructions below:

5. Disconnect ac power to the control.
6. Disconnect terminal P12 located at the top of the ac supply board (Figure 23).
7. Reconnect ac power.
8. Using a digital multimeter, place the ground probe against the aluminum plate of the back panel of the control.
9. Place the positive probe into the Pin 4 location of P11 (Figure 24).

If the power supply measures 24 Vdc with terminal P12 disconnected, the computer board is defective and the control front panel must be replaced.

If the power supply is less than 24 Vdc with terminal P12 disconnected, the power supply board is defective and must be replaced.

The computer board and the display board are located under an aluminum cover on the inside front panel of the control.

IMPORTANT: These boards must have compatible software versions to operate properly. Therefore, the entire front panel must be replaced if either the computer or display boards is defective. Contact your Cooper Power Systems representative for replacement information.

Isolated DC Outputs Fail to Operate

(Automation Power Supply Units Only)

WARNING: Hazardous Voltage. Turn off power before removing safety shield. Failure to do so can result in contact with high voltage which will cause death or severe personal injury.

T261.0

CAUTION: 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

CAUTION: 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

CAUTION: Recloser misoperation. The control must be removed from service prior to performing any maintenance, testing, or programming changes. Failure to comply can result in misoperation (unintentional operation) of the recloser.

T216.2

1. Energize ac power to the control. Verify that control powers up on ac. Red ac power-on LED indicator on power supply board should illuminate (Figure 17).
2. Using a digital multimeter, verify dc output voltage of the Automation Power Supply by checking terminals P3 and P4 for output of 24 Vdc and 12 Vdc respectively per labels on side of cabinet (Figure 17).
3. If no power is detected at 24 Vdc output terminal P3 replace fuse at F3 (Figure 17). The absence of voltage after replacing fuse indicates the power supply board is defective and must be replaced.
4. If no power is detected at 12 Vdc output terminal P4 replace fuse at F2 (Figure 17). The absence of voltage after replacing fuse indicates the power supply board is defective and must be replaced.

Test Input Signals of the Standard Universal I/O Board

The Standard Universal I/O board contains five test points (Figure 25) for checking the input signals to the Form 4C control. The voltages across these test points are proportional to the recloser line current. The output voltages on these test points is 70 mV on phase or ground per 100 Amps of recloser load current.

Test point designation is as follows:

Phase A = TP1

Phase B = TP2

Phase C = TP3

Ground = TP4

Common = TP5

With 100 Amps of load current applied to the control, test point voltages should read:

TP5 to TP1 = 70 mV for Phase A

TP5 to TP2 = 70 mV for Phase B

TP5 to TP3 = 70 mV for Phase C

TP5 to TP4 = 70 mV for Ground

These five test points are provided for simple operation testing of the Form 4C control with a standard 100 watt soldering gun. The gun should have an output voltage of 0.6 Vac minimum.

For accurate test results, the control must be connected to a bypassed recloser, or a Type MET tester (or comparable test set).

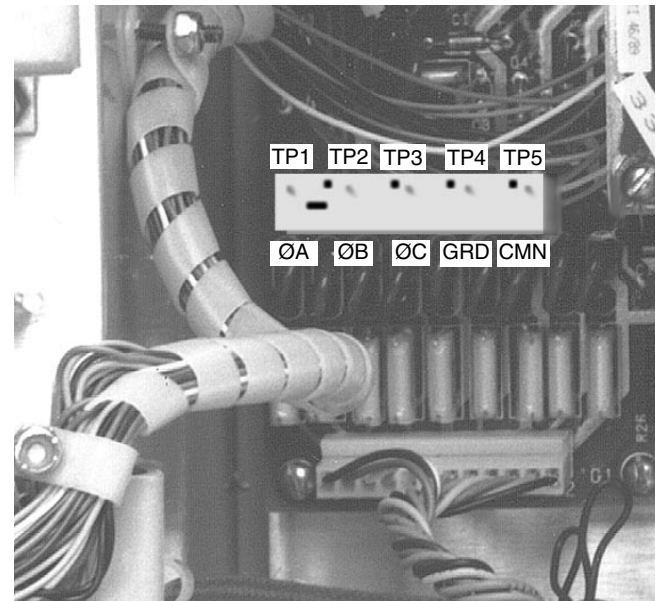


Figure 25.
Test Points on the Standard Universal I/O Board.

961065KM

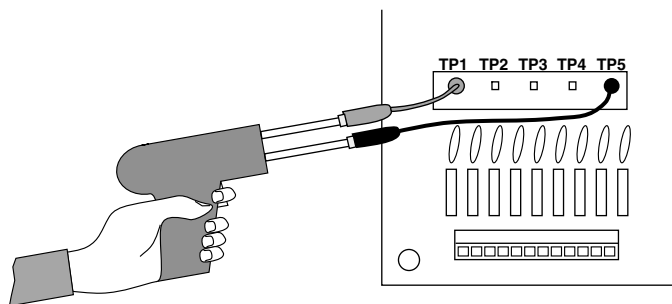


Figure 26.
Soldering gun connected to Standard Universal I/O Board test points.

Soldering Gun Test

Note: The Soldering Gun test can only be done with the Form 4C control connected to a recloser.

A soldering gun with the proper output voltage of 0.6 Vac will send a 700 Amp fault to the control. The control will respond to the fault on its target accessory, and record the fault current on its event recorder for each trip operation. Actual current may vary depending on the soldering gun used. To solder-gun test a control:

1. Set the Non-Reclosing/Normal Reclosing switch to NORMAL reclosing and Ground Trip Block switch to NORMAL.
2. Move the Manual Control switch on the control front panel to trip, to open the recloser contacts.
3. Remove the tips from the posts of the soldering gun by loosening the locking hardware.
4. Clip a short lead to one post of the gun and to test point TP5 (Common). See Figure 26.
5. Clip a short lead from the other post of the soldering gun to test point TP1 (Phase A). See Figure 26.
6. Move the Manual Control switch, on the control panel, to CLOSE. The recloser should close (or the test set simulate a closing operation).
7. Energize the soldering gun by depressing and holding the gun trigger until the recloser trips (or the test set simulates a tripping operation).
8. Immediately after the tripping operation, release the trigger.
9. Repeat Steps 6 and 7 until the control locks out.
10. Count the number of fast and delayed trip operations and compare the count with the control settings.
11. Verify lockout with the LCD control lockout indicator on the operator panel.
12. Repeat this procedure for test points TP2 (Phase B), TP3 (Phase C) and TP4 (Ground).

IMPORTANT: Battery voltage and charge current measurements made from the test terminals on the battery test panel, can be done while the control is in service as explained in the **Battery Test Procedure** and **Battery Charger Operation** sections of this manual. The control must be taken out of service for all other battery maintenance, battery replacement, battery drain tests, or changes to control parameters.

Testing the Battery Test Panel

The LCD battery meter display is powered by the battery circuit. If the LCD display does not function at all, no power exists to run the battery meter. The battery is defective and must be replaced.

If the LCD display of the Battery Test Panel does not function when verifying battery status, the battery or the LCD display may be faulty.

To diagnose the defective component, connect a voltmeter to the battery test terminals at the right side of the test panel (Figure 27). The required voltage should be 27 to 29 Vdc.

Compare the voltmeter reading with the LCD display reading. If the battery voltage is correct, and the display value is different, check to see that the battery is connected properly to the control. If the LCD display still does not read the required voltage rate, the LCD display is faulty and the battery test panel must be replaced.

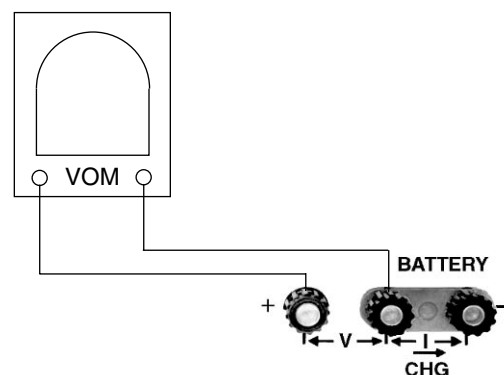


Figure 27.
Testing battery from battery test terminals.

CAUTION: Equipment damage. Shorting battery positive to battery negative at the battery test terminals on the control panel will cause damage to the control. The control will be inoperative and possible misoperation (unintentional operation) of the recloser may result. T214.1

CAUTION: Equipment damage. Do not short battery positive to mechanical ground. Failure to comply will cause damage to the control. T256.1

Test Operation of Status Contacts on the Optional Universal I/O Board

The operation of the various status contacts in both input/output boards is verified with an ohmmeter while the contact is changed by operation of the manual operating switches on the front panel of the control. Refer to Figure 28 and 29 when testing the terminal blocks of the Input/Output boards.

On the Optional Universal I/O Board (Detail A, Figure 18), customer connection terminals 1 through 14 are used for testing the status contacts of Ground Trip Block, Non-Reclosing, Alternate Minimum Trip, Control Lockout, and Phase Targets A through C. Figures 28 and 29 shows the condition of the contacts for each position of the manual control switches located on the front panel.

Testing the Ground Trip Block Status Contact

Connect the ohmmeter probes to terminals 1 and 2.

1. Move the Ground Trip Block switch to the Ground Trip Block position. The ohmmeter must indicate a closed circuit across terminals 1 and 2.
2. Move the switch to the Ground Trip Normal position. The ohmmeter must indicate an open circuit across terminals 1 and 2.

Testing the Non-Reclosing Status Contact

Connect the ohmmeter probes to terminals 3 and 4.

1. Move the Non-Reclosing switch to the Non-Reclosing position. The ohmmeter must indicate a closed circuit across terminals 3 and 4.
2. Move the switch to the Normal Reclosing position. The ohmmeter must indicate an open circuit across terminals 3 and 4.

Testing the Alternate Minimum Trip Status Contact

Connect the ohmmeter probes to terminals 5 and 6.

1. Move the Alternate Minimum Trip switch to the ALTERNATE MINIMUM TRIP position. The ohmmeter must indicate a closed contact across terminals 5 and 6.
2. Move the switch to the Normal position. The ohmmeter will indicate no continuity or an open contact across terminals 5 and 6.

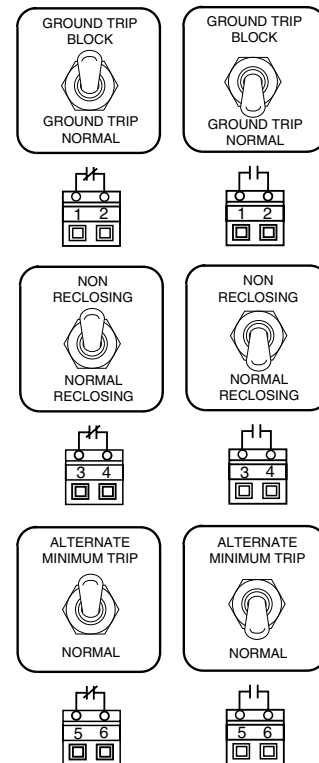


Figure 28.
Verifying operation of status contacts on the Optional Universal I/O Board.

Testing the OPT1 and OPT2 Status Contacts

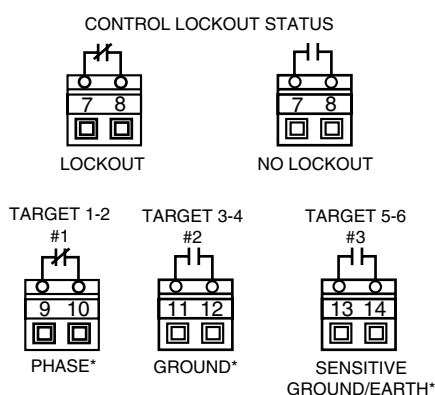
Refer to the *Accessories* section of this manual to find test procedures for each CPU firmware accessory.

Testing the Control Lockout Status Contact

The Form 4C control must be connected to either an operating, bypassed recloser; or Type MET tester (or comparable test set). The test set should be ON and no fault current applied.

Connect the ohmmeter probes to terminals 7 and 8.

1. Turn the Manual Control switch to the CLOSE position to close the control. An initial reading will indicate no continuity or an open contact across terminals 7 and 8.
2. Turn the Manual Control switch to the TRIP position to lockout the control. The ohmmeter will indicate continuity or a closed contact across terminals 7 and 8.



* When Sensitive Ground/Earth Fault in ON (Code 120), target indications change to PHASE, GROUND, and SENSITIVE GROUND/EARTH in place of Phase A, B, and C respectively.

Figure 29.
Verifying operation of status contacts (fault applied)
on the Optional Universal I/O Board.

Testing Phase Target Status Contacts

The control must be connected to a Type MET tester or comparable test set and a fault generated. A fault is generated by applying any current to the control that is at least 120% above *phase minimum trip*.

1. Set the control so that Access Code 21 (Target Reset after Successful Reclose) is ON. Refer to S280-77-4 for information on changing access code parameters.
2. Connect the ohmmeter and attach the probes to terminals 9 and 10 for Phase Target 1-2 (Phase A).

The ohmmeter should read no continuity or an open contact across terminals 9 and 10.

3. Simulate a fault current on Phase A. Refer to the appropriate operating instructions for generating current with your test set.

A fault on Phase A results in continuity on terminals 9 and 10.

4. Connect the ohmmeter probes to terminals 11 and 12 for Phase Target 3-4 (Phase B).

The ohmmeter should read no continuity or an open contact across terminals 11 and 12.

5. Simulate a fault current on Phase B.

A fault on Phase B results in continuity on terminals 11 and 12.

6. Connect the ohmmeter probes to terminals 13 and 14 for Phase Target 5-6 (Phase C).

The ohmmeter should read no continuity or an open contact across terminals 13 and 14.

7. Simulate a fault current on Phase C.

A fault on Phase C results in continuity on terminals 13 and 14.

Note: Remote indication of targets is altered when the Sensitive Ground/Earth fault feature is ON. The remote targets normally indicate phases A, B, and C (alternatively 1, 2, and 3 - see Access Codes 17, 18, and 19 in Programming Guide S280-77-4), but with Sensitive Ground/Earth Fault feature ON, the remote indications are Phase, Ground and Sensitive Ground/Earth in place of Phase A, B, or C respectively.

If the readings from any of these tests do not appear on the ohmmeter as indicated, the Optional Universal I/O board is defective and must be replaced.

Test Operation of Status Contacts on the Standard Universal I/O Board

On the Standard Universal I/O board, customer connection terminals 5 through 15 are for testing the status contacts of the Supervisory Switch and recloser, as well as power and malfunction status. Figure 30 shows the condition of the contacts of each function.

To test the Supervisory Switch status contacts, connect the ohmmeter and attach the black and red probes to terminals 5 and 6 on the Standard Universal I/O Board.

1. Move the Supervisory switch to the ON position. The ohmmeter will indicate continuity or a closed contact.
2. Move the switch to the OFF position. The ohmmeter will indicate no continuity or an open contact.

To test the recloser status contacts, connect the ohmmeter and attach the red and black probes to terminals 10 and 11.

1. Turn the Manual Control switch to the CLOSE position to close the control. The ohmmeter will indicate no continuity or an open contact on terminals 10 and 11.
2. Connect the ohmmeter probes to terminals 11 and 12. The ohmmeter will indicate continuity or a closed contact on terminals 11 and 12.

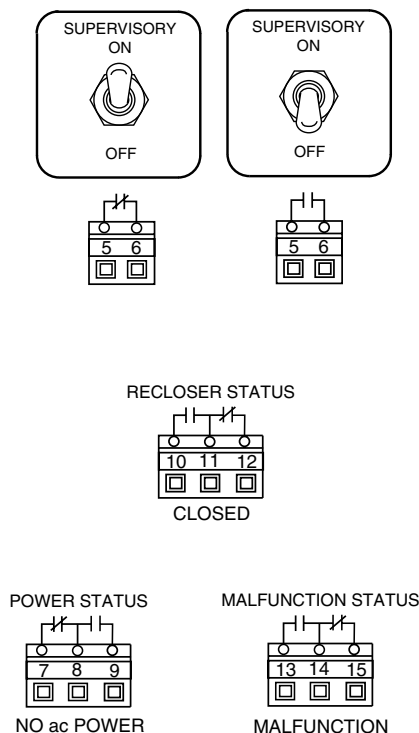


Figure 30.
Verifying operation of status contacts on the Standard Universal I/O Board.

To test the Power status contacts, Connect the ohmmeter and attach the probes to terminals 7 and 8.

1. Energize the recloser control with ac and battery power.
2. Disconnect the ac power. With no ac power, the ohmmeter will indicate continuity or a closed contact on terminals 7 and 8.
3. Connect the probes to terminals 8 and 9. The ohmmeter will indicate no continuity or an open contact on terminals 8 and 9.

To test the Malfunction status contacts, connect the ohmmeter and attach the probes to terminals 13 and 14.

1. Disconnect the battery and energize the control with ac power.
2. After several seconds the malfunction indicator on the front panel will show a malfunction. The ohmmeter will indicate no continuity or an open contact across terminals 13 and 14.
3. Place the probes on terminals 14 and 15. The ohmmeter will indicate continuity or a closed contact across terminals 14 and 15.

If these test readings do not appear on the ohmmeter, the Standard Universal I/O board is defective and must be replaced.

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).

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 31).

WARNING: Hazardous voltage. Interconnect source leads X and Y and ground solidly to the recloser tank (Figure 32). 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 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 32). A 75 kVA transformer of the proper voltage rating with an impedance drop of approximately 3% is satisfactory. The ac source must have a comparable impedance drop.

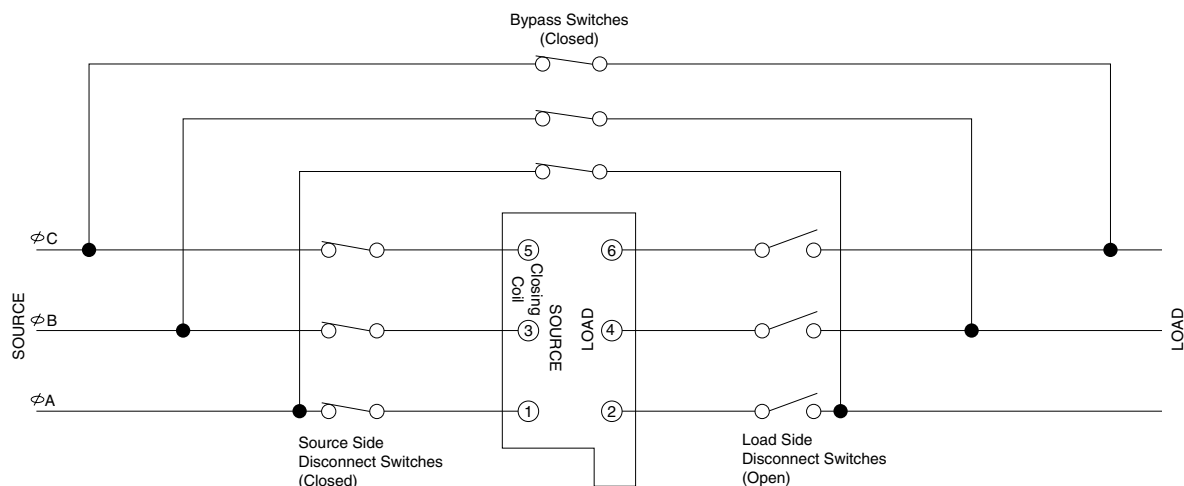


Figure 31.
Closing source-side switches of a bypassed “on-line” recloser provides closing solenoid power for automatic operation during testing.

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.

WARNING: Hazardous voltage. The switchgear and high voltage transformer must be in a test cage or similar protective device 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. T221.3

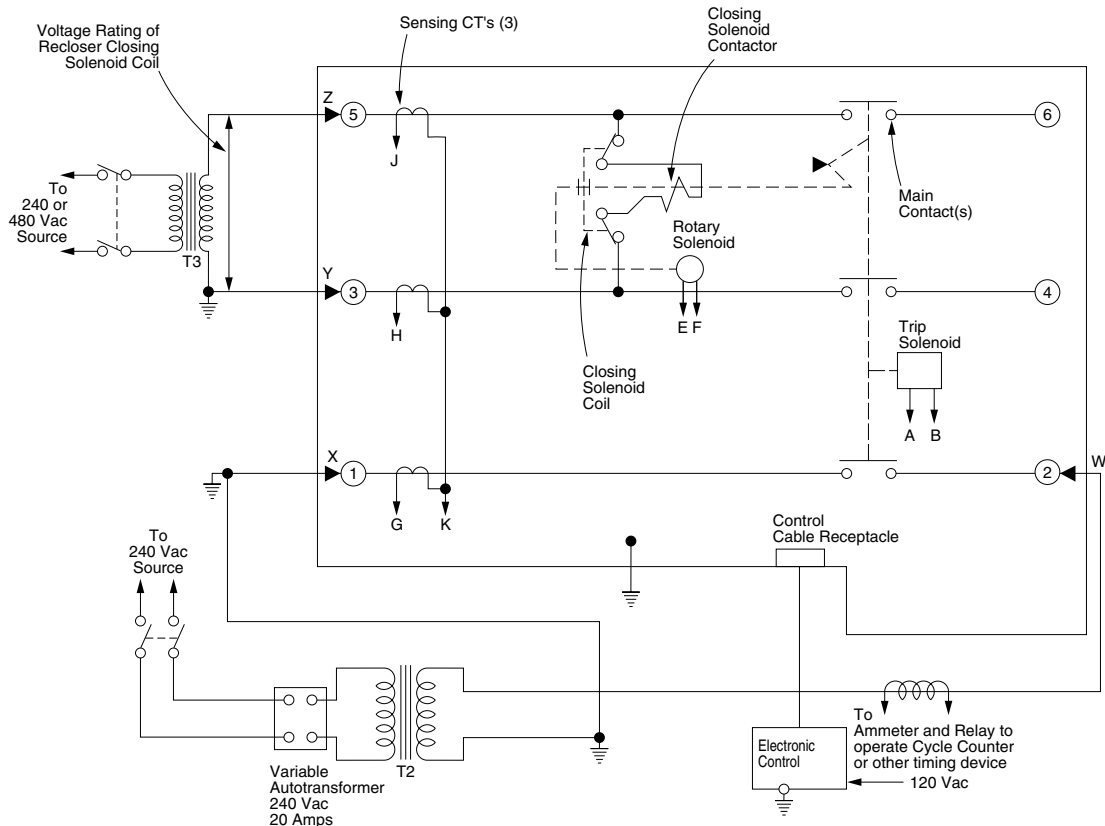


Figure 32.
Suggested test circuit for solenoid-closing reclosers.

Electrical Closing - Motor-Operated Reclosers

High-voltage is not required for reclosers utilizing a motor-operated closing mechanism energized from a 240 Vac power source. For information on energizing the recloser, refer to the appropriate motor-operated recloser installation manual.

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

T223.2

Figure 33 shows a test circuit for motor-operated reclosers. Since these reclosers require only a 240 Vac 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 34.

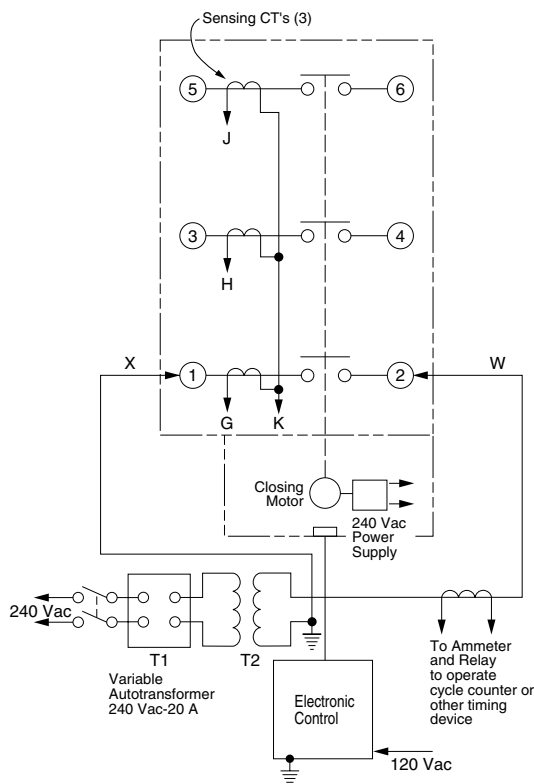


Figure 33.
Suggested test circuit for motor-operated reclosers, solenoid closing reclosers with low voltage closing, and NOVA reclosers.

Electrical Closing - NOVA™ Reclosers

Type NOVA 3-phase reclosers utilize an interface circuit located in the mechanism housing. The electronic interface circuit controls the opening and closing signals to the metal actuator.

The control-powered NOVA Recloser is tested with the dc-to-dc converter and 19-pin cable connected to the dc power supply.

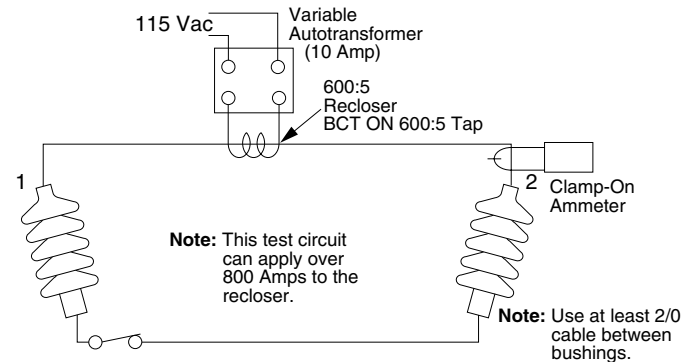


Figure 34.
Alternate method of producing variable line current (substitute for T2 and W-X circuit in Figures 32 and 33).

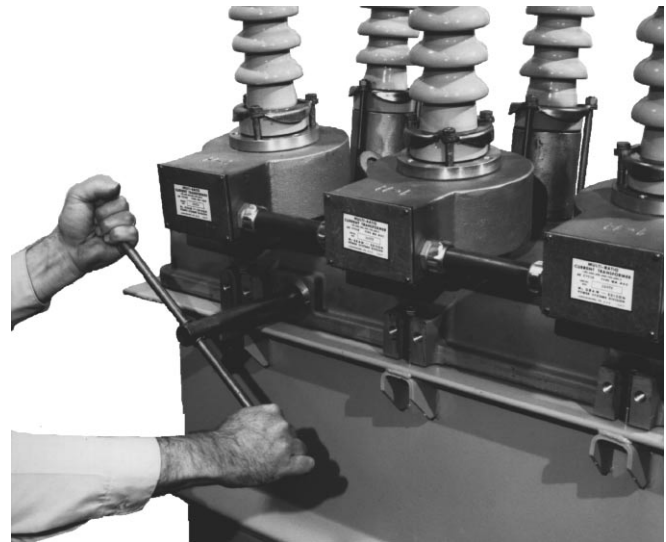
Manual Closing - Solenoid-Operated Reclosers

If high-voltage for operating the closing solenoid is not available, manual closing can be substituted for electrical closing. However, not all control settings can be checked since manual closing is not synchronized with the closing coil control circuit in the control.

IMPORTANT: If manual closing is used during trip testing, the Form 4C control's manual closing must be synchronized with the control's close signal.

If the recloser is not manually closed before the Form 4C control completes its closing signal, the control will go into its close-retry mode.

At this point, if the recloser is manually closed, the control will define the recloser contact position as not valid. The control will trip the recloser and lockout.



82284KMA-F

Figure 35.
Using a manual closing tool to operate the recloser.

WARNING: Explosion Hazard. Excessive Contact Arcing. Do not use the manual closing tool to close an oil-insulated energized recloser. Closing an energized oil-insulated recloser with a manual closing tool can cause excessive contact arcing, rapid build-up of gas within the equipment, and possible explosion that can cause death, severe personal injury, and equipment damage.

T203.2

To manually close the recloser:

1. Remove the closing tool port cover and gasket from the side of the recloser head casting.
2. Insert the tee-handled tool (available as an accessory) into the port, engaging the pin on the closing shaft (Figure 35).

CAUTION: Equipment damage. Do not turn the manual closing tool more than one-quarter turn clockwise. Forcing the tool beyond the mechanism stop may shear the pin on the closing shaft of the recloser.

T222.0

3. Close the recloser by placing the yellow operating handle (located under the sleethood) into the up or CLOSED position and turning the closing tool one-quarter turn clockwise.
4. After each trip operation, about 1/2 second elapses while the closing solenoid plunger is moving upward to reset the main toggle latch.
5. After the main toggle latch resets, the recloser can be closed again by operating the manual closing tool.
6. Replace the gasket and port cover on the recloser head after testing has been completed.

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

After the required work is completed, disconnect the control from the test set and follow this procedure to return the control to service:

1. While still in service shop, appropriate personnel must verify that all control settings are correct.
2. Reconnect the ground cable to the control.
3. Control cable properly connected and supported.
4. Plug in the control battery.

Note: The Form 4C control will not power up until ac power is applied.

5. Apply ac power to the control.
6. Switch Ground Trip Block switch to NORMAL.
7. Reset the control clock after ac power has been re-applied. (Refer to the **Setting The Control Clock** section of *S280-77-4 Form 4C Control Programming Guide*.)

MAINTENANCE 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 Kyle Form 4C 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 Cooper Power Systems representative for additional information and ordering procedures.

Factory-Authorized Service Centers

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

Factory Maintenance Classes

The factory service department offers a basic testing and troubleshooting course for the Form 4C Microprocessor-based Control and Reclosers. This course, taught by experienced service technicians, is held at the factory's in-house training facility. For additional information, contact your Cooper Power Systems sales representative.

Instructional Video Cassette Programs

Form 4C Control

A video cassette program entitled *KSPV9 Form 4C Microprocessor-Based Control Description and Operation* is available as a supplemental training aid for operating and service personnel.

This video program, developed for use in the factory training school, is used in conjunction with existing service literature. For additional information, contact your Cooper Power Systems representative.

Type MET Recloser Control Tester

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

REMOVAL OF CONTROL FRONT PANEL ASSEMBLY

CAUTION: Recloser misoperation. The control must be removed from service before disconnecting the control battery. Disconnecting the control battery from an in-service control may cause recloser misoperation (unintentional operation). Failure to comply can result in equipment damage and personal injury.

T213.4

CAUTION: 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

CAUTION: 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

IMPORTANT: Disconnect switches for ac sensing and power connections are necessary to isolate the Form 4C Recloser Control for testing and servicing.

The front panel assembly of the Form 4C recloser control contains all the necessary software for programming the control parameters.

To remove the control front panel, refer to Figure 36 and proceed as follows:

1. Remove the control from service. Follow all locally approved safety regulations, practices, and procedures.
 - A. Set Ground Trip Block switch to BLOCK.
 - B. Unplug the control battery.
 - C. Remove control ac sensing and power connections from the control using a separate disconnect switch.

WARNING: Hazardous voltage. If the recloser is energized while the control cable is disconnected, the CT secondaries can generate high voltages. Contact with high voltage can cause severe personal injury or death.

T204.2

CAUTION: Hazardous voltage. Cable conductors attached to NOVA reclosers will remain at 53Vdc potential after disconnection of source power to the recloser. Contact with any pins at the end of cables directly or indirectly connected to a NOVA recloser can result in personal injury or equipment damage.

T312.0

IMPORTANT: Electro-static discharge. All microprocessor equipment is subject to electrostatic discharge (ESD) damage which can affect programming or result in component degradation or failure.

To prevent possible ESD damage to circuit boards, make sure of the following when removing, handling, or installing circuit boards.

- Make sure the control is grounded.
- Use a grounding wrist strap connected to the control ground connection.
- Always transport and store circuit boards in static-free packaging.

2. Disconnect the front-panel ground strap by removing the #8 nut and lockwasher. Retain these parts for later use.
3. Disconnect the cable plug from socket P7 on the Standard Universal I/O board. Release the cable from the tie-wraps and wire clips.
4. Disconnect the cable plug from the power supply plug P12. Release cable from tie-wraps and wire clips.
5. If control is equipped with the Optional Universal I/O board, disconnect cable plug from socket P15. Release the cable from its tie-wraps and wire clips.
6. If control is equipped with the Fiber-Optic Digital Communications accessory, disconnect cable plug from socket P19.
7. Disconnect the cable plug from socket P2 on the top-right corner, on the back of the front panel assembly. Remove and retain the cable clamp and hardware from the cable.
8. Disconnect the front panel door-stop link. Retain for later use.
9. Remove the panel by lifting it off the slide hinges.

- D. Disconnect control cable from the control.

Note: If the control is connected to a control-powered NOVA recloser, wait approximately 10 minutes for the 53 Vdc to dissipate from the control cable before touching the pins in the male end.

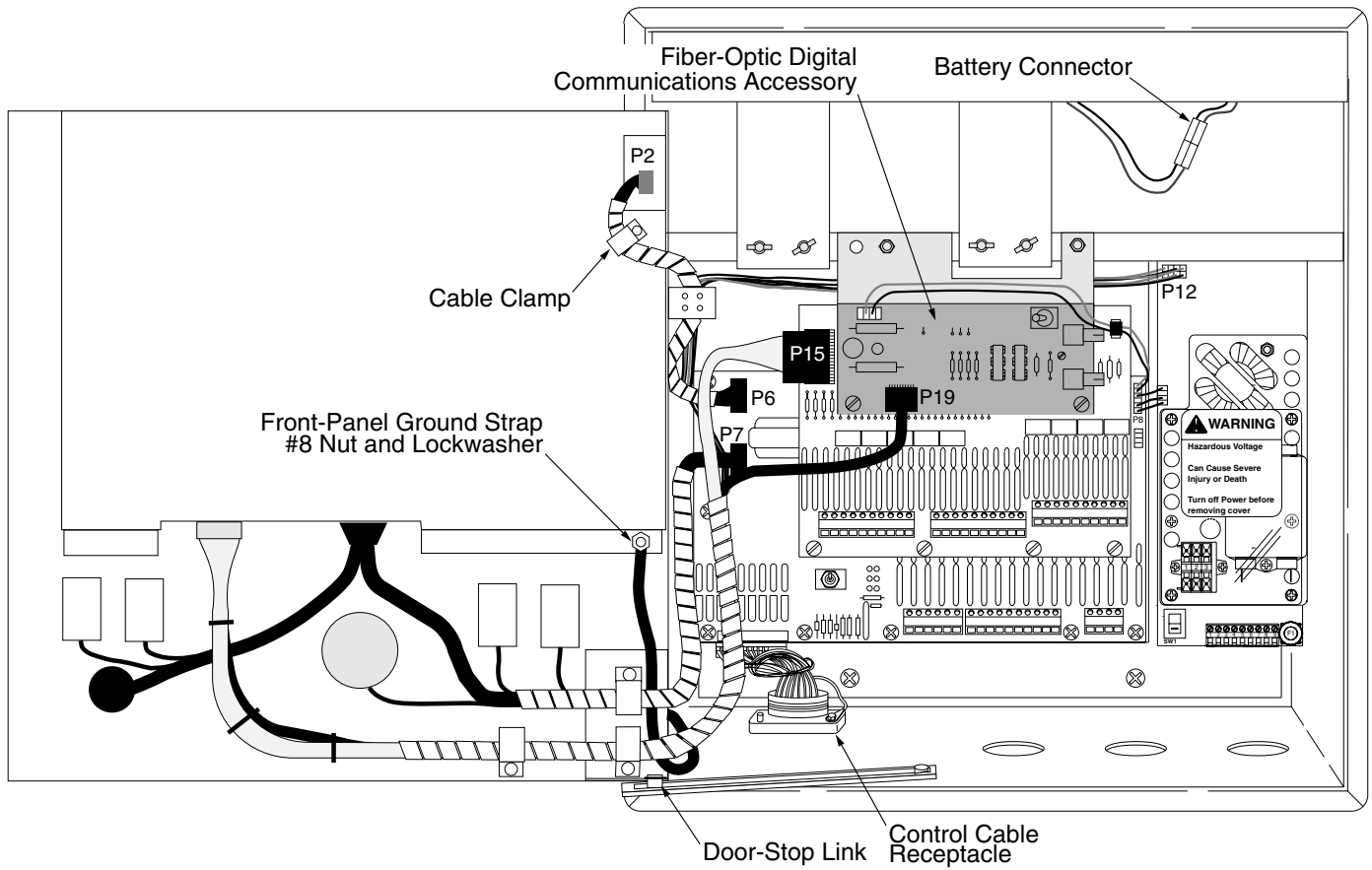


Figure 36.
Removal of the Form 4C control front panel assembly.

Event Recorder Data Record Sheet

Name: _____

Date: _____ Location: _____ Circuit No.: _____

Control Serial No.: _____ Recloser Serial No.: _____

EVENT 161	Event Type 162	Month/Day 163	Hour/Min. 164	Seconds 165	Ground 166	Phase 1-2 167	Phase 3-4 168	Phase 5-6 169
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
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35								
36								

EVENT TYPE

IDENTIFICATION

- | | |
|----|---|
| 1 | Overcurrent Trip |
| 2 | Reset |
| 3 | Close-Manual Control Switch |
| 4 | Close-Supervisory |
| 5 | Lockout-Manual Control Switch |
| 6 | Lockout-Remote |
| 7 | Lockout-Supervisory |
| 8 | Trip-Supervisory |
| 9 | Loss of AC Voltage (2 minutes minimum) |
| 10 | Restoration of AC Voltage (.03 seconds) |
| 11 | Sequence Coordination |
| 12 | Sensitive Ground/Earth Fault Trip |

EVENT TYPE

IDENTIFICATION

- | | |
|----|---|
| 13 | Close Retry Lockout |
| 14 | Fault Target* |
| 15 | Switch Mode* |
| 16 | Recloser Mode* |
| 17 | Recloser Manual Lockout |
| 18 | Attempt To Close When Hot Line Tag Is Active* |
| 19 | Diagnostic |
| 20 | Alternate Minimum Trip On |
| 21 | Alternate Minimum Trip Off |

* Only available when the appropriate accessory is ordered.



