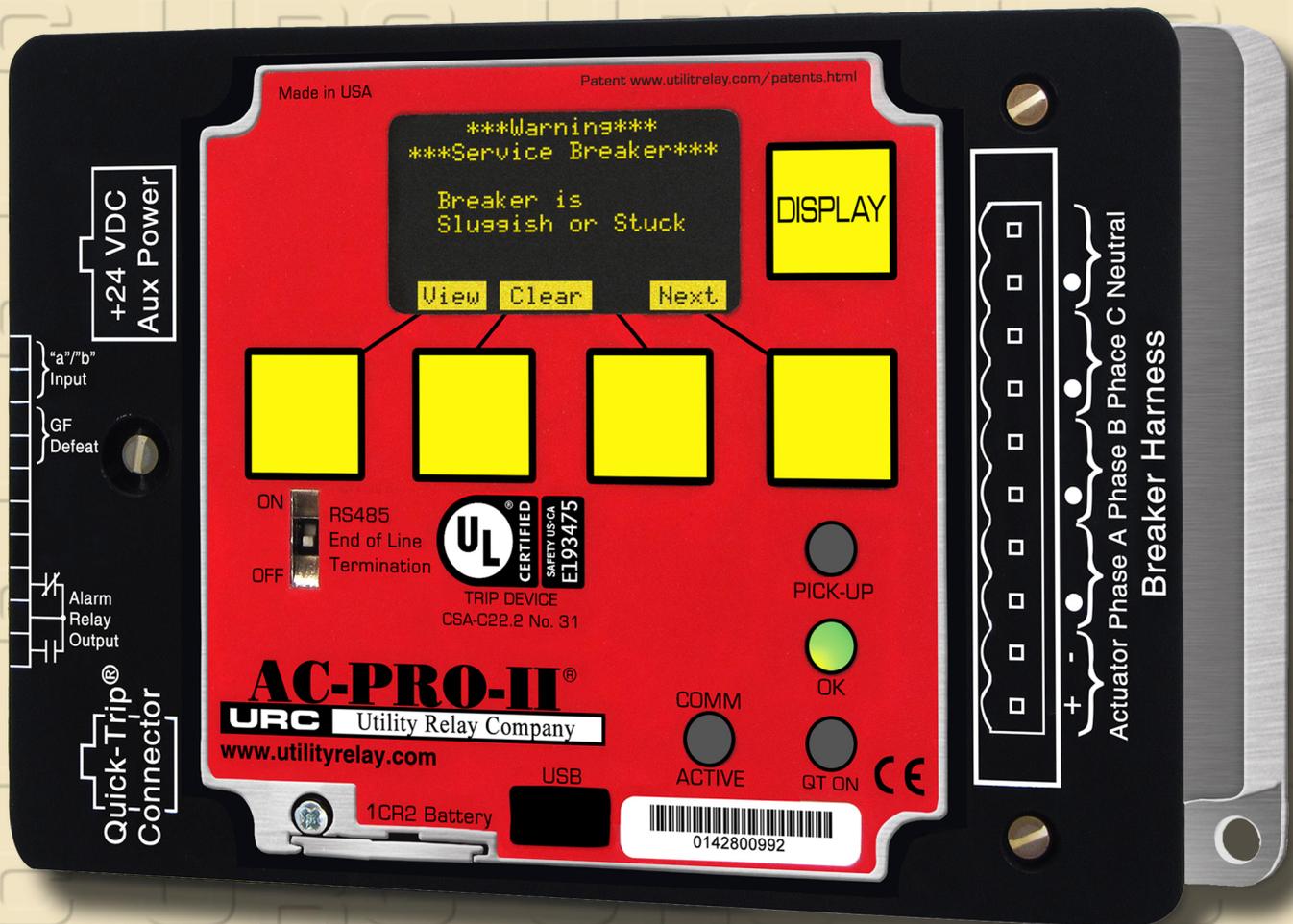


AC-PRO-II®

I-AC-PRO-II

AC TRIP UNIT



INSTRUCTION MANUAL

STATE OF THE ART TECHNOLOGY FOR LOW
VOLTAGE CIRCUIT BREAKER RETROFITTING

URC Utility Relay Company

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1.0 Introduction and Product Overview

The AC-PRO-II® is a state of the art, micro-controller based trip unit for use on three phase, 600 Volt class, AC circuit breakers on 50 Hertz or 60 Hertz systems. The AC-PRO-II features a rotatable 128 x 64 Multi-line, Organic Light Emitting Diode (OLED) Display, smart buttons, and LEDs.

The standard AC-PRO-II provides:

- Overload and fault protection
- RS485 communications
- QUICK-TRIP® arc flash hazard reduction ready
- Patented Sluggish Breaker® detection
- Time stamped trip history with waveform capture
- InfoPro-AC™ software interface
- Ready for the SAFE-T-TRIP® hand-held remote trip device
- And many other features

Additionally, with the optional Voltage Divider Module (VDM™), the AC-PRO-II can provide over/under voltage protection and power calculations.

The AC-PRO-II is 55% smaller than the original AC-PRO® and includes more features and more flexibility. The smaller form factor allows application on a wider range of breakers. The trip unit features versatile user settings that allow setting the frequency (50 Hz or 60 Hz), CT secondary rating, and Ground Fault type in the field, eliminating the need for a special factory-configured trip unit and simplifying the kit ordering process.

The AC-PRO-II is backwards compatible with existing AC-PRO CTs, actuators, wiring harness, and settings, making direct replacements easy. Similar to AC-PRO, the AC-PRO-II settings are entered using simple parameters. No percentages or multipliers are required. AC-PRO-II settings are programmed using the easy-to-read multi-line OLED display.

1.1 Current Protection and Functions

The AC-PRO-II includes the following Current-based features:

- Long Time (LT)
- Short Time (ST)
- Instantaneous (I)
- Ground Fault (GF)
- Thermal Memory (for LT, ST, & GF)
- Neutral Overload (NOL)
- QUICK-TRIP Instantaneous (QT-I)
- QUICK-TRIP Ground Fault (QT-GF)
- Current Metering
- Overload (Long Time pickup) Alarm
- Instantaneous Override (I-OVRD) (factory setting – normally disabled)
- Instantaneous on Close (I-CLOS) (factory setting – normally enabled)

The AC-PRO-II measures the true RMS current through each of the breaker's three poles.

AC-PRO-II settings include a Ground Fault type setting, which allows the user to select either Residual Ground Fault protection (vector sum), or Ground Return Ground Fault protection (measures GF directly).

The QUICK-TRIP Instantaneous and QUICK-TRIP Ground Fault protective settings are available to minimize downstream Arc Flash Hazard.

The AC-PRO-II uses a unique algorithm to determine if the RMS currents are greater than 12 times the CT rating where the CTs may be saturated. The AC-PRO-II then corrects the effect of CT saturation on the Long Time and Short Time trip functions.

1.2 Voltage and Power Features - optional Voltage Divider Module (VDM)

The AC-PRO-II can be provided with an optional Voltage Divider Module (VDM) attached to the back of the trip unit. When configured with the VDM, the AC-PRO-II offers the following Voltage-based features:

- Rated for up to 600V three-phase systems
- Voltage metering and protection
 - Firmware v1: Line to Neutral
 - Firmware v2: Line to Line
- Under-Voltage trip & alarm
- Over-Voltage trip & alarm
- Phase Loss/Reversal trip & alarm (firmware v2)
- Power metering: (KW, KVA, KWhr, KVAHr, Power Factor)
- VDM provides continuous trip unit power even when the breaker is open and not carrying current, allowing for communications, even without CT power.

1.3 Additional Features

In addition, the AC-PRO-II also features the following: (features are standard for all AC-PRO-II trip units unless noted otherwise)

- Configurable alarm relay (form C)
- Self-Test
- Front USB port for settings upload and download, SAFE-T-TRIP remote trip device, auxiliary power and firmware updates
- OLED multi-line display
- RS-485 Modbus RTU communications
- Versatile user settings provide more flexibility than the original AC-PRO:
 - 50 Hz or 60 Hz operation
 - Phase CT secondary ratings: 1A, 0.5A, 0.4A, 0.25A, 0.2A
 - Neutral CT secondary ratings: 2A, 1.5A, 1A, 0.5A, 0.4A, 0.25A, 0.2A, 0.18A
 - Ground Fault type can be set to "Residual" or "Ground Return" depending on the CT location & Ground Fault scheme.
- Compact form-factor allows the AC-PRO-II to be used on a wide range of breakers, including more insulated case breakers.
- Backwards compatibility with AC-PRO actuators, CT's, wiring harness, and settings.
- Waveform capture
- Sluggish Breaker
- Time-stamping of Trip events

The trip unit stores the trip history data for the last 8 trip events and the trip log data in a non-volatile FRAM memory for later recall. All the settings are stored in non-volatile memory. Battery backup is not required.

The trip unit does not require external power to operate. Power is derived from the current transformers (CTs). An internal battery provides power to review and change protection settings when CT power is not available.

The AC-PRO-II trip unit is manufactured under multiple patents. See the link below for additional information: <http://www.utilityrelay.com/patents.html>

NOTE: this manual is written based on version 2 firmware. See the following for details: http://www.utilityrelay.com/Side_Bar/Firmware_versions.html

2.0 UL/ULC Classification & CE Mark

AC-PRO-II® is currently UL and ULC classified for use on the following low voltage AC power circuit breakers:

Square D/Westinghouse DS-206, DS-416, DS-632, DB-50
Schneider H-3 Series
General Electric AKR-75, AK-2-50, AK-2-75
ITE K-600, K-800, K-1600, K-3000, KB Steel
Siemens/Allis-Chalmers LA-1600

UL and ULC classification is in accordance with UL1066, CSA C22.2, IEEE C37.59-2007 as well as appropriate sections of ANSI C37.17-1979 and C37.50-1989.

The AC-PRO-II has the CE Mark.

AC-PRO-II was tested by an independent laboratory and found in compliance with the following standards:

IEEE C37.90.1-2002, Surge Withstand
IEEE C37.90.2-2004, RF Susceptibility
EN 61000-4-3: 2006, RF Immunity
EN 61000-4-4: 2004, Fast Transient
EN 61000-4-5: 2006, Surge Immunity
EN 61000-4-2: 2009, Electrostatic Discharge Immunity
EN 55011: 2007, Radiated Emissions

3.0 Trip Unit Power

The AC-PRO-II can be powered in 5 different ways: CTs, internal battery, USB port, 24VDC auxiliary, or by the Voltage Divider Module (VDM).

The AC-PRO-II is normally powered from the breaker phase CT's if at least one phase current is above the CT power-up threshold. See Table 3-A for CT power-up values. If the current is not high enough to power the trip unit, the trip unit will power down. If the unit is powered down and a fault occurs requiring rapid response, the high current of the fault provides CT power and the trip unit performs as published in the Time Current Curves.

If the trip unit is connected to a Voltage Divider Module (VDM), USB, or 24VDC auxiliary power, these sources provide constant power.

During normal operation (in service), if the trip unit is powered by current or voltage and no errors are present, the OK LED should be ON. If current is too low or if voltage (via VDM) is not present, pressing the "DISPLAY" Push button will temporarily power up the trip unit and display using the internal battery. The OK LED should then be on.

3.1 Current Transformer (CT) Power

The AC-PRO-II derives both the signal and power from the breaker phase CTs. For 1-Amp CT's, the trip unit will power-up with less than 6% of the rated CT tap current through a single CT. See complete table below:

Phase CT Secondary Rating	Current required to power AC-PRO-II (in % of CT Primary Rating)
1.0 Amp	6%
0.5 Amp	12%
0.4 Amp	15%
0.25 Amp	24%
0.2 Amp	30%

Table 3-A: CT Power-up values

3.2 Battery Power

A 3-Volt, 850 mAh, CR2, long life Lithium battery is used in the trip unit. There are no restrictions on transport and no special methods of disposal required with this battery.

The AC-PRO-II design uses the battery for the following functions / features:

- 1) Allows the user to commission (program) the trip unit without using the auxiliary power pack.
- 2) Allows the user to recall last trip data even if the breaker is open and without using the auxiliary power.
- 3) Maintains the internal clock for accurate time and date stamping for trip history and on-demand waveforms.
- 4) Allows resetting (unlatching) the alarm relay when no other power source is available.

Press the "DISPLAY" push button to turn the trip unit on under battery power.

When on battery power, the trip unit will automatically turn off 60 seconds after the last button is pushed to conserve battery energy.

**** NOTE ****

The battery is NOT involved in the protective functions of the trip unit. The trip unit will provide protection even if the battery is removed.

The battery is NOT required for the trip unit to maintain any of its memory including the user programmed pick-up and delay settings and the last trip data.

If the battery voltage is low, the internal date/time clock will not be correct.

See Section 21.0 for battery data and instructions on replacing the battery.

3.3 USB Power

The AC-PRO-II® is equipped with a mini-USB port on the face of the trip unit and it can be used to power the trip unit display with the USB 5Vdc supplied by a computer, USB wall-pack, etc.

Note: USB power is NOT sufficient for powering AC-PRO-II when using a relay (secondary injection) test set.

3.4 24VDC Auxiliary Power

The AC-PRO-II® includes a 24VDC auxiliary power input, for connection to the B-292 Secondary Injection Test Set, and other auxiliary power sources.

URC 24VDC Accessories:

24VDC wall-pack: URC Part # T-490-ASM
24VDC harness: URC Part #CA-AC2-24VDC

24VDC Auxiliary power requirements:

Voltage: 23-28VDC with correct polarity
Power supply sizing: 3 watts minimum per AC-PRO-II
Protection: protect each AC-PRO-II with 1A fuses
Use a minimum of 1 power supply per lineup.
Do not ground the minus of the 24VDC system

3.5 Voltage Divider Module (VDM) Power

The AC-PRO-II® trip unit is available with an optional Voltage Divider Module (VDM). The VDM provides breaker 3-Phase voltage used for power information and also provides power for the trip unit independently from the CTs. See Section 8.0 for more information on the Voltage Divider Module (VDM).

4.0 AC-PRO-II® Pictures and Configurations

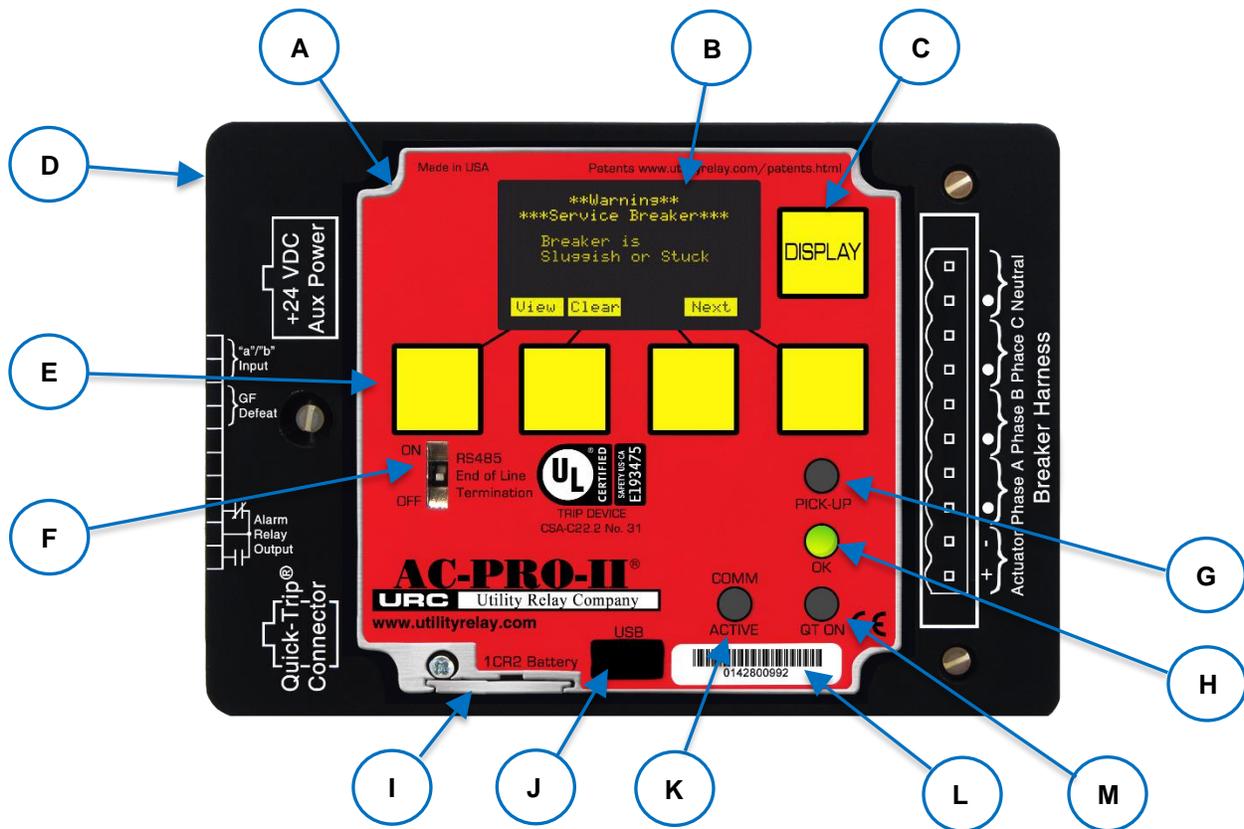


Figure 4.1 AC-PRO-II Front View - Horizontal Configuration

- A. Local Display (rotatable)**
The Local Display is normally mounted to the trip unit. It can be rotated or separated from the trip unit for specific breakers where space is limited.
- B. OLED Display**
The display is normally off. Pushing the "DISPLAY" button (C) turns on the display. The OLED displays the following information. Refer to Section 6.0 for menu navigation.
- C. DISPLAY Push Button**
Pushing the "DISPLAY" button will turn on the display. If no buttons are pushed for 60 seconds, the display will turn off.
- D. Removable wire cover**
Cover with printed connection labels. See Section 5.0 for external connections (behind cover).
- E. "Smart" Push Buttons**
These push buttons perform the functions indicated on the bottom of the OLED display. These buttons are used for all menu navigation.
- F. RS-485 Line Termination Switch**
This switch should be placed in the ON position only if the trip unit is the last in the RS-485 communications wiring run.
- G. Red PICK-UP LED (red)**
This LED will illuminate if the current exceeds the LT pick-up setting.
- H. Green OK (Self-Test) LED**
When the trip unit is powered up, this LED is on unless a problem is detected. If the trip unit is not powered up, the OK LED will not be on. If the "DISPLAY" button is pressed, the OK LED should come on, unless a problem is detected. See Section 11.1 for Trip Unit Power and Section 20.0 for Errors.
- I. Battery Cover**
To replace the battery, remove the single screw and slide battery cover out, remove the old battery and insert a new CR2, 3-Volt Lithium battery. Replace the battery cover and screw. See Section 21.0.
- J. Mini-USB Port (shown with cover removed)**
The electrically isolated mini-USB port is available for connection to a laptop/ personal computer for uploading & downloading of settings, information, and firmware; SAFE-T-TRIP remote trip device operation; or USB wall pack for auxiliary power.
- K. COMM ACTIVE LED (green)**
The communications active LED illuminates when the trip unit is transmitting information via Communications.
- L. AC-PRO-II Serial Number**
- M. Quick-Trip LED (red)**
This LED will illuminate if a Quick-Trip switch is connected and on the ON position.

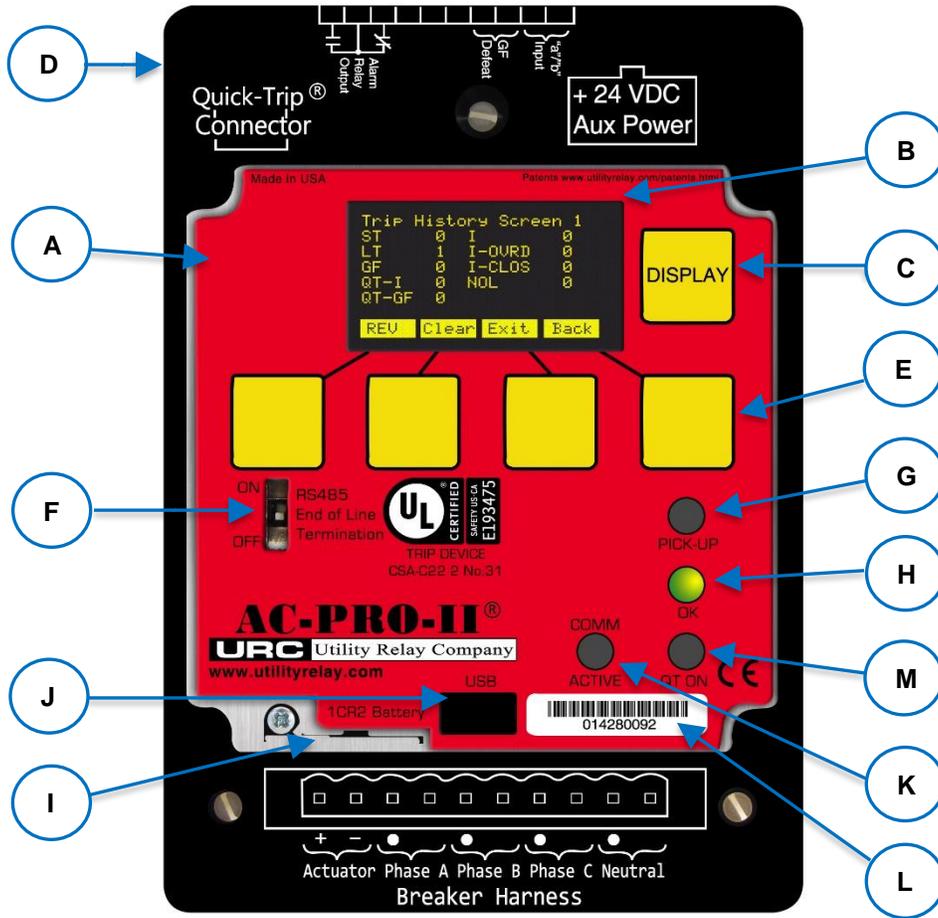


Figure 4.2: AC-PRO-II Front View - Vertical Configuration with Breaker Harness at bottom

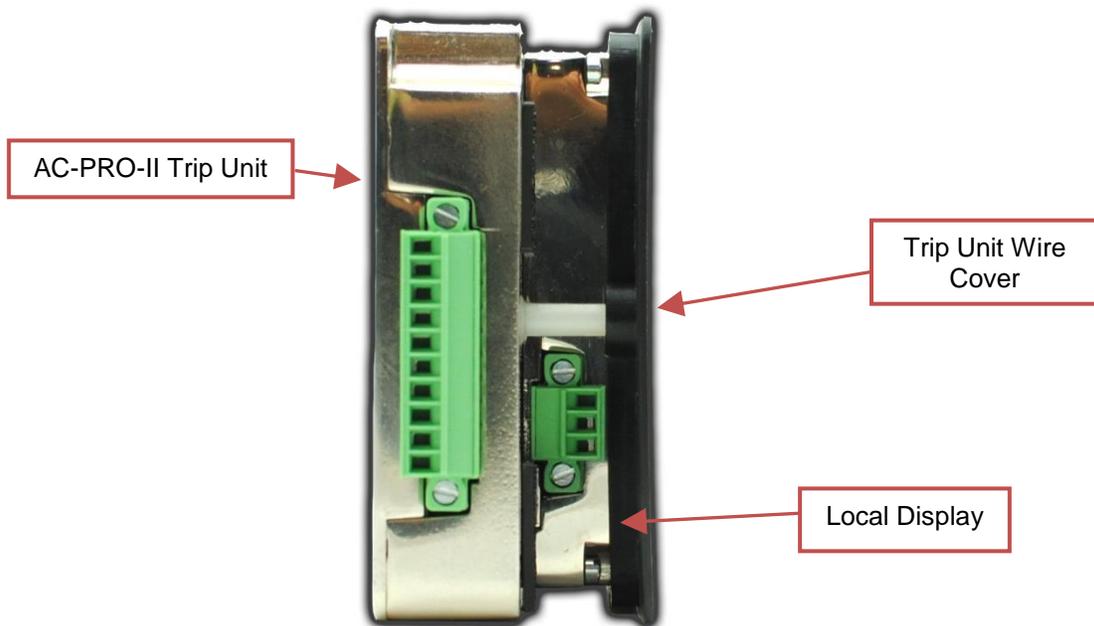


Figure 4.3: AC-PRO-II Side View (without VDM)

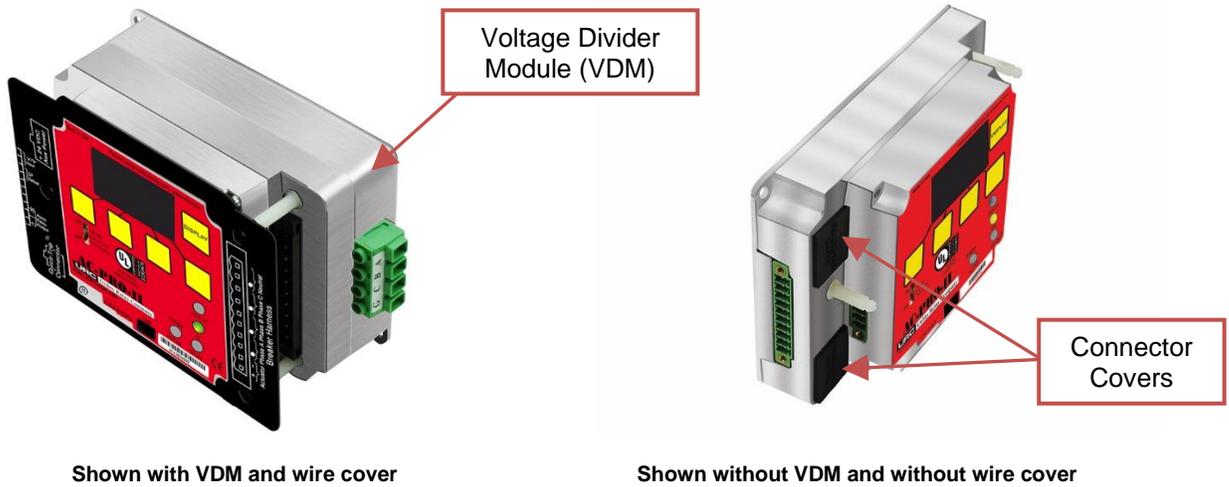


Figure 4.4: AC-PRO-II Angled Views – with and without VDM

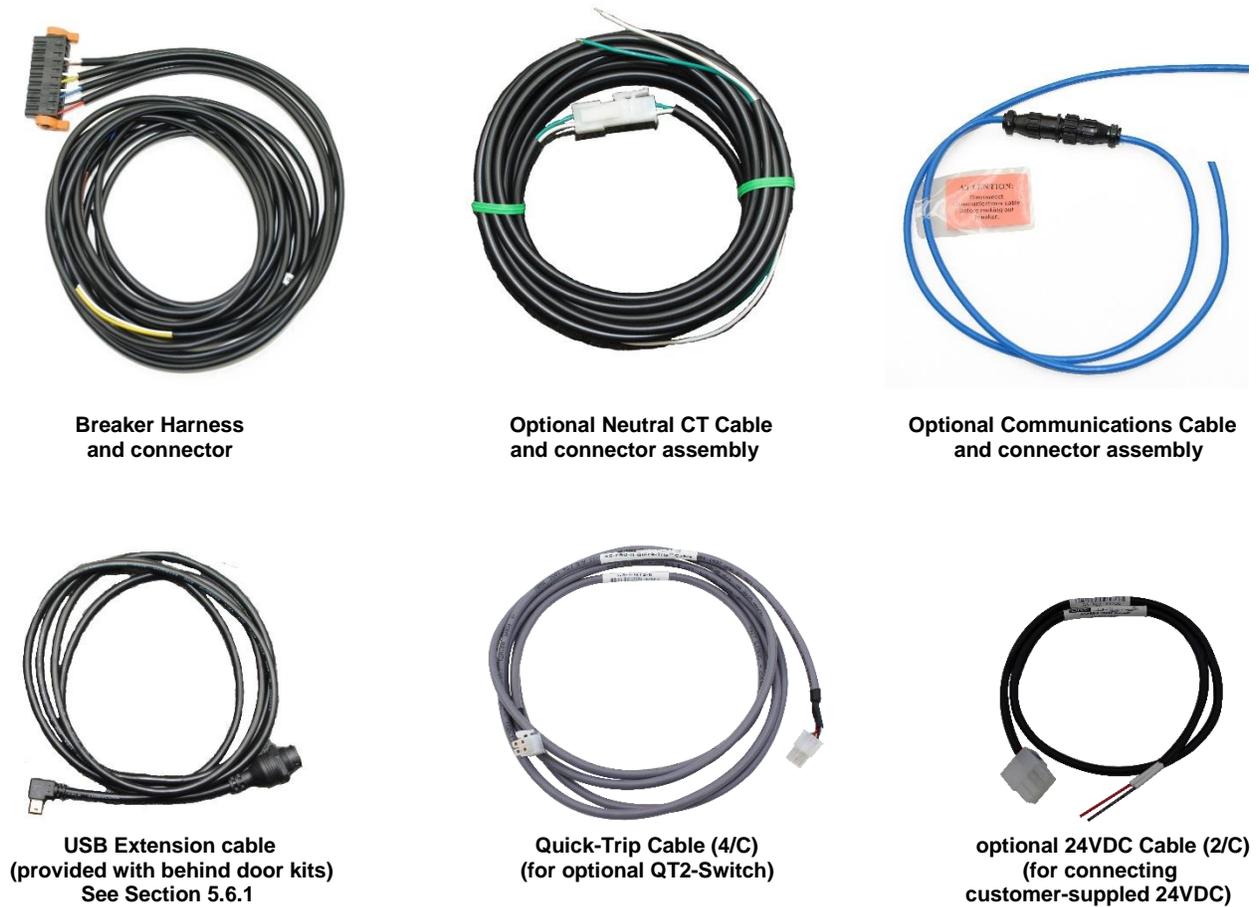
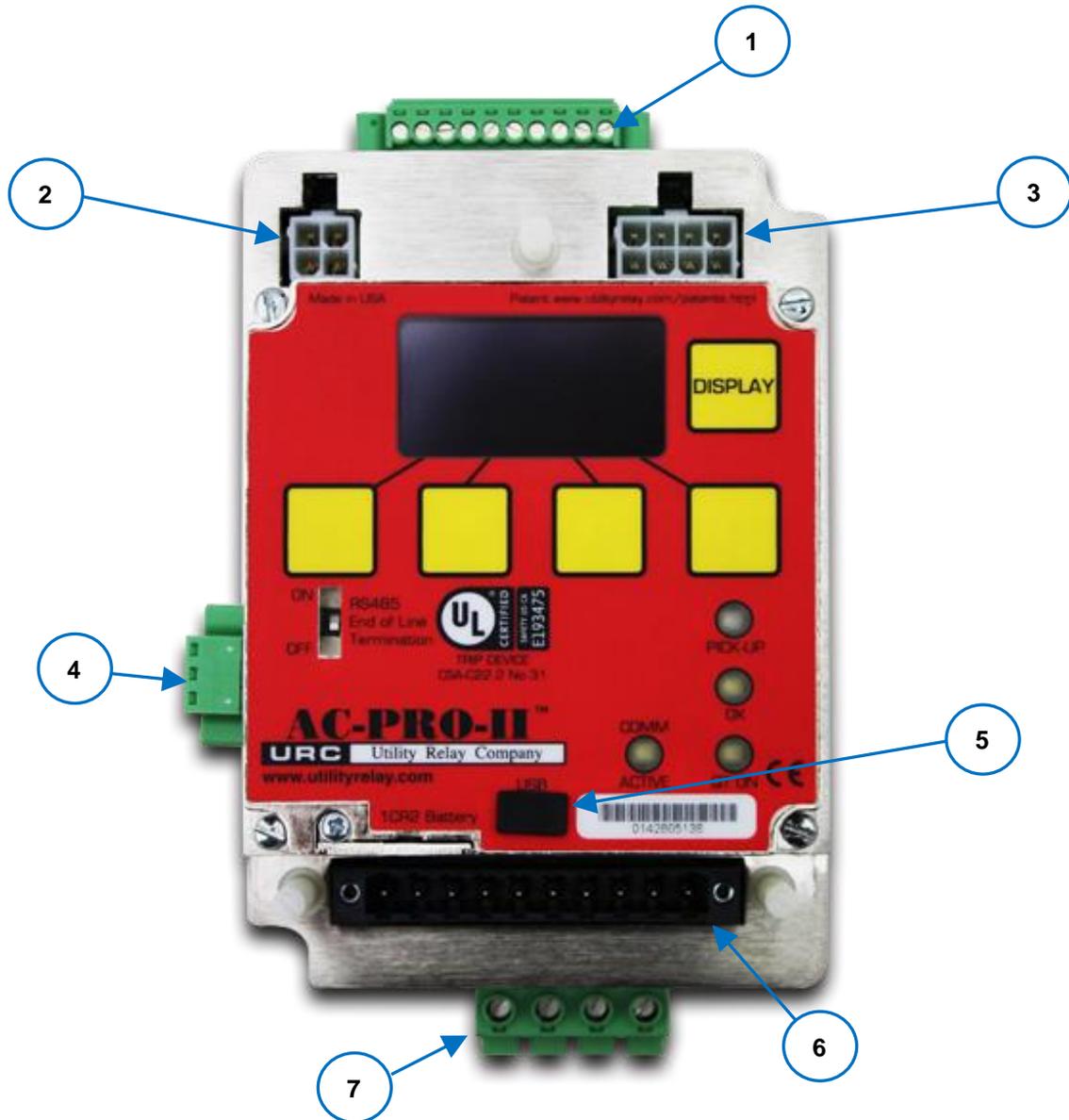


Figure 4.5: AC-PRO-II connectors and cables

5.0 External Connections



**Figure 5.1: AC-PRO-II (with VDM) External Connections - Vertical Bottom Configuration
(Breaker Harness at bottom, shown with wiring cover off)**

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Auxiliary Terminal Block <ol style="list-style-type: none"> a. Configurable alarm relay output b. Ground Fault Defeat input c. Breaker limit switch contact input 2. QUICK-TRIP connector 3. 24VDC Auxiliary power connector | <ol style="list-style-type: none"> 4. RS-485 Communications terminal block 5. Mini-USB port 6. Breaker wiring harness connection 7. VDM connection (VDM is optional) |
|---|--|

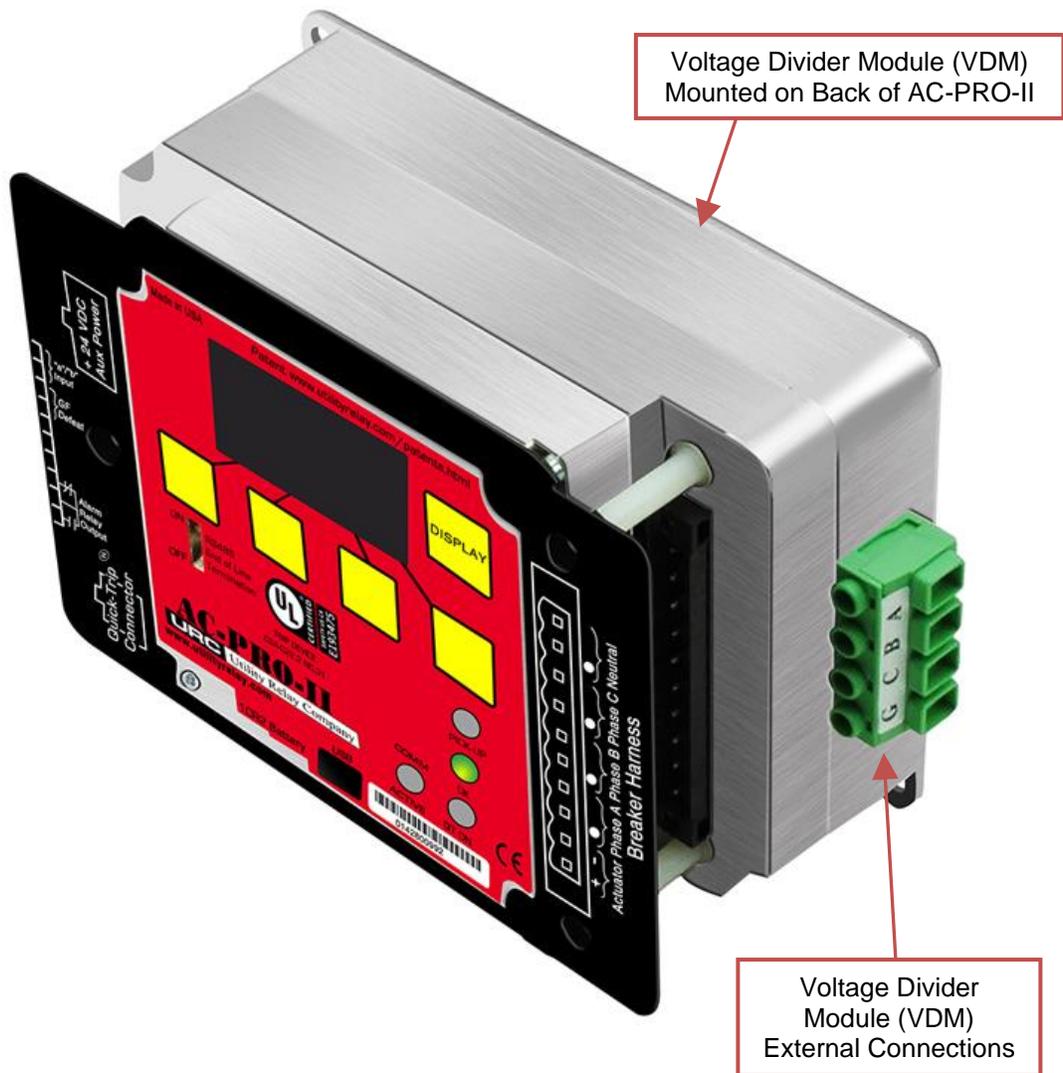


Figure 5.2: Voltage Divider Module (VDM) External Connections

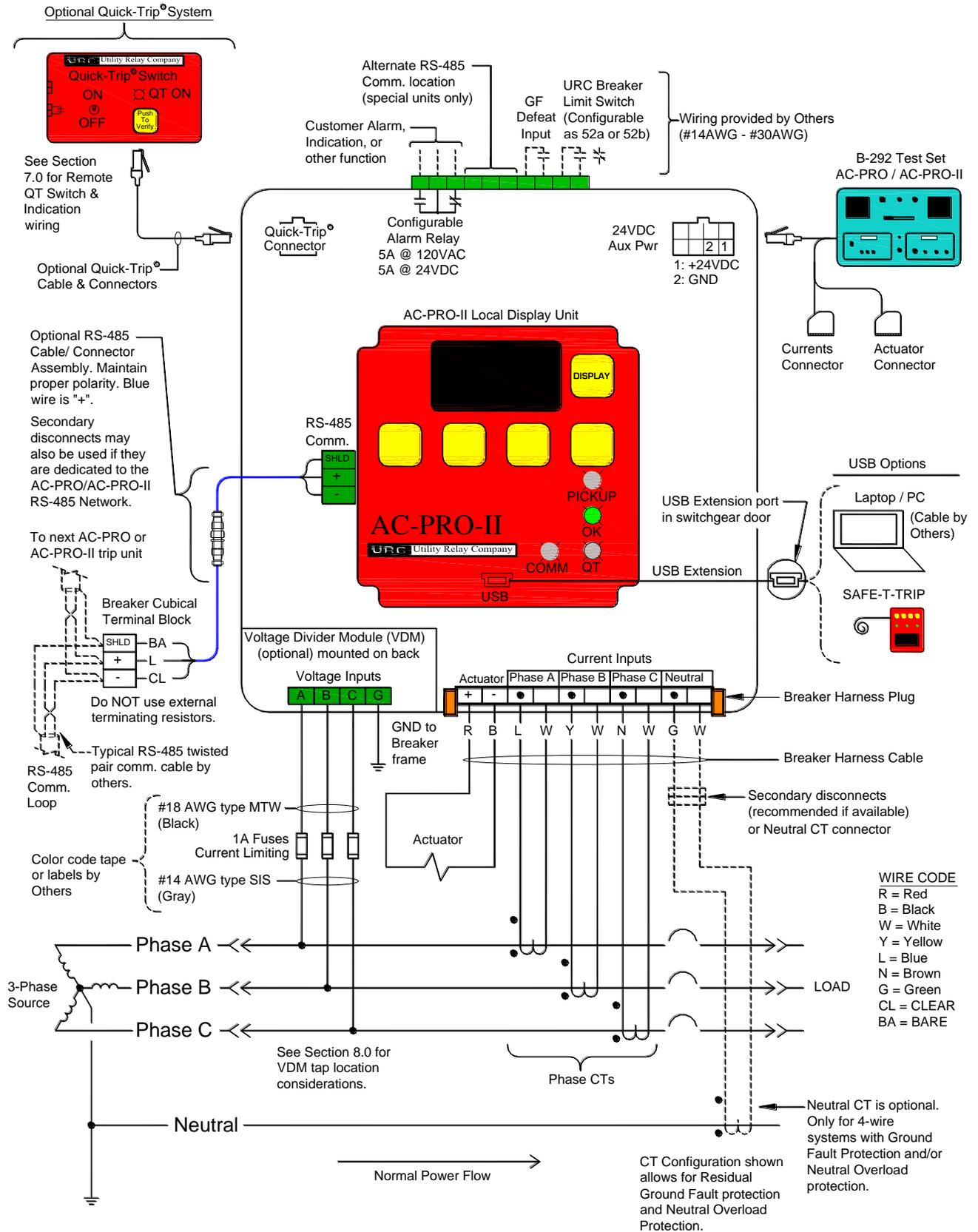


Figure 5.3: AC-PRO-II Typical Wiring Diagram

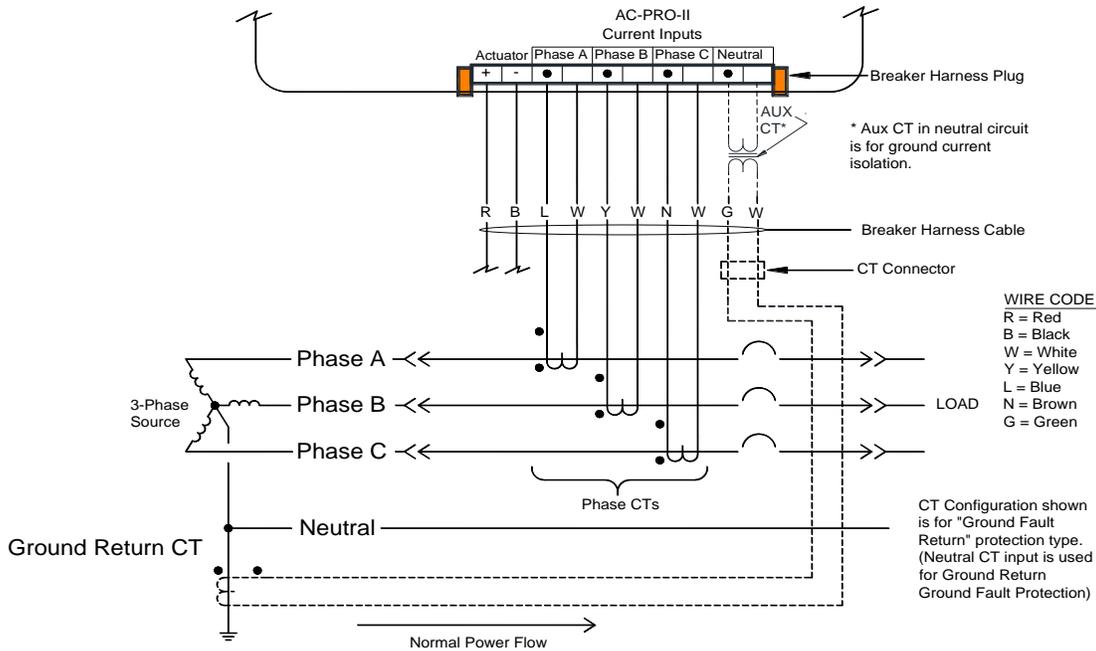


Figure 5.4: AC-PRO-II Typical Ground Return Wiring Diagram

5.1 Breaker Wiring Harness

The breaker wiring harness connects the trip unit to the CTs and actuator. The wiring harness plugs into the 10-pin connector on the front of the trip unit. The breaker wiring harness includes wires for the Actuator, Phase A CT, Phase B CT, Phase C CT, and optional Neutral CT. Two ejector levers are provided to help in disconnecting the harness connector. The ejector levers also lock the connector in place.

A neutral CT wiring harness is provided as part of the neutral CT installation kit. The neutral CT kit is required for units applied to 4-wire systems where Ground Fault protection is desired or required. The ground fault function on a 3-wire system does not require a neutral CT. Additionally, this connection method allows Neutral Overload Protection to be implemented.

The breaker wiring harness connection to the AC-PRO-II is compatible with existing AC-PRO breaker wiring harness.

5.1.1 Ground Fault Wiring Configurations

The AC-PRO-II is compatible with multiple types of existing Ground Fault protection schemes.

Figure 5.3 shows a residual Ground Fault wiring diagram. For this configuration, the AC-PRO-II calculates the residual Ground Fault current. If the system is a 4-wire (3-phase + neutral), the neutral CT must be provided if Ground Fault protection is desired.

Figure 5.4 shows a ground return Ground Fault wiring diagram. For this configuration, the AC-PRO-II directly measures the Ground Return current on the neutral current input. An Aux CT is supplied for current isolation in the ground circuit. This configuration only applies to 4-wire systems where Ground Fault protection is required. Neutral Overload protection cannot be implemented if the Ground Fault type is Ground Return.

See Section 11.13 for Ground Fault settings.

Contact Utility Relay Company if your Ground Fault Protection scheme is different than the typical schemes shown above.

****** NOTE ******

For Ground Fault protection at Mains & Ties of 4-wire double-ended substations, see Technical Bulletin #1 at the link below:
http://www.utilityrelay.com/Side_Bar/Technical_Bulletins.html

5.2 QUICK-TRIP® Connector

All AC-PRO-II trip units are equipped with the capability of connecting to an AC-PRO-II QUICK-TRIP Switch, which provides arc flash hazard reduction. Refer to Section 7.0 for QUICK-TRIP system information.

5.3 Auxiliary Connections

The auxiliary terminal block is available for the alarm relay output, Ground Fault defeat Input, and breaker position input. See the terminal labels in Figure 5.3.

Wiring for the auxiliary terminal block is not furnished in AC-PRO-II retrofit kits.

The auxiliary terminal block features set-screw connections and accepts #14 AWG - #30 AWG conductors.

5.3.1 Configurable Alarm Relay

The AC-PRO-II is equipped with an internal configurable alarm relay that has (1) Form C output contact for external wiring. The output contacts are rated 5A @ 120VAC or 5A @ 24VDC.

The configuration of this relay is included in the settings menu. All related alarms and errors result in a specific message on the display screen. The alarm relay can be configured to operate for any combination of the conditions

listed in Table 5-A. The reset method for each alarm condition is also listed in the Table below.

Alarm Condition	Reset Method
Trip	Manual reset
Internal Error	Auto reset
Actuator Open Error	Auto reset
Sluggish Breaker	Manual reset
UnderVoltage	Manual reset
OverVoltage	Manual reset
LT Pickup	Auto reset
Phase Loss/Rev (v2)	Auto reset
Ground Fault (v2)	Manual reset

“Manual” = reset by user

“Auto” = trip unit resets when condition no longer present

Table 5-A: Alarm Relay Configuration

The alarms listed as “Manual Reset” can be reset at the alarm screens or at the manual reset screen. Additionally, the alarm relay can be manually reset using the “More” menu. See Section 20.0 for the alarm screens and Section 20.3 for the manual alarm reset screen.

**** NOTE ****

If no other power source is available, the battery is used to reset the alarm relay. (applies to manual resets only)

5.3.2 Ground Fault Defeat Input

The Ground Fault defeat input is used to temporarily disable Ground Fault protection. Defeating Ground Fault protection is necessary for some protective schemes, for example double-ended switchgear that is operated with the tie breaker closed.

When the Ground Fault defeat input is open, the Ground Fault protective function will operate normally. When the Ground Fault defeat input terminals are shorted, the Ground Fault current (if any) will be calculated and displayed, however Ground Fault trips will not occur.

Note: If the GF Defeat input is opened during a Ground Fault event, the Ground Fault protection function will begin functioning and timing as soon as the Ground Fault Defeat input is opened.

5.3.3 URC Breaker Limit Switch

If a breaker position limit switch was provided by URC with the breaker retrofit kit, it can be wired to the breaker position contact “a/b” input for breaker position indication, and also to allow the patented Sluggish Breaker® detection feature to operate with low or no breaker current. The type of limit switch contact used is configured in the settings menu. The limit switch type can be set as 52a (contact is open when the breaker is open), or 52b (contact is closed when the breaker is open).

5.4 RS-485 Communications Terminal Block

The RS-485 communications terminal block on the AC-PRO-II provides communication using the industry standard MODBUS RTU protocol through a single shielded twisted pair cable. Refer to the Communications Section of this manual for additional information.

5.5 24VDC Auxiliary Power

The 24VDC auxiliary power port is available for connection to the following sources:

- 1) B-292 Secondary Injection Test Set.
- 2) T-490-ASM 24VDC Power Supply.
- 3) Customer supplied auxiliary power. See Section 3.4.

5.6 USB Port

The USB Port (mini-USB) on the front of the trip unit is electrically isolated and available for the following connection options:

- 1) Laptop or personal computer with InfoPro-AC software:
 - a. Download and/or print all data from trip unit, including settings, trip history, waveforms, etc.
 - b. Upload of new or modified settings to trip unit
 - c. Upload of firmware updates.
 - d. View trip unit currents, voltages, power, alarms, status, serial number, firmware version, etc.
- 2) SAFE-T-TRIP remote trip device.

A rubber cover is provided for the USB port.

**** IMPORTANT ****

Replace the USB port cover after use.

If the AC-PRO-II is installed on a breaker where the face of the trip unit is not concealed by a cubicle door, the USB port on the face of the trip unit itself can be safely accessed.

If the AC-PRO-II is installed on a breaker concealed behind a cubicle door, the kit will include a USB extender cable that mounts flush in the door. This allows the USB port to be used without opening the door. See Section 5.6.1 for USB extension cable information.

5.6.1 USB Extension cable

If AC-PRO-II is installed on a breaker that is located behind a cubicle door, a USB panel mount extension cable and legend plate is provided in the retrofit kit. This provides a permanent USB connection from the AC-PRO-II to a USB port that is accessible at the cubicle door. The cable (5/C, 6 feet long) features a right angle mini-USB connector for the AC-PRO-II and a USB port with cover, and a threaded nut for securing to the cubicle door.



Figure 5.5: USB Extension cable

5.6.2 USB Extension Cable Installation

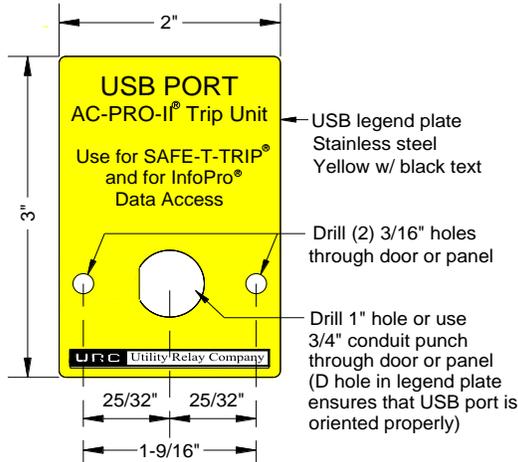


Figure 5.6: USB Extension Plate Drilling

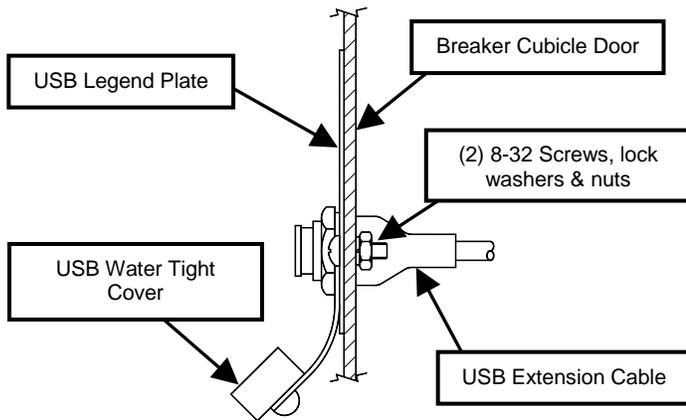


Figure 5.7: USB Extension Plate & Cable Installation

To install the USB Extension cable:

1. Find a suitable location on the cubicle door and mark the three (3) holes using the dimensions in Figure 5.6.
2. Drill two (2) 3/16" mounting holes.
3. For the center hole, cut a 1" diameter hole using a hole saw or alternately, use a 3/4" conduit knockout punch.
4. Attach the USB legend plate to the front of the cubicle door using the supplied two (2) 8-32 screws, nuts, and lock washers.
5. Connect the right-angle USB connector to the AC-PRO-II. Route the cable so it does not interfere with the opening or closing of the cubical door or with the racking of the breaker between connect and disconnect positions. Use the supplied cable ties and holders to hold the cable in position.
6. Position the USB port through the 1" opening and through the opening in the legend plate. Ensure one rubber washer is on the interior of the door / panel, and the threaded USB cover and rubber washer are on the exterior.
7. Thread the plastic nut onto the USB port connector, securing it to the door / panel.

5.7 VDM Connections (optional)

The optional Voltage Divider Module (VDM) is available for voltage-based protection and information functions. The VDM requires connection to the line-side bus of the breaker for Phase A, B, and C, as well as a connection to the breaker frame for Ground. Refer to Section 8.0 for additional Voltage Divider Module (VDM) information.

6.0 Menu Navigation

AC-PRO-II settings and information can be navigated using the push buttons on the face of the trip unit. Pressing the "DISPLAY" button wakes the display up from its power saving mode. After the display is on, all menu navigation is accomplished using the screen prompts and (4) smart buttons below the display. The smart button labels appear at the bottom of the screen.

In normal operation, the main screen is the first screen displayed after waking the display up. The main screen provides actual values for Phase A, B, and C current, as well as Neutral and Ground Fault currents. For Phase currents below 10% of the CT rating, "LOW" will be displayed. Neutral and Ground Fault fields will be blanked when these currents are below 10% of the CT rating.

Additionally, if a Voltage Divider Module (VDM) is present, the main screen also displays voltages for Phase A, B, and C. The main screen also provides access to four (4) main menus via smart buttons. See the main screen example below along with list of menus and sub-menus:

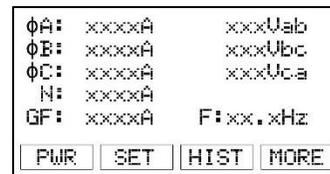


Figure 6.1: Main Screen
(Optional voltage values shown)

- 1) PWR (Power Menu): This menu provides access to power values, which become available if the optional Voltage Divider Module (VDM) is connected.
- 2) SET (Settings Menu).
 - a. REV (Review Settings sub-menu): This sub-menu allows review of all user settings without the option of changing the settings.
 - b. CHNG (Change Settings sub-menu): This sub-menu allows the user to change all protection, alarm, and breaker information settings.
 - c. TEST (Test Mode): See Section 14.1.1.
- 3) HIST (Trip History Menu): This menu provides access to trip history information for up to eight (8) trips.
- 4) MORE (Trip Unit Information Menu): This menu includes serial number(s), time & date settings, battery status, URC contact info, etc.

See Section 13.0 for information on values displayed on readings screens.

For reference, see the following table for common smart buttons and associated actions, which may appear depending on the specific screen.

Smart Button Label	Action
Next	Proceed to next screen or next setting
Back	Return the previous screen or previous setting
Exit	Return to the Main Screen
Up	Increase setting value or toggle to next setting value.
Down	Decrease setting value or toggle to previous setting value.
ON	Turn function or feature ON.
OFF	Turn function or feature OFF.

Table 6-A: Common Smart Button Actions

The following figure shows a simple view menu navigation map.

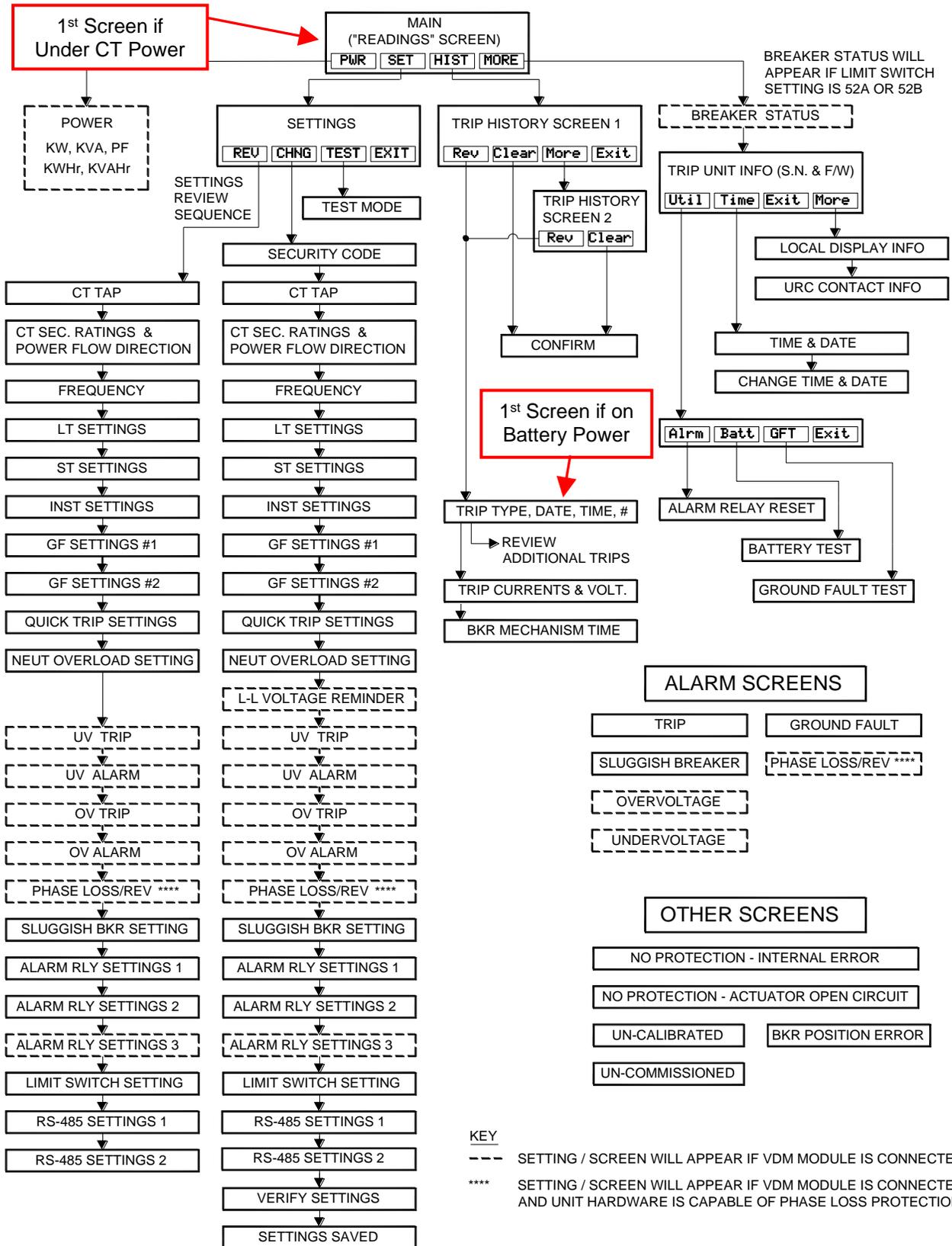


Figure 6.2: Typical AC-PRO-II Menu Navigation Map - Simple View

6.1 Power Menu

If the AC-PRO-II is equipped with the optional Voltage Divider Module (VDM), the power menu becomes available. The power menu is accessed from the main screen by pressing the "PWR" smart button. The smart buttons allow navigation to subsequent screens, which display power information, as well as the capability of resetting energy usage values. The figure below shows the flow of the Power Menu.

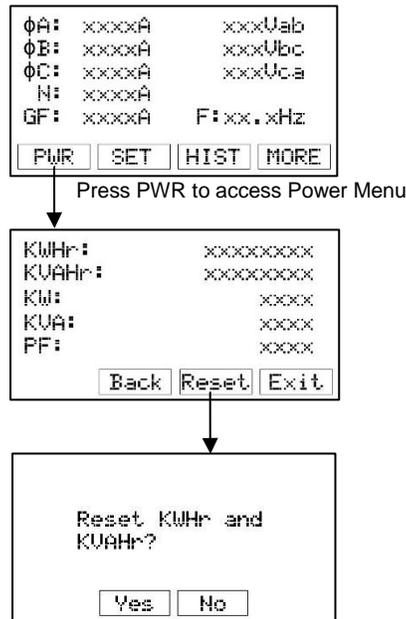


Figure 6.3: Power Menu Screens

Note: Power Menu only appears if the optional VDM is connected.

See Section 13.0 for information on values displayed on the readings screens.

6.2 Settings Menu

The settings menu provides the ability to review and modify settings. The first settings menu screen provides access to the following settings sub-menus by pressing the associated smart push buttons: review settings sub-menu, change settings sub-menu, and RS-485 settings sub-menu. See the settings menu first screen in the following figure:

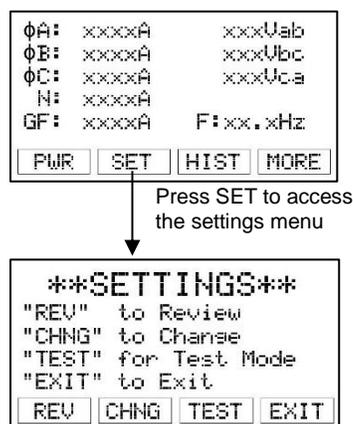


Figure 6.4: Settings Menu first screen

For details regarding Settings, refer to Section 11.0.

6.3 Trip History Menu

The AC-PRO-II stores data from the last eight (8) trips. The trip history menu displays this information. The trip unit stores trip counts, types, time stamps, and currents. If a VDM is connected, voltages will also be stored in the trip history. Additionally, the breaker mechanism times for all trips are stored. Refer to Section 12.0 for details regarding trip history and navigating the trip history menu. In addition to the data displayed on the trip unit display, the AC-PRO-II also saves current and voltage waveforms that can be displayed using InfoPro-AC Software. See Section 23.0.

6.4 More Menu

The more menu provides access to the following trip unit information and functions:

- 1) Trip unit serial number.
- 2) Local display serial number (this is separately provided since the local display can be separated from the trip unit).
- 3) Trip unit firmware revision number and VDM version number (if applicable).
- 4) Local display firmware revision number.
- 5) Viewing and setting time and date.
- 6) Manually reset the alarm relay
- 7) Battery test and status.
- 8) Utility Relay Company contact information.
- 9) Perform a Ground Fault Trip Test

6.4.1 Time and Date Setting

The time and date setting is accessed via the MORE menu, by pressing the MORE button at the main screen, then the time button, then the change button, as shown and noted below in Figure 6.5.

The time and date setting is important, as trip events and waveform captures are time stamped.

**** IMPORTANT ****

The time and date must be set after commissioning the AC-PRO-II or after replacing the battery to ensure the time stamps (of trips and on-demand waveforms) are recorded and are correct.

In order for the time and date to remain accurate after setting, a fresh battery must be in place.

There is no provision for daylight savings time.

6.4.2 Battery Test and Status

The trip unit internal battery state can be tested and viewed using the MORE menu. Press "MORE", then press "Util", then "Next" as shown below.

At the battery state screen, the battery voltage is not displayed until a battery test (during the current trip unit power cycle) is performed by pressing the test button.

6.4.3 Ground Fault Trip Test

The trip unit can perform a Ground Fault trip test. This simulates a measured Ground Fault condition, and tests the trip unit's ability to perform a trip. Ground Fault Protection or Quick-Trip Ground Fault Protection must be turned on to perform a Ground Fault Test Trip. See Figure 6.5.

7.0 QUICK-TRIP® System (optional)

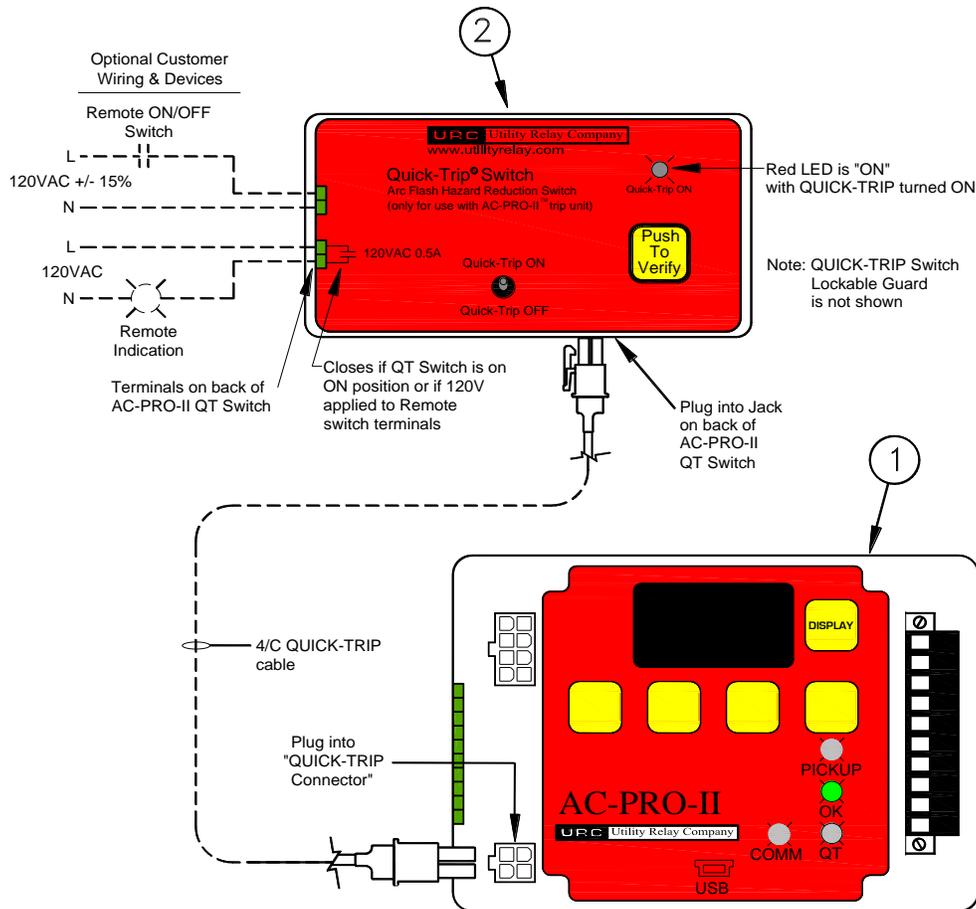


Figure 7.1: QUICK-TRIP System and Connections

7.1 QUICK-TRIP® Basics & Operation

The QUICK-TRIP system is a manually controlled arc flash hazard reduction system. It can reduce trip times when turned on and allows selective coordination between circuit breakers when turned off.

If maintenance personnel must work on energized equipment, they will first turn the QUICK-TRIP system on at the upstream breaker feeding the equipment or breaker. If a fault now occurs, the upstream breaker will trip quickly based on the QUICK-TRIP settings **reducing the Arc Flash Hazard to personnel.**

When the maintenance work is finished, the QUICK-TRIP system is turned off and the original selective coordination is back in effect.

The QUICK-TRIP system consists of the following components:

- 1) AC-PRO-II trip unit.
- 2) AC-PRO-II QUICK TRIP Switch: (URC Part #QT2-SWITCH) consisting of Padlockable QUICK-TRIP On/Off toggle switch, QUICK-TRIP On LED, Push-to-Verify button, Remote Switch Terminals, and Remote Indication Terminals.
- 3) 4/C QUICK-TRIP cable with connectors.

When QUICK-TRIP is **on**, the following settings are enabled:

- I QUICK-TRIP (I QT)
- GF QUICK-TRIP (GF QT)

These are standard AC-PRO-II settings. All other settings remain in effect. Refer to Section 6.2.

The "QUICK-TRIP ON LED" provides positive indication that the QUICK-TRIP settings are active if the LED is on. If the AC-PRO-II is not powered up (by current, voltage (VDM), USB or 24VDC Aux.), the QUICK-TRIP Switch "Push-to-Verify" button is available. Pressing this button will "wake up" the trip unit using the AC-PRO-II battery, and the QUICK-TRIP ON LED will illuminate, providing positive indication that the QUICK-TRIP switch or remote QUICK-TRIP switch is in the ON position.

**** NOTE ****

QUICK-TRIP Instantaneous and QUICK-TRIP Ground Fault features can be activated only if the AC-PRO-II is installed with (connected to) an AC-PRO-II QUICK-TRIP switch.

**** IMPORTANT ****

A qualified engineer must determine the QUICK-TRIP settings, calculate the incident energy levels and determine the Hazard Risk Categories (HRC).

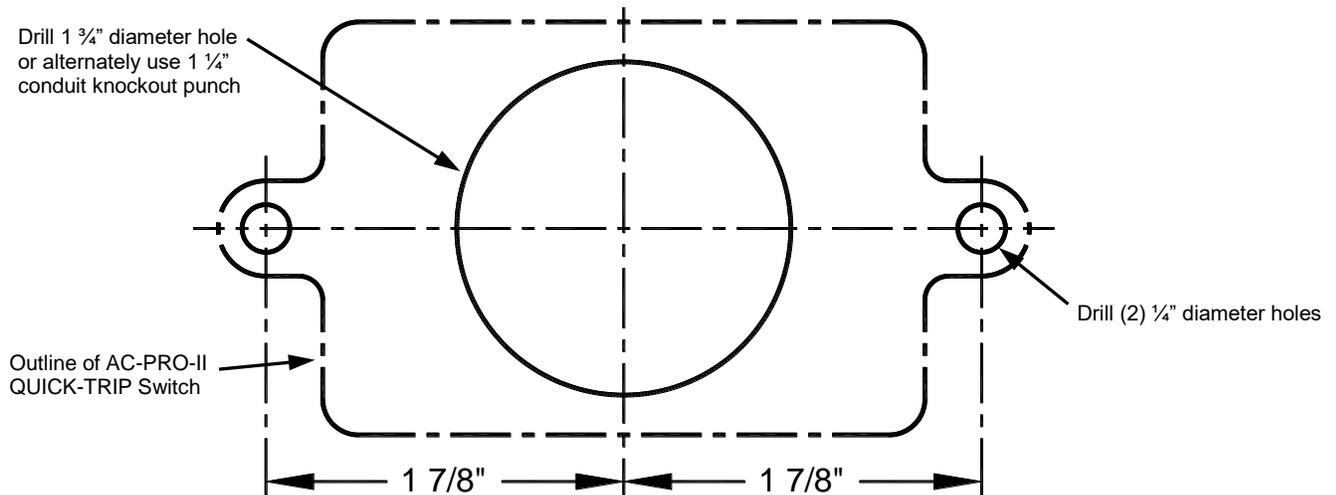


Figure 7.2: AC-PRO-II QUICK-TRIP Switch Drilling Plan

7.2 AC-PRO-II QUICK-TRIP® Switch Mounting

The QUICK-TRIP system is easy to install on the front of the breaker cubicle door.

To install the QUICK-TRIP Switch:

1. Find a suitable location on the cubicle door and mark the location of the three (3) holes using the dimensions in Figure 7.2.
2. Drill two (2) 1/4" mounting holes.
3. For the center hole, cut a 1-3/4" diameter hole using a hole saw or alternately, use a 1-1/4" conduit knockout punch (1.73" D).
4. Attach the QUICK-TRIP Switch to the front of the cubicle door using the two (2) supplied 10-32 screws and lock washers.
5. Connect the QUICK-TRIP Switch to the AC-PRO-II trip unit by plugging one end of the 4/C cable provided into the jack on the back of the QUICK-TRIP Switch. Plug the other end of the cable into the "QT" jack on the front of the AC-PRO-II.
6. Route the cable so it does not interfere with the opening or closing of the cubical door or with the racking of the breaker between connect and disconnect positions. Use cable ties and holders to hold the cable in position.

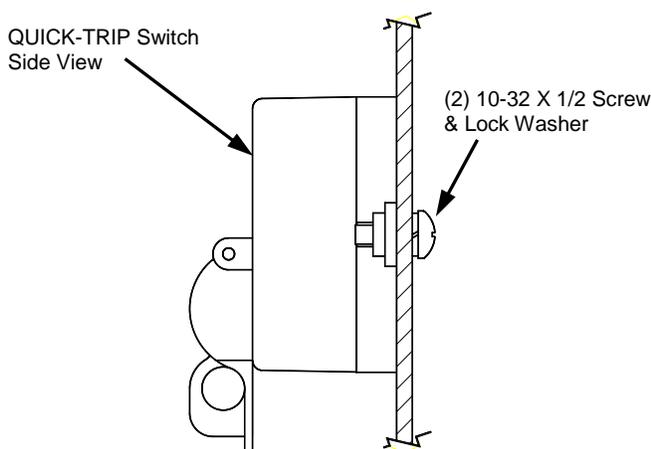


Figure 7.3: QUICK-TRIP Switch Mounting



Figure 7.4: AC-PRO-II QUICK-TRIP Switch

7.3 Remote QUICK-TRIP® Switch

The AC-PRO-II QUICK-TRIP switch includes terminals on the rear for connection to a remote QUICK-TRIP switch (provided by others).

Refer to Figure 7.1. If 120VAC (+/- 15%) is applied to the remote QUICK-TRIP switch terminals, the QUICK-TRIP settings are activated.

**** NOTE ****

QUICK-TRIP protection can be activated (by applying 120VAC to the remote Quick Trip switch terminals) even when the AC-PRO-II QUICK-TRIP toggle switch is in the OFF position. Therefore, if a remote QUICK-TRIP switch is installed, URC recommends installing label(s) or nameplate(s) that indicate the presence and location of the remote QUICK-TRIP switch.

7.4 QUICK-TRIP® Remote Indication

The AC-PRO-II QUICK-TRIP switch includes terminals on the rear for connection to a customer-supplied remote QUICK-TRIP indicating light or other device.

Refer to Figure 7.1. If the QUICK-TRIP System is activated (ON), the Remote QUICK-TRIP trip Indication contacts close. The contacts are rated 120VAC, 0.5A.

8.0 Voltage Divider Module (VDM) (optional)

The optional Voltage Divider Module (VDM) provides the following voltage-based protection and voltage and power calculations:

- Voltage Metering
 - Line-to-Line (v2 firmware)
 - Line-to-Neutral (v1 firmware)
- Power Metering: (KW, KVA, KWHr, KVAHr, Power Factor)
- Under-Voltage Trip & Alarm
- Over-Voltage Trip & Alarm
- Phase Loss/Reverse Trip and Alarm (requires VDM rev 2)

The VDM is rated for up to 600V three-phase power systems. In addition, the VDM provides continual power to the AC-PRO-II when the breaker line side is energized, allowing the trip unit to communicate breaker status even if the breaker is open or not carrying sufficient current. For that reason, the VDM option is recommended if the trip unit will be incorporated in a communications system to avoid possibility of intermittent communications.

The VDM mounts directly to the back of the AC-PRO-II and connects to the trip unit via an internal ribbon cable.

See Figure 5.2 for VDM picture and Figure 5.3 for a diagram.

**** IMPORTANT ****

The normal location for the VDM taps is the line side of the breaker. This results in continuous trip unit power when the breaker is racked into an energized cubicle, even when the breaker is open. This is desirable for communications applications where breaker position indication is desired.

For fused breakers where Phase Loss protection (for blown fuse conditions) is desired, the VDM taps must be located on the load side of the fuses. If continuous trip unit power is desired in these conditions, 24VDC Auxiliary power is recommended.

**** NOTE ****

In multi-source applications (i.e. Main-Tie-Main): Phase Loss protection will NOT provide blown fuse protection on tie breakers, or on main breakers where sources can be paralleled, since the VDM taps may be on "wrong" side of the fuse, since multiple sources exist.

Firmware Version	VDM (Hardware) Version	
	"VDM rev 1"	"VDM rev 2"
v1.x	Line-Neutral Voltages "Basic Voltage protection"	Line-Neutral Voltages "Basic Voltage protection"
v2.x	Line-Line Voltages "Basic Voltage protection"	Line-Line Voltages "Advanced Voltage protection"

Table 8-A: Voltage-based protection versions

"**Basic Voltage Protection**" is defined as OverVoltage and Brownout UnderVoltage. Basic voltage protection (using VDM rev 1) requires voltage to be present at the VDM (at least 90V between Va and Vb). See Sections 11.17.2 and 11.18.

"**Advanced Voltage Protection**" is defined as OverVoltage, UnderVoltage, and Phase Loss/Reverse Protection. Advanced Voltage Protection (using VDM rev 2 and firmware v2) requires CT power (10% current or greater), OR voltage at the VDM (>90V between Va and Vb), OR 24VDC Auxiliary power. Applying 24VDC Auxiliary power is recommended. This will allow the AC-PRO-II with VDM to provide advanced voltage-based protection, even when CT power or VDM power is not available (for example, in the event of a total power loss). See Sections 11.17.1, 11.18, and 11.19.

**** IMPORTANT ****

If line voltage is the only source to the trip unit (no current, no 24VDC aux power), it must be present for 5 seconds before a voltage-based trip can occur.

**** IMPORTANT – PHASE LOSS & UV ****

Reminder: Although AC-PRO-II derives power from the system current (CTs) and from system voltage (VDM), there are some UnderVoltage (UV) or Phase Loss circumstances (i.e. a total power loss, Phase Loss with no current, etc) where the AC-PRO-II is not powered by the CTs or the VDM. Therefore, if Phase Loss or UV protection is desired in these circumstances, reliable 24VDC Auxiliary power to AC-PRO-II is recommended.

8.1 Voltage-Based Protection

When equipped with the Voltage Divider Module (VDM), the AC-PRO-II can be used to provide voltage-based protection using the UnderVoltage, OverVoltage, and Phase Loss/Reverse features.

IMPORTANT: The AC-PRO-II with VDM voltage-based protection capabilities depend on the version of AC-PRO-II firmware and the version of the VDM. The VDM and Firmware version information can be viewed on the screen. See the Table 8-A for voltage features based on firmware and VDM versions.

NOTE: The AC-PRO-II Firmware version and the "VDM rev" can be viewed on the AC-PRO-II screen in the "More" menu. See Figure 6.5. From the "Main/Readings screen", press "More" to see this information.

9.0 SAFE-T-TRIP™ (optional)

The SAFE-T-TRIP remote trip device is available for the AC-PRO-II. The SAFE-T-TRIP allows an operator to trip open a breaker without standing in front of the breaker. It also provides a way to obtain the breaker mechanism operation speed for the important **first operation**. This is accomplished using the patented Sluggish Breaker feature in the AC-PRO-II.

The SAFE-T-TRIP device is furnished with a permanently connected 30-foot USB cable, allowing the breaker to be tripped without standing directly in front of the breaker, thus reducing the arc flash hazard risk.

The SAFE-T-TRIP device connects directly to the trip unit Mini-USB port or the door-mounted USB Extender.



The SAFE-T-TRIP device should not be operated while standing in front of a racked in breaker or breaker cubicle. The SAFE-T-TRIP is supplied with a 9V lithium battery, the attached USB cable with magnetic cable wrap (for stress relief), and Instructions, in a durable, waterproof case.



Figure 9.1: SAFE-T-TRIP



Figure 9.2: SAFE-T-TRIP in case

10.0 Sluggish Breaker™ Detection

The AC-PRO-II patented Sluggish Breaker Detection feature captures the breaker mechanism time when a trip occurs that was initiated by the trip unit. If the breaker mechanism time is in excess of the Sluggish Breaker mechanism time setting (see Section 11.20), an alarm message will appear, and if set, the alarm relay will operate.

If a “sluggish” trip occurs, breaker mechanism maintenance is required.

When the AC-PRO-II sends a trip pulse to the breaker actuator, the Sluggish Breaker timer starts. The trip unit determines the breaker mechanism time by one of two methods:

- 1) Zero Current Method: If a limit switch is NOT wired into the trip unit, the limit switch user setting should be set to “None”, and the trip unit will record the breaker mechanism time by monitoring the current values. The Sluggish Breaker timer stops when the current is zero. This method records the breaker mechanism time for each breaker pole.

**** NOTE ****

When using the zero current method, the Sluggish Breaker feature requires the pre-trip primary current to be 10% of the CT rating or greater.

- 2) URC Limit Switch Method: If a limit switch is wired into the trip unit, the limit switch user setting should be set to “52a” or “52b”, and the trip unit will record the breaker mechanism time based on the change in state of the limit switch. The Sluggish Breaker timer stops when the limit switch changes state. This method records one breaker mechanism time and reports the same value for each pole.



Figure 10.1: Sluggish Breaker Screen

11.0 Commissioning the AC-PRO-II®

Before the AC-PRO-II trip unit is put into service, it must first be commissioned so it will function. This requires the user to enter all of the pick-up and delay settings into the unit.

The commissioning process normally takes less than a few minutes to complete.

The AC-PRO-II can be commissioned using the local display screen, or using the InfoPro-AC software application. For commissioning using the local display screen, continue reading this section. For commissioning using the InfoPro-AC software application, see Section 23.0, and the InfoPro-AC help guide included in the application.



**** IMPORTANT ****

The trip unit will NOT FUNCTION as it is shipped from the factory. The user must first COMMISSION the unit as outlined in this Section or Section 11.3 to make it functional.

11.1 Powering-Up the Trip Unit for Commissioning

In normal service, the AC-PRO-II is powered directly from the breaker mounted CT's.

For commissioning, the trip unit can be powered up in any of the following ways:

11.1.1 Internal Battery

Press the "DISPLAY" button to power-up the trip unit using the internal battery.

The trip unit is designed to shut off automatically if none of the push buttons on the face of the unit are pressed for 60 seconds. It is best to have all the desired settings readily available before commissioning the unit when using the battery.

If the unit shuts down before the commissioning process is completed, the process must be started again from the beginning.

11.1.2 USB Power

Connect a laptop, PC, or USB wallpack to the front mini-USB port of the AC-PRO-II, or the USB extension port. The unit will be powered continuously, regardless of the power system current and voltage.

11.1.3 24VDC Auxiliary Power

Apply 24 VDC to the "+24VDC Aux Power" connector located on the front of the trip unit, primarily for the Secondary Injection Test Set. Refer to Section 15.0 for additional sources.

NOTE: 24VDC can only be applied to the specific pins identified in Figure 5.3.

11.2 Un-commissioned Screen

After the AC-PRO-II is installed on the breaker and powered up, it must be commissioned as follows:

- 1) Press the "DISPLAY" button to turn on the display.
- 2) The "Un-commissioned" message will appear (see figure below).



Figure 11.1: Un-commissioned Screen

Pressing "SET" will start the user settings process. See Section 11.3.

Pressing "MORE" will go to the "MORE" menu. See Section 6.4.

11.3 Entering & Changing Settings locally

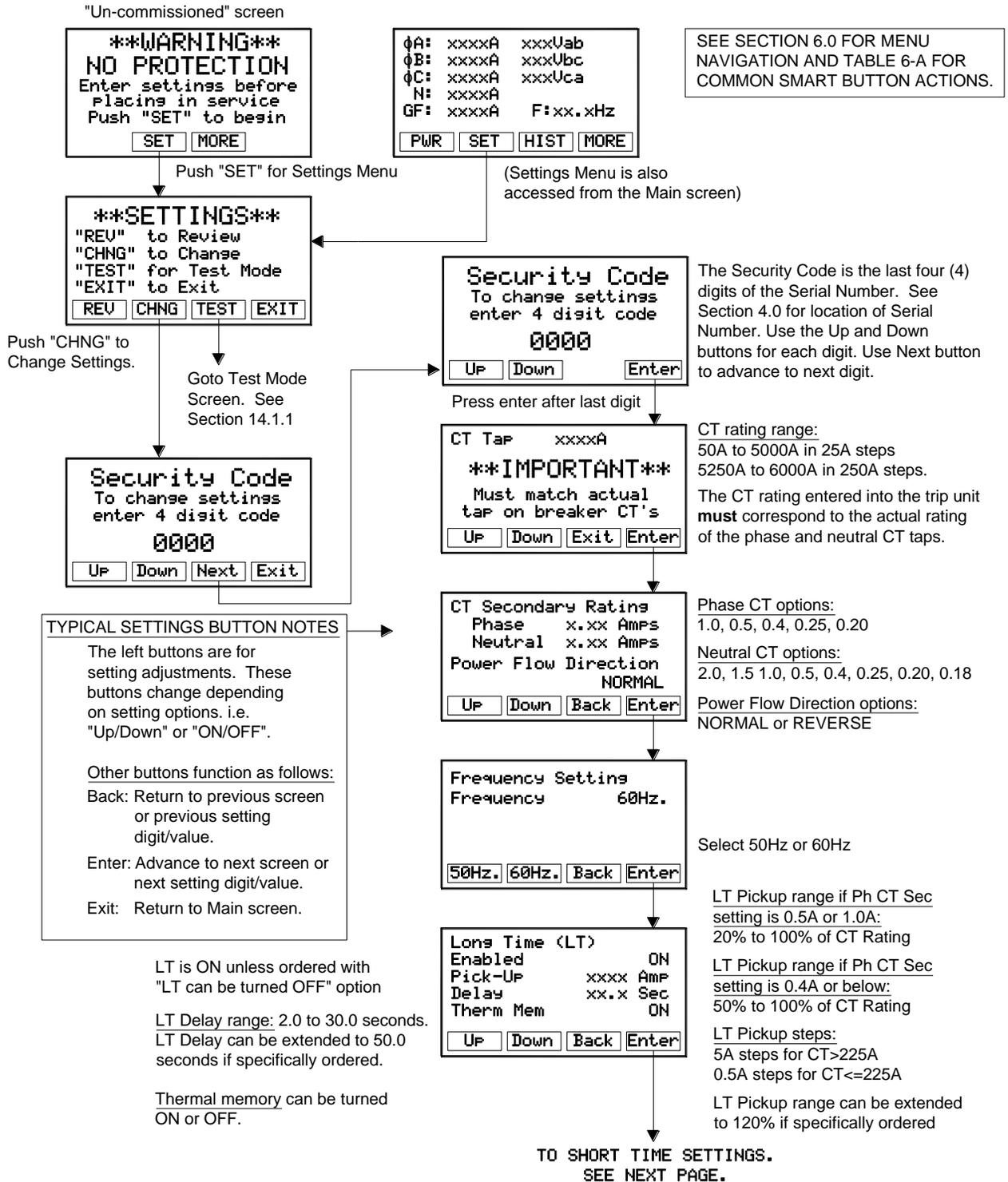


Figure 11.2: Change Settings Menu - Part 1

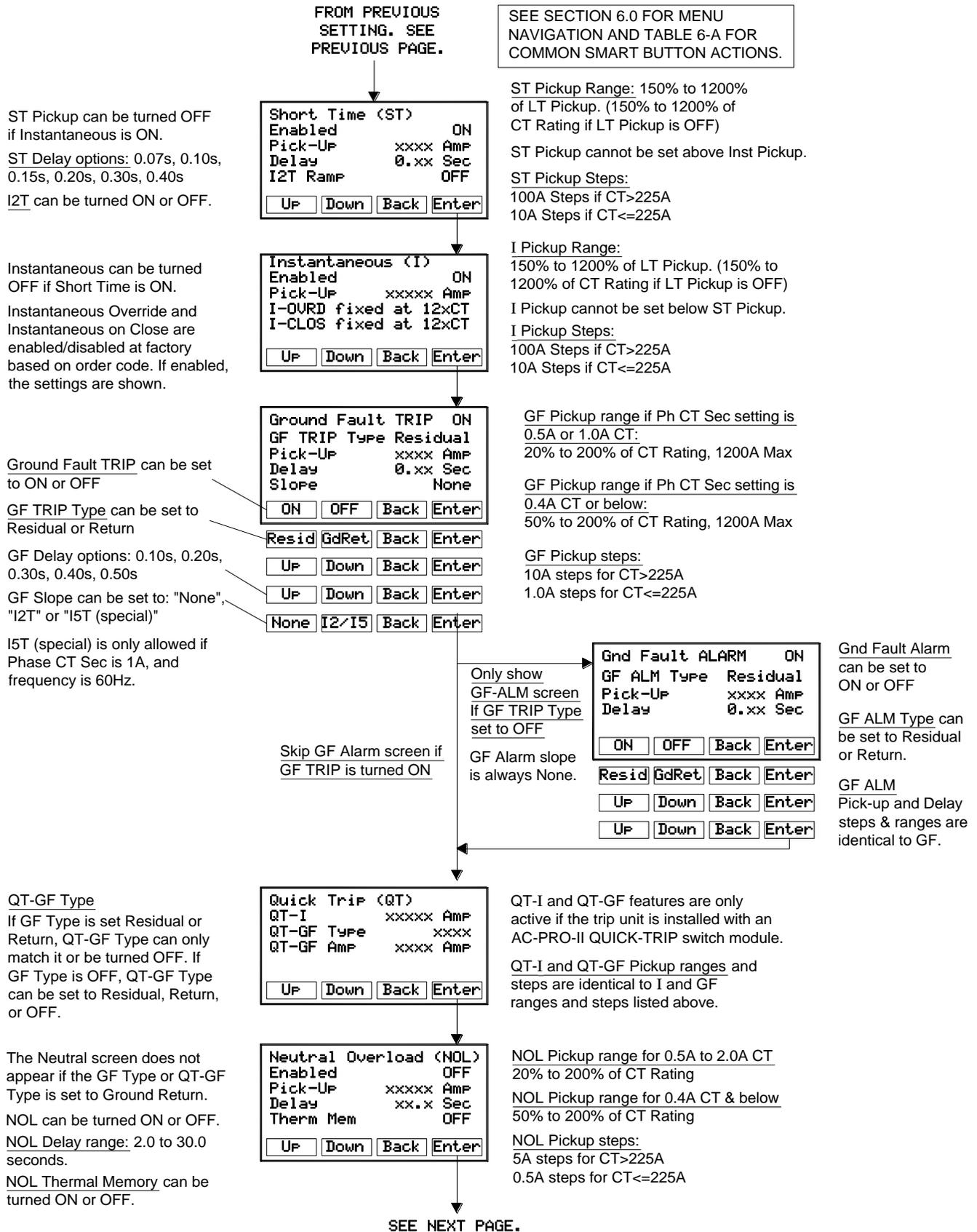


Figure 11.3: Change Settings Menu - Part 2

SEE SECTION 6.0 FOR MENU NAVIGATION AND TABLE 6-A FOR COMMON SMART BUTTON ACTIONS.

UV and OV Notes:

1. These screens only appear if the optional Voltage Divider Module (VDM) is connected.
2. The UV and OV functions are set using Line-to-Line voltages. (version 2 firmware) (version 1 firmware uses line-to-neutral voltages).
3. The UV and OV both have Trip and Alarm functions that can be turned ON or OFF. If the Alarm is ON, the Alarm Output Relay will be operated if a UV or OV event occurs.

```

UNDERVoltage Trip (UVT)
UV TRIP          ON
UV Pickup       xxxU L-L
UV Delay        xxx Sec
Up Down Back Enter
    
```

UV Pickup range & steps:
100 to 600V L-L, 1V Steps
If OV Trip or Alarm are ON, the highest UV Pickup setting available is 12V below OV Pickup.

UV Delay range & steps:
3 to 255 Seconds, 1S Steps

```

UNDERVoltage Alarm (UVA)
UV ALARM        ON
UV Pickup       xxxU L-L
UV Delay        xxx Sec
Up Down Back Enter
    
```

OV Pickup range & steps:
100 to 660V L-L, 1V Steps
If UV Trip or Alarm are ON, the lowest OV Pickup setting available is 12V above UV Pickup.

OV Delay range & steps:
1 to 255 Seconds, 1S Steps

```

OVERVoltage Trip (OVT)
OV TRIP         ON
OV Pickup       xxxU L-L
OV Delay        xxx Sec
Up Down Back Enter
    
```

```

OVERVoltage Alarm (OVA)
OV ALARM        ON
OV Pickup       xxxU L-L
OV Delay        xxx Sec
Up Down Back Enter
    
```

Ph Loss/Rev Notes:

1. These screens only appear if the optional Voltage Divider Module (VDM) is connected AND if the VDM hardware supports Phase Loss.
2. The Phase Loss/Rev function has Trip and Alarm functions that can be turned ON or OFF. If the Alarm is ON, the Alarm Output Relay will be operated if an Alarm condition occurs.
3. The system rotation is only set and displayed if Ph Loss/Rev trip or alarm is enabled.
4. The NegSeqOV pickup is only set and displayed if Ph Loss/Rev trip or alarm is enabled.

```

Ph Loss/Rev (φ-LOSS)
Trip            ON
Delay           XX Sec
Alarm           ON
System Rotation ABC
NegSeq-OV Pickup XX%
ON OFF Back Enter
    
```

Phase Loss /Reverse Delay
2 to 60 Sec in 1 sec steps

Phase Loss/Reverse Alarm
2 Sec ON delay & 1 Sec OFF delay (fixed)

```

UP DOWN
ABC CBA
    
```

System Rotation
ABC or CBA

Negative Sequence OV % Pickup
10-30%.
Default is 20%
10% is more sensitive
30% is less sensitive

SEE NEXT PAGE.

Figure 11.4: Change Settings Menu - Part 3

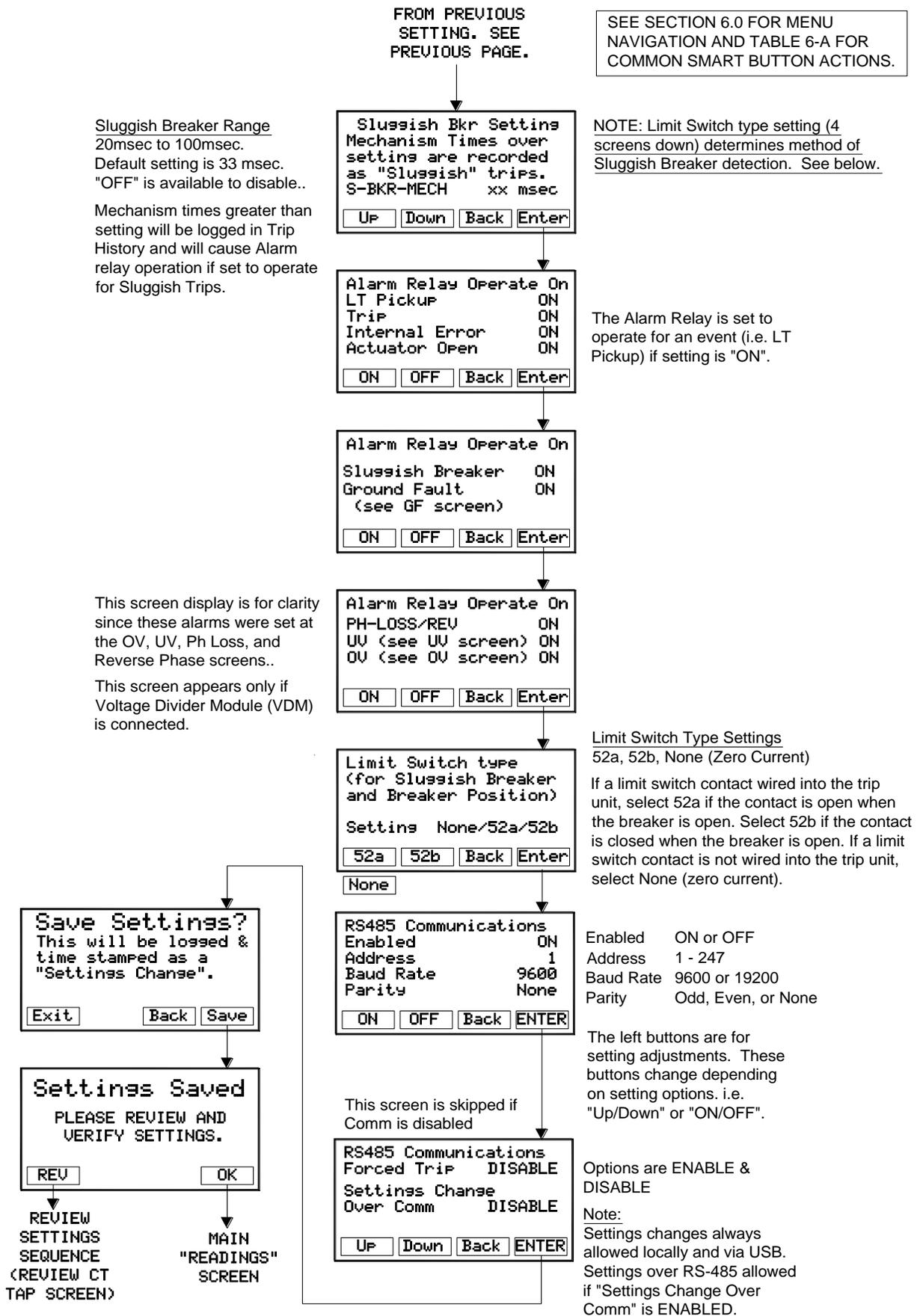


Figure 11.5: Change Settings Menu - Part 4

11.4 Security Code

The security code is the last four (4) digits of the serial number. See Section 4.0 for location of serial number. See Figure 11.2.

NOTE: For convenience, the AC-PRO-II offers a "Test Mode". When the AC-PRO-II is in Test Mode, the need for the Security Code is disabled for one (1) hour, after it is entered once. See Section 14.1.1

11.5 CT Tap

After the Security Code is entered, the first setting is the CT Tap (rating) in amps. The CT tap can range from 50 amps to 5,000 amps in 25 amp steps.

The CT rating entered into the trip unit **must** correspond to the actual rating of the phase and neutral CT taps. See Figure 11.2.

11.6 CT Secondary Rating

The CT secondary rating settings are entered in Amps and **must** correspond to the actual CT ratings. See Figure 11.2.

The Phase CT secondary rating is set in Amps with the following setting options:

1.0, 0.5, 0.4, 0.25, 0.20 Amp

The Neutral CT secondary rating is set in Amps with the following setting options:

2.0, 1.5, 1.0, 0.5, 0.4, 0.25, 0.20, 0.18 Amp

Note: the 0.18 CT secondary rating is an abbreviated representation of 0.185. The associated settings and performance are based on 0.185.

11.7 Power Flow Direction

The power flow direction setting only applies when a VDM is connected. When the CT wiring polarity matches Figure 5.3, the power flow direction should be set to "NORMAL". When the CT wiring polarity is the opposite of Figure 5.3, the power flow Direction should be set to "REVERSE".

Note: This setting affects the KVA and KVAHr values displayed by the trip unit. See Section 13.0.

11.8 Frequency

Set the AC-PRO-II frequency to match the power system frequency. The setting options are 50 Hertz and 60 Hertz. See Figure 11.2.

11.9 Long Time (LT)

The Long Time (LT) settings screen includes the following settings: Enabled (ON or OFF), pick-up, delay, and thermal memory.

See Figure 11.2 for Long Time protection settings notes, ranges, steps, and options.

Long Time (LT) protection is ON, unless the trip unit is ordered with the "LT can be turned OFF" option.

Please note that the LT trip time is not a constant value, but is a function of breaker current. For lower currents the trip time is longer, and for higher currents the trip time is shorter. See Figure 18.1 for Time Current Curve.

See Section 18.1 for LT Trip Times.

11.10 Thermal Memory

The AC-PRO-II trip unit has a thermal memory feature for the following protective functions:

- Long Time (LT) (set at Long Time screen)
- Short Time (ST)
- Ground Fault (GF) (always on)
- Neutral Overload (set at Neutral Overload screen)

The thermal memory feature for LT and ST can be turned on or off at the LT screen. See Figure 11.2.

Thermal memory for the GF function is always on and cannot be turned off. The GF thermal memory feature provides protection against "sputtering" ground faults.

Except for unusual conditions, it is recommended that the thermal memory feature for LT and ST should be turned on.

Cycling overloads that are not above the LT Pick-Up long enough to cause a trip can still lead to thermal damage to wiring and equipment. With thermal memory turned on, a cycling overload can still produce a LT trip to protect cables and equipment even if any individual overload event did not persist long enough to directly cause a LT trip.

With thermal memory turned off, an overload that drops below the LT Pick-Up will reset the LT trip register. If the current goes above the LT Pick-Up again, the LT trip register starts from zero.

11.11 Short-Time (ST)

The Short Time (ST) settings screen includes the following settings: enabled (ON/OFF), pick-up, delay, and I²T ramp (ON/OFF).

See Figure 11.3 for ST protection settings, notes, ranges, steps, and options.

**** NOTE ****

The trip unit does not allow setting both the ST and Instantaneous to be set to OFF at the same time.

See Figure 18.1 for the Time Current Curve.
See Section 18.2 for ST Trip Times.

11.12 Instantaneous (I)

The Instantaneous (I) settings screen includes the following settings: enabled (ON/OFF) and pick-up.

See Figure 11.3 for Instantaneous settings, ranges, and steps.

**** NOTE ****

The trip unit does not allow setting both the ST and Instantaneous to be set to OFF at the same time.

See Figure 18.1 for the Time Current Curve.

In addition, the Instantaneous settings screen displays the Instantaneous override and Instantaneous-on-close features if they are enabled. These features are fixed and set at the factory. See below:

Instantaneous Override (I-OVRD): The AC-PRO-II is configured at the factory with this feature either ON or OFF. If the feature is ON, a fixed Instantaneous pickup of 12 times the CT rating is applied. In some applications, this feature is enabled at the factory to protect the specific breaker this trip unit is paired with. Additionally, this feature can be enabled if requested at the time of order. Unless specified or specifically required to protect the breaker, AC-PRO-II trip units are normally configured with this feature OFF.

Instantaneous-on-Close (I-CLOS): The AC-PRO-II is configured at the factory with this feature ON or OFF. If this feature is ON, a fixed Instantaneous pickup of 12 times the CT rating is applied for only the first 6 cycles (96ms for 60Hz) after initial current flow: after the trip unit powers up, or after the current transitions from very low current (less than 2.5% of CT rating), to current greater than 12 times the CT rating. Unless specified at the time of order, AC-PRO-II trip units are normally configured with this feature ON.

Note: The AC-PRO-II uses a unique algorithm to determine if RMS currents greater than 12 times the CT rating are present, in which case the CTs may be saturated. The AC-PRO-II then corrects the effect of CT saturation on the LT and ST trip functions.

The AC-PRO-II features redundant Instantaneous protection. The primary Instantaneous is an analog peak-detecting circuit that directly trips the actuator, regardless of the state of the microprocessor. The microprocessor provides digital backup Instantaneous protection for the analog circuit.

11.13 Ground Fault (GF) Protection

The Ground Fault screens include the following settings: GF trip type, pick-up, delay, slope. In addition, if the GF trip function is turned OFF, a GF Alarm function can be turned ON.

GF type can be set to residual, ground return, or OFF)

The residual GF method calculates a vector sum of the three phase currents (and neutral current if applicable) and determines the fundamental frequency component. The ground return method is used for applications where a ground return CT directly measures the GF current, and the AC-PRO-II calculates the fundamental value. See Section 5.1.1 for typical wiring diagrams of the two ground fault methods.

See Figure 11.3 for Ground Fault settings notes, ranges, steps, and options.

See Figure 18.2 for Ground Fault Time Current Curve.

**** NOTE ****

On a 4-wire system, a neutral CT must be installed to avoid nuisance GF trips.

**** NOTE ****

Due to possible CT saturation, RMS currents greater than 12 times the CT rating are not considered in the GF protection calculations. The ST and/or Instantaneous functions will provide protection for these currents.

**** IMPORTANT ****

To implement GF protection on the main breakers and the tie breaker of a double ended 4-wire substation, see the following Technical Bulletin:
http://www.utilityrelay.com/Side_Bar/Technical_Bulletins.html

11.14 Neutral Overload (NOL) Settings

The neutral overload (NOL) screen includes the following settings: enabled (ON/OFF), pick-up, delay, and NOL thermal memory.

See Figure 11.3 for NOL settings notes, ranges, steps, and options.

See Figure 18.2 for the NOL Time Current Curve (TCC).

The NOL thermal memory feature operates the same as the LT and ST thermal memory feature. See Section 11.10 for a description.

**** NOTE ****

Neutral Overload (NOL) protection cannot be enabled if the Ground Fault (GF) type is set to ground return. This is because with the ground return method, the neutral CT input is used for GF protection and thus cannot be used for NOL protection.

11.15 QUICK-TRIP® Instantaneous (QT-I)

This setting only applies if the AC-PRO-II QUICK-TRIP switch module is installed and connected. See Section 7.0 for details.

The QT-I pickup range and steps are the same as the Instantaneous pickup range and steps.

See Figure 18.4 for the QUICK-TRIP Time Current Curves (TCC).

The QT- I function does not have an OFF setting. It is turned ON or OFF using the QUICK-TRIP ON-OFF selector switch. If the AC-PRO-II QUICK-TRIP switch module is not installed, then this function is always off.

11.16 QUICK-TRIP Ground Fault (QT-GF)

This setting only applies if the AC-PRO-II QUICK-TRIP switch module is installed and connected. See section 7.0 for details.

The QUICK-TRIP GF feature has two settings: QT-GF type and QT-GF pick-up.

If GF type is set to OFF, QT-NG type can be set to residual, return, or OFF. If GF type is set to residual or return, the QT-GF type can only match it or be turned OFF.

The QT-GF pick-up range and steps are the same as the GF pickup range and steps.

See Figure 18.4 for the QUICK-TRIP Time Current Curves (TCC).

11.17 Undervoltage (UV)

This setting only applies if the AC-PRO-II is installed with the optional Voltage Divider Module (VDM).

The Undervoltage (UV) function of the AC-PRO-II utilizes RMS voltages and a definite time delay, to provide three-phase UV protection.

See Table 8-A in Section 8.1 for determining if your unit has "Basic" or "Advanced" voltage-based protection.

11.17.1 Basic Undervoltage

The Basic UnderVoltage (UV) function uses voltage magnitude only, which provides "brownout" protection, using adjustable UnderVoltage pickup and delay settings. "Brownouts" are when system voltage is still present, but the voltages are lower than the nominal system voltage. UnderVoltage protection is not intended to be "Phase Loss" protection and will not operate reliably in the event of a total phase loss, or total system outage. Firmware v1 uses line-to-neutral voltages. Firmware v2 uses line-to-line voltages.

The UV function is disabled under the following conditions:

- If a Secondary Injection Test set is connected.
- After a UV trip, repeated UV trips are blocked until current is re-established, until the limit switch changes state (if used), or until the UV condition goes away. (firmware v1 only uses current re-established)
- When the AC-PRO-II is in "Test Mode". See Section 14.1.1 (v2 firmware only)
- If (2) Phase currents are "LOW" (v1 firmware only)

****** IMPORTANT ******

For Undervoltage trips and alarms to occur, the following conditions must be present:

1. At least (2) phase currents must be greater than 10% of the CT rating. (v1 firmware only)
2. The Phase A-to-B voltage must be greater than 90V.

****** IMPORTANT ******

The Basic Undervoltage function will not operate in the event of a total phase loss or total system outage. The UnderVoltage function is not "Phase Loss" protection.

****** IMPORTANT ******

Use caution when using the Undervoltage (UV) Trip function on Non-solidly grounded systems. (v1 firmware uses line-to-neutral voltages).

11.17.2 Advanced Undervoltage

The Advanced UnderVoltage (UV) function uses line-to-line voltage magnitude only, with adjustable UnderVoltage pickup and delay settings.

See Figure 11.4 for UV settings notes, ranges, steps, and options.

The UV function is disabled under the following conditions:

- If a Secondary Injection Test set is connected.
- After a UV trip, repeated UV trips are blocked until current is re-established, until the limit switch changes state (if used), or until the UV condition goes away.
- When the AC-PRO-II is in "Test Mode". See Section 14.1.1 (v2 firmware only)

****** IMPORTANT ******

For Undervoltage trips and/or alarms to occur, at least one (1) of the following conditions must be present:

1. The Phase A-to-B voltage must be greater than 90V, OR
2. At least (1) phase current must be greater than 10% of the CT rating, OR
3. 24VDC Auxiliary power must be present.

11.18 Overvoltage (OV)

This setting only applies if the AC-PRO-II is installed with the optional Voltage Divider Module (VDM).

The Overvoltage (OV) function of the AC-PRO-II utilizes voltage and a definite time delay, to provide three-phase OV protection.

Version 1 firmware uses Line-to-Neutral voltages.
Version 2 firmware uses Line-to-Line voltages.

See Figure 11.4 for OV settings notes, ranges, steps, and options.

The OV function is disabled under the following condition:

- After an OV trip, repeated OV trips are blocked until current is re-established, until the limit switch changes state, or until the UV condition goes away. (firmware v1 only uses current re-established).
- When the AC-PRO-II is in "Test Mode". See Section 14.1.1. (v2 firmware only)

****** IMPORTANT ******

Use caution when using the Overvoltage (OV) Trip function on Non-solidly grounded systems. (v1 firmware uses line-to-neutral voltages)

11.19 Phase Loss / Reverse

This setting only applies if the AC-PRO-II is installed with the optional rev 2 Voltage Divider Module (VDM) and Version 2 firmware.

The Phase Loss / Reverse feature utilizes Negative Sequence Overvoltage calculations to determine if a Phase Loss or Reverse Phase condition is present.

See Figure 11.4 for Phase Loss / Reverse settings notes, ranges, steps, and options.

The Phase Loss/Reverse function is disabled under the following conditions:

- If a Secondary Injection Test set is connected.
- After a Phase Loss/Reverse trip, repeated trips are blocked until current is re-established, until the limit switch changes state (if used), or until the Phase Loss condition goes away.
- When the AC-PRO-II is in "Test Mode". See Section 14.1.1 (v2 firmware only)

****** IMPORTANT ******

For Phase Loss/Reverse trips and alarms to occur, at least one the following conditions must be present:

1. At least (1) phase current must be greater than 10% of the CT rating, OR
2. The Phase A-to-B voltage must be greater than 90V, OR
3. 24VDC Auxiliary power must be present.

In order to provide Phase Loss / Reverse protection, the power “System Rotation” setting of “ABC” or “CBA” must be entered correctly. If the system rotation is not known, the Phase Loss/Reverse Alarm feature can be used as a check, without initiating a trip.

Determining System Rotation:

1. Remove the breaker from service.
2. Ensure the VDM phasing is wired correctly (i.e. Phase A breaker stab through fuse block to AC-PRO-II VDM phase A, etc).
3. Set Phase Loss/Reverse Trip to OFF.
4. Set Phase Loss/Reverse Alarm to ON.
5. Set System Rotation to ABC.
6. Set NegSeq-OV Pickup to 20%.
7. Save Settings.
8. Rack the breaker into the connected position.
9. Verify the VDM reads 3-phase voltage.
10. If a Phase Loss/Reverse Alarm occurs, then the System Rotation setting is not correct. If a Phase Loss/Reverse Alarm does not occur, then the System Rotation ABC setting is correct.

**** NOTE ****

In multi-source applications (i.e. Main-Tie-Main): Phase Loss protection will NOT provide blown fuse protection on tie breakers, or on main breakers where sources can be paralleled, since the VDM taps may be on “wrong” side of the fuse, since multiple sources exist.

11.20 Sluggish Breaker Setting

The Sluggish Breaker setting range is 20ms – 100ms. The default setting is 33ms.

The following steps are recommended for determining the Sluggish Breaker setting on a recently serviced breaker with a mechanism in good operating condition:

1. Perform Primary or Secondary Injection to initiate a ST or LT trip; or use the SAFE-T-TRIP device to initiate a trip. If using SAFE-T-TRIP on a breaker that does not have primary current flowing through it, or if using Secondary Injection, a 52a or 52b limit switch must be wired to AC-PRO-II.
2. Use the trip history menu to review the recorded breaker mechanism times of the trip initiated in step 1 above. The breaker mechanism times should be in the 20ms to 100ms range. The total trip time (different than breaker mechanism time) should conform to the Time Current Curve in Figure 18.1.
3. URC recommends setting the Sluggish Breaker time to be 17ms greater than the recorded mechanism time from step 2.

See Figure 11.5 for Sluggish Breaker setting screen.

See Section 10.0 for additional information about the Sluggish Breaker feature.

11.21 Configurable Alarm Relay Settings

The alarm relay configuration occurs via two alarm relay settings screens, where the alarm relay can be set to operate for any combination of events. If the setting is “ON”, the relay will operate for that particular event/condition. See Figure 11.4 for alarm relay settings options and notes.

Refer to Section 5.3.1 and Table 5-A for additional information about the configurable alarm relay.

11.22 Limit Switch Type Setting

If a limit switch is wired to the AC-PRO-II, the contact type is set at this screen. If the limit switch contact is open when the breaker is open, select 52a. If the limit switch contact is closed when the breaker is open, select 52b. Refer to the breaker-specific AC-PRO-II kit installation manual supplied with the kit. If a limit switch is not wired into the trip unit, this setting should be None. See Figure 11.4.

Note that this setting affects the Sluggish Breaker detection method. See Section 10.0.

11.23 Communications Settings

The AC-PRO-II is capable of communicating over an RS485 network via Modbus RTU protocol. The RS485 communications screen includes the following settings:

Communications Enabled: Set to ON if RS485 communications is desired.

Address: Each trip unit that shares the same twisted pair must have a unique address. The address identifies each individual trip unit connected to the same twisted pair.

Note: two trip units can have the same Address as long as they are not connected to the network via the same twisted pair cable.

The address is selectable from 1 to 247, in increments of 1. In most applications, only addresses 1 through 32 will be used due to the limitations of RS485 communications.

Baud Rate should be selected to match the baud rate of the master communicating device (i.e. PC, gateway, etc.).

Parity should be set to match the parity of the master communicating device (i.e. PC, gateway, etc.).

Forced Trip: If enabled, this feature permits tripping of the breaker via a forced trip command over RS485 communications.

Settings Change Over Communications: If enabled, this feature permits the user to make settings changes via the communications network. Otherwise, settings can only be changed at the AC-PRO-II using the smart buttons or using the local USB connection.

NOTE: The CT settings can only be changed at the AC-PRO-II.

See Figure 11.5 for setting options and Section 24.0 for additional Communications information.

11.24 Saving Settings

Once the last setting is entered, the "Save Settings?" screen will appear. The save settings screen also provides a reminder that if the "Save" button is pressed, the settings will be saved, logged, and time stamped as a "Settings Change". The settings change time stamp is stored and available via Modbus communications.

Pressing "Exit" will return to the Main screen.
Pressing "Back" will return to the previous setting screen.

11.25 Settings Verification

Once the settings are saved, the "REV" and "OK" buttons are available at the "Settings Saved" screen.

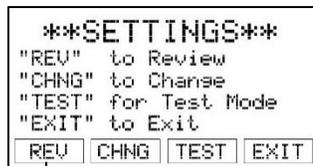
Pressing "REV" will lead to the review settings sequence.
Pressing "OK" will lead to the main screen.

To complete the entering or changing settings process, press "REV" to review and confirm all settings entered.

The settings review sequence is very similar to the settings change sequence, except the settings are only viewed and cannot be changed. The existing settings are viewed and navigated with the "Next" and "Back" buttons. See below and Figure 6.2.

11.26 Settings Review

Settings can also be changed, reviewed, saved, and printed using the InfoPro-AC software application.



To Settings
Review Sequence.

Figure 11.6: Settings Screen - Review Button

See Figure 6.2 for the settings review sequence.

11.27 Time & Date Settings

See Section 6.4.1 for the time & date Settings.
NOTE: It is important to set the time & date for time stamping of events.

12.0 Trip History

The AC-PRO-II stores the trip data for the last 8 trip events. The stored trip data includes the following:

1. Trip counts
2. Trip type (see Table 12-A for types)
3. Time stamp (date and time).
4. Trip number (1-8, assigned by trip unit)
(if trip is the "Last trip", this will be identified on the screen).
5. Phase currents and voltages
6. Neutral and ground currents
7. Breaker mechanism time for each phase
8. Waveforms can be viewed using InfoPro-AC software application only. See Section 23.0.

This data can be accessed using the Trip History Menu. See Figure 12.1.

NOTE: The date and time must be set properly, and a fresh battery must be installed to ensure accurate trip history date and time stamps.

Trip Type Abbreviation	Trip Type Description
LT	Long Time
ST	Short Time
I	Instantaneous
I-OVRD	Instantaneous Override
I-CLOS	Instantaneous on Close
GF	Ground Fault
NOL	Neutral Overload
QT-I	QUICK-TRIP Instantaneous
QT-GF	QUICK-TRIP Ground Fault
UV	Under Voltage
OV	Over Voltage
Forced	Modbus Communications trip
SAFE-T	SAFE-T-TRIP Hand held device trip
Ph Loss/Rev	Phase Loss / Reverse (NSOV) (v2)
GFT	Ground Fault Test Trip (v2)

Table 12-A: Trip Types

The trip history data, including the associated waveform capture data, can be viewed, saved and printed using the InfoPro-AC software application. All trip unit data is also available via RS485 Modbus RTU communications.

To ensure accurate recording of breaker mechanism times, and proper Sluggish Breaker™ Detection, the breaker position contact user setting must be set properly. See Sections 10.0 and 11.22.

The AC-PRO-II uses multiple methods to determine trip currents and voltages. However, some Instantaneous trips may occur too rapidly for AC-PRO-II to report RMS trip values. For these trips, AC-PRO-II will report "> Pickup value" for the current values for all three phases.

See Figure 12.1 for the trip history screens navigation map.

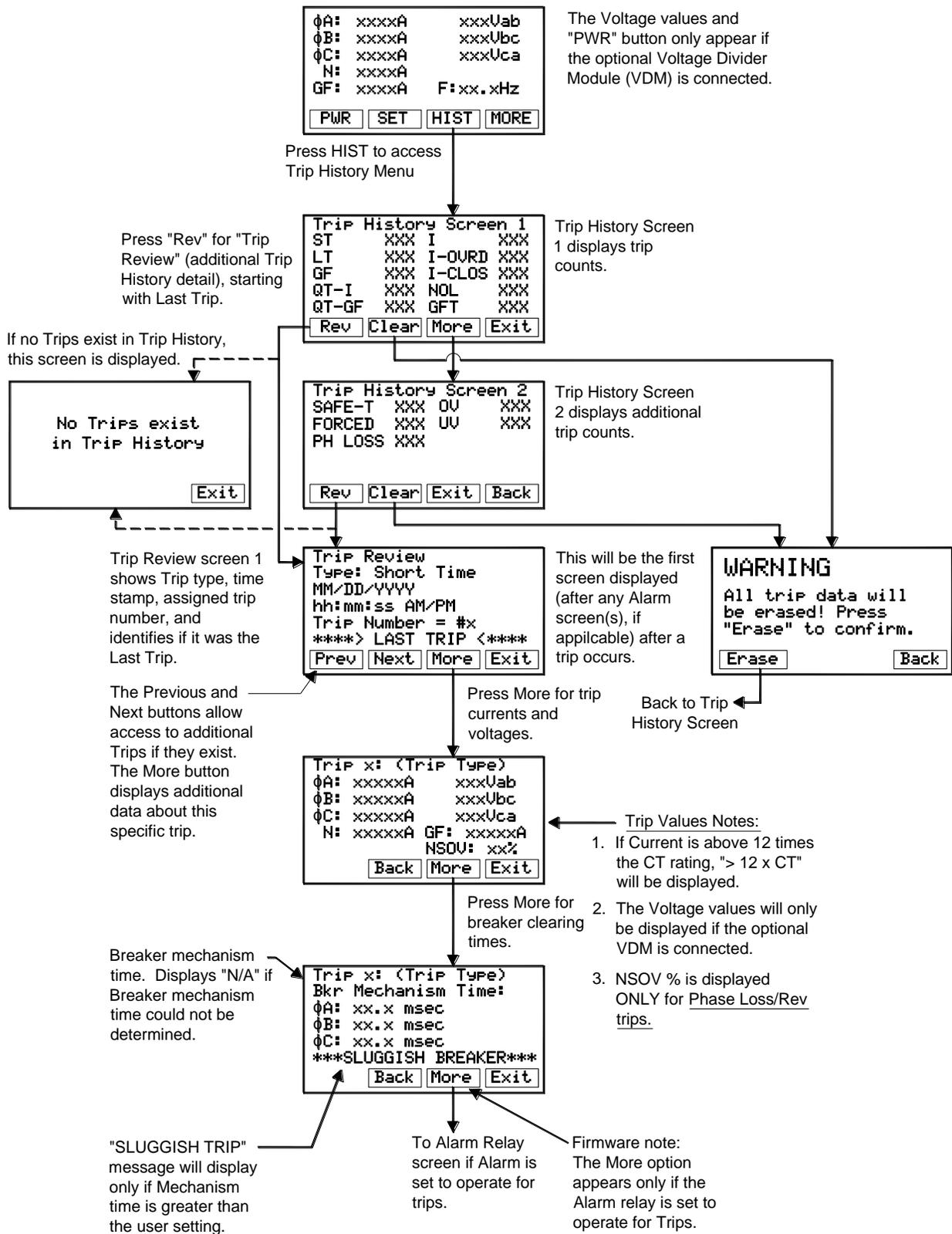


Figure 12.1: Trip History Menu

13.0 Normal Operations & Readings

During normal operation, the trip unit display screen will be off and in its power saving mode. See Section 11.1 for trip unit power information. When the "DISPLAY" button is pressed during normal operation (no trips, errors, alarms, etc), the trip unit will display current and voltage (if equipped with VDM) readings. The neutral and GF currents will only be displayed if neutral or GF protective functions are turned on. See below. The "XXXX" digits will display actual readings.

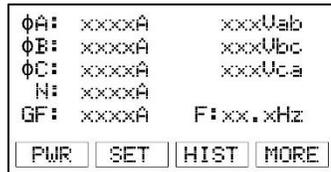


Figure 13.1: Main ("Readings") Screen

- The left column displays Currents in Amps for Phases A, B, C, Neutral and Ground Fault.
- The right column displays Voltages and Frequency

Breaker Current Less than 10% of CT Rating:

When the currents are less than about 10% of the CT rating, the display will display "LOW" for currents.

Breaker Current Greater than 10% of CT Rating:

If the breaker current is greater than about 10% of the CT rating, the current readings will be displayed.

Line-to-Line Voltages (if equipped with VDM):

"LOW" will be displayed if the Line-to-Line voltage is 90V or below.

"N/A" will be displayed if the Voltage cannot be determined.

Note: If voltages and voltage labels ("Vab, Vbc, Vca") do not display, the AC-PRO-II is either not equipped with a VDM, or the VDM is not properly connected to the AC-PRO-II. Contact URC.

See Section 8.0 for additional information about the Voltage Divider Module (VDM).



Figure 13.2: Power and Energy screen (if equipped with VDM)

- KWHr: Total Real Energy usage, measured in KiloWatt-Hours. This value increments and decrements depending on the power flow direction and Power Flow Direction user setting. See Section 11.7.
- KVAHr: Total Apparent Energy usage, measured in KiloVoltAmpere-Hours. This value only increments.
- KW: Total Real Power, measured in KiloWatts.
- KVA: Total Apparent Power, measured in KiloVoltAmperes.
- PF: Total Power Factor

Instantaneous Power Values (if equipped with VDM):

- "LOW" or "N/A" is displayed if the power cannot be determined, most likely because system voltage (i.e. 480V) is not present at the VDM, or if voltage or current is too low.
- The KW values are affected by the direction of the power flow, and the Power Flow Direction user setting. See Section 11.7.

Energy Values (if equipped with VDM):

- Energy values increment if the current for a particular phase is above 3% of the CT rating and the phase voltage is above 90V.

Frequency is displayed based on Phase A current.

14.0 Testing

A "primary injection" test is recommended as the final test of the AC-PRO-II retrofit.

If residual GF is used, it must be temporarily turned off when testing the other trip functions.

14.1 Commission the Trip Unit

Before proceeding with the normal primary injection tests, the trip unit must be commissioned to make it functional. See Section 11.0 for the commissioning procedure.

It is best to use the final pick-up and time delay settings if they are known. If not, use typical settings for the primary injection test.

14.1.1 Test Mode

For Testing convenience, AC-PRO-II offers a "Test Mode". When the AC-Pro-II is in Test Mode, all Voltage Protection is temporarily disabled, and the need to enter the Security Code to change settings is temporarily disabled. Though Test Mode is automatically turned OFF after 60 minutes, it should always be manually turned OFF after testing is complete. See the screens in Figure 14.1.

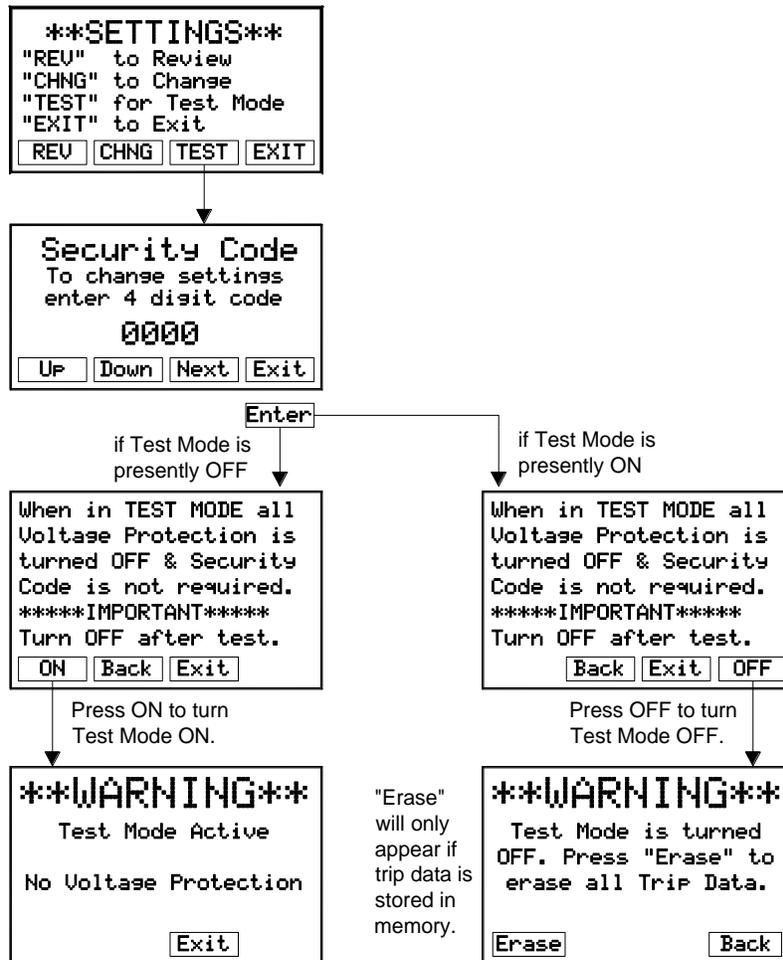


Figure 14.1: Test Mode Screens

14.2 Long Time Trip Test

If residual GF is used, make sure it is temporarily turned off.

To test the LT Pick-Up, increase the current until the "Pick-Up" LED illuminates.

The injected current should correspond to the programmed LT pick-up setting. Verify that the correct phase is indicated on the display.

To test the LT trip time, first calculate the trip time based on the value of the test current that will be applied. Use the formula in Section 18.1 or the chart in Section 15.3.

**** NOTE ****

A simple shortcut is to note that the trip time (center of the curve) at 3 times the LT pick-up current is 4 times the LT Delay setting.

For example:
If LT Pick-Up is 1600A and Delay is 10.0S, then the trip time at 4800A (3 times 1600A) is 40 sec. (4 times 10 sec).

14.3 Short Time Trip Test

If residual GF is used, make sure it is temporarily turned off.

To test the ST pick-up, temporarily set ST I²T off and apply a short pulse of current that is 10% or 20% less than the ST pick-up setting. Continue applying short pulses of current while increasing the current for each pulse until a ST trip occurs. The first current where a ST trip occurred is the ST pick-up.

To test the ST delay, turn ST I²T on again (if applicable) and apply a current that is at least 10% greater than the ST pick-up current.

The trip time should fall within the time band shown on the Time-Current-Curves.

**** NOTE ****

To bypass Instantaneous-on-Close (I-CLOS) when primary injection testing at high currents, power the AC-PRO-II prior to applying current using USB power via a laptop or a mini-USB wallpack. See section 11.12 for I-CLOS description.

14.4 Instantaneous Trip Test

If residual GF is used, make sure it is temporarily turned off.

Test the Instantaneous pick-up and trip time in the same manner as ST in Section 14.3.

14.5 Neutral Overload (NOL) Trip Test

If residual GF is used, make sure it is temporarily turned off.

If Ground Return GF is used, NOL cannot be used.

To perform a primary injection test of the NOL function, temporarily shift the Phase C CT secondary wires to the neutral CT input terminals on the AC-PRO-II. Connect a laptop, PC, or USB wallpack to the front mini-USB port of the display to power the trip unit. Primary injection into Phase C will simulate neutral current. If this testing method is not preferred, the NOL function can be tested using the Secondary Injection Test Set. See Section 15.0.

Test the Neutral Overload Pick-up and trip time in the same manner as LT in Section 14.2.

Refer to Neutral Overload formula in Section 18.4.

**** NOTE ****

A simple shortcut is to note that the trip time (center of the curve) at 3 times the NOL pick-up current is 4 times the NOL Delay setting.

For example:

If NOL Pick-Up is 2000A and Delay is 20.0S, then the trip time at 6000A (3 times 2000A) is 80 sec. (4 times 20 sec).

**** NOTE ****

Only Phase current will power the AC-PRO-II. When doing primary injection testing of the NOL, the AC-PRO-II must be powered via 24VDC or the USB port.

14.6 Ground Fault Trip Tests

14.6.1 Residual Ground Fault Trip Test

When the AC-PRO-II is set for residual GF protection, the trip unit calculates ground fault current.

With GF Pick-Up and Delay set to the required values, primary injection testing any one of the three poles will provide a GF trip.

Test the GF Pick-Up and trip time in the same manner as ST in Section 14.3.

14.6.2 Ground Return Fault Trip Test

When the AC-PRO-II is set for ground return GF protection, the neutral current input is used for direct measurement of the GF current.

To perform a primary injection test of ground return GF protection, temporarily shift the Phase C CT secondary wires to the Neutral CT input terminals on the AC-PRO-II. Connect a laptop, PC, or 24VDC wallpack to the front mini-USB port of the display to power the trip unit. Primary injection into Phase C will simulate ground return current. If this testing method is not preferred, the ground return GF function can be tested using the Secondary Injection Test Set. See Section 15.0.

Test the GF pick-up and trip time in the same manner as ST in Section 14.3.

14.7 QT-GF Trip Test

To test QT-GF the AC-PRO-II QUICK-TRIP switch module must be connected to the trip unit as shown in Figure 7.1.

With QT-GF pick-up set to the required value and the QUICK-TRIP selector switch turned to the on position, testing any one of the three poles will provide a QT-GF trip.

Test the QT-GF pick-up and trip time in the same manner as the normal GF function.

14.8 CT Phasing Test for GF

Proper breaker CT polarity is always recommended, and is required for residual GF and residual QUICK-TRIP GF protection. Without proper CT polarity wiring, a nuisance GF trip will probably occur. **With the breaker in service on a 3-phase system, the last trip data with a reversed polarity phase CT will show the GF current magnitude as approximately two times the phase current of the CT connected in reverse polarity.**

Since primary injection testing normally tests only one phase at a time, a breaker CT with reversed polarity will not be detected with the normal tests. By using the following method, a primary injection test set can be used to test for proper CT polarity.

Figure 14.2 and Figure 14.3 show a method to verify that the breaker CT polarities match. The setup in Figure 14.1 verifies that the CT polarities of Phase A and Phase B match. The setup in Figure 14.3 verifies that the CT polarities of Phase B and Phase C match.

It is only necessary to inject a current slightly greater than the GF Pick-Up setting and to verify that a GF trip does not occur.

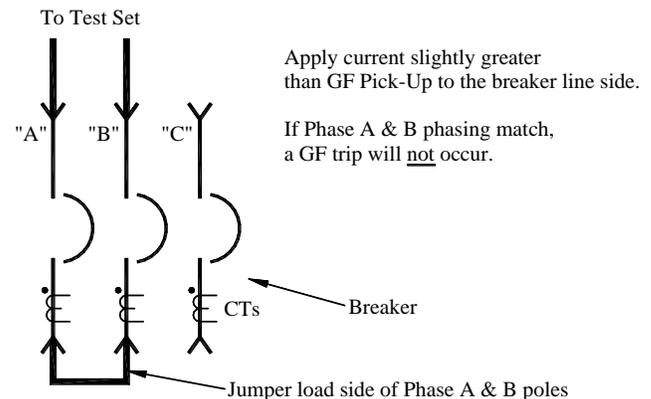


Figure 14.2: Phase A & B, CT Polarity Test

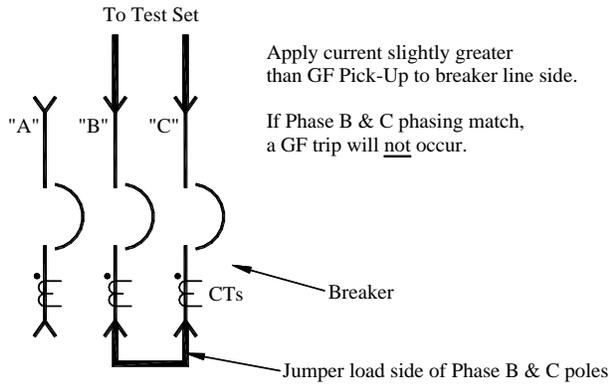


Figure 14.3: Phase B & C, CT Polarity Test

If a GF trip does occur, determine which CT has the reversed polarity. Reverse the secondary connections at the CT to correct the reversed polarity.

The breakers shown in the Figures above have the CTs on the load side. Use exactly the same method if the CTs are on the breaker line side or if they are staggered.

If a neutral CT is used, its polarity must match the polarity of the breaker mounted CTs.

14.9 QT-I Trip Test

To test QT-I the AC-PRO-II QUICK-TRIP switch module must be connected to the trip unit as shown in Figure 7.1.

With QT- I pick-up set to the required value and the QUICK-TRIP selector switch turned to the on position, test all three breaker poles in the same manner as the normal Instantaneous function.

14.10 Undervoltage (UV) Test

To test the UV trip or alarm function, a primary injection current test set, a voltage source, and a timer is needed.

NOTE: For Firmware Version 2, current does not need to be applied.

Since both a current test set and a voltage source will be used, ensure the AC-PRO-II voltage connections are isolated from the breaker poles by removing the fuses from the fuse block that feeds the VDM (Voltage Divider Module). Make the temporary testing connections shown in Figure 14.4. The voltage source can be 120VAC (voltage must be at least 90VAC). Verify that the Phase A voltage is indicated on the display. Reminder: firmware version v1 uses line-to-neutral voltages, and firmware version v2 uses line-to-line voltages.

The UV delay feature can be tested with a timer. The UV function is "definite time", so the delay remains the same regardless of the severity of the undervoltage.

****** IMPORTANT ******

If line voltage is the only source to the trip unit (no current, no 24VDC aux power), it must be present for 5 seconds before a voltage-based trip can occur.

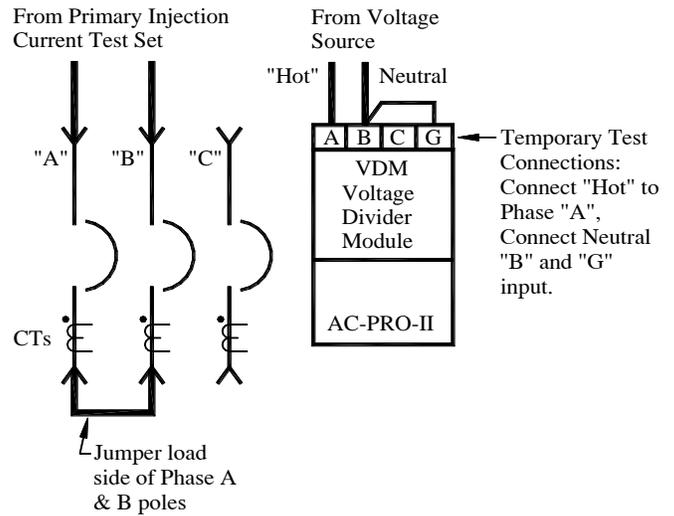


Figure 14.4: Undervoltage Test temporary connections

Undervoltage Test Notes:

- 1) In addition to the voltage source, current must be above 10% of the CT rating on any two phases for a UV Trip or Alarm to occur. (v1 firmware only).
- 2) UV is disabled if a Secondary Injection Test Set is connected.
- 3) After a UV trip occurs, repeated UV trips are blocked until current is re-established, or until the breaker is closed (if a 52a or 52b limit switch is connected and v2 firmware is installed).
- 4) If a UV alarm occurs, it is latched and must be reset using the display and push buttons.
- 5) Refer to Section 11.17 for additional Undervoltage information.

****** IMPORTANT ******

The Undervoltage function will not operate in the event of a total phase loss or total system outage. The UnderVoltage function is not "Phase Loss" protection.

Undervoltage Test Procedure:

- 1) Set the AC-PRO-II UnderVoltage Trip or Alarm setting to ON.
- 2) Apply 120VAC across terminals A & B. (must be at least 90VAC)
- 3) Apply current greater than 10% of the CT rating on two phases and start the timer. (current does not need to be applied for firmware version 2).
NOTE: as soon as current is applied to any two phases (v1 firmware only), the AC-PRO-II internal UV pickup timer will start since the voltages applied to Phases B & C are both "Low".
- 4) The UV trip or alarm should occur within +/- 0.25 seconds of the UV time delay setting.

****** IMPORTANT ******

If line voltage is the only source to the trip unit (no current, no 24VDC aux power), it must be present for 5 seconds before a voltage-based trip can occur.

14.11 Overvoltage (OV) Test

To test the OV trip or alarm function, a variable voltage source, and a timer is needed.

Make the temporary connections shown in Figure 14.5. The maximum voltage of the variable voltage test source should be at least 10% above the programmed OV pick-up setting. Verify that the Phase A voltage is indicated on the display. Reminder: firmware version v1 uses line-to-neutral voltages, and firmware version v2 uses line-to-line voltages.

The OV delay feature can be tested with a timer. The OV function is definite time, so the delay remains the same regardless of the severity of the overvoltage.

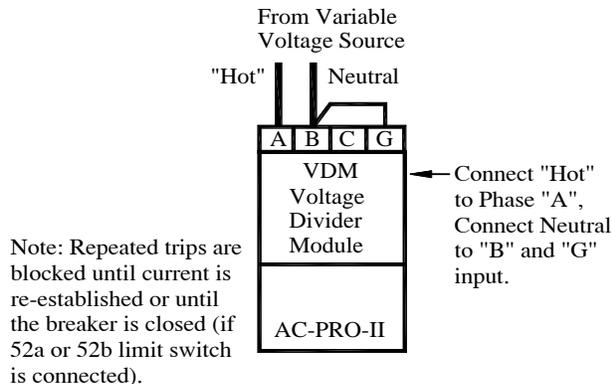


Figure 14.5: Overvoltage Test temporary connections

Overvoltage Test Notes:

- 1) After an OV trip or occurs, repeated OV trips are blocked until current is re-established, or until the breaker is closed (if 52a or 52b limit switch is connected and v2 firmware is installed).
- 2) If an OV alarm occurs, it is latched and must be reset using the display and push buttons.
- 3) OV is disabled if the Secondary Injection Test Set auxiliary power is connected to AC-PRO-II.

Overvoltage Test Procedure:

- 1) Apply voltage at least 10% below the OV Pickup setting.
- 2) No OV trip should occur.
- 3) Increase the voltage to at least 10% above the OV Pickup setting and start the timer.
- 4) An OV trip should occur within +/- 0.25 seconds of the OV time delay setting.

NOTE: with firmware version v1 ONLY: At least one phase current (at least 10% of the CT rating) must be present during OverVoltage testing.

If using URC Secondary Injection test set, apply 75% of CT rating, and temporarily disconnect the Auxiliary power (from the test set) to the AC-PRO-II, during the Overvoltage test.

14.12 Phase Loss / Reverse Test

To test the Phase Loss / Reverse function, a 3-phase voltage source and a timer is needed. 24VDC Auxiliary power is recommended.

Phase Loss/Reverse Test Notes:

- 1) After an Phase Loss/Reverse trip or occurs, repeated Phase Loss trips are blocked until current is re-established, or until the Phase Loss condition goes away, or until the breaker is closed (if a limit switch is installed for the AC-PRO-II).
- 2) If a Phase Loss/Reverse alarm occurs, it is automatically reset when the condition goes away.

Phase Loss Test Procedure:

- 1) For safety, temporarily disconnect the breaker stabs from the VDM fuses.
- 2) Recommended step: Apply 24VDC auxiliary power to the AC-PRO-II. See Section 3.4 for additional information about 24VDC Auxiliary Power.
- 3) Connect the 3-phase voltage source to the AC-PRO-II VDM, at the line side of the VDM fuses.
- 4) The voltages should be equal magnitude (120VAC minimum), 120 degrees apart.
- 5) No Phase Loss trip should occur. Correct Line-to-Line voltages should be displayed on the AC-PRO-II.
- 6) Disconnect one phase voltage by safely pulling the VDM fuse for that phase and start the timer.
NOTE/REMINDER: If primary current is not flowing through the breaker (for CT power), and 24VDC auxiliary power is not applied, this test can only be performed by disconnecting Phase C voltage. (since AC-PRO-II derives VDM power from Phase A-B voltage).
- 7) A Phase Loss/Reverse trip should occur within +/- 0.25 seconds of the Phase Loss/Reverse time delay setting.

15.0 Secondary Injection Testing

Although primary injection testing is the recommended and preferred method to test an AC-PRO-II installation, secondary injection testing can also be used.

15.1 Secondary Injection Test Set

The B-292 secondary injection test set (with blue panel) can test both the original AC-PRO and AC-PRO-II trip units. The B-291 secondary injection test set (with red panel) cannot test the AC-PRO-II trip unit.

**** IMPORTANT ****

The B-292 test set displays Current in Amps, which is most suitable for AC-PRO-II with CT secondary settings of 1-Amp. If the AC-PRO-II Phase and Neutral CT secondary settings are not 1-Amp, this must be considered when determining the equivalent primary current. Additionally, if the Phase and Neutral CT secondary settings are different values, these settings should be temporarily changed for secondary injection testing purposes.

**** IMPORTANT ****

The CT circuits are internally grounded to the AC-PRO-II case. **If any of the CT wires are externally grounded, the AC-PRO-II will not read current correctly.**

Some relay test sets have a grounded current output. To secondary injection test the AC-PRO-II trip unit with this type of test set, the AC-PRO-II trip unit must be isolated from the test set ground.



Figure 15.1: B-292 Secondary Injection Test Set

NOTE: Utility Relay Company can modify newer versions of existing AC-PRO secondary injection test sets (with red panel) to be compatible with AC-PRO-II trip units. Contact Utility Relay Company for details.

15.2 Standard Relay Test Set

Many standard relay test sets can also be used to secondary injection test the AC-PRO-II trip unit.

The following are required:

- 24VDC Power Supply (URC Part #T-490-ASM) to power up the AC-PRO-II trip unit so that it will accept current
Note: 24VDC must be used. (USB power is NOT adequate for this purpose).
- Relay test set with a 0 to 12 Amp range
- True RMS ammeter in the test set or externally connected
- Method to stop the relay test set and test set timer when the breaker trips

Test procedure:

1. Power up the AC-PRO-II trip unit with 24VDC power so it will accept current.
2. Temporarily turn off GF.
3. Connect the output leads from the relay test set to the Phase "A" CT terminals (it is not necessary to disconnect the CT)
4. Proceed with pick-up and time testing of Phase "A"
5. When finished, similarly test Phase "B" & "C"
6. Turn GF on (if desired) and test by injecting current on any one of the Phases

15.3 LT Delay Testing Chart

This chart provides trip times in Seconds for the LT delay settings at 3.0X, 4.0X and 6.0X where "X" is in multiples of the LT pick-up setting.

The Time-Current Curves in Figure 18.2 along with the equations in Section 18.1 can be used to determine the trip times of the other trip functions.

The Maximum, Minimum and Nominal trip times are given for each LT delay setting and the three listed test currents.

LT Delay Setting	Trip Time Range	Test Current			LT Delay Setting	Trip Time Range	Test Current			LT Delay Setting	Trip Time Range	Test Current		
		3.0X	4.0X	6.0X			3.0X	4.0X	6.0X			3.0X	4.0X	6.0X
2.0	Max	9.88	5.56	2.47	11.5	Max	56.79	31.94	14.20	21.0	Max	103.70	58.33	25.93
	Nominal	8.00	4.50	2.00		Nominal	46.00	25.88	11.50		Nominal	84.00	47.25	21.00
	Min	6.61	3.72	1.65		Min	38.02	21.38	9.50		Min	69.42	39.05	17.36
2.5	Max	12.35	6.94	3.09	12.0	Max	59.26	33.33	14.81	21.5	Max	106.17	59.72	26.54
	Nominal	10.00	5.63	2.50		Nominal	48.00	27.00	12.00		Nominal	86.00	48.38	21.50
	Min	8.26	4.65	2.07		Min	39.67	22.31	9.92		Min	71.07	39.98	17.77
3.0	Max	14.81	8.33	3.70	12.5	Max	61.73	34.72	15.43	22.0	Max	108.64	61.11	27.16
	Nominal	12.00	6.75	3.00		Nominal	50.00	28.13	12.50		Nominal	88.00	49.50	22.00
	Min	9.92	5.58	2.48		Min	41.32	23.24	10.33		Min	72.73	40.91	18.18
3.5	Max	17.28	9.72	4.32	13.0	Max	64.20	36.11	16.05	22.5	Max	111.11	62.50	27.78
	Nominal	14.00	7.88	3.50		Nominal	52.00	29.25	13.00		Nominal	90.00	50.63	22.50
	Min	11.57	6.51	2.89		Min	42.98	24.17	10.74		Min	74.38	41.84	18.60
4.0	Max	19.75	11.11	4.94	13.5	Max	66.67	37.50	16.67	23.0	Max	113.58	63.89	28.40
	Nominal	16.00	9.00	4.00		Nominal	54.00	30.38	13.50		Nominal	92.00	51.75	23.00
	Min	13.22	7.44	3.31		Min	44.63	25.10	11.16		Min	76.03	42.77	19.01
4.5	Max	22.22	12.50	5.56	14.0	Max	69.14	38.89	17.28	23.5	Max	116.05	65.28	29.01
	Nominal	18.00	10.13	4.50		Nominal	56.00	31.50	14.00		Nominal	94.00	52.88	23.50
	Min	14.88	8.37	3.72		Min	46.28	26.03	11.57		Min	77.69	43.70	19.42
5.0	Max	24.69	13.89	6.17	14.5	Max	71.60	40.28	17.90	24.0	Max	118.52	66.67	29.63
	Nominal	20.00	11.25	5.00		Nominal	58.00	32.63	14.50		Nominal	96.00	54.00	24.00
	Min	16.53	9.30	4.13		Min	47.93	26.96	11.98		Min	79.34	44.63	19.83
5.5	Max	27.16	15.28	6.79	15.0	Max	74.07	41.67	18.52	24.5	Max	120.99	68.06	30.25
	Nominal	22.00	12.38	5.50		Nominal	60.00	33.75	15.00		Nominal	98.00	55.13	24.50
	Min	18.18	10.23	4.55		Min	49.59	27.89	12.40		Min	80.99	45.56	20.25
6.0	Max	29.63	16.67	7.41	15.5	Max	76.54	43.06	19.14	25.0	Max	123.46	69.44	30.86
	Nominal	24.00	13.50	6.00		Nominal	62.00	34.88	15.50		Nominal	100.00	56.25	25.00
	Min	19.83	11.16	4.96		Min	51.24	28.82	12.81		Min	82.64	46.49	20.66
6.5	Max	32.10	18.06	8.02	16.0	Max	79.01	44.44	19.75	25.5	Max	125.93	70.83	31.48
	Nominal	26.00	14.63	6.50		Nominal	64.00	36.00	16.00		Nominal	102.00	57.38	25.50
	Min	21.49	12.09	5.37		Min	52.89	29.75	13.22		Min	84.30	47.42	21.07
7.0	Max	34.57	19.44	8.64	16.5	Max	81.48	45.83	20.37	26.0	Max	128.40	72.22	32.10
	Nominal	28.00	15.75	7.00		Nominal	66.00	37.13	16.50		Nominal	104.00	58.50	26.00
	Min	23.14	13.02	5.79		Min	54.55	30.68	13.64		Min	85.95	48.35	21.49
7.5	Max	37.04	20.83	9.26	17.0	Max	83.95	47.22	20.99	26.5	Max	130.86	73.61	32.72
	Nominal	30.00	16.88	7.50		Nominal	68.00	38.25	17.00		Nominal	106.00	59.63	26.50
	Min	24.79	13.95	6.20		Min	56.20	31.61	14.05		Min	87.60	49.28	21.90
8.0	Max	39.51	22.22	9.88	17.5	Max	86.42	48.61	21.60	27.0	Max	133.33	75.00	33.33
	Nominal	32.00	18.00	8.00		Nominal	70.00	39.38	17.50		Nominal	108.00	60.75	27.00
	Min	26.45	14.88	6.61		Min	57.85	32.54	14.46		Min	89.26	50.21	22.31
8.5	Max	41.98	23.61	10.49	18.0	Max	88.89	50.00	22.22	27.5	Max	135.80	76.39	33.95
	Nominal	34.00	19.13	8.50		Nominal	72.00	40.50	18.00		Nominal	110.00	61.88	27.50
	Min	28.10	15.81	7.02		Min	59.50	33.47	14.88		Min	90.91	51.14	22.73
9.0	Max	44.44	25.00	11.11	18.5	Max	91.36	51.39	22.84	28.0	Max	138.27	77.78	34.57
	Nominal	36.00	20.25	9.00		Nominal	74.00	41.63	18.50		Nominal	112.00	63.00	28.00
	Min	29.75	16.74	7.44		Min	61.16	34.40	15.29		Min	92.56	52.07	23.14
9.5	Max	46.91	26.39	11.73	19.0	Max	93.83	52.78	23.46	28.5	Max	140.74	79.17	35.19
	Nominal	38.00	21.38	9.50		Nominal	76.00	42.75	19.00		Nominal	114.00	64.13	28.50
	Min	31.40	17.67	7.85		Min	62.81	35.33	15.70		Min	94.21	53.00	23.55
10.0	Max	49.38	27.78	12.35	19.5	Max	96.30	54.17	24.07	29.0	Max	143.21	80.56	35.80
	Nominal	40.00	22.50	10.00		Nominal	78.00	43.88	19.50		Nominal	116.00	65.25	29.00
	Min	33.06	18.60	8.26		Min	64.46	36.26	16.12		Min	95.87	53.93	23.97
10.5	Max	51.85	29.17	12.96	20.0	Max	98.77	55.56	24.69	29.5	Max	145.68	81.94	36.42
	Nominal	42.00	23.63	10.50		Nominal	80.00	45.00	20.00		Nominal	118.00	66.38	29.50
	Min	34.71	19.52	8.68		Min	66.12	37.19	16.53		Min	97.52	54.86	24.38
11.0	Max	54.32	30.56	13.58	20.5	Max	101.23	56.94	25.31	30.0	Max	148.15	83.33	37.04
	Nominal	44.00	24.75	11.00		Nominal	82.00	46.13	20.50		Nominal	120.00	67.50	30.00
	Min	36.36	20.45	9.09		Min	67.77	38.12	16.94		Min	99.17	55.79	24.79

Table 15-A: Long Time Delay Test Chart

15.4 Neutral Overload Testing Chart

The LT testing chart in previous section can also be used for NOL testing.

16.0 Ratings & Physical Information

Ambient Temperature:

Trip Unit:

-4°F (-20°C) to 158°F (70°C)

Trip Unit with Voltage Divider Module (VDM):

Serial #0142800497 and above:

-4°F (-20°C) to 158°F (70°C)

Serial #0142800497 and below:

-4°F (-20°C) to 140°F (60°C)

OLED Display:

-22°F (-30°C) to 185°F (85°C)

Battery:

-40°F (-40°C) to 158°F (70°C)

Humidity:

95% non-condensing

Conformal Coating (on circuit boards):

Acrylic conformal coating,

HumiSeal type 1A33

Contamination resistant membrane keypad

AC-PRO-II without VDM:

Die-cast Aluminum enclosure with bright nickel finish:

Nominal overall dimensions:

Maximum dimensions: 3.5 x 5 x 1.52 inches
88.9 x 127 x 38.5 Millimeters

AC-PRO-II with VDM:

Die-cast Aluminum enclosure with bright nickel finish:

Maximum dimensions: 3.5 x 5 x 2.28 inches
88.9 x 127 x 57.8 Millimeters

QUICK-TRIP Switch:

Die-cast Aluminum enclosure with electroless nickel finish:

See Drawings below for Dimensions.

Battery:

See Section 21.0

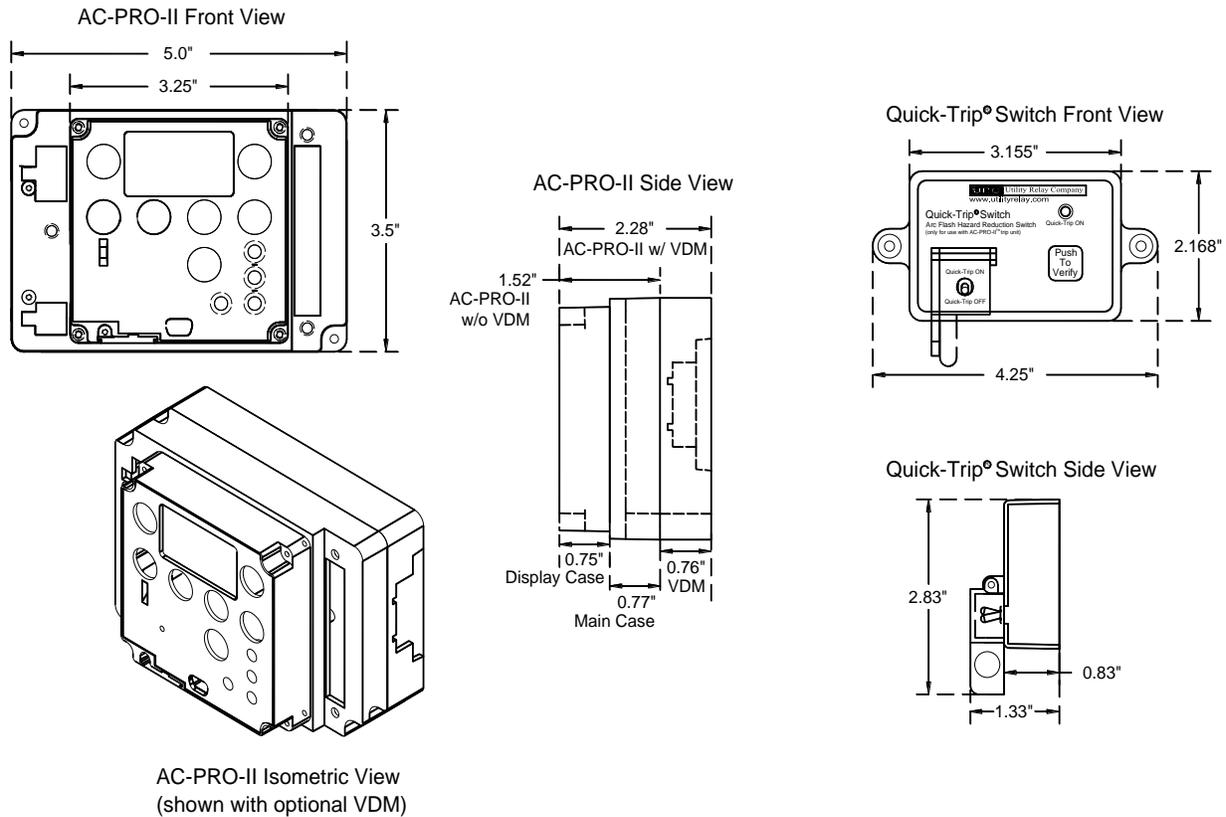


Figure 16.1: AC-PRO-II & Quick Trip Switch Drawings and Dimensions

17.0 Warranty

A conditional 2-year warranty is offered with each AC-PRO-II trip unit.

Contact Utility Relay Company for full details.

18.0 Time-Current Curves (TCC)

The TCCs are shown in Figures 18.1, 18.2, 18.3 and 18.4.

AC-PRO-II TCCs are similar to AC-PRO TCCs, except with improvements.

The AC-PRO-II TCCs offers the following improvements and/or updates:

- Narrower ST bands now allow coordination between the 0.2, 0.3, and 0.4 ST bands.
- Improved power-up times.
- GF I²T ON affects currents up to 0.6xCT instead of 2xCT.

The curves are shown on log-log graph with seconds in the vertical direction and current in the horizontal direction.

Overload and fault currents are shown as multiples of the LT pick-up setting. GF current is shown as a percentage of the CT rating.

Tolerances for the Pick-Up bands are ± 10% (or +/-10A, whichever is greater) in the current direction. Tolerance for LT, ST I²T and GF I²T trip times are + 23% and -17% in the time direction. Tolerance for GF I²T trip times are +69% and -38% in the time direction.

Instantaneous pick-up tolerance is ± 10% for 1A and 0.5A CTs. Instantaneous pickup tolerance is ± 20% for 0.4A, 0.25A, and 0.2A CTs.

The curves for the following time bands:

- Long Time (LT)
- Short Time (ST) with I²T ON
- Ground Fault (GF) with I²T ON
- Neutral Overload (NOL)

are based on the following equation:

$$I^2T = \text{Constant}$$

Where: I is current in amps
T is time to trip in seconds (center of the band)

When performing trip-timing tests using a primary injection test set, the trip time at various test currents can be determined by calculation as explained in Sections 18.1, 18.2, 18.3 and 18.4.

The TCCs are based on a total actuator operating time plus breaker opening time in the 16ms to 33ms range.

18.1 Long Time (LT) Trip Time

For overload currents, the "I²T = Constant" equation can be restated as follows:

$$T = \frac{TBC_{LT}}{X^2}$$

Where: T = time to trip in seconds (center of the band)

X = current in multiples of the LT pick-up setting

$$TBC_{LT} = \text{the LT Time Band Constant} \\ = 36 \times \text{LT time band setting}$$

**** NOTE ****

The LT Time Band Constant (TBC_{LT}) is by definition 36 times the LT Time Band Setting in seconds.

EXAMPLE #1:

CT Rating	1600A
LT pick-up	1200A
LT time band	20.0S
Overload Current	3600A

$$TBC_{LT} = 36 \times \text{LT Time Band Setting} \\ = 36 \times 20.0 \\ = 720$$

$$\text{and } X = \frac{\text{overload current}}{\text{LT Pick-Up}} = \frac{3600A}{1200A} = 3$$

therefore:

$$\text{trip time} = T = \frac{TBC_{LT}}{X^2} \text{ or } \frac{720}{3^2} = \frac{720}{9} \\ = 80 \text{ seconds}$$

**** IN SUMMARY ****

To calculate the LT trip time:

- 1) Calculate the LT Time Band Constant (TBC_{LT})
- 2) Calculate "X" where

$$X = \frac{\text{overload current}}{\text{LT Pick-Up Setting}}$$

- 3) Solve the equation:
trip time(sec) = $\frac{TBC_{LT}}{X^2}$

18.2 Short Time (ST) Trip Time

With I^2T off or for currents greater than 10 X LT pick-up setting, the ST trip time is a constant equal to the ST time band setting.

With I^2T on and for currents less than 10 X LT pick-up setting, the ST trip time is determined by the following equation:

$$T = \frac{TBC_{ST}}{X^2}$$

Where: **T** = time to trip in seconds (center of the band)

X = current in multiples of the LT pick-up

TBC_{ST} = the ST Time Band Constant

**** NOTE ****

The ST Time Band Constant (TBC_{ST}) =

- 40 for the .40S Time Band
- 30 for the .30S Time Band
- 20 for the .20S Time Band
- 15 for the .15S Time Band
- 10 for the .10S Time Band
- 7 for the .07S Time Band

EXAMPLE #2:

CT Rating 1600A
 LT pick-up 1200A
 ST pick-up 6000A
 ST delay .20S I^2T ON
 Overload Current 7200A

$$TBC_{ST} = 20$$

$$\text{and } X = \frac{\text{overload current}}{\text{LT Pick-Up}} = \frac{7200A}{1200A} = 6$$

therefore:

$$\begin{aligned} \text{trip time} = T &= \frac{TBC_{ST}}{X^2} \text{ or } \frac{20}{6^2} = \frac{20}{36} \\ &= .556 \text{ seconds} \end{aligned}$$

**** IN SUMMARY ****

To calculate the ST I^2T trip time:

- 1) Determine the ST Time Band Constant (TBC_{ST})
- 2) Calculate "X" where

$$X = \frac{\text{overload current}}{\text{LT Pick-Up}}$$

- 3) Solve the equation:

$$\text{trip time(sec)} = \frac{TBC_{ST}}{X^2}$$

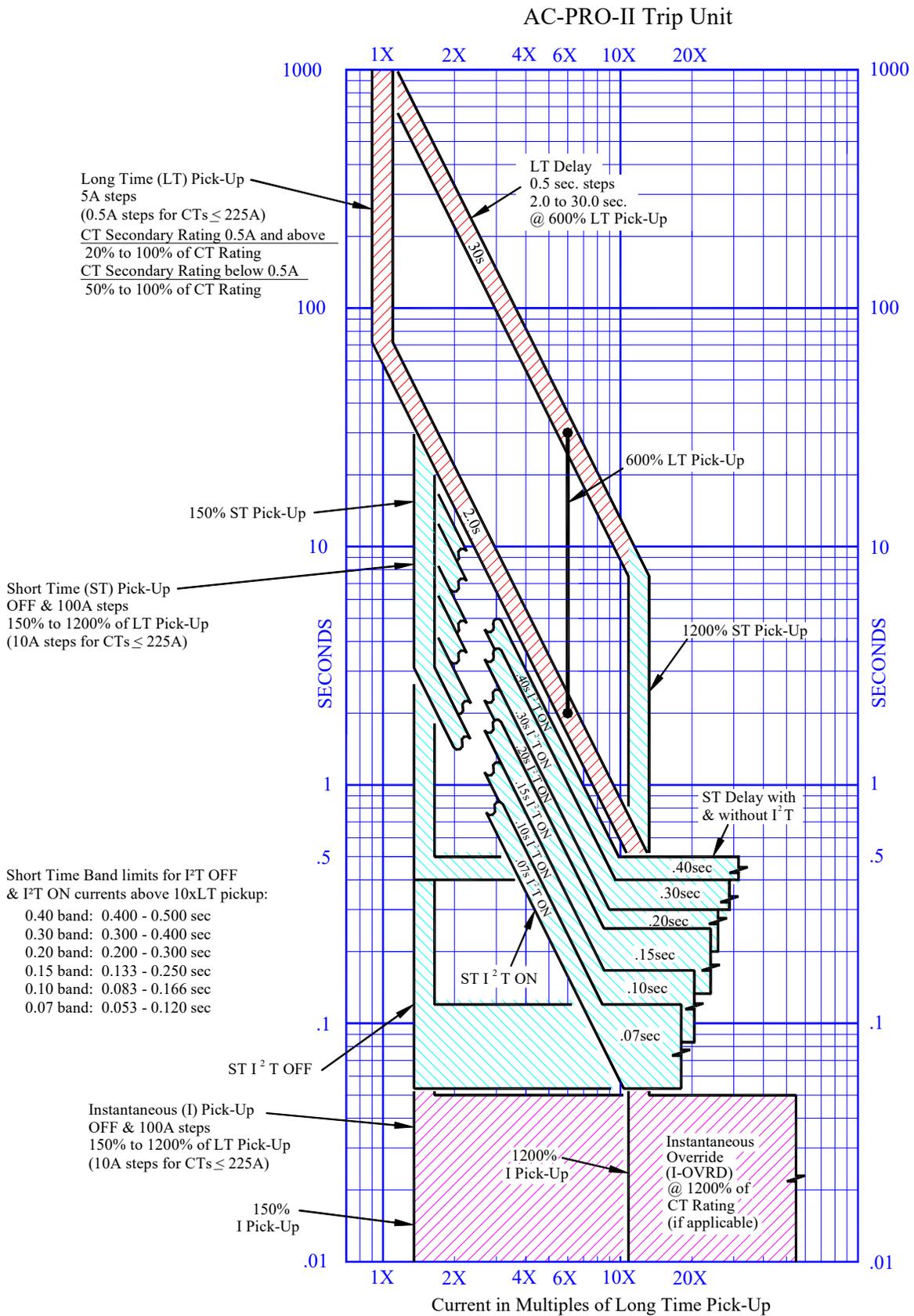


Figure 18.1: Overload TCC

18.3 Ground Fault (GF) Trip Time

With the GF slope set to OFF, the GF trip time is a constant equal to the GF Time Band setting.

With the GF slope set to I²T:

For GF currents greater than 0.6 times the CT rating, the GF trip time is a constant equal to the GF Time Band setting.

For GF currents less than 0.6 times the CT rating, the GF trip time is determined by the equations below.

With the GF slope set to I⁵T:

For GF currents greater than 4.0 times the GF Pickup, the GF trip time is a constant equal to the GF Time Band setting.

For GF currents less than 4.0 times the GF Pickup, the GF trip time is determined by the equations below:

$$T = \frac{TB2C_{GF}}{X_{GF}^2} \text{ for } I^2T \quad \text{OR} \quad T = \frac{TB5C_{GF}}{X_{GF}^5} \text{ for } I^5T$$

Where: T = time to trip in seconds (center of the band)

$$X_{GF} = \frac{\text{ground fault current}}{\text{CT rating}}$$

$$X_{5GF} = \frac{\text{ground fault current}}{\text{GF Pickup}}$$

TB2C_{GF} = the GF I²T Time Band Constant

TB5C_{GF} = the GF I⁵T Time Band Constant

**** NOTE ****

The GF I²T Time Band Constant (TB2C_{GF}) =
 0.18 for the .50S Time Band
 0.144 for the .40S Time Band
 0.108 for the .30S Time Band
 0.072 for the .20S Time Band
 0.036 for the .10S Time Band

**** NOTE ****

The GF I⁵T Time Band Constant (TB5C_{GF}) =
 512 for the .50S Time Band
 409.6 for the .40S Time Band
 307.2 for the .30S Time Band
 204.8 for the .20S Time Band
 102.4 for the .10S Time Band

EXAMPLE #3 (I²T Slope):

CT Rating 1600A
 LT pick-up 1200A
 GF pick-up 640A
 GF time band .20S I²T Slope
 Ground Fault Current 800A

$$TB2C_{GF} = 0.072$$

$$\text{and } X_{GF} = \frac{\text{ground fault current}}{\text{CT Rating}} = \frac{800A}{1600A} = 0.5$$

therefore:

$$\text{trip time} = T = \frac{TB2C_{GF}}{X_{GF}^2} \text{ or } \frac{0.072}{(0.5)^2} = \frac{0.072}{0.25} = 0.288 \text{ sec}$$

**** IN SUMMARY ****

To calculate the GF I²T trip time:

- 1) Determine the GF Time Band Constant (TB2C_{GF})
- 2) Calculate "X_{GF}" where
 $X_{GF} = \frac{\text{ground fault current}}{\text{CT Rating}}$
- 3) Solve the equation:
 $\text{trip time(sec)} = \frac{TB2C_{GF}}{X_{GF}^2}$

EXAMPLE #4 (I⁵T Slope):

CT Rating 2000A
 LT pick-up 2000A
 GF pick-up 800A
 GF time band .30S I⁵T Slope
 Ground Fault Current 2400A

$$TB5C_{GF} = 307.2$$

$$\text{and } X_{5GF} = \frac{\text{ground fault current}}{\text{GF Pickup}} = \frac{2400A}{800A} = 3.0$$

therefore:

$$\text{trip time} = T = \frac{TB5C_{GF}}{X_{5GF}^5} \text{ or } \frac{307.2}{(3.0)^5} = \frac{307.2}{243} = 1.264 \text{ sec}$$

18.4 Neutral Overload (NOL) Trip Time

The NOL trip time is calculated in the same manner as the LT trip time.

For NOL currents, the "I²T = Constant" equation can be restated as follows:

$$T = \frac{TBC_{NOL}}{X^2}$$

Where: T = time to trip in seconds (center of the band)

X = current in multiples of the NOL pick-up setting

TBC_{NOL} = the NOL Time Band Constant
 = 36 X NOL time band setting

**** NOTE ****

The NOL Time Band Constant (TBC_{NOL}) is by definition 36 times the NOL Time Band Setting in seconds.

EXAMPLE #5:

CT Rating 1600A
 NOL pick-up 800A
 NOL time band 15.0S
 NOL Current 2400A

$$TBC_{NOL} = 36 \times \text{NOL Time Band Setting} = 36 \times 15.0 = 540$$

$$\text{and } X = \frac{\text{overload current}}{\text{NOL pick-up}} = \frac{2400A}{800A} = 3$$

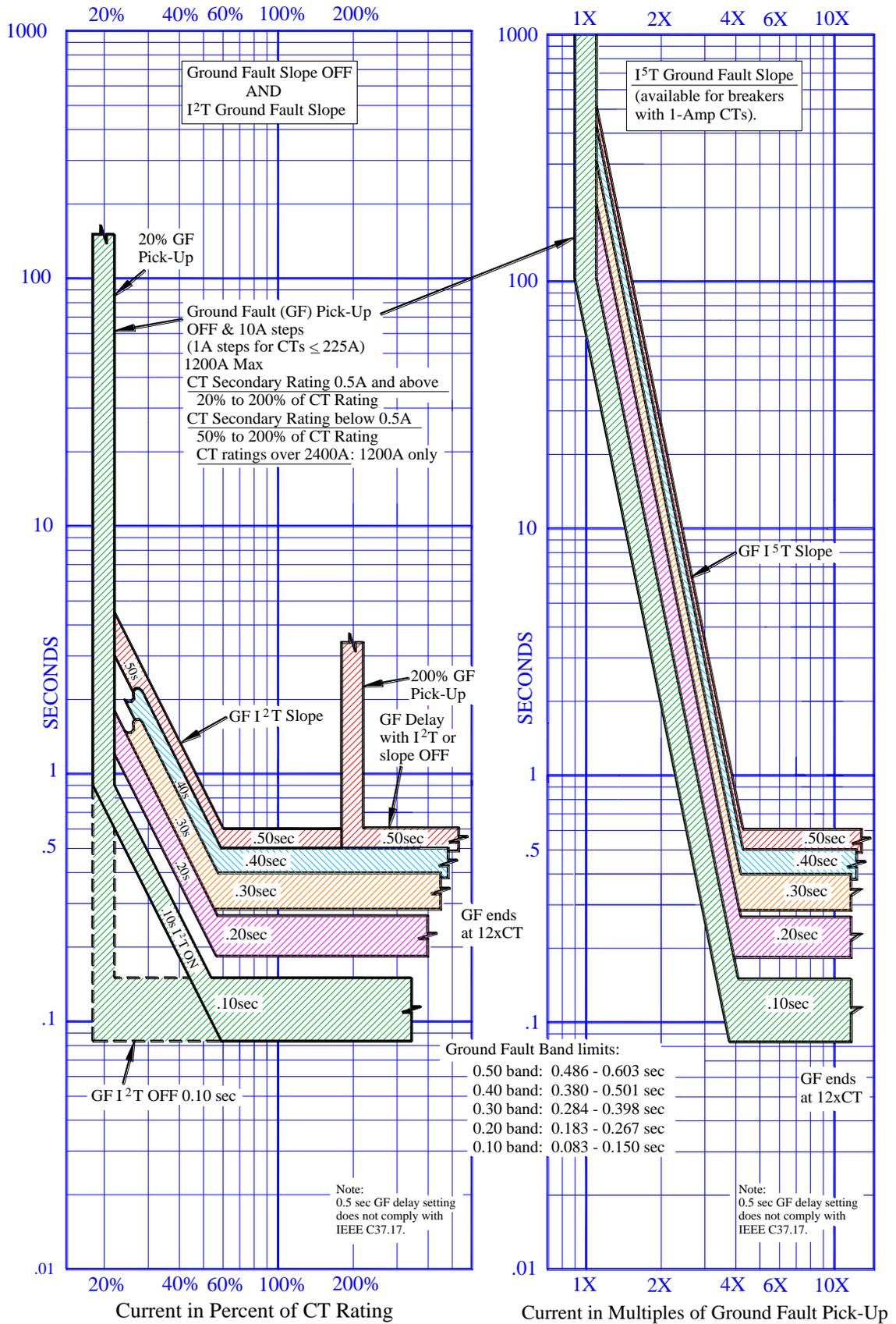
therefore:

$$\text{trip time} = T = \frac{TBC_{NOL}}{X^2} \text{ or } \frac{540}{3^2} = \frac{540}{9} = 60 \text{ seconds}$$

**** IN SUMMARY ****

To calculate the NOL trip time:

- 1) Calculate the NOL Time Band Constant (TBC_{NOL})
- 2) Calculate "X" where
 $X = \frac{\text{overload current}}{\text{NOL pick-up Setting}}$
- 3) Solve the equation:
 $\text{trip time(sec)} = \frac{TBC_{NOL}}{X^2}$



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Figure 18.2: Ground Fault (GF) TCC

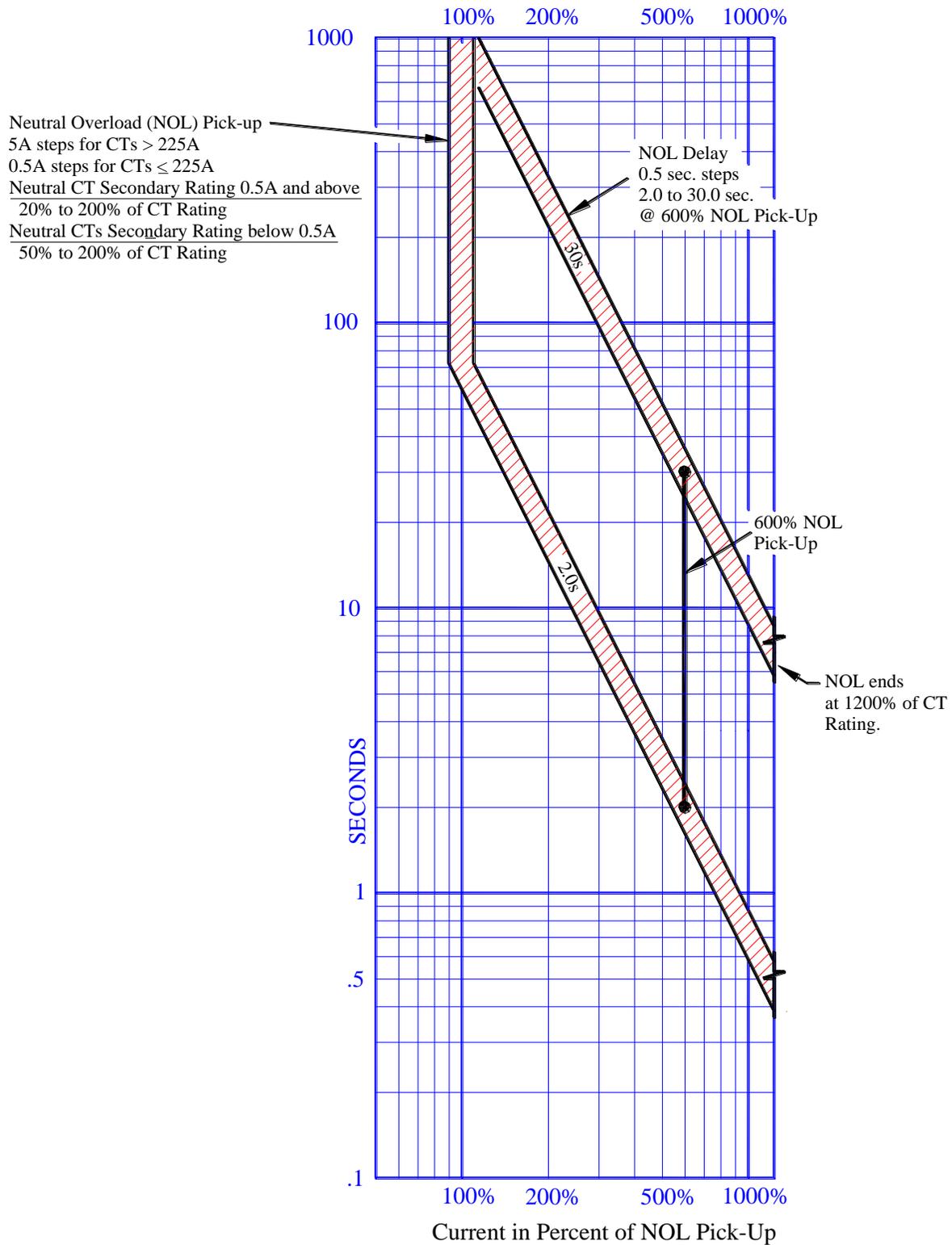
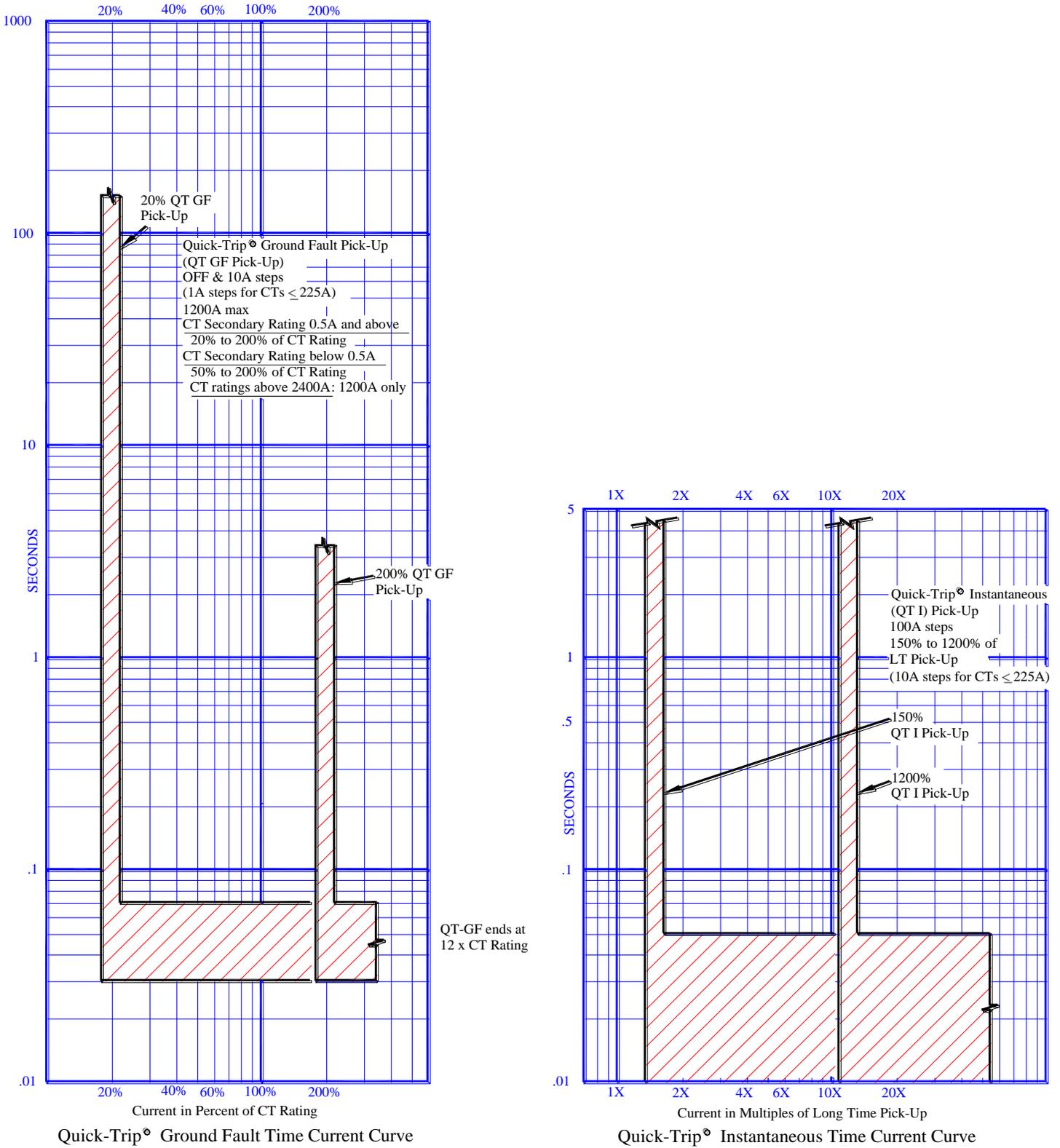


Figure 18.3: Neutral Overload (NOL) TCC



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Figure 18.4: QUICK-TRIP Ground Fault and QUICK-TRIP Instantaneous TCCs

18.5 Current Metering Accuracy

For 1-Amp and 0.5-Amp secondary CTs:
+/- 2% (or +/- 10A, whichever is greater) for currents between 20% and 150% of CT Rating

For CTs with secondary below 0.5A:
+/- 2% (or +/- 10A, whichever is greater) for currents between 50% and 150% of CT Rating

(contact URC for currents below the ranges listed above)

19.0 Voltage & Power Calculations

Voltage accuracy:
+/- 1.5% for 80V and greater, +/- 1.2V for 0 – 80V.

Power accuracy (Instantaneous values)
+/- 5% for currents between 10% and 150% of CT rating

Energy calculations: Refer to Section 13.0.

20.0 Error and Alarms

20.1 Internal Error

If an internal error occurs in the AC-PRO-II, the OK LED will not be lit and the screen below will appear.



Figure 20.1: Internal Error Screen

If this screen appears and persists, please contact Utility Relay Company.

If configured in user settings, the alarm relay will operate for this condition. The "Exit" button is available and allows bypassing this screen for temporary menu navigation. If the condition is still present, this screen will re-appear the next time the display is turned on.

20.2 Actuator Open Circuit

If the AC-PRO-II detects an open circuit at the actuator terminals, the OK led will not be ON and the following screen will appear, indicating an actuator open circuit condition, in which case the trip unit will not trip the breaker. Repair the actuator connection.



Figure 20.2: Actuator Open screen

If configured in user settings, the alarm relay will operate for this condition.

The "Exit" button allows bypassing this screen for temporary menu navigation. If the condition is still present, this screen will appear the next time the display is turned on.

20.3 Alarm Screens

If configured in user settings, the alarm relay will operate when a Trip Alarm, OV Alarm, UV Alarm, Phase Loss Alarm, or Ground Fault Alarm occurs and an "Alarm" screen will appear.

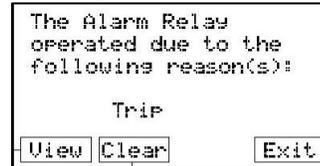


Figure 20.3: Alarm Screen (example shown is Trip Alarm)

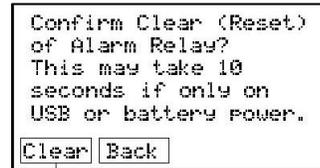


Figure 20.4: Clear Alarms Screen

Pressing the "View" button will show the trip history information. Pressing the "Clear" button will show the clear alarm screen. Pressing "Exit" will temporarily bypass this screen for temporary menu navigation. If the condition is still present, this screen will appear the next time the display is turned on.

Refer to Section 5.3.1 and Table 5-A.

20.4 Un-Calibrated

If the following screen appears, do not place the trip unit in service. Please contact URC.



Figure 20.5: Un-Calibrated Screen

21.0 Battery

21.1 Checking the Battery Voltage

See Section 6.4.2.

21.2 Battery Replacement

For best performance, replace the battery with the following 3-volt lithium battery:

Panasonic CR2 Industrial Lithium battery 3V
#CR15H270

A replacement battery can be purchased from:

- Utility Relay Co. Part # T-125
- Digi-Key Part # P157-ND
www.digikey.com
- Newark Part #15R3550
www.newark.com

Lithium battery ratings:

- 850 mAh Capacity

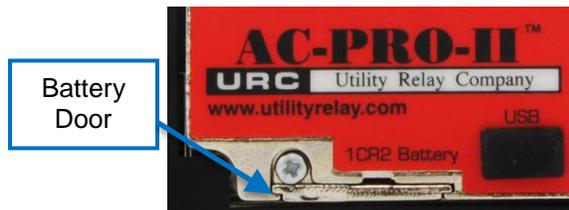


Figure 21.1: Battery Door

To replace the battery:

- The breaker must be out of service and de-energized for safety.
- Remove the black wiring cover by pulling the wiring cover off the three (3) standoff posts.
- Loosen the single #2-56 x 1/4 screw with a screwdriver.
- Remove the screw and associated locking washer.
- Before sliding the battery door forward, place hand below the battery door, as the battery contact spring will push the battery out.
- Slide the battery door forward.
- Remove the old battery.
- Check battery markings and insert positive (+) nub end of the battery into the trip unit first (the positive (+) nub should be up when trip unit is upright, flat (-) end should be down).
- Replace Battery door, washer and screw.
- If applicable, to reset low battery state, perform manual battery test using the MORE Menu. See Figure 6.5 for MORE Menu.

****** IMPORTANT ******

For best performance, replace the battery with the recommended Panasonic CR2 3-volt lithium battery.

The breaker must be removed from service before replacing the battery.

The replacement battery must be inserted with the proper polarity.

For proper contact, the battery door screw must be in place and hand-tightened.

After replacing battery, Time and Date must be set. See Section 11.27.

22.0 Rotating the Display

The AC-PRO-II trip unit consists of a main case and a display case. Refer to Figure 4.3. The trip unit orientation can be modified by rotating the display case. Refer to the AC-PRO-II retrofit kit installation manuals for breaker-specific trip unit orientation options. The AC-PRO-II can be configured in the three (3) normal orientations listed below.

1. Horizontal (breaker harness connection at right). All units are shipped in this orientation.
2. Vertical bottom (breaker harness connection at bottom).
3. Vertical top (breaker harness connection at top).

To rotate the Display Case:

- The breaker must be out of service and de-energized for safety.
- Ensure the person rotating the display is properly grounded and takes special care to avoid static discharge onto trip unit and display internal components.
- Remove the black wiring cover by pulling the wiring cover off the three (3) standoff posts.
- NOTE: the display case is connected to the main case via the following
 - One (1) Ribbon cable. See Figure 22.2.
 - Four (4) captive screws. See Figure 22.1
- Loosen the four (4) captive screws with a screwdriver.
- Leave the ribbon cable connected. **Do not disconnect the ribbon cable.**
- Rotate the display to one of the three options listed at the beginning of this section. Be careful not to damage, pinch, or disconnect the ribbon cable.
- Tighten the four (4) captive screws.
- Press the "DISPLAY" button and smart buttons to confirm operation.
- Refer back to the AC-PRO-II retrofit kit Instructions for additional breaker specific steps.

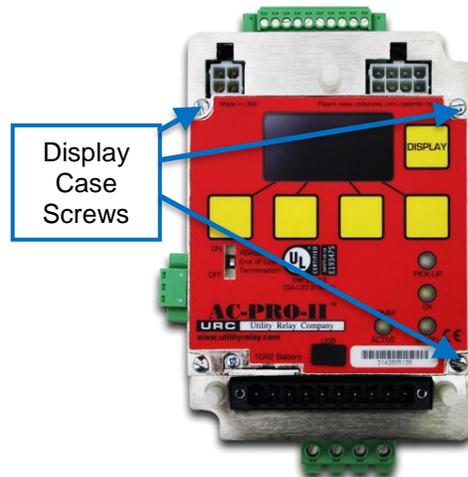


Figure 22.1: Display Case Screw locations

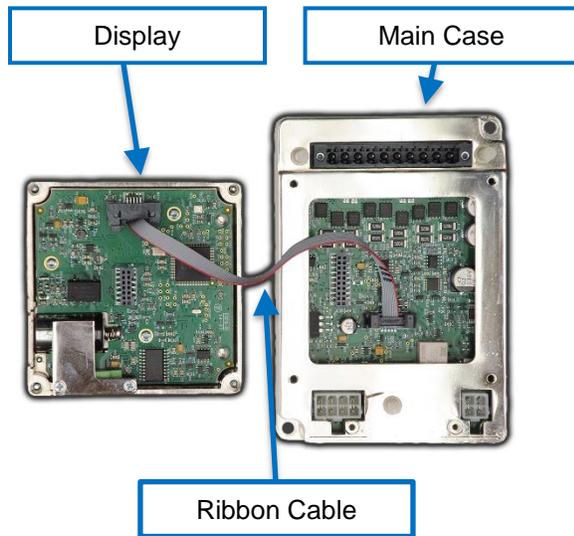


Figure 22.2: Trip Unit and Display (separated)

23.0 InfoPro-AC™ Software Application

InfoPro-AC is a software application that can be used with AC-PRO-II for the following:

- Settings – upload, download, view, save, and print.
- Trip history including waveforms – view, save, and print.
- Waveforms (on-demand) – view, save, and print.
- Current, voltage, & power readings – view.
- Alarms and trip unit status Information
- Trip unit info: serial number, firmware versions, breaker name.
- Firmware updates

Operating System:

Microsoft Windows, ideally Windows 10, 8, 7, or Vista.

Connection:

mini-USB (cable not included)

NOTE: if AC-PRO-II is located behind a cubicle door, a USB panel mount extension was provided with the retrofit kit. (See Section 5.6.1).

The InfoPro-AC™ software application is available for download at:

http://www.utilityrelay.com/Side_Bar/Downloads.html



Open the downloaded file and follow the instructions to install the application.

**** IMPORTANT ****

InfoPro-AC needs the correct USB device driver to communicate with AC-PRO-II. Microsoft Windows often already includes these drivers. However, if this driver is not already installed:

- 1) Ensure your PC is connected to the Internet.
- 2) Connect AC-PRO-II to your PC with the USB cable.
- 3) Automatic driver update process:
 - a) After you connect the AC-PRO-II, if you have an internet connection and administrative rights on your PC, Microsoft Windows should install the driver automatically after a few minutes.
- 4) Manual driver update process:
 - a) Open Windows Device Manager
 - b) Right click on the AC-PRO-II device. It will be located under Ports or under Other Devices.
 - c) Choose the "Update Driver Software" option.
 - d) Choose the "Search automatically" option.
 - e) After the driver is installed, close and then reopen the InfoPro-AC Application.

NOTE: Any pending Microsoft Windows updates can interfere with the driver installation process.

For more detailed instructions with screenshots, contact URC.

Refer to the InfoPro-AC™ Help Guide within the InfoPro—AC application for specific information and instructions.

23.1 Firmware Versions and Updates

To determine which firmware version is currently installed on your AC-PRO-II, use the MORE menu. See Figure 6.5.

The InfoPro-AC application can be used to update AC-PRO-II firmware in the field using the USB port. AC-PRO-II Firmware update instructions can be found in the InfoPro-AC Help Menu. For firmware version information see the following link:

http://www.utilityrelay.com/Side_Bar/Firmware_versions.html



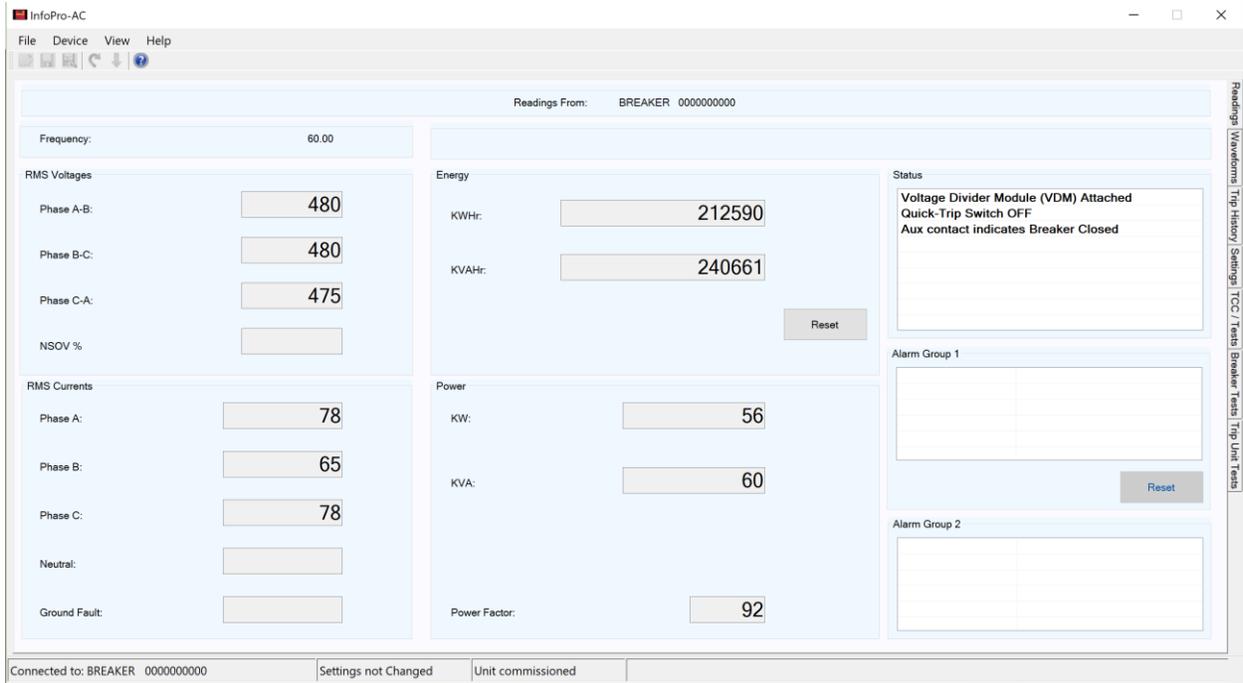


Figure 23.1: InfoPro-AC Readings Tab Screenshot

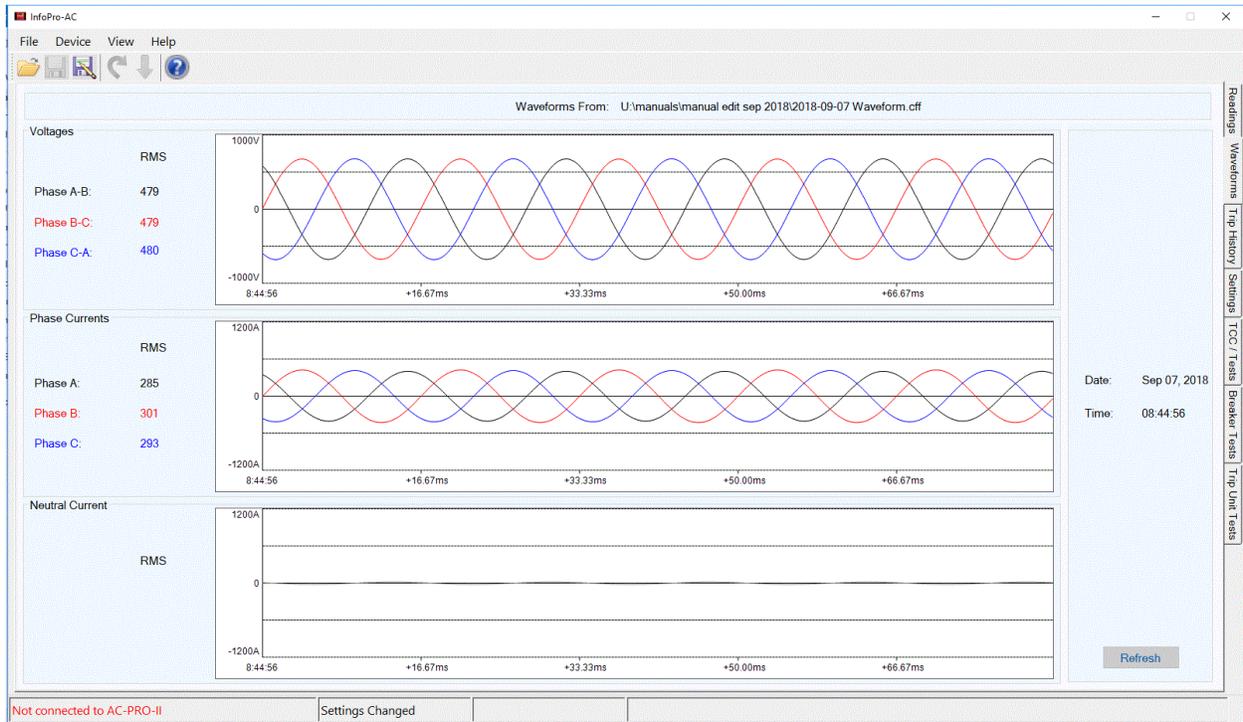


Figure 23.2: InfoPro-AC Waveform Tab Screenshot

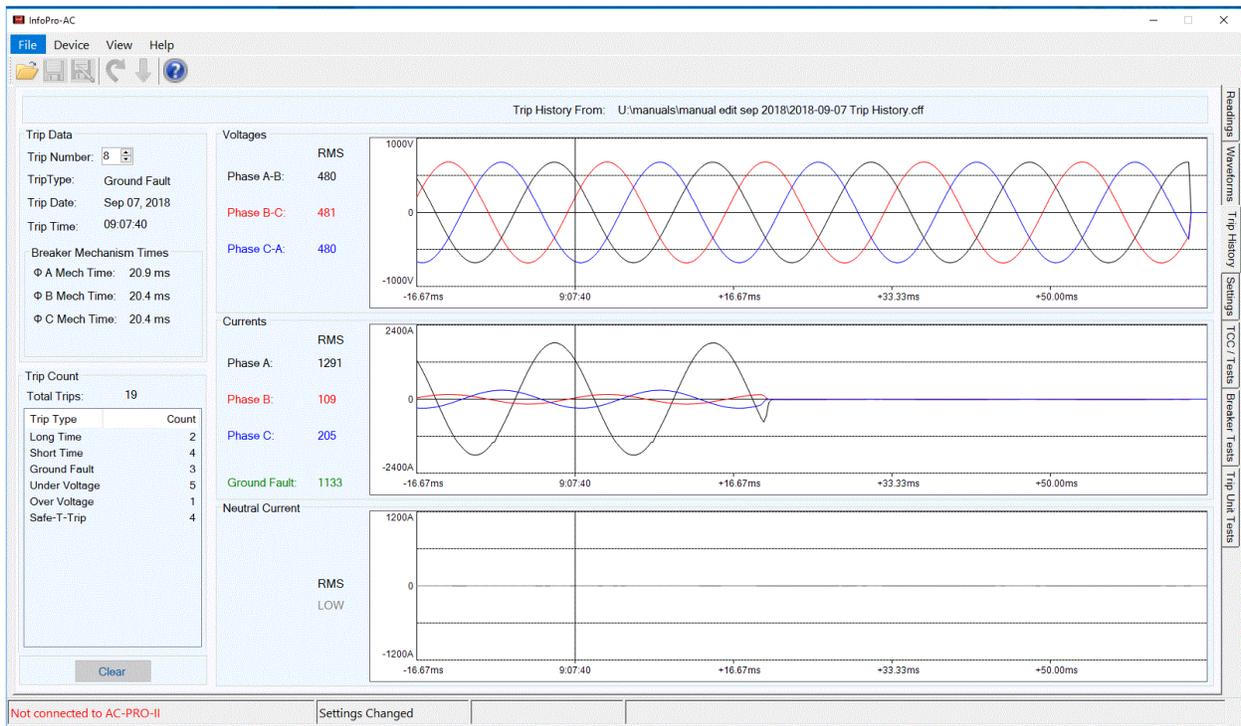


Figure 23.3: InfoPro-AC Trip History Tab Screenshot

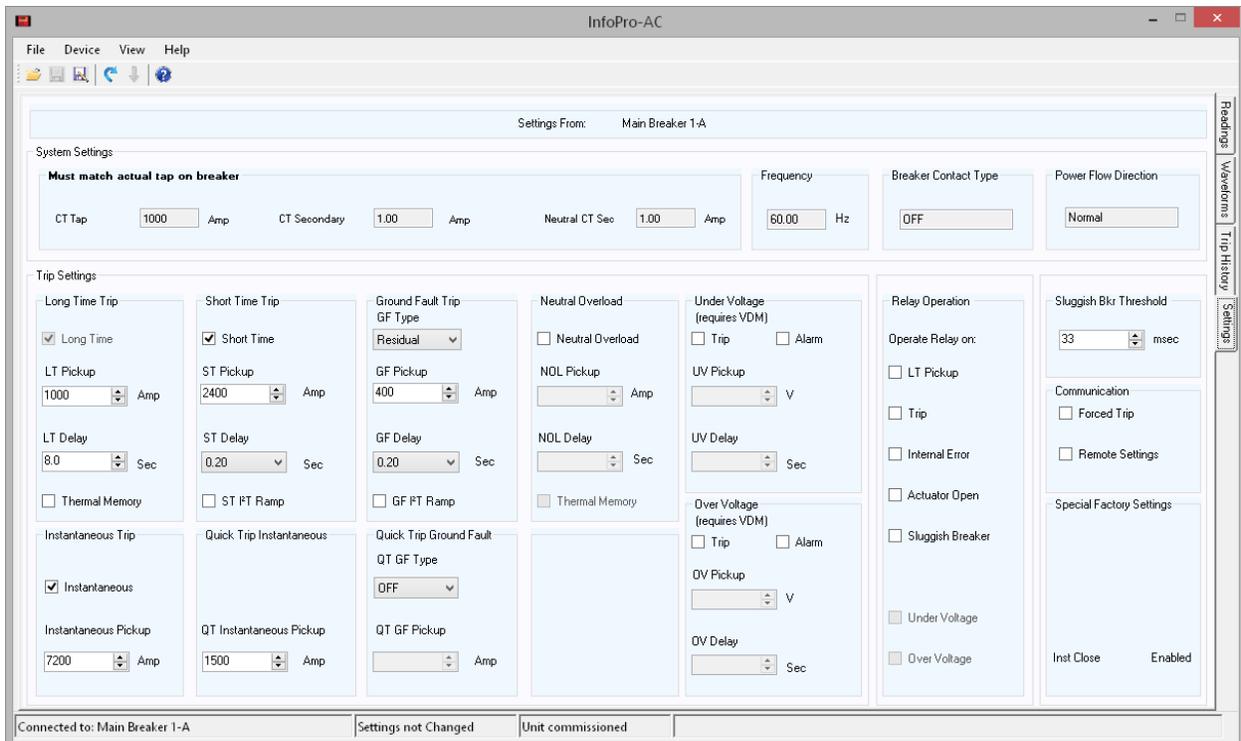


Figure 23.4: InfoPro-AC Settings Tab Screenshot

24.0 Communications

24.1 Communications Introduction

Creating a complete power monitoring and communications system for a low voltage power distribution system is easy with Utility Relay Company's AC-PRO-II. The standard AC-PRO-II trip unit communicates using industry standard Modbus RTU protocol through a single shielded twisted pair wire connected to the RS485 port. A number of trip units can be daisy-chained together to simplify installation.

AC-PRO-II communications features and information:

- Currents, 3-phase ($\pm 2\%$ accuracy for currents between 20% and 150% of the CT rating)
- Review and change all settings ("Changing settings over Comm" user setting must be enabled at trip unit).
- Voltages, 3-phase
- KW, 3-phase & total ($\pm 5\%$ accuracy for currents between 10% and 150% of the CT rating)
- KWHr, total
- KVA, 3-phase & total
- KVAHr, total
- Power Factor data
- Breaker position status (open or closed)
- Trip unit alarms and status information
- Sluggish-Breaker indication
- QUICK-TRIP ON /OFF status
- Trip history data for the last 8 trips
 - Trip counts
 - Trip type (reason for trip)
 - Trip dates & timestamps
 - Trip currents & voltages
 - Breaker mechanism times
- Trip unit time and date
- Trip unit Information: serial number, firmware revision.
- Forced trip ("Forced trip over Comm" user setting must be enabled at trip unit).

NOTE: Voltage Divider Module (VDM) is required for voltage and power information.

A host PC running HMI software with Modbus device drivers collects information from the trip units. The driver interrogates each trip unit individually and reports that information back to the host PC applications on a continual basis. Additional trip units can be added to the system by simply providing the new trip unit's ADDRESS to the HMI software.

AC-PRO-II trip units are compatible with the Modbus RTU communication protocol supplied with most HMI systems such as Inductive Automation's Ignition, Siemens WinPM; Wonderware's *InTouch*™, *Intellution*™; Schneider *PowerLogic SMS-3000*™, *ION Enterprise*™, and PME (Power Monitor Expert); Eaton Power Xpert; GE EnerVista; and Power Measurements *PEGASYS*™.

24.2 Communications Components

An AC-PRO-II Modbus Communications system consists of the following hardware components:

1. AC-PRO-II trip unit and breaker retrofit components.
2. Host PC (supplied by others).
3. Cabling topology (supplied by others).

Additional components to consider include:

1. OPC software with Modbus device drivers (supplied by others).
2. Modbus RTU/Ethernet converter (supplied by others).
3. Human-Machine Interface (HMI) System (supplied by others). These systems are used to view trip unit information graphically and often contain their own compatible Modbus Driver.

24.3 Communications Wiring

Although all AC-PRO-II trip units are capable of communications, units that are specifically ordered for communications are furnished with quick-disconnect communications cable assemblies. The cable assembly features a heavy-duty twist-lock connector and a terminal block, which mounts inside the switchgear.

The purpose of the terminal block is to provide a connection location for the twisted pair wire as it is daisy-chained from cell to cell in a switchgear lineup. This enables any individual communicating AC-PRO-II (mounted on a circuit breaker) to be removed without disrupting communications between the other communicating AC-PRO-II trip units.

See Figure 5.3 for wiring diagram. If replacing an existing AC-PRO with AC-PRO-II, remove the existing 2-piece AC-PRO communications cable from the cubicle, and use the new 2-piece cable shipped with the AC-PRO-II.

NOTE: The RS485 End of Line Termination switch should be in the on position on the AC-PRO-II that is the last device in the RS-485 loop. See Figure 4.1.

****IMPORTANT****

Do NOT use external termination resistors or circuits with AC-PRO-II.

24.4 System Components & Computer Hardware

URC trip units communicate over the RS485 interface at 9600 or 19200 Baud, with 8 data bits, 1 stop bit and no parity using the Modbus RTU communications protocol.

24.4.1 Ethernet

With the addition of an RS485 to Ethernet Converter an existing Local Area Network (LAN) can be used to carry data between trip units and the PC. Converters are widely available from a variety of industrial computer manufacturers.

RS485 to Ethernet Converters are designed to be compatible with a TCP/IP network environment and typically connect to a LAN using standard 10Base-T modular CAT-5 cabling. These converters offer a relatively inexpensive means of connecting to a LAN.

24.4.2 LCI Ethernet

The LCI (Local Communications Interface) is a legacy unit manufactured by Utility Relay Company until mid 2017. It is a substation monitor that continuously monitors up to 32 AC-PRO and/or AC-PRO-II trip units that are connected to the LCI's RS485 port.

NOTE: To ensure proper communication with AC-PRO-II, jumper connector J6 must be removed from the LCI circuit board. This jumper was removed at the factory for units that shipped after March 2015. Contact URC for additional details.

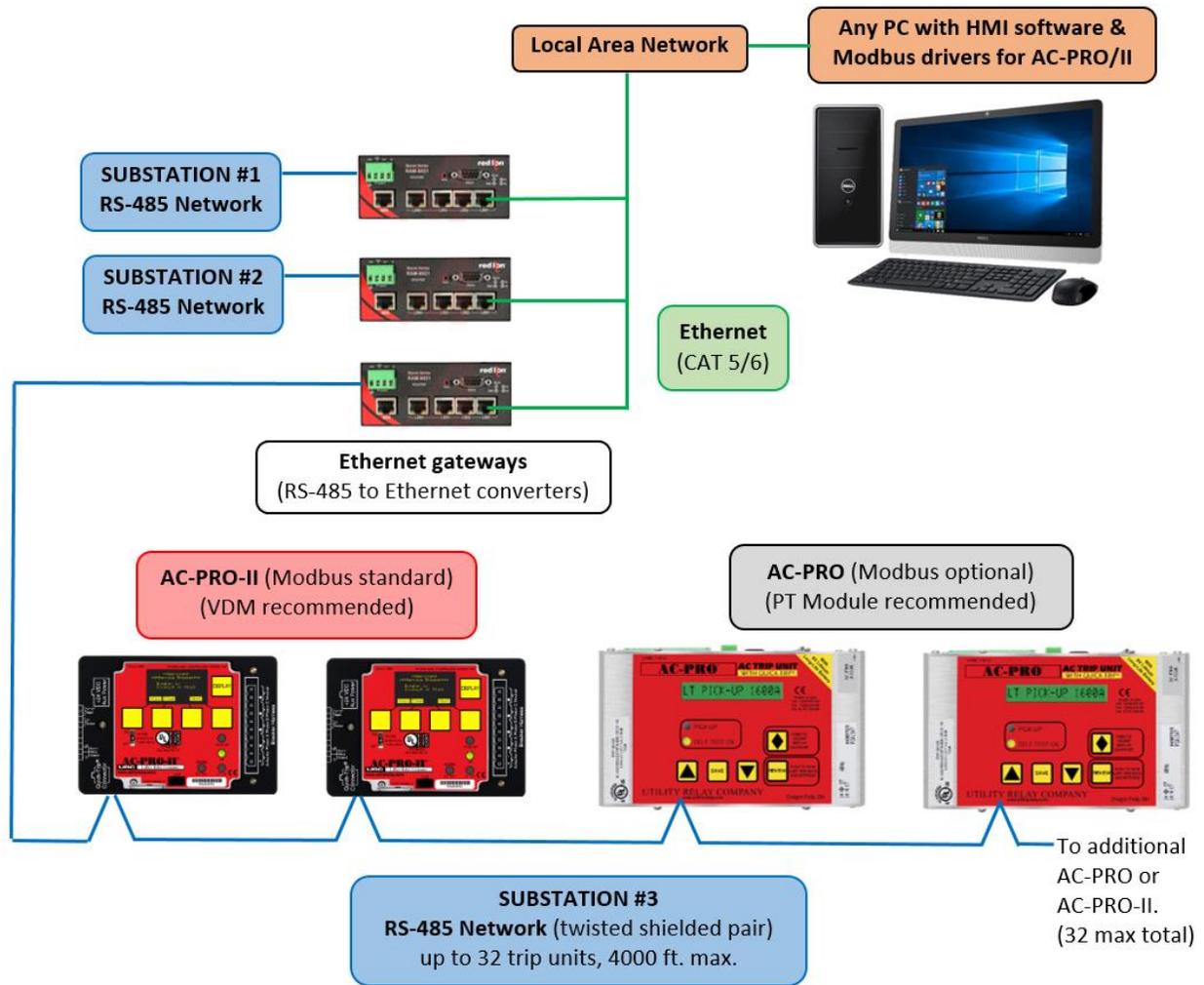


Figure 24.1: Typical Communications Configuration Example

24.5 Trip Unit Programming

AC-PRO-II trip unit has several programmable settings related to communications. See Section 11.23 for communications settings.

REPLY DELAY

The REPLY DELAY set point is the minimum delay between the trip unit's receipt of a MODBUS packet and its reply. Adjusting it enables the trip unit to operate properly with other manufacturers' MODBUS RS-485 connections.

The factory default of this set point is 5 milliseconds.

The reply delay can be changed using the InfoPro-AC software application.

24.6 Modbus Registers

The AC-PRO-II Modbus Register Map is available for download at the following location:

http://www.utilityrelay.com/PDFs/Product_Manuals/I-AC2-COMM.pdf



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