etc-12 / etd

Section II Instruction Manual

Instructions for:

Wiring, Set Up, Operation, and Test

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etc-12 / etd

Section II Instruction Manual

Table of Contents

Introduction:

The *etc-12 / etd* is a patent pending electronic trip device designed to replace overloads and existing trip units on low voltage power circuit breakers. The system is easy to use and provides the ultimate in versatility and operator safety. The trip unit consists of two components; the *electronic trip display (etd)* module and the *electronic trip controller (etc-12)*.

The *etd* module consists of a 4-button user interface and a 4 line by 20 character backlight LCD display. It interfaces with the *etc-12* through a standard RJ45 connector and can be mechanically coupled with the *etc-12* for mounting on the circuit breaker. The display can also be mounted in a remote location such as outside a cubicle door or on a centralized control panel. All basic setup functions can be accessed through the *etd* and the user is able to view settings, previous trip data and real-time three phase and, optionally, ground currents as well as access many advanced features. The *etd* contains a 9V lithium-manganese battery for querying the *etc-12* when system current is not present. The *etd* module does not provide power to the *etc-12* for any protective functions nor do settings reside on the *etd.*

The electronic trip controller *(etc-12)* module is designed to mount on the circuit breaker and is mechanically compatible with all *etc* brackets and harnesses manufactured by Satin American since its first trip device was introduced in 1987. The unit provides full LSIG protection for both three and four wire systems and allows the user to disable unneeded functions. A large number of available pick-up points and delay bands allow it to be configured to replicate virtually any time-current curve. The *etc-12* does not contain a battery and receives all of its power from the current sensors on the breaker being monitored. Settings and past trip information reside in non-volatile memory which can be queried by the *etd*. The following advanced functions are available as standard features on the *etc-12*[*]:

- *flashSAFE* arc-flash reducing maintenance mode[†].
- Selective zone interlocks.
- Phase Imbalance
- Bell alarm trip indication.
- Thermal memory.
- Remote trip ability.
- MODBUS communications interface.

The *etc-12* is the first trip controller designed to work with multiple current sensor secondary ratings. The unit can be interfaced with 200 mA current sensors and is fully backwards compatible with Satin *etc-11*, *etc-11r*, and *etc-11d* trip controllers. The *etc-12* is also compatible with the 1A current sensors supplied with newer Satin kits. The *etc-12* has a significantly expanded settings range and affords greater flexibility than traditional trip units functioning with multi-tapped sensors.

The unique two-piece convertible design provides the user the option of mounting the *etd* display module directly to the circuit breaker or outside the breaker cubicle. Remotely mounting the display greatly reduces exposure to arc-flash hazards since it allows all setup, monitoring, querying and battery maintenance operations to be performed outside of the NFPA-70E flash protection boundary.

[*] An etc auxiliary terminal kit is required to access some of these functions.

[†] *flashSAFE* may be activated through the front panel however, a module enabling remote activation and indication and the ability to comply with lockout / tagout requirements is optionally available.

1.0 Hardware Overview:

Figures 1, and 2 show an *etd* display module and a *etc-12* control module and identifies several key hardware features. Before setting up, commissioning or testing the *etc-12/etd* retrofit system, the user should become familiar with these items.

Figure 1, Front View of *etc-12*

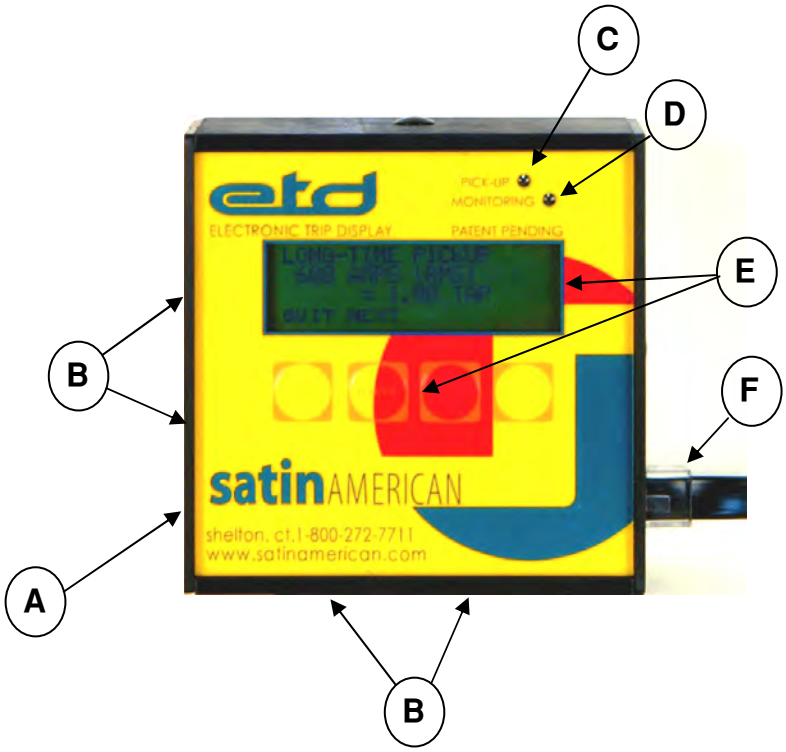


Figure 2, Front View of *etd*

a) Battery Access.

Removing the four screws on this panel allows the user to access the battery in the *etd*. The *etd* uses a long-life 9V lithium battery to power the backlight and set up or query the breaker when system current is not present.

Under ideal conditions, the battery is rated to provide 15 hours of continuous operation and have a 10-year storage life. Since trip units are often exposed to higher than optimal temperatures and are typically used in a manner that places sporadic, non-linear current demands on the battery, it can be expected that the actual service life will be between 3 and 5 years. It is recommended that batteries be replaced as part of the breakers scheduled, preventative maintenance program.

In order to maximize longevity when operating under battery power, the *etc-12* uses a number of power management techniques. All modes of operation employ timeouts that powers down the unit after a predetermined period of inactivity. The internal power monitor automatically disables the LCD backlight when battery voltage decreases below a predetermined value. Disabling the backlight conserves the remaining battery life so that the user can access the more essential setup and querying functions.

Although Satin American recommends that only 9V lithium batteries be used for replacement, a standard 9V alkaline battery may be used in emergency situations. The service life of an alkaline battery will be significantly less than that of a lithium equivalent. Lithium batteries are available in the photo or electronics departments of many retail stores. Contact Satin American or the national sources listed in table 1 for bulk purchases.

Table 1, Sources for 9V Lithium Manganese Batteries.

Company	Part Number	Phone
Grainger	2LBJ8	(888) 361-8649
McMaster-Carr	7745K56	(609) 223-4200
MSC Industrial Supply	67463752	(800) 645-7270
Radio Shack	23-665	(800) 843-7422

b) Nesting Pin receptacles.

The *etd* is designed to nest into either the *etc-12* or other brackets intended for remote mounting. This nesting is accomplished through the use of retention pins and a spring loaded plunger. In order to achieve backwards compatibility with older bracket designs, the *etd* is made to mount in two orientations. The *etd* is supplied with plastic plugs to fill the unneeded set of mounting holes. If it is necessary to change the mounting orientation in the field, these plugs can be removed and reinserted where needed.

c) Pickup Indicator

This red LED illuminates when the etc-12 has entered pickup and the breaker is timing to trip.

d) Monitoring Indicator

This green LED illuminates when the *etc-12* senses AC current. This LED will not illuminate when the unit is operating only on battery power. Currents must be above approximately 3% of the tap rating for 1A sensors 5% of the tap rating for

200mA sensors for this LED to illuminate.

e) LCD Display / Soft key buttons.

The display on the *etd* consists of a 4x20 line backlight LCD and a 4 button keypad. Pressing the key labeled *power* will activate battery power on a de-energized unit. The *power* button will also activate the backlight on units that are in-service. Note that the backlight is powered exclusively by the battery and does not receive any power from the circuit being monitored. The *etc-12* automatically disables the backlight when battery voltage is low. This feature permits the use of critical setup and querying functions even when the battery is weak.

An intuitive menu structure is used to access various functions and reports. A system of soft keys is used, where the function of the key is shown on the bottom line of the display, directly above each button.

f) Receptacles for connecting *etc-12 to etd*

The *etc-12* and *etd* modules are connected using 8 conductor cable terminated to 8P8C (RJ45) plugs. Both flat telecommunications cable and Ethernet cable (Category 5, 5e, 6, 6a or 7) can be used to make this connection. The modules can be positioned up to 250 feet apart. Shielded cable is recommended for runs over 25 feet in electrically noisy environments.

etc-12/etd retrofit kits are supplied with short, pre-made cables for connecting the *etd* to the *etc-12* when the units are in the nested configuration. If a retrofit kit is purchased with the door mount kit, an additional 5' cable and an additional plug is supplied. This cable may be either used as-is or cut to length and re-crimped in the field. The crimpers for RJ-45 connectors are readily available at most commercial supply houses and at retail locations that sell computer networking or wiring supplies.

Refer to appendix 1 for instructions for crimping RJ-45 connectors.

g) Auxiliary Connector

This connector interfaces the *etc-12* with various accessories and auxiliary devices. All of the functions listed below are supported by the *etc-12* and can be utilized at any time if the device is connected to the proper hardware.

- Latching trip (bell alarm) relay.
- Remote activation switch and indicator LED for *flashSAFE*
- Selective zone interlocks.
- MODBUS communications.
- Remote shunt trip.
- Hardware interlock which prevents settings changes.

h) Breaker connector (on back)

This connector accepts the breaker wiring harness and interfaces the etc-12 with breaker mounted current sensors, the flux trip device as well as the neutral sensor (through secondary disconnects), on 4 wire systems.

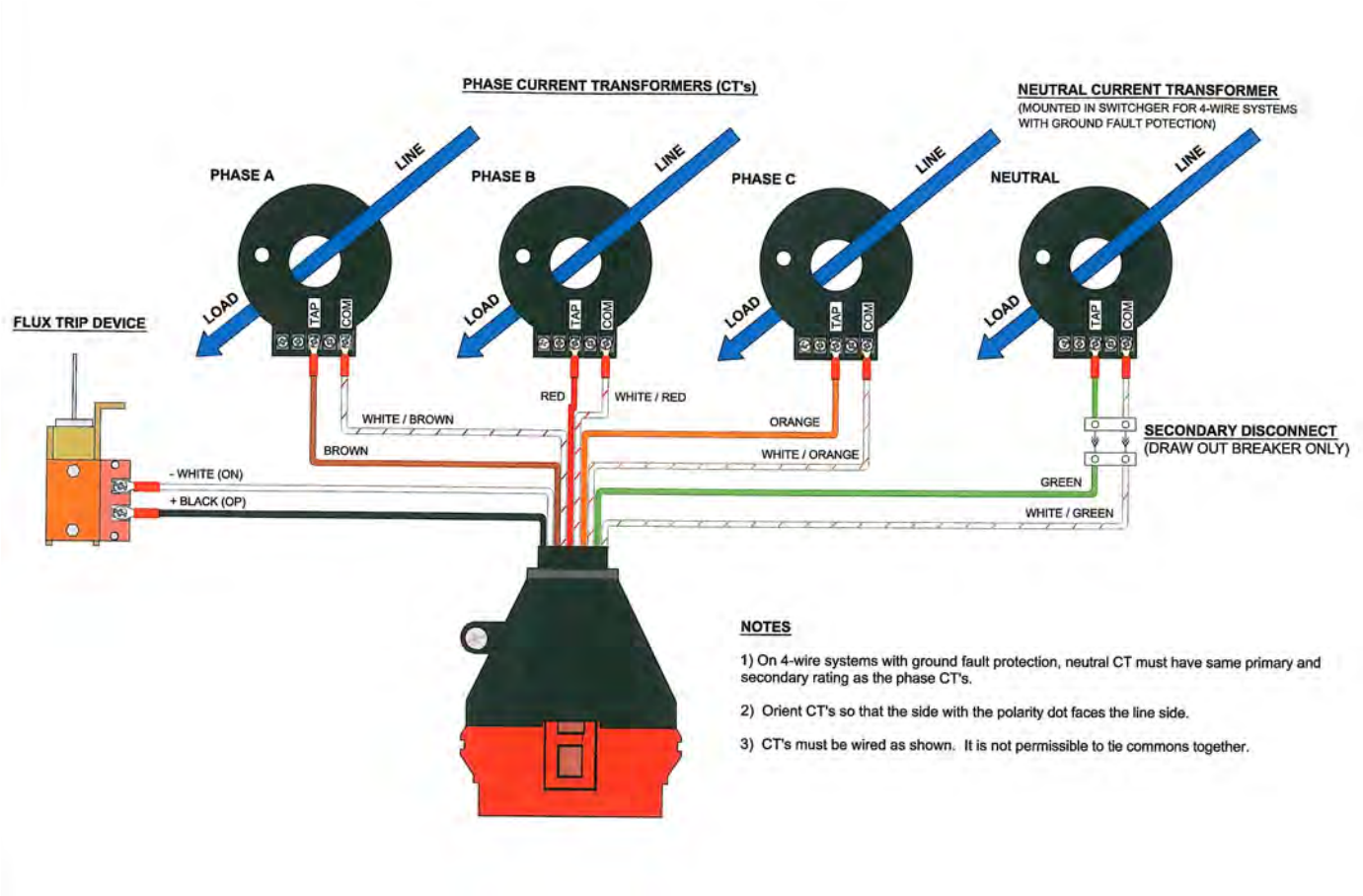
i) Wiring Harness (supplied with complete retrofit kits only)

This harness mates with the breaker connector and interfaces current sensors and the flux trip device to the

etc-12. The *etc-12* is designed to work with sensors that have either a 200 mA or 1A secondary rating. A different harness is supplied for each current sensor secondary rating. The programmer detects the pinout of the harness and automatically configures itself to operate with the appropriate sensor type. It is critical that the rating of the harness match the CT rating. All harnesses originally supplied with *etc-11*, *etc-11r* and *etc-11d* programmers are configured for use with 200 mA current sensors and are compatible with the *etc-12* when used with 200 mA sensors. Refer to table 2 for connector wire pin-outs and color code. The below illustration shows how the harness is connected to other kit components.

Table 2, Wiring Harness Pinout and Wire Color Code.

Pin Number	Wire Color	Function
28	White	Flux device (+)
32	Black	Flux device (-)
18	White with brown stripe	Phase A CT com
22	Brown	Phase A CT tap
19	White with red stripe	Phase B CT com
23	Red	Phase B CT tap
20	White with orange stripe	Phase C CT com
24	Orange	Phase C CT tap
21	White with green stripe	Neutral CT com
17	Green	Neutral CT tap



A harness for 1A sensors is shown in figure 3. The 1A harness can be distinguished from the 200 mA harness by the polarizing plug that prohibits it from mating with older *etc* units which are not configured for 1 A operation.

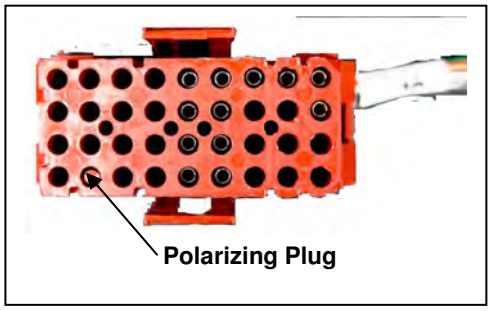


FIGURE 3, VIEW OF 1A Breaker Harness

In some applications, space limitations prohibit the black harness connector cover from fitting between the rear of the *etc-12* and the breaker. The connector cover is used for cosmetic purposes only and does not provide support or strain relief for the connector wires. This cover may be removed and discarded in situations where spacing prevents its use.

2.0 Modes of operation:

In order to simplify setup and use, the *etc-12/etd* is designed to operate five distinct modes of operation. Each mode allows the user to input settings or view specific information.

The user may navigate though these modes using the keypad on the *etd*. The following is a detailed description of the features and functions available in each of these modes.

2.1. Setup Mode:

Setup mode allows the user to input or change trip settings and configure advanced features and options. It is necessary to enter initial settings before placing the breaker in service. If the *etc-12* is placed into service before settings are input, the unit will trip the breaker immediately.

Settings information is retained into non-volatile memory and will be preserved even after the programmer is disconnected from all power sources.

While in setup mode, the programmer will prompt the user for the breaker settings information listed in table 3A. This information must be available before the breaker is placed in service and should be obtained from the most recent coordination study performed by a qualified engineer. Tables 3B and 3C contain additional settings which are required for advanced features or customizing options. The user may choose to skip this part of the setup routine and accept the default values.

TABLE 3A, Settings Information Required for Setup.			
Parameter	**Range of Settings**	**Notes**	**Value for this application**
Current sensor tap rating	40A, 70A, 80A, 100A, 120A, 150A, 200, 225, 300, 400, 600, 800A, 1000A, 1200A, 1600A, 2000A, 2400A, 2500A, 3000A, 3200A, 4000A, 4200A, 5000A, 6000A		
Long-time pickup	From 25 to 110% of the current sensor tap ratings, in increments of 5% of the tap rating.		
Long time delay (defined at 6 x long-time pickup)	MIN (5 seconds), INT (13 seconds), MAX (27 seconds) or custom.	Custom delays are available between 1 and 5 seconds in .5 second intervals and from 6 seconds to 30 seconds in 1 second intervals.	
Short circuit protection type	Short-time delay, with or without I^2t function, instantaneous, or both.		
Short time pickup	From 150 to 1000% of long time pickup, in increments of 25% of the long time pickup value.	May be defeated if instantaneous is enabled.	
Short time I^2t	Constant delay or I^2t		
Short time delay	.070, .100, .150, .200, .300, .400, .500, .seconds		
Instantaneous pickup	From 150 to 1200% of the long-time pickup value. For values below 4L, increments are in 50% multiples of the longtime pickup value. Above 4L, increments are in 100% multiples of the long-time pickup value.	May be defeated if short time is enabled.	
Ground fault pickup	From 10 to 200% of the sensor tap rating, provided that this value is not greater than 1200A. Increments are of 5% of the sensor tap rating up to 100% of tap rating. Above 100% of tap rating, increments are in 10% of tap rating.	May be defeated.	
Ground fault delay mode	Constant or I^2t		
Ground fault delay.	.100, .150, .200, .300, .400, or .500 seconds		

TABLE 3B, Advanced Features				
Parameter	**Range of Settings**	**Notes**	**Default Value**	**Value for this application**
flashSAFE Instantaneous Pickup	150 to 1200% of the long time pickup value.	May be defeated. Must be lower than the previously entered instantaneous pickup. May be enabled even if instantaneous is defeated.	Off	
flashSAFE Ground fault pickup.	From 10 to 200% of the sensor tap rating, provided that this value is not greater than 1200A. Increments are of 5% of the sensor tap rating up to 100% of tap rating. Above 100% of tap rating, increments are in 10% of tap rating.	May be defeated. Must be lower than the previously entered ground fault pickup. May be enabled even if ground fault is defeated.	Off	
Phase imbalance pickup	Current differentials between 15% and 50%.	May be defeated.	Off	
Phase imbalance delay	From 1 to 10 seconds in 1 second intervals, from 12 to 20 seconds in 2 second intervals, from 25 to 50 in 5 second intervals, from 60 to 90 in 10 second intervals.		Off	
Long time thermal memory	On or Off	May be defeated.	Off	
Ground fault thermal memory	On or Off	May be defeated.	Off	
Selective Zone Interlocks	On or Off	May be defeated.	Off	

TABLE 3C, Options				
Parameter	**Range of Settings**	**Notes**	**Default Value**	**Value for this application**
Frequency	50 or 60 Hz		60 Hz	
Allow settings changes when in service.	Yes or No		No	
Permit activation of flashSAFE from front panel.	Yes or No		No	
Permit shunt trip from front panel.	Yes or No		No	
Permit display of ground fault current	Yes or No		No	

2.1.1. Entering Setup Mode:

When a new programmer is received from the factory, pressing the *POWER* button on an *etd* that is connected to an *etc-12* will energize both units and initialize setup mode.

Setup mode must be entered through the main menu if settings have previously been entered. To enter setup, the user must press the menu button and use the arrow keys until *SETUP MODE* is displayed. Pressing *ENTER* will then initialize setup mode.

A unit that is sensing current on more than one phase or on one phase plus neutral is considered to be in service. Setup mode can be accessed on in-service breakers if both:

a) The option to allow in-service settings is selected in the *OPTIONS* menu prior to the breaker being placed in service.

b) Setup is not locked with a hardware interlock.

If both of the above conditions exist, *SETUP MODE* can be accessed through the main menu. When setup mode is accessed for in-service breakers, the option to change sensor tap is not available.

Note: On in-service breakers, protective functions, including *flashSAFE* are temporarily disabled when in *SETUP MODE*. Care must be taken to ensure that in-service settings changes are made a safe and expeditious manner.

2.1.1.1. Serial Number

When setup mode is first entered, the serial number and software version number are displayed on the LCD as shown in figure 4. The user may select "QUIT" to exit to the main menu or "NEXT" to continue with setup.

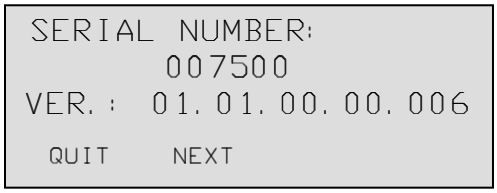


Figure 4, Serial Number Screen

2.1.1.2. Sensor Tap Rating:

If the breaker is not in service, the screen shown in figure 5 is displayed, prompting the user to enter the CT tap rating. The programmer will not permit the tap rating to be changed on in-service breakers. If the breaker is in service, the option to change sensor tap is not available.

The user may use the up and down arrow keys to scroll through the available ratings. When the correct rating is displayed, pressing the *SELECT* key configures the *etc-12* for operation with the displayed sensor tap value.

Note that the programmer senses the current sensor secondary rating based on the breaker harness that is plugged into the breaker connector. The unit defaults to 0.2 amperes if no harness is connected.

Changing the harness will automatically reconfigure the unit for use with 0.4, 0.5 or 1.0A sensor secondary ratings. In order for the rating change to take effect, the programmer must be completely powered down then restarted. This can be accomplished by allowing the display to time out or simply by unplugging the display cable. Once this is done, setup mode will display an additional screen where the sensor secondary rating can be selected.

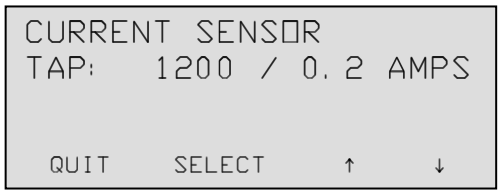


Figure 5, Sensor Tap Screen

2.1.1.3. Long Time Pickup:

The user is then prompted to select a *Long Time Pickup* (LTP) setting. The LTP is the current at which the *etc-12* begins to time towards a trip against the long-time delay. It is displayed both in amps and as a percentage of the sensor tap. Figure 6 shows a typical screen that is encountered when selecting the long-time pickup point. The up and down arrow keys are used to scroll through the available values and the select key configures the *etc-12* for the displayed pickup point.

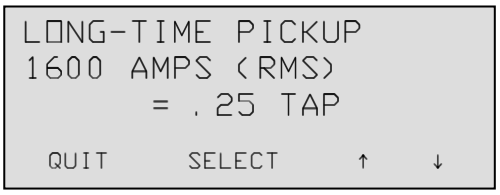


Figure 6, Long Time Pickup Screen

2.1.1.4. Long Time Delay:

After a long-time pickup point is selected, the screen shown in figure 7 is displayed. This screen prompts the user to select the *long-time delay* (LTD). The LTD sets the time delay between the instant that the long-time pickup is exceeded and when the *etc-12* initiates a breaker trip. The delay has an inverse I^2t relationship with the magnitude of the over-current so that the delay becomes shorter as current increases. A long-time thermal memory feature may be selected in the *Advanced Features* setup menu. Refer to section 2.1.2.3 for more information. Unless thermal memory is selected, the delay timer will be reset if current decreases below the pickup value.

The long time delay is based on time to trip at 600% of the long-time pickup setting. Minimum (5 second), Intermediate (13 second) and Maximum (27 second) delay bands are available. These bands correspond with the MIN, INT, and MAX delay bands available on all previous Satin American trip devices. The user may also define a custom band that has a selectable delay between 1 and 30 seconds at 600% of the long-time pickup value.

Figure 7, Long Time Delay Screen

2.1.1.5. Short Circuit Protection

The next menu screen asks the user to select the type of short circuit protection that will be used. The arrow keys may be used to select short-time, instantaneous, or both.

Figure 8, Short Circuit Protection Band Selection

Based on the selection made in the *Short Circuit Protection Band* screen, the setup routine will allow the user to select the short-time pickup, delay and delay curve as described starting in section 2.1.1.6 and / or the instantaneous pickup point as described in 2.1.1.9.

2.1.1.6. Short-Time Pickup Point

The screen shown in figure 9 is displayed, prompting the user to select a *Short-Time*

Pickup (STP). The STP is the value at which the *etc-12* begins timing to trip against the short time delay.

The arrow keys can be used to scroll through the available values, which are between 1.5 and 10 times the long-time pickup value. Once the desired pickup point is displayed, pressing the *Select* key will configure the etc-12 for operation at this pickup point.

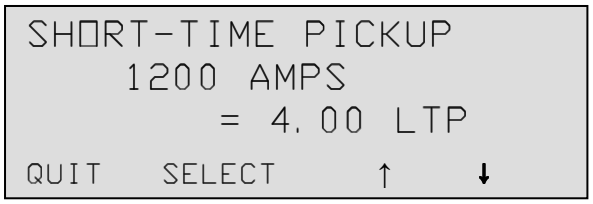


Figure 10, Short-Time Pick-up Selection

2.1.1.7. Short-Time Delay Mode

The screen shown in figure 11 prompts the user to select either a constant delay (I2t off) or a ramped delay (I2t on). The arrow and select buttons are used to enter the desired option.

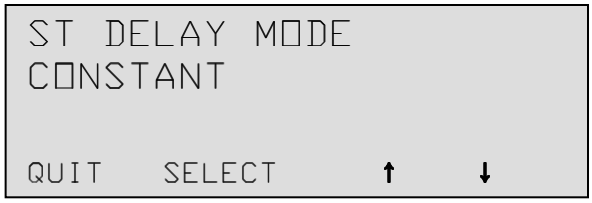


Figure 11, Short-Time Delay Mode Selection

2.1.1.8. Short-Time Delay

After configuring the short-time pickup, the user is asked to select a delay value. This value is defined as the amount of time that the etc-12 will count down after the short time pickup is exceeded and before initiating a breaker trip. If current drops below the preset pickup point at any time during the delay period, the delay counter will be reset.

The available delays are .070, .100, .150, .200, .300, .400, .500, .600 and .700 seconds. The arrow and *Select* keys can be used to display and choose the appropriate value. The *Short-Time Delay* screen is illustrated in figure 12.

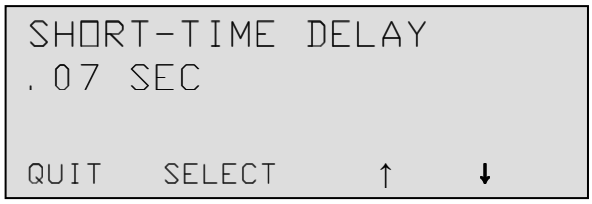


Figure 12, Short-Time Delay

2.1.1.9. Instantaneous Pickup Point

If the instantaneous protection option has been selected in section 2.1.1.5, the screen shown in figure 13 will be displayed. If this option hasn't been selected, the setup routine will proceed with *Ground Fault Selection* as detailed in 2.1.1.10.

This screen prompts the user to enter an instantaneous pickup point. When current exceeds this set-point, the etc-12 will initiate a breaker trip without intentional delay (less than 3 cycles). The pickup point is expressed in both amps and multiples of the LTP. This value can be between 1.5 and 12 times the LTP value. The arrow keys can be used to scroll through the available choices. The *Select* key is used to choose the displayed value.

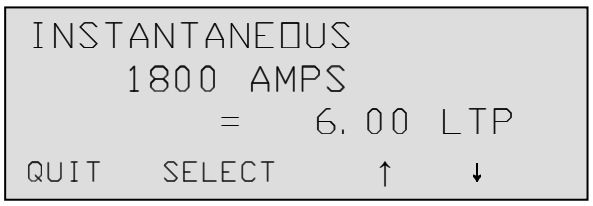


Figure 13, Instantaneous Pickup Point

2.1.1.10. Ground Fault Selection

After the short-circuit setup is complete, the ground fault selection screen shown in figure 14 is displayed. This screen allows the user to enable or defeat the ground fault protection feature. If ground fault protection is not required, select "NO" and the setup routine will proceed to Advanced Features setup as described in 2.1.2.

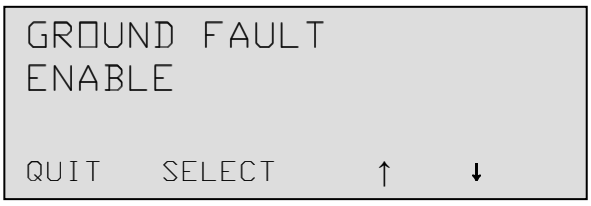


Figure 14, Ground Fault Enable / Defeat

The *etc-12* senses ground fault on both 3 and 4 wire systems by performing a direct summation of currents. Ground fault protection has a selectable time delay with both constant or I^2t delays available. When the I^2t delay curve is selected, ground fault thermal memory can also be enabled in the advanced features menu. The ground fault thermal memory feature is designed to protect against repetitive, short duration sputtering faults.

The *etc-12* determines ground by calculating the vector sum of the currents that it measures on each phase and neutral (if applicable). Under normal (non-ground fault) conditions, this sum will always equal zero. In order for the ground fault function to operate properly, it is vital that all current sensors have the same primary and secondary ratings and are connected with proper polarity. Refer to the cabling diagram included as an appendix.

2.1.1.11. Ground Fault Pickup

If ground fault protection is enabled, the *etd* will display the screen shown in figure 15, prompting the user to enter a pickup setting. The ground fault pickup is the current at which the *etc-12* begins to time to trip against the ground fault delay. The pickup values are based on multiples of the current sensor tap value. The arrow and select keys can be used to select the desired pickup current.

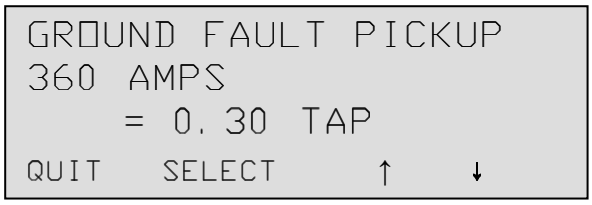


Figure 15, Ground Fault Pickup

2.1.1.12. Ground Fault Delay Mode

The screen shown in figure 16 is displayed. This screen prompts the user to select either a constant ground fault or a ramped delay based on the inverse I^2t curve. If the I^2t delay is selected, the option to select ground fault thermal memory will be available in the *Advanced Features* menu.

The arrow and select keys can be used to choose the desired option.

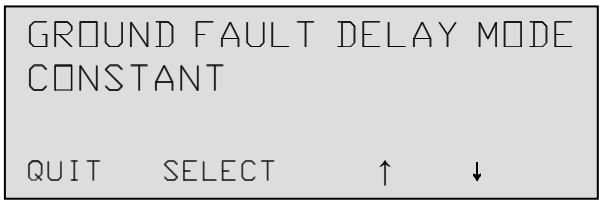


Figure 16, Ground Fault Delay Mode

2.1.1.13.Ground Fault Delay

The screen shown in figure 17 is displayed, prompting the user to select a ground fault delay time. The arrow and select keys can be used to display and select the desired value. Available ground fault delays are: .10, .15, .20, .30, .40, and .50 seconds.

The *etc-12* will count down for this delay period after the ground fault pickup is exceeded and before initiating a trip. If the I^2t option is selected, the time to trip follows the inverse I^2t curve and the delay is adjusted based on the magnitude of the fault, with higher current faults having shorter delays. Unless the thermal memory feature is enabled, the ground fault delay timer will be reset if the current decreases below the pickup point.

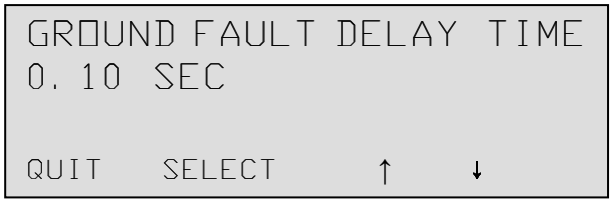


Figure 17, Ground Fault Delay

2.1.2. Advanced Features

The screen shown in figure 18 is displayed. Selecting *SKIP* will configure the *etc-12* to operate with the advanced features default values detailed in table 3B. If the *SKIP* option is selected, the setup routine will continue with the *OPTIONS* menu as described in 2.1.3

Figure 18, Advanced Features

WARNING!!

flashSAFE settings must be determined by a qualified engineer after short circuit and arc-flash studies have been completed. Improper settings can result in injury or death to personnel, equipment damage and nuisance tripping.

This device is intended to augment an existing safety system and does not eliminate the need for personnel to be trained and equipped with appropriate levels of PPE. Refer to NFPA-70E for comprehensive guidelines for workplace electrical safety.

It is vital that breakers are suitably adjusted and maintained as any advantage gained by faster response from the trip unit will be negated by improper mechanical operation.

When properly used, *flashSAFE* can reduce the arc-flash hazard levels at locations electrically downstream from where it is applied. Arc-flash danger is NOT decreased at the breaker flashSAFE is installed OR upstream of the device.

2.1.2.1. *flashSAFE* Arc-Flash Reduction

The flashSAFE feature is designed to provide a means to reduce the destructive potential of an arc-flash by allowing the remote activation of additional fast-acting protection bands. By enabling these bands while equipment is energized and in-rush conditions are minimized, lower pickup points can used. This allows for faster breaker response in a fault situation. Since the magnitude of the incident energy in an arc-flash is directly proportional to the time duration of the event, decreasing the breaker response time also diminishes the severity of the event.

Once *flashSAFE* settings have been entered, they must be activated in order for them to take affect. This activation can be achieved through one of the following three methods.

1) Making a selection in the *UTILITIES* menu (this option must be selected prior to placing the breaker into service).
2) Through the MODBUS communications interface.
3) Using the optional *flashSAFE* switch box.

Although any one of the above methods can be used to activate *flashSAFE,* there must be a unanimous agreement in order to deactivate this feature.

Sections 2.1.2.1.1 through2.1.2.1.4 detail *flashSAFE* setup.

2.1.2.1.1. *flashSAFE* Instantaneous

The first screen of the *ADVANCED FEATURES* menu, shown in figure 19, enables the setup of the *flashSAFE* instantaneous element. This feature can be used even if the instantaneous protection is defeated.

If the "DISABLE" option in this screen is selected, the setup routine will skip to the flashSAFE ground fault setup as described in 2.1.2.1.3.

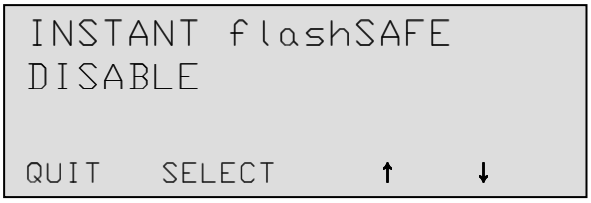


Figure 19, *flashSAFE* Instantaneous Selection

2.1.2.1.2. *flashSAFE* Instantaneous Pickup

The *flashSAFE* instantaneous pickup point is entered through the screen shown in figure 20. This pickup is only active when the *flashSAFE* function is activated. This setting can be between 1.50 and 12 times the long time pickup setting but can not be higher than the instantaneous pickup.

Figure 20, *flashSAFE* Instantaneous Selection

2.1.2.1.3. *flashSAFE* Ground Fault

The screen shown in figure 21 allows for the selection of *flashSAFE ground fault*. This feature can be used even if ground fault is defeated when the *etc-12* is not in *flashSAFE* mode. Any pickup point between 10% of the sensor tap value to two times the sensor tap value or 1200 A (whichever is lower) may be selected for *flashSAFE ground fault.* The delay for this feature is not user adjustable and is fixed at .100 seconds.

If "DISABLE" is selected, the setup routine will skip to the phase imbalance section as

detailed in paragraph 2.1.2.2

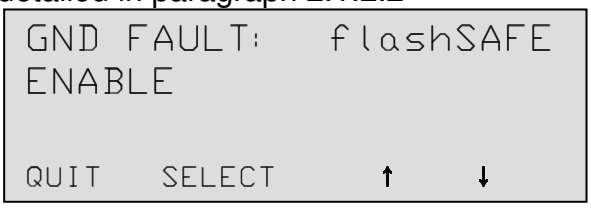


Figure 21, *flashSAFE* Ground Fault Selection

2.1.2.1.4. *flashSAFE* Ground Fault Pickup

The *flashSAFE* ground fault pickup point is entered through the screen shown in figure 22. This pickup is only enabled when the *flashSAFE* function is activated. The arrow keys scroll through the available settings and the select key configures the *etc-12* for operation at this pickup point

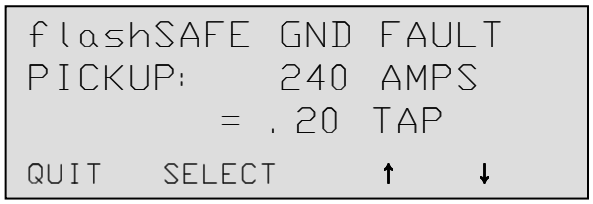


Figure 22, *flashSAFE* Ground Fault Selection

2.1.2.2. Phase Imbalance

The phase imbalance feature provides protection in situations where phase currents are normally balanced. This feature should not be confused with ground fault protection. The screen shown in figure 23 allows the user to configure this feature. Selecting *DISABLE* will cause the setup routine skip this feature and proceed with thermal memory setup as detailed in section 2.1.2.3.

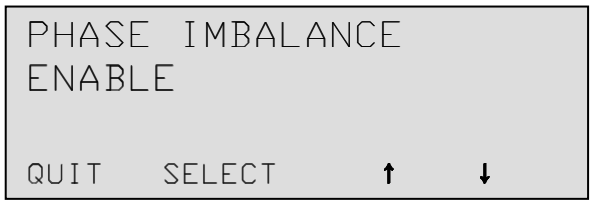


Figure 23, Phase Imbalance Selection

2.1.2.2.1. Phase Imbalance Pickup

The screen shown in figure 24 allows the user to set the phase imbalance pickup point. When the magnitude of current imbalance between any two phases exceeds this value, the *etc-12* will begin timing to trip. Pickups between 15 and 50% are available in 5% increments. The arrow keys are used to scroll through the available values. The select key will configure the *etc-12* for operation at the displayed pickup value.

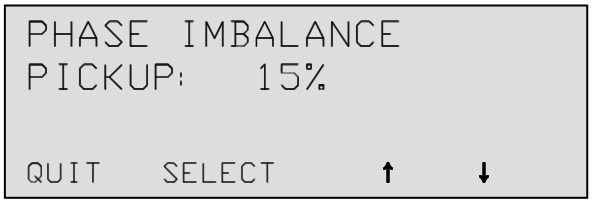


Figure 24, Phase Imbalance Pickup

2.1.2.2.2. Phase Imbalance Delay

The phase imbalance delay is set using the screen shown in figure 25. Delays between 1 and 90 seconds are available. The arrow and select keys are used to display and select the desired delay.

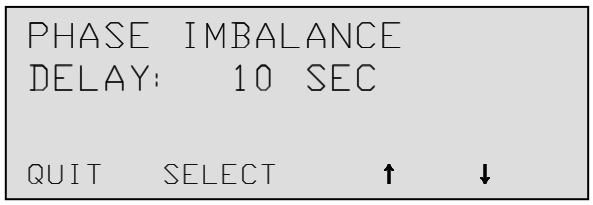


Figure 25, Phase Imbalance Pickup

2.1.2.3. Thermal Memory

The *etc-12* offers the option of applying thermal memory to both the long-time and ground fault functions. These functions can be enabled independently of each other. When thermal memory is enabled, trip timers are not immediately reset when current drops below the pickup point. Instead, timers reset based on the calculated rate of heat

dissipation in the bus. If the pickup threshold is exceeded before the timer completely resets, the *etc-12* will resume the trip countdown from a lower time based on amount of heat energy remaining in the system.

When enabled with long-time protection, thermal memory guards against over currents that are the result of cycling loads. Thermal memory offers protection against persistent "sputtering" faults when applied to ground fault protection.

2.1.2.3.1. Long-Time Thermal Memory
The next screen in the *Advanced Features* menu is shown in figure 26. Selecting *ENABLE* turns on the thermal memory feature for the long-time protection band.

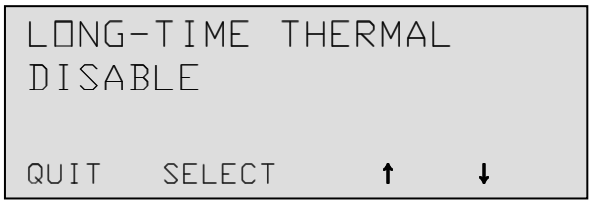


Figure 26, Long –Time Thermal Memory

2.1.2.3.2. Ground Fault Thermal Memory
The next screen in the *Advanced Features* menu is shown in figure 27. Selecting *ENABLE* turns on the thermal memory feature for the ground fault protection band.

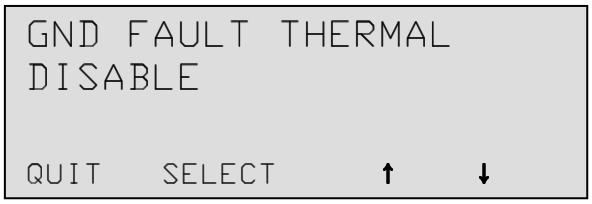


Figure 27, Ground Fault Thermal Memory

2.1.2.4. Selective Zone Interlocks
Zone interlocks allow for tighter power system coordination by disabling the trip function on upstream breakers if a downstream breaker is timing to clear a fault.
If zone interlocks are enabled, the *etc-12* transmits a restraint signal when in pickup for either short-time or ground fault. If this signal is received by anther *etc-12* configured for zone interlocking, tripping for these two functions is suppressed until the signal ceases. The system is designed so that the restraint signal ceases when the *etc-12* initiates a breaker trip. In the unlikely event that a breaker does not open due to a mechanical failure, the upstream breaker will clear the fault based on its pre-entered short-time or ground fault setting.

2.1.2.4.1. Enabling Zone Interlocks
The screen shown in figure 28 allows the user to enable selective zone interlocks.

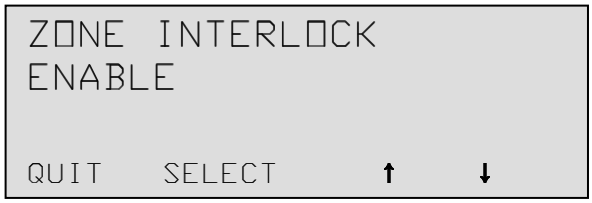


Figure 28, Zone Interlocks

2.1.3. Options
The screen shown in figure 29 is displayed. Selecting *SKIP* will configure the *etc-12* to operate with the default values for the options detailed in table 3C. The setup routine will also skip to the commissioning screen detailed in 2.1.4 If the *Options* is selected, the setup menu allow the user to custom configure the options detailed in sections 2.1.3.1through 2.1.3.5.

Figure 29, Options Menu

2.1.3.1. Frequency

The *etc-12* is designed for operation on both 50 and 60 Hz systems. The arrow and select keys can be used to reconfigure the unit for operation at different frequencies.

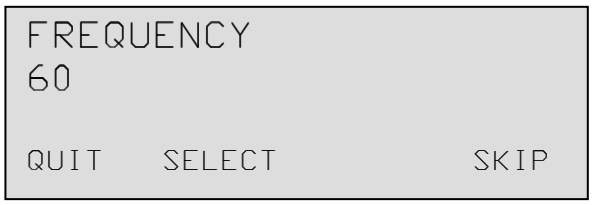


Figure 30, Options Menu

2.1.3.2. In-Service Setup Changes

The user can permit or disallow in-service settings changes using the menu screen shown in figure 31. Standard configuration locks out setup mode once it is determined that the breaker has been placed in service. Changing this option to *YES* will permit settings changes on in-service breakers.

If the optional hardware interlock for setting changes is being used, this option should be set to *ENABLE.*

WARNING!!

Protective functions are temporarily disabled while settings are being changed. De-energizing the breaker before making changes is strongly advised. If changes are made on live gear with the cubicle door open, it is vital to utilize appropriate levels of PPE.

Figure 31, Enabling in-service changes

2.1.3.3. Front Panel Shunt Trip

The *etd* can serve as a virtual shunt trip and open the breaker using the flux trip mechanism, eliminating the need for control power or a separate shunt trip coil. If this function is enabled in setup mode, the trip can be initiated though a selection in the *Utilities* menu. It is necessary to have sufficient current to power the LCD display (above approximately 3% of the tap value for 1A sensors and 5% for 200mA sensors) in order to utilize this function.

With the addition of optional hardware, it is possible to utilize the *etc-12* to trip a breaker though an external contact closure. If a unit is configured in this manner, the hardware initiated trip can be preformed regardless of whether the front panel shunt trip is enabled.

Figure 32 illustrates the front panel shunt trip setup screen.

Figure 32, Enabling shunt trip from front panel

2.1.3.4. Front Panel *flashSAFE* activation.

All *etc-12* controllers are equipped with the *flashSAFE* arc-flash reduction system. If settings for this feature have been entered in the *Advanced Features* menu, the screen shown in figure 33 will be displayed. From this screen, the user can select whether *flashSAFE* can be activated through a selection in the *Utilities* menu. If the *NO* option is selected, activation can only be

achieved through the optional *flashSAFE* toggle or through MODBUS communications.

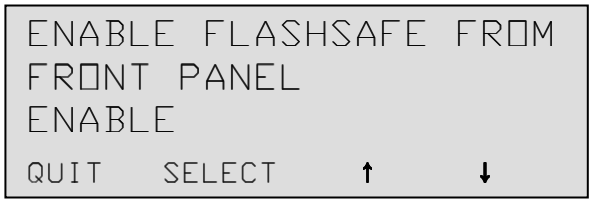


Figure 32, Enabling *flashSAFE* from panel

2.1.3.5. Display of ground current

The *etc-12/etd* is capable of displaying real-time ground current. This option can be utilized only if ground fault protection is used and can be enabled in the screen shown in figure 33.

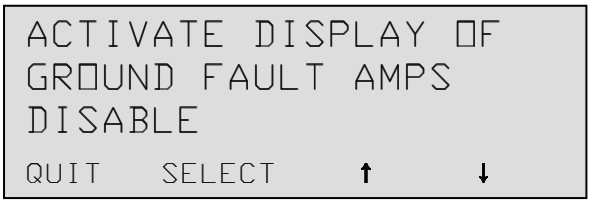


Figure 33, Ground Current Display

2.1.4. Commissioning

The screen illustrated in figure 34 is illustrated at the end of the setup route or whenever the *QUIT is* pressed from any screen in setup mode. Pressing *SAVE* will load all changes made during setup into non-volatile memory and configure the *etc-12* for operation. Pressing *QUIT* will discard any changes made while in setup.

Figure 34, Commissioning Screen

2.2. View Settings Mode

View settings mode can be entered through the main menu at any time. When in this mode, the user can use the up and down arrow keys to scroll through and view all breaker settings. Changes to settings can not be made from this mode. If in-service changes have been permitted as described in 2.1.3.2, it will be possible to enter setup mode to make modifications.

2.3. Monitoring Mode

When the *etc-12/etd* is placed into service, and phase current is sufficient (more than about 3% of tap rating for 1A sensors or 5% of the tap rating for 200mA sensors) the unit will automatically enter monitoring mode. A screen similar to the one shown in figure 35 will be displayed and the green LED will illuminate.

If current is zero or below the measurement threshold, "—" will be displayed in place of a numeric value. If the option to display ground current is not enabled as described in 2.1.3.5, no value will be displayed. If the name of the equipment or circuit being protected has been entered through MODBUS, this information will appear on the top line of the display.

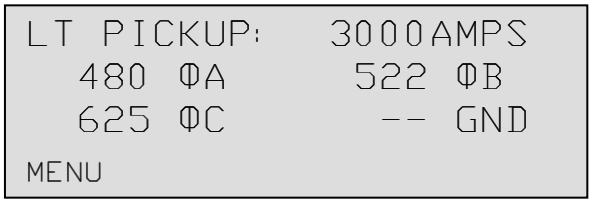


Figure 35, Monitoring Screen

When a preset pickup value is exceeded, the red LED will illuminate and the top line of the display will count down time to trip.

Pressing the *MENU* key will allow the user to access other available modes of operation.

2.4. Trip Counts and Log

The *etc-12* logs individual phase and ground currents (where applicable) at time of trip. Information for the last 8 trip events is stored in non-volatile memory. In addition, the *etc-12* totalizes trips and provides a detailed breakdown of the number of trips by protection band. (Long-time, Short-Time, Instantaneous, Ground Fault, Phase Imbalance, Remote, *flashSAFE* Instantaneous, *flashSAFE ground.)* This information can be viewed in the *Trip History* menu.

When *Trip History* mode is entered through the main menu, the screen shown in figure 36 is shown. Selecting *COUNT* or *LOG* from this screen will display detailed trip data shown in figures 36 and 37.

Pressing *CLEAR* will display the screen shown in figure 38. The history and count memories can be individually erased from this screen.

Figure 36, Trip History Screen

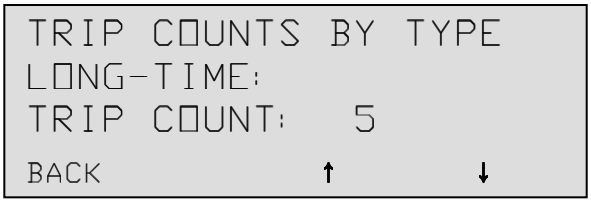


Figure 37, Trip Count Screen

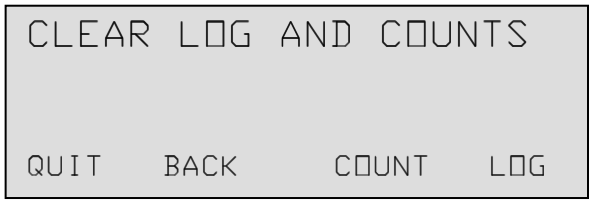


Figure 38, Clear Trip History Screen

2.5. Breaker Information

When the MODBUS communications features of etc-12 are utilized, there a several addressable fields that tag the *etc-12* with information specific to the breaker or the equipment being protected. These fields include *equipment name, cubicle number, building name, substation name, breaker model, breaker manufacturer, breaker serial number, etc.*

If information for any of these fields have been entered through the MODBUS port, it can be viewed in the *Breaker Information* menu.

Use of this feature is optional. The *breaker information* screen also permits the user to clear this information through the *etd* keypad. The *CLEAR BREAKER INFO* allows field technicians to move breakers or swap out trip units and delete no longer relevant information without the need to access communication features. It should be noted that once executed, the clear feature deletes all breaker information fields and the only way to re-enter this information is through MODBUS communications.

2.6. Utilities

The utilities menu allows the activation of special features including *flashSAFE, virtual shunt trip* and *test mode.* In order to activate *flashSAFE* and *virtual shunt trip* from this menu, permission to allow these features must first be selected in the *OPTIONS* menu. If these features have not been permitted, selections for them will not appear in the *UTILITIES* menu.

2.6.1. Activating *flashSAFE*

The menu screen shown in figure 39 allows for the activation of *flashSAFE* through the front panel display. As previously noted, this ability is available only if properly configured in the *OPTIONS* menu during the setup process.

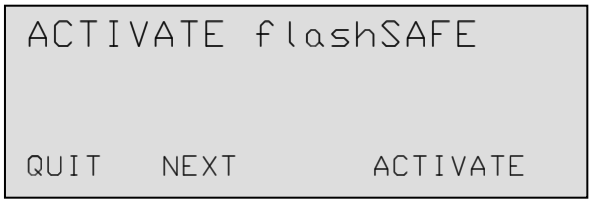


Figure 39, Activating flashSAFE

Pressing *ACTIVATE* will turn on the flashSAFE feature.

WARNING!!

Before activating *flashSAFE,* appropriate settings must be determined by a qualified engineer. When properly applied, *flashSAFE* can reduce hazards at locations electrically downstream from the breaker where it is utilized. Arc-flash hazard is not reduced at or upstream of the breaker on which *flashSAFE* is applied.

After *flashSAFE* has been activated, the *etd* displays the screen shown in figure 40. The

options to view or change settings, view trip history or activate utility features are not available with *flashSAFE* active. The user may deactivate *flashSAFE* by pressing the *EXIT* key. If *flashSAFE* has been activated through the optional switchbox or MODBUS communications, it must be deactivated through these means.

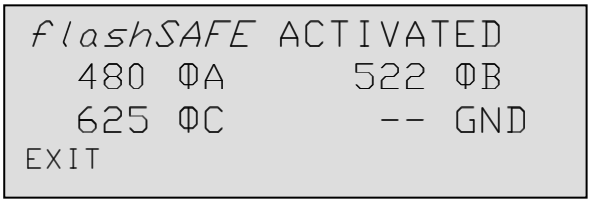


Figure 40, View of Display with *flashSAFE* Activated

2.6.2. Virtual Shunt Trip

If the *SHUNT TRIP FROM FRONT PANEL* option has been selected from the *OPTIONS* menu, the screen shown in figure 41 appears.

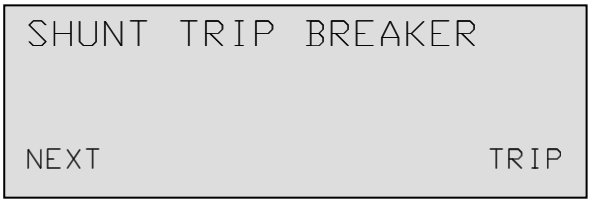


Figure 41, Virtual Shunt Trip Screen

Pressing the *TRIP* button causes the breaker to trip. Note that this function is not available if the breaker is equipped with an optional hardware interlock or if AC current is not high enough to exceed the threshold for self-power.

2.6.3. Test Mode

Test mode is entered through the *Utilities* menu from the screen shown in figure 42.

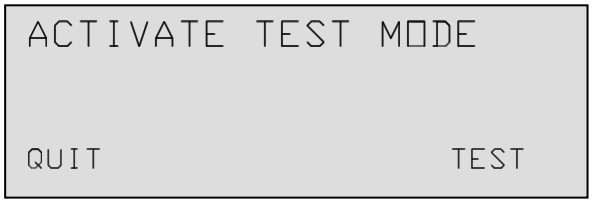


Figure 42, Test Mode Activation Screen

Test mode is intended as an aid to field technicians performing primary or secondary injection tests. It is recommended that all such testing be performed while in this mode. When test mode is activated, the screen shown in figure 43 is displayed and the following occurs:

- Logging of trips into trip log and count memory is suspended.
- The display timeout is increased to approximately 15 minutes.
- Thermal memory is disabled.
- Soft keys that allow the toggling of Short-Time, Instantaneous, Ground Fault and Phase Imbalance functions become available.
- "As found" settings are logged into permanent memory. These settings will be restored when test mode is exited.

IMPORTANT

When the *etc-12* is configured in *test* mode, it is vital to clear a trip using the softkey shown on the screen depicted in figure 44. The unit will not trip a second time until either the first trip is cleared or test mode is exited.

Note that this action is only necessary when in test mode. The breaker will function properly even if it is inadvertently placed in service without clearing a prior trip.

The *SETUP* and *UTILITIES* are also available from test mode. This allows for changing of settings and activation of *flashSAFE* or other features.

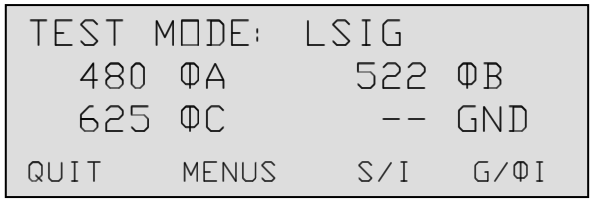


Figure 43, Test Mode Metering Screen

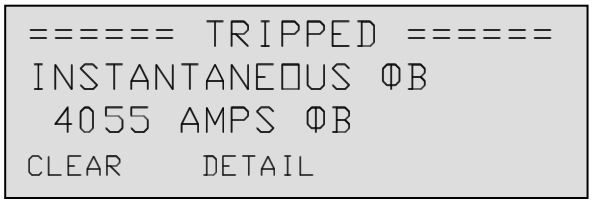


Figure 43, Test Mode Tripped Screen

Test mode can be exited through any the following methods:

1) Disconnecting the *ETD* display from the *etc-12.*
2) Allowing the timeout to occur by not pressing any buttons for 15 minutes.
3) Pressing the *QUIT* key.
4) Applying more than one phase of current to the *etc-12.*

After test mode is exited, “As found” settings are automatically restored and normal trip logging is resumed.

Refer to section 2.4 for further information regarding clearing the trip log and counter. Breaker information can be cleared as detailed in section 2.5. Recommended test procedures are described in the following section.

3.0 Testing

The *etc-12* programmers is designed to be field tested using either a primary injection test set or the Satin secondary injection test (*PTS*) coupled with the *etc-12 adapter*. It is not possible to perform secondary injection testing using the *PTS* without this adapter.

The very low output voltage and impedance of typical primary injection test sets can cause the test set to act erratically when testing an *etc-12* that is interfaced with low ratio current sensors (below 70:0.2A 400:1A). If primary injection is to be performed for these applications, the *etc-12* must be either receive supplemental power or be tested using a test set with a load bank and a minimum output voltage of 60 VAC. Contact factory for more details.

WARNING!!

To prevent electrical shock or injury, disconnect the breaker from all primary and secondary power sources and be sure that the breaker is open and charging springs are discharged before performing tests or troubleshooting.

It is strongly recommended that all breakers be fully performance tested before being placed into service. Prior to testing, breakers should be lubricated and adjusted per the original manufacturer's maintenance instructions. The following procedures are intended to serve as guidelines to allow individuals with breaker maintenance and testing experiences to evaluate retrofitted circuit breakers.

WARNING!!

Never energize a breaker with the wire harness disconnected from the *etc-12* programmer or from the current sensors. Also, do not disconnect the harness while the breaker is in service or being tested. Doing either will open-circuit the current sensors and allow dangerous and damaging voltage to develop.

Before applying current, always verify that there is a proper electrical connection between the current sensors and the wiring harness and between the wiring harness and the etc-12 programmer.

NOTE

It is recommended that all testing be performed while in test mode. Refer to section 2.6.3 for further information.

3.1. No Pickup Test

This test verifies that the *etc-12* will not improperly enter pickup or have the propensity to nuisance trip when monitored current is just slightly less than the set pickup value.

Procedure:

a) While in *TEST MODE,* disable ground fault and phase imbalance, as applicable.
b) Apply a current that has a magnitude of 90% of the long-time pickup value.
c) Allow the current to dwell for the period listed in table 4 while observing that the *etc-12* does not enter pickup or trip.
d) Repeat test for all three phases.
e) The unit passes if it does not enter pickup or trip at any time during this test.

TABLE 4, *No Trip Test* Durations	
LTD setting	**Test time in seconds**
MIN or custom from 1-9 sec	300
INT or custom from 10-20 sec	725
MAX or custom above 27 sec	1650

3.2. Long-Time Pickup Test

This test verifies that the *etc-12* programmer begins to count down for a long-time trip at the proper current value. This test requires checking the delay at three points.

Procedure:

a) While in *TEST MODE,* disable ground fault and phase imbalance, as applicable.
b) Slowly increase current from zero until the red pickup LED illuminates.
c) Verify that the LED turns on when current is between 90 and 113% of the long-time pickup value.
d) Repeat test for all three phases.

3.3. Long-Time Delay Test

This test verifies that the long-time delay characteristics meet the upper and lower limits. Delays are checked at three points along the delay band.

Procedure:

a) While in *TEST MODE,* disable ground fault, phase imbalance, short-time and instantaneous, as applicable.
b) Preset one of the test currents listed in table 5.
c) Apply test current and allow the programmer to count down and trip.
d) Verify that trip time conforms to the tolerances listed in table 5.
e) Repeat the test at each current level for all three phases.

TABLE 5, *Long Time Delay Test* Tolerances						
	I = 2X LTP		**I = 4X LTP**		**I = 6X LTP**	
LTD (sec @ 6x)	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
1.0	7.64	10.52	1.91	2.63	0.85	1.17
1.5	11.45	15.78	2.86	3.95	1.27	1.75
2.0	15.27	21.04	3.82	5.26	1.70	2.34
2.5	19.09	26.30	4.77	6.58	2.12	2.92
3.0	22.91	31.57	5.73	7.89	2.55	3.51
3.5	26.72	36.83	6.68	9.21	2.97	4.09
4.0	30.54	42.09	7.64	10.52	3.39	4.68
4.5	34.36	47.35	8.59	11.84	3.82	5.26
5.0 (MIN)	38.18	52.61	9.54	13.15	4.24	5.85
6.0	45.81	63.13	11.45	15.78	5.09	7.01
7.0	53.45	73.65	13.36	18.41	5.94	8.18
8.0	61.08	84.17	15.27	21.04	6.79	9.35
9.0	68.72	94.70	17.18	23.67	7.64	10.52
10.0	76.35	105.22	19.09	26.30	8.48	11.69
11.0	83.99	115.74	21.00	28.94	9.33	12.86
12.0	91.62	126.26	22.91	31.57	10.18	14.03
13.0 (INT)	99.26	136.78	24.81	34.20	11.03	15.20
14.0	106.89	147.31	26.72	36.83	11.88	16.37
15.0	114.53	157.83	28.63	39.46	12.73	17.54
16.0	122.16	168.35	30.54	42.09	13.57	18.71
17.0	129.80	178.87	32.45	44.72	14.42	19.87
18.0	137.43	189.39	34.36	47.35	15.27	21.04
20.0	152.70	210.44	38.18	52.61	16.97	23.38
21.0	160.34	220.96	40.08	55.24	17.82	24.55
22.0	167.97	231.48	41.99	57.87	18.66	25.72
23.0	175.61	242.00	43.90	60.50	19.51	26.89
24.0	183.24	252.52	45.81	63.13	20.36	28.06
25.0	190.88	263.05	47.72	65.76	21.21	29.23
26.0	198.51	273.57	49.63	68.39	22.06	30.40
27.0 (MAX)	206.15	284.09	51.54	71.02	22.91	31.57
28.0	213.78	294.61	53.45	73.65	23.75	32.73
29.0	221.42	305.13	55.35	76.28	24.60	33.90
30.0	229.05	315.66	57.26	78.91	25.45	35.07

3.4. Instantaneous Pickup and Delay Test

This test verifies that instantaneous pickup and delay occur within tolerance. This requires measurement of the pickup point and the delay beyond the knee of the published curve.

Procedure:

a) While in *TEST MODE,* disable ground fault and phase imbalance, as applicable.
b) Refer to table 6 and preset the lower test current associated with the instantaneous pickup setting.
c) Apply short bursts of current and incrementally increase magnitude until an instantaneous trip occurs. This is the actual instantaneous pickup point and should fall between the upper and lower limits shown in table 6.
d) Preset a test current that is 150% of the value of the nominal instantaneous pickup setting.
e) Allow the *etc-12* to run at the test current. The programmer should trip within .050 seconds. Note that that the actual time to open the breaker is dependant upon the mechanical operation of the breaker. Additional adjustment and lubrication may be necessary if performance requirements are not met.
f) Repeat this test for each phase.

TABLE 6, *Instantaneous and Short Time* Pickup Tolerances

NOMINAL PICKUP	LOWER TOLERANCE LIMIT	UPPER TOLERANCE LIMIT
1.5L	1.35L	1.65L
2.0L	1.80L	2.20L
2.5L	2.25L	2.75L
3.0L	2.70L	3.30L
3.5L	3.15L	3.85L
4.0L	3.60L	4.40L
4.5L	4.05L	4.95L
5.0L	4.50L	5.50L
6.0L	5.40L	6.60L
7.0L	6.30L	7.70L
8.0L	7.20L	8.80L
9.0L	8.10L	9.90L
10.0L	9.00L	11.00L
11.0L	9.90L	12.10L
12.0L	10.80L	13.20L

3.5. Short Time Pickup Test

This test verifies that short-time pickup occurs within tolerance limits.

Procedure:

a) While in *TEST MODE,* disable ground fault and phase imbalance, as applicable.
b) Refer to table 6 and preset the lower test current associated with the short-time pickup setting.
c) Apply short bursts of current and incrementally increase magnitude until a short time trip occurs. This is the actual short-time pickup point and should fall between the upper and lower limits shown in table 6.
d) Repeat this test for each phase.

3.6. Short-Time Delay Test (I^2t off)

This test verifies that the constant mode short-time delay is within tolerance. The measurement is made 50% above the pickup setting. It is only necessary to verify one point on the curve when I^2t is set to off.

Procedure:

a) While in *TEST MODE,* disable ground fault and phase imbalance, and instantaneous as applicable.
b) Preset a test current that is 150% of the nominal short-time pickup setting.
c) Allow the *etc-12* to run at this test current.
d) Verify that the programmer trips within the tolerance limits described in table 7.
e) Repeat this test for each phase.

TABLE 7, *Short Time Delay* Tolerances with I^2t Off		
NOMINAL DELAY (s)	**LOWER TOLERANCE (s)**	**UPPER TOLERANCE (s)**
.070	.055	.125
.100	.068	.142
.150	.120	.192
.200	.170	.240
.300	.255	.345
.400	.340	.470
.500	.425	.585
.600	.510	.700
.700	.595	.905

3.7. Short-Time Delay Test (I^2t on)

This test verifies that the short-time I^2t delay is within tolerance. The delay trimming is verified at a current level that is between 125 and 150% of the pickup value. It is only necessary to check one point to verify this function.

Procedure:

a) While in *TEST MODE,* disable ground fault and phase imbalance, and instantaneous as applicable.
b) Preset a test current that is between 125 and 150% of the short time pickup value.
c) Allow the *etc-12* to run at this test current.
d) Verify that the programmer trips within the tolerance limits described in table 8.
e) Repeat test for each phase.

	TABLE 8, Tolerances for *Short-time delay with I^2t ON*													
	I = 3L		**I = 4L**		**I = 5L**		**I = 6L**		**I = 7L**		**I = 8L**		**I = 9L**	
ST DELAY	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
.070s	0.611	1.389	0.344	0.781	0.220	0.500	0.153	0.347	0.112	0.255	0.086	0.195	0.068	0.154
.100s	0.756	1.578	0.425	0.888	0.272	0.568	0.189	0.394	0.139	0.290	0.106	0.222	0.084	0.175
.150s	1.333	2.133	0.750	1.200	0.480	0.768	0.333	0.533	0.245	0.392	0.188	0.300	0.148	0.237
.200s	1.889	2.667	1.063	1.500	0.680	0.960	0.472	0.677	0.347	0.490	0.266	0.375	0.210	0.296
.300s	2.833	3.833	1.594	2.156	1.020	1.380	0.708	0.958	0.520	0.704	0.398	0.539	0.315	0.426
.400s	3.778	5.222	2.125	2.938	1.360	1.880	0.944	1.306	0.694	0.959	0.531	0.734	0.420	0.580
.500s	4.722	6.500	2.656	3.656	1.700	2.340	1.181	1.625	0.867	1.194	0.644	0.914	0.525	0.722
.600s	5.667	7.778	3.188	4.375	2.040	2.800	1.417	1.944	1.041	1.429	0.797	1.094	0.630	0.864
.700s	6.611	10.056	3.719	5.656	2.380	3.620	1.653	2.514	1.214	1.847	0.930	1.414	0.735	1.117
	TIME TO TRIP (SECONDS)													

3.8. Ground-Fault Pickup

This test verifies that ground-fault pickup occurs within tolerance limits.

Procedure:

e) While in *TEST MODE,* disable phase imbalance, if applicable.
f) Refer to table 9 and preset the lower test current associated with the ground-fault pickup setting.
g) Apply short bursts of current and incrementally increase magnitude until a ground fault trip occurs. This is the actual ground-fault pickup point and should fall between the upper and lower limits shown in table 9.
h) Repeat this test for each phase.

TABLE 9, *Ground-Fault* Pickup Tolerances

NOMINAL PICKUP	LOWER TOLERANCE LIMIT	UPPER TOLERANCE LIMIT
.10X	.07X	.14X
.15X	.11X	.20X
.20X	.17X	.23X
.25X	.22X	.28X
.30X	.26X	.34X
.35X	.30X	.40X
.40X	.35X	.45X
.45X	.39X	.51X
.50X	.44X	.57X
.55X	.48X	.62X
.60X	.52X	.68X
.65X	.57X	.73X
.70X	.61X	.79X
.75X	.65X	.85X
.80X	.70X	.90X
.85X	.74X	.96X
.90X	.78X	1.02X
.95X	.83X	1.07X
1.00X	.87X	1.13X
1.10X	.96X	1.24X
1.20X	1.04X	1.36X
1.30X	1.13X	1.47X
1.40X	1.22X	1.58X
1.50X	1.31X	1.70X
1.60X	1.39X	1.81X
1.70X	1.48X	1.92X
1.80X	1.57X	2.03X
1.90X	1.65X	2.15X
2.00X	1.74X	2.26X

3.9. Ground-Fault Delay (I^2t off)

This test verifies that the constant mode ground-fault delay is within tolerance. The measurement is made 100% above the pickup setting. It is only necessary to verify one point on the curve when I^2t is set to off.

Procedure:

a) While in *TEST MODE,* disable phase imbalance, if applicable.
b) Preset a test current that is 100% above the ground fault pickup.
c) Apply current and verify that the *etc-12* trips for ground fault within the tolerances described in table 10.
d) Repeat test for remaining phases.

TABLE 10, *Ground-Fault Delay* Tolerances with I^2t Off

NOMINAL DELAY (s)	LOWER TOLERANCE (s)	UPPER TOLERANCE (s)
.100	.068	.132
.150	.118	.182
.200	.168	.232
.300	.268	.332
.400	.350	.432
.500	.445	.532

3.10. Ground-Fault Delay (I^2t on)

This test verifies that the I^2t ground-fault delay is within tolerance. The measurement is made 150 to 200% above the pickup setting. It is only necessary to verify one point curve when I^2t is set to off.

Procedure:

a) While in *TEST MODE,* disable phase imbalance, if applicable.
b) Preset a test current that is between 150 and 200% of the short time pickup value.
c) Allow the *etc-12* to run at this test current.

d) Verify that the programmer trips within the tolerance limits described in table 12.
e) Repeat test for each phase.

TABLE 12, Tolerances for *Ground-Fault delay with I^2t ON*

	I = .15x		I = .25x		I = .50X		I =.75x		I = 1.0x		I = 1.25x		I = 1.50x		I = 1.75x	
GF DELAY	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
.100s	14.756	20.800	5.312	7.488	1.328	1.872	.590	.832	.332	.468	.212	.300	.148	.208	.108	.153
.150s	22.133	31.200	7.968	11.232	1.992	2.808	.885	1.248	.498	.702	.319	.449	.221	.312	.163	.229
.200s	29.511	41.600	10.624	14.976	2.656	3.744	1.180	1.664	.664	.936	.425	.599	.295	.416	.217	.306
.300s	44.267	64.400	15.936	22.464	3.984	5.616	1.771	2.496	.996	1.404	.637	.899	.443	.624	.325	.458
.400s	59.022	83.200	21.248	29.952	5.312	7.448	2.361	3.328	1.328	1.872	.850	1.198	.590	.832	.434	.611
.500s	73.778	104.00	26.560	37.440	6.640	9.360	2.951	4.160	1.660	2.340	1.062	1.498	.738	1.040	.542	.764
	TIME TO TRIP (SECONDS)															

4.0 Communications:

The *etc-12* can communicate with outside devices such as PLC's and computers that are equipped with DDE or MMI software supporting the *MODBUS* protocol. A network of up to 245 *etc-12* units can be connected to a monitoring station by a single twisted pair cable. The monitoring station can be separated up to 4000 feet from any individual *etc-12* devices. All addresses and commands are provided in this manual and permit individuals with MODBUS experience to integrate the *etc-12* into their SCADA systems.

Communications functions on the *etc-12* are powered completely by system current. Additional control power or PT's are not required. All *etc-12* programmers are supplied with a fully functional *MODBUS* interface. In order to access the communication features, the following is required:

- *etc-12* communications cable with terminal block for termination to RS-485 cable.
- RS-485 to RS-232 or RS-485 to USB converter and appropriate cable.
- RS-485 shielded twisted pair cable (Belden #3105 or equivalent).
- PLC or PC with available serial or USB port.
- Third-party software capable of addressing MODBUS devices.

The *etc-12* communications package offers a number of features that permit customization for any particular application. A full list of addresses and functions are listed in tables 14 and 15.

4.1. Basic Configuration:

The *MODBUS* protocol exists on a master-slave basis where the monitoring station serves as the "master". Individual etc-12 "slaves" are assigned a unique I.D. and respond only when polled by the master. The slave I.D. is numeric in format and must be between 1 and 247, excluding 210, which is designated as the "default I.D." for all *etc-12* programmers. Since all *etc-12* units respond when I.D. 210 is polled, this I.D. can not be used if there is more than one unit on a twisted-pair network. The user may assign a second and unique I.D. to an *etc-12* by accessing the unit with I.D. 210 and issuing a numeric command between 1 and 247 to register address 100. When changing the I.D. of an etc-12, the unit(s) must be connected to the PC separately and may not be networked with other units. When all units have a new I.D. assigned, other then the "default I.D.", they can be connected on a twisted-pair network and polled individually. Please note that even when a new I.D. is assigned, the default I.D. is still active and the unit will respond if polled to either I.D.

The *etc-12* will respond to MODBUS commands only if the unit is in the "monitor", "tripped" and "setup required" mode. Current of about 10% of the CT rating must be present for the *etc-12* to respond to MODBUS polls. When a breaker trips due to an over-current condition, the *etc-12* automatically enables battery power so that it can respond to polls for an additional two minutes.

Configuration settings for *Modbus* communication are listed in table 13.

TABLE 13, *MODBUS* Configuration	
Protocol	*MODBUS* RTU
Physical network	RS-485
Baud rate	9600
Data Bits	8
Stop Bits	2
Parity	None
Default slave I.D.	210
Password for field-level access	Provided by factory

Write Permissions Definitions
Read only - Write never allowed
Password Required - Field password required to write
Always Writable - No password is required to write

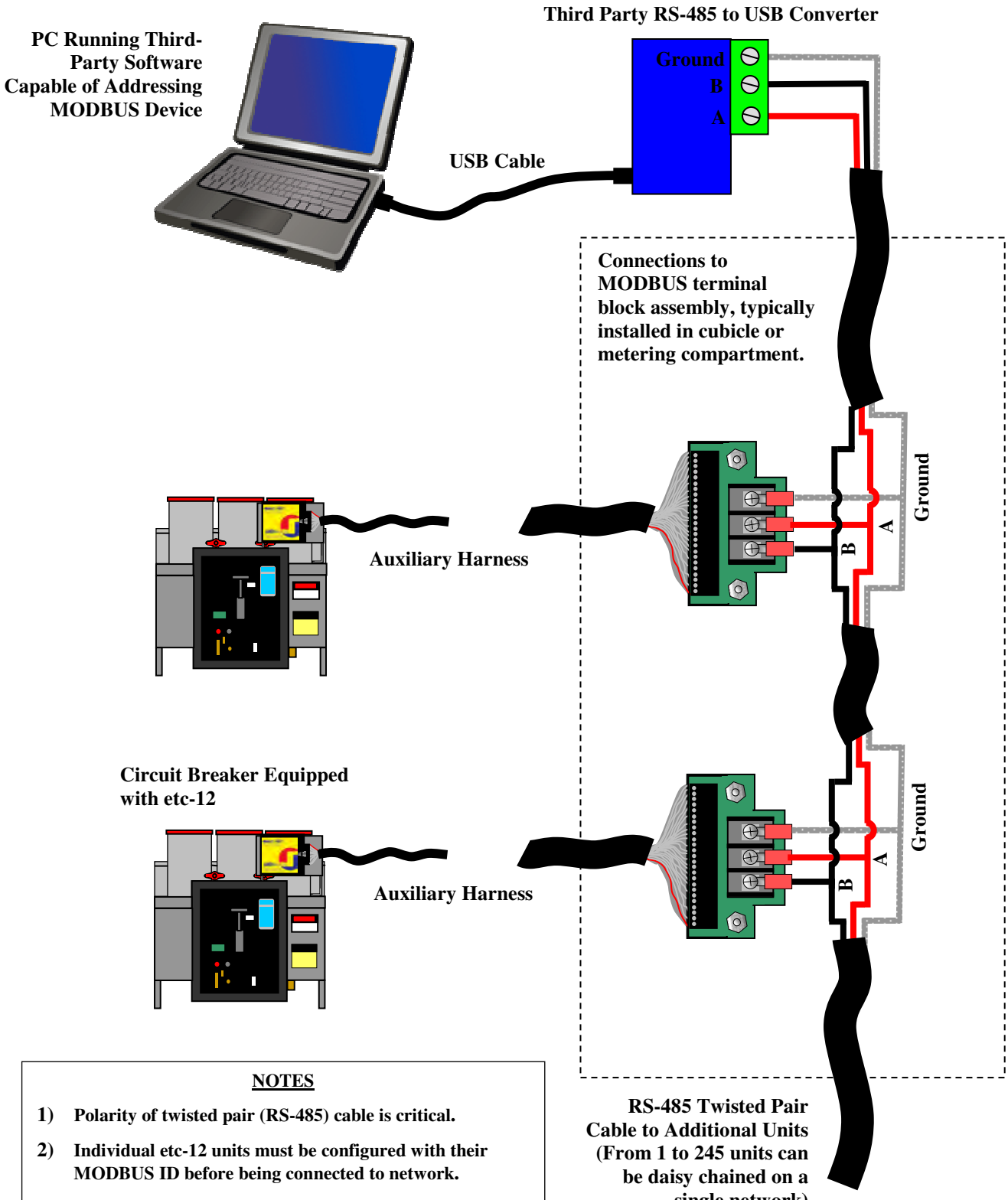
Table 14, MODBUS Addresses and Commands (Single Coils)			
Address	**Function**	**Write Permissions**	**Notes**
10	At least one phase active	Read only	Returns a “1” if there is current on any phase.
11	In service.	Read only	Returns a “1” if there is current on more than one phase or if there is current on one phase plus neutral.
12	Long Time Pick-up	Read only	Returns a “1” if one or more phases has a current greater than the long-time pickup value.
13	*flashSAFE* active	Read only	Returns a “1” if flashSAFE settings are being used
14	External *flashSAFE* request	Read only	Returns a “0” if an external *flashSAFE* switch is set to “Activate *flashSAFE*” Returns a “1” if an external *flashSAFE* switch is set to “*Deactivate flashSAFE*”
15	Programmer Pick-up	Read only	Returns a "1" if the unit is in any kind of pick-up and timing to trip.
16	Zone Interlocks INPUT	Read only	Returns a "0" if the unit is receiving a restraint signal from another programmer. Short-Time and Ground-Fault bands are disabled. Returns a "1" if the unit is not receiving any restraint signal.
17	Zone Interlocks OUTPUT	Read only	Returns a "1" if the unit is in Short-Time or Ground Fault pick-up, timing to trip, and sending a restrain signal to another unit.
20	1-AMP MODE	Read only	Returns a "1" if the unit is in 1Amp Mode Returns a "0" if the unit is in 200mA Mode.
21	Settings Lock Out	Read only	Returns a "0" if the unit has an external jumper preventing settings changes from being made.
22	AC Power	Read only	Returns a "1" if the unit is being powered by Alternating Current
23	Shunt Trip	Read only	Returns a "0" if the unit is receiving an external trip request.
24			
25	Trip Screen	Read only	Returns a "1" if the unit is displaying a trip screen
30	Clear Trip Record	Always Writable	No Associated Memory
31	Clear Trip Count	Always Writable	No Associated Memory
32	Save to EEPROM	Always Writable	No Associated Memory
33	Load from EEPROM	Always Writable	No Associated Memory
34	Clear Breaker Info	Always Writable	No Associated Memory
40	Shunt Trip	Password Required	No Associated Memory. Same as external trip.
41	Field Reset	Password Required	No Associated Memory. Resets unit back to "set-up required" screen

60	Test Mode	Password Required	Activate test Mode. Returns a "1" if Test Mode is activated.
70	Activate *flashSAFE*	Always Writable	Activate *flashSAFE*. Returns a "1" if *flashSAFE* has been activated by a ModBUS selection. Units display will not show an "exit" key.
71	Activate *flashSAFE*	Always Writable	Activate *flashSAFE*. Returns a "1" if *flashSAFE* has been activated by a Menu selection. Units display will show an "exit" key.
100	Unit Setup	Password Required	Returns a "0" if the unit has been setup at least once.
101	LT Thermal	Password Required	Activate Long-Time Thermal Memory. Returns a "1" if this function is active.
102	ST Delay Mode	Password Required	Short-Time Delay Mode. Returns a "0" if the Constant Delay Mode is being used. Returns a "1" if the I2T Delay Mode is being used.
103	GF Enable	Password Required	Activate Ground Fault. Returns a "1" if Ground Fault is activated.
104	GF Delay Mode	Password Required	Ground Fault Delay Mode. Returns a "0" if the Constant Delay Mode is being used. Returns a "1" if the I2T Delay Mode is being used.
105	GF Thermal	Password Required	Activate Ground Fault Thermal Memory. Returns a "1" if this function is active.
106	*f* Setting	Password Required	Frequency setting. Returns a "0" when unit is set to operate with 60Hz. Returns a "1" when unit is set to operate with 50Hz.
107	Ø Imbalance	Password Required	Activate Phase Imbalance. Returns a "1" if this function is active.
108	Zone Interlocks	Password Required	Activate Zone Interlocks. Returns a "1" if this function is active.
109	Instant *flashSAFE*	Password Required	Activate Instantaneous *flashSAFE*. Returns a "1" if this function is active.
110	GF *flashSAFE*	Password Required	Activate Ground Fault *flashSAFE*. Returns a "1" if this function is active.
111	Instant Enable	Password Required	Activate Instantaneous protection band. Returns a "1" if this function is active.
112	ST Enable	Password Required	Activate Short-Time protection band. Returns a "1" if this function is active.
123	GF Display	Password Required	Activate the display of Ground Fault amps. Returns a "1" if this function is active.

Table 15, MODBUS Addresses and Commands (Registers)

Address	Function	Write Permissions	Notes
10	Ø A Amps	Read only	Displays current value on phase A
11	Ø B Amps	Read only	Displays current value on phase B
12	Ø C Amps	Read only	Displays current value on phase C
13	GF Amps	Read only	Displays current value on phase Ground Fault
100	ModBUS Address	Password Required	Displays the ModBus address assigned to the unit.
101	Tap Setting	Password Required	Displays the current sensor tap setting.
102	LT Pick-Up	Password Required	Displays the Long-Time Pick-up setting.
103	LT Delay	Password Required	Displays the Long-Time Delay setting.
104	Instant Pick-Up	Password Required	Displays the Instantaneous Pick-up setting.
105	ST Pick-Up	Password Required	Displays the Short-Time Pick-up setting.

106	ST Delay	Password Required	Displays the Short-Time Delay setting.
107	GF Pick-Up	Password Required	Displays the Ground Fault Pick-up setting.
108	GF Delay	Password Required	Displays the Ground Fault Delay setting.
109	Ø Imbalance %	Password Required	Displays the Phase Imbalance pick-up percentage
110	Ø Imbalance Delay	Password Required	Displays the Phase Imbalance Delay setting.
111	Instant *flashSAFE*	Password Required	Displays the Instantaneous *flashSAFE* pick-up setting
112	GF *flashSAFE*	Password Required	Displays the Ground Fault *flashSAFE* pick-up setting.
200	LT Trip Count	Read only	Displays the Long-Time trip count
201	ST Trip Count	Read only	Displays the Short-Time trip count
202	Instant Trip Count	Read only	Displays the Instantaneous trip count
203	GF Trip Count	Read only	Displays the Ground Fault trip count
204	Ø Imbalance Trip Count	Read only	Displays the Phase Imbalance trip count
205	Instant *flashSAFE* Trip Count	Read only	Displays the Instantaneous *flashSAFE* trip count
206	GF *flashSAFE* Trip Count	Read only	Displays the Ground Fault *flashSAFE* trip count
207	Shunt Trip Count	Read only	Displays the Shunt Trip, trip count
501	Information Registers	Password Required	Breaker Electrically Operated
502	Information Registers	Password Required	AC/DC
503	Information Registers	Password Required	Breaker Control Voltage
507	Information Registers	Password Required	Breaker Interrupting Capacity
515	Information Registers	Password Required	Circuit Breaker Type
520	Information Registers	Password Required	Building Name
530	Information Registers	Password Required	Substation Name
540	Information Registers	Password Required	Cubical Number
550	Information Registers	Password Required	Equipment Name
560	Information Registers	Password Required	Equipment Location
570	Information Registers	Password Required	Breaker Serial Number
580	Information Registers	Password Required	Breaker Manufacturer
590	Information Registers	Password Required	Breaker Model



NOTES

1) **Polarity of twisted pair (RS-485) cable is critical.**
2) **Individual etc-12 units must be configured with their MODBUS ID before being connected to network.**
3) **The RS-485 to USB converter may be replaced with a RS-485 to serial or RS-485 to TCP/IP converters as the application dictates.**

Figure 45, Sketch Showing Interconnections for MODBUS Communications Network

5.0 Mounting the *etd* Display:

The *etd* display can either be mounted on the circuit breaker or external to the breaker cubicle using the door mounting bracket.

To mount the display on the circuit breaker, it is simply nested onto the *etc-12* and locked in place with the spring-loaded retention pin. Figure 46 shows the *etd* nested to the *etc-12.* The *etd* is designed to mount in either a horizontal or vertical orientation. It may be necessary to remove and reposition the plastic plugs shown in figure 2 in order to correctly orient the display.

When nesting the *etd, it* is important to keep the RJ-45 connector cable away from any obstructions in the cubicle or moving parts on the breaker. If necessary, secure the connection cable with a cable tie.

Figure 46, *etd* Nested on *etc-12* for Breaker Mounting

5.1. Remote Mounting Display:

The *etd* display can be mounted outside of the breaker cubicle using the *Remote Mounting Kit.* Figure 47 shows a typical application with the *etd* mounted on the cubicle door. While the 5 foot cable length supplied with this kit is sufficient for most applications, it is possible to use longer cable lengths and mount the display as far as 1500 feet from the *etc-12.*

Figure 47, Photo Showing *etd* Mounted Outside of a Breaker Cubicle

When the *etd* is mounted outside of the cubicle, personnel are able to view real-time displays of three phase loads, ground fault current, trip counts and history as well as breaker settings. If permission is selected through the *OPTIONS* menu prior to the breaker being placed in service, trip settings can be changed and / or *flashSAFE* can be activated through the *etd*.

The display module can be removed from the mounting bracket by retracting the spring-loaded retention pin. The *etd* display may be disconnected from an energized breaker without compromising protection. Since settings and trip history reside in the *etc-12* and not the *etd*, a display can be moved from breaker to breaker without the need to adjust settings.

5.2. Installing the Door Mount Bracket:

Figure 48 shows the contents of the door mount kit. In addition to this kit, the following tools will be required:

- Electric Drill
- 7/32" Drill Bit
- 7/8" Hole Saw, Step Drill or ½" Conduit Punch.
- Philips Head Screwdriver
- Hammer
- Center Punch
- Tape Measure
- Level
- RJ-45 / RJ-11 Crimp Tool

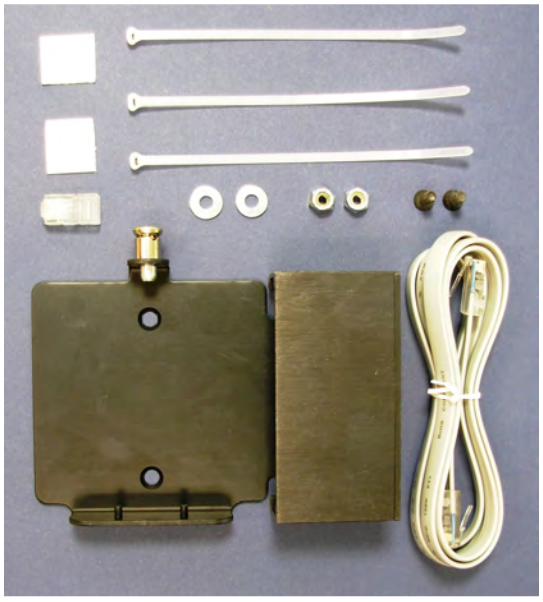


Figure 48, Contents of Door Mount Kit

Since each application is different, it is important to thoroughly consider where the bracket will be located. Items that must be taken into account include:

- Interference issues that inhibit opening the door. Make sure that the door will open freely even with the adjacent cubicle open or with the adjacent breaker in the racked-out position.
- Interference issues that inhibit closing the door. Make sure that the mounting screws and umbilical cable is located away from parts of the breaker that are close to the door when it is closed.
- Cable routing issues that prohibit the breaker from being racked in or out or prevent the breaker from being removed from the cubicle. Also, make sure that the cable can be secured in a manner so that it will not be pinched or come close to energized parts.
- Viewing angle considerations. On top cubicles, it may be advantageous to mount the display near the bottom of the door so that it will be closer to eye level. Likewise, it may be advantageous to locate displays for lower cubicles near the top of the door.

Once the mounting location is determined, place the template from appendix 3 of this manual on the switch gear door and mark the locations of the holes. Using a 7/32 (.212) drill bit, drill the two #10 screw holes. For the RJ45 thru-door connection; either drill or punch out the switch gear door to 7/8" (1/2 inch punch).

Using the two screws, flat washers and lock nuts attach the door mount bracket to the

switch gear door. The nuts and washers should be on the inside of the door. Connect the long *RJ-45* cable between the *etc-12* and the rear jack on the door mount bracket. After confirming that the cable does not inhibit the racking of the breaker, secure it in place with the supplied tie wraps. If the cable is too long, its length may be customized using the supplied *RJ-45* plug. Refer to appendix 1 for further directions.

Connect the short *RJ-45* between the *etd* and the jack inside of the mounting bracket. The excess cable is tucked into the recess on the bracket.

The display is attached to the bracket by first mating the two small nesting pins to the two holes on the display. Retract the larger, spring-loaded pin then snap the display onto the bracket. The spring-loaded pin is then extended to lock the display in place.

6.0 Installing the *flashSAFE* Lock Box:

An optional *flashSAFE* lock box is available for use with the *etc-12* programmer. This accessory allows for the *flashSAFE* feature to be activated by a toggle switch. The switch may be locked either in the *ON* or *OFF* position. A blinking LED provides visual indication that the *flashSAFE* feature is activated.

NOTE

Since the *flashSAFE* feature is powered exclusively from system current, the LED on lockout box will not illuminate if system current is low (approximately 10% of tap value for 200mA sensors, 5% of tap value for 400 and 500mA sensors or 3% of tap value for 1A sensors). Even under these low current conditions, *flashSAFE* is still active and is capable of initiating a breaker trip in less than .05 seconds from the onset of a fault.

The same tools needed to install the display door mount are required to install this device. As with the display door mount, each application is different and careful consideration must be taken when choosing a location for the *flashSAFE* lock-out box. Refer to section 5.2 of this manual for a complete list of tools as well as guidelines for determining mounting location.

Figure 49 illustrates a typical illustration of the *flashSAFE* lockout box. The following is an outline of the installation procedure:

- After the desired position is determined drill two 3/16” holes in the breaker door corresponding to the two studs on the back of the flash safe unit. For a larger margin of adjustment drill ¼” holes instead of the 3/16” holes.

- In order to operate the Flash Safe unit the RJ 11 cable must be connected through the back or side access port on the unit itself. Satin American Suggests using the rear jack and punching or drilling a hole in the cubicle door.

  Note: The auxiliary harness assembly is mounted on the side of the breaker and a short 34 pin cable is used to connect the two. A longer RJ 11 cable connects the auxiliary harness assembly to the flashSAFE unit.

- The cables provided only have one end crimped to allow for field adjustment of length. Determine the length of the RJ 11 cable and crimp the RJ 11 plug using a modular crimp

tool; this can be purchased at any large hardware or electronics store. *Note: The plugs must be identical to one another. In other words, if the blue wire is on the left side of one plug, then it should be the same on the other plug.*

- The 34 Pin cable can be crimped using a tool such as *Philmore HT214.* Alternately, it is possible to make the crimp by compressing both ends of the connector in a vise. The plug should match the plug already crimped on the cable. You can only crimp where the 34 cables are all joined together like ribbon cable. If you feel the cable there are flexible parts and hard parts, the hard parts are the crimpable locations.

- After complete installation of all the *flashSAFE* components ensure that nothing rubs, bends or tweaks anything on the breaker or the breaker door. Make sure all the cables are out of harms way.

- Turn on the etc 12 and enter the set up menu, scroll through to the advanced features menu and activate Instant *fashSAFE* by entering yes. This allows the Flash Safe unit to operate.

- Rotate and slide the safety bar out, to flip the toggle switch up and turn on the Flash Safe unit. The red light should begin to blink and etc 12 display will read "*flashSAFE* Activated" across the top of the screen.

6.1. ***flashSAFE*** **Activation Module:**

An optional remote activation module is available as an alternative for the lockout box described above. The remote activation module is designed to permit activation of *flashSAFE* though an external contact closure.

The remote activation module is shown in figure 50.

Figure 50, Remote Activation Module

The remote activation module can be mounted either on the circuit breaker or in another location in the switchgear. The module is connected to the auxiliary connector on the *etc-12* by a 34 pin cable. This is the same cable the *etc-12* uses for other auxiliary devices. Instructions for adjusting and crimping this cable are given in section 6.0, above.

Shorting the two terminals on the remote activation module activates the *flashSAFE* function. These terminals may be connected to an external switch, addressable relay or similar device.

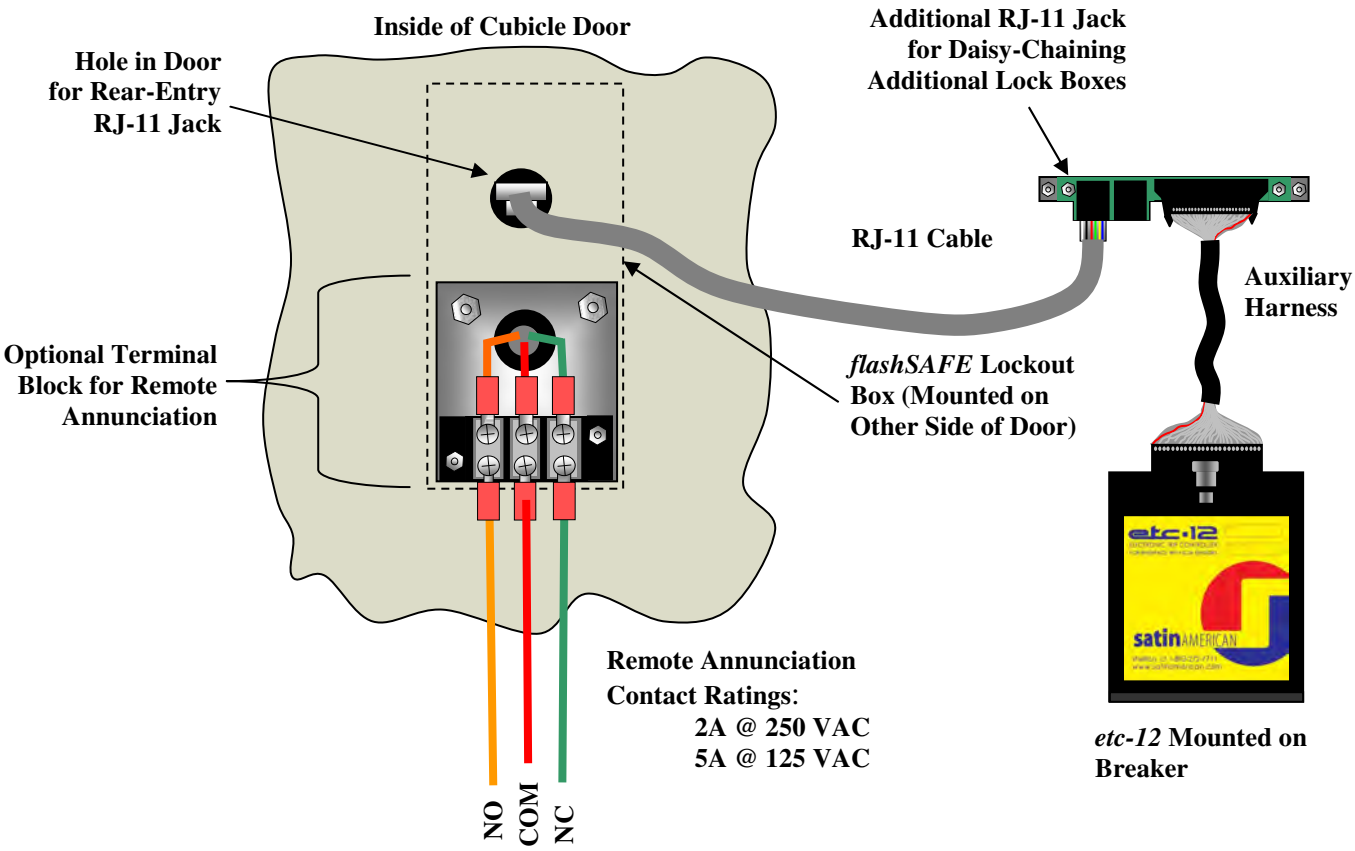
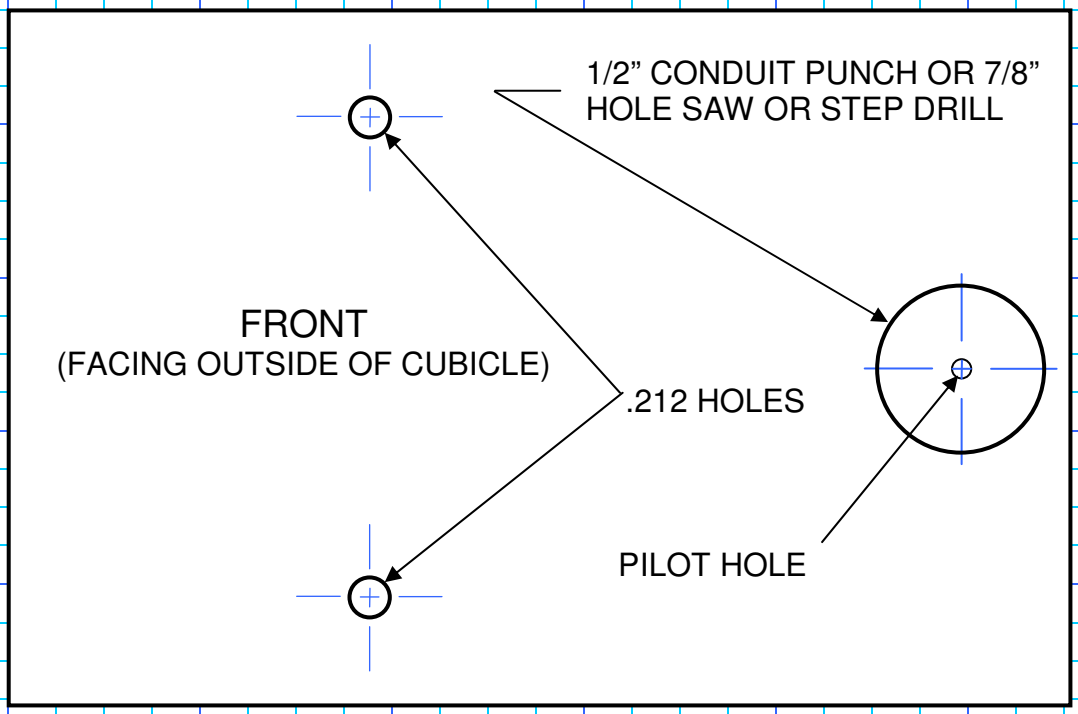
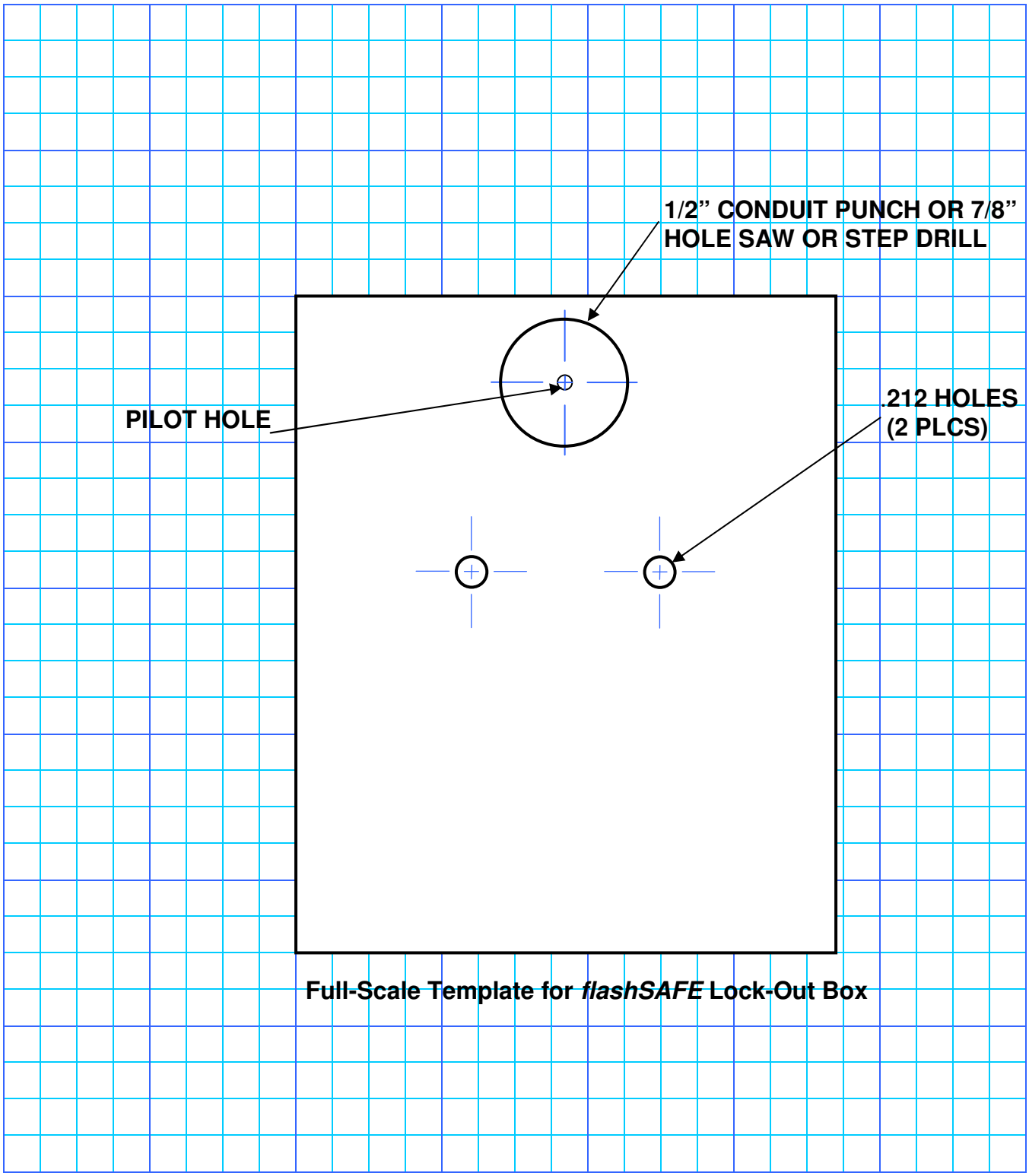


Figure 49, Connection Diagram for *flashSAFE* Lockout Box

Appendix 1: *Templates*



Full-Scale Template for Door Display Mount



Full-Scale Template for *flashSAFE* Lock-Out Box

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