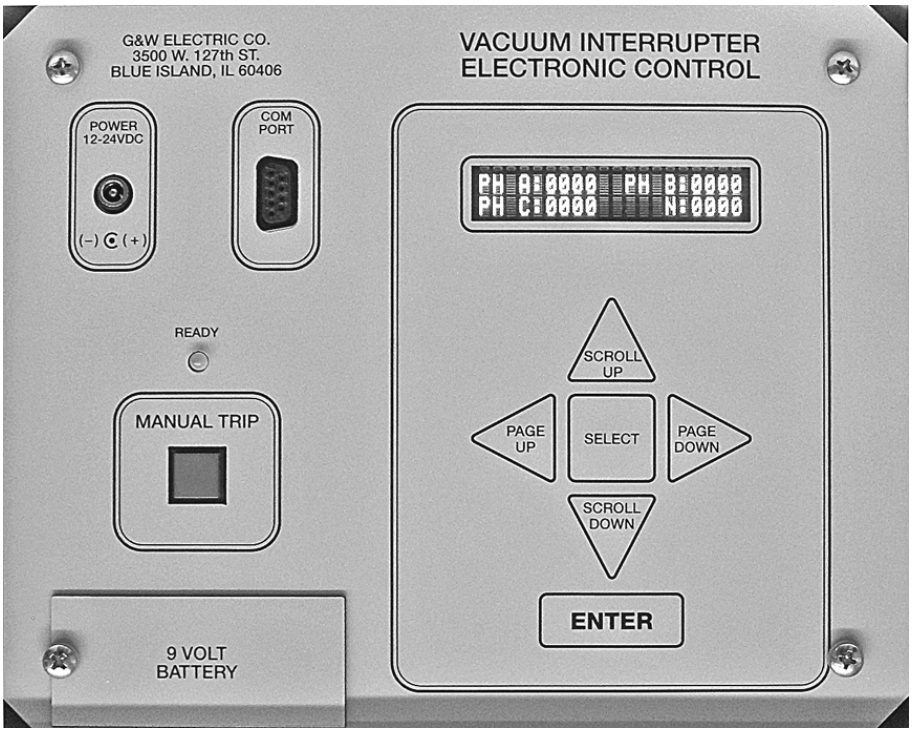
INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

Type 3 Vacuum Interrupter Control

GWI 523-333
Rev. 3
August, 2007
Supersedes Rev. 2
dated March, 2007

Note: For Time Current Curves, reference G&W website at www.gwelec.com



SECTION 1 INTRODUCTION

1.1 General

This document is intended to provide the user with necessary information to properly receive, operate, and maintain the G&W Type 3 Vacuum Interrupter Control. If, after reviewing the information contained herein, you should have any questions, please contact your G&W representative or call our customer service number.

Read these Instructions	**Read and understand the contents of this document and follow all locally approved procedures and safety practices before installing, operating or maintaining this equipment. Be sure to read and understand the Safety Information in Section 2.**	
Keep these Instructions	**This document is a permanent part of your G&W switch. Keep it in a safe location where it can be readily available and referred to as necessary.**	
How to Contact G&W	**By Phone:**	**708-388-5010, Monday through Friday, 8:00 AM to 5:00 PM Central Time**
	By Fax:	**708-388-0755**
	E-Mail:	**webmail@gwelec.com**
	Mail:	**3500 W. 127th Street, Blue Island, Illinois 60406, USA**
	Internet:	**To find your local G&W Representative visit our Web site: www.gwelec.com**

1.2 Qualified Persons

⚠ WARNING

The equipment covered by this document is intended to be installed, operated and maintained by qualified persons who are trained in the installation, operation and maintenance of electric power distribution equipment along with the associated hazards. A qualified person has been trained and is competent:

- **To de-energize, clear and tag circuits and equipment in accordance with established safety procedures.**
- **To distinguish between live parts from non-live parts of the equipment.**
- **In the proper use of insulated tools, wears protective equipment such as rubber gloves, hard hat, safety glasses, flash-clothes, etc. in accordance with established safety practices and is trained in the care of such equipment.**
- **As in certified in rendering first aid, especially in the technique of removing a person in contact with a live circuit and in applying cardiopulmonary respiration.**

These instructions are intended only for qualified persons and are not intended as a substitute for adequate training and experience in safety procedures for this type of equipment.

1.3 Shipment Inspection

Examine the crated equipment carefully for any damage that may have occurred in transit. If damage is found, a claim must be filed at once with the transportation company. Uncrate and remove packing as soon as possible after receiving the equipment. Examine the equipment carefully for any hidden damage that may have occurred in transit and was previously undetected. If damage is found, a claim should be filed at once with the transportation company.

SECTION 2 SAFETY INFORMATION & PRECAUTIONS

2.1 Safety Alert Messages

The following is important safety information. For safe installation and operation, be sure to read and understand all danger, warning and caution information. The various types of safety alert messages are described below:

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

CAUTION - Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. May also be used to alert against unsafe practices.

2.2 Following Safety Instructions

Carefully read all safety messages in this manual and on your equipment. Keep safety signs in good condition. Replace missing or damaged safety signs.

Keep your equipment in proper working condition. Unauthorized modifications to the equipment may impair the function and/or safety and effect equipment life.

If you do not understand any part of these safety instructions and need assistance, contact your G&W representative or G&W Customer Service.

2.3 Replacement Instruction and Labels

Replacement instructions and safety labels are available from G&W. To obtain them, please contact Customer Service**.**

⚠ WARNING

Before setting, operating, or maintaining this equipment, carefully read and understand the contents of this guide. Improper installation, handling, or maintenance can result in death, severe personal injury, and/or equipment damage.

⚠ WARNING

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

3.1 General

This device is intended for operation with G&W SF6 and Solid Dielectric insulated Vacuum Interrupter mechanisms and current transformers. The Type 3 is a microprocessor based measurement and control system, which performs a trip action on the Vacuum Interrupter mechanism after executing a time delay corresponding to the monitored phase current. The device monitors the current in each of the three phases. If any of the phase currents exceed the pre-selected limit for a given period of time, that phase, or all three phases will be tripped depending on the control settings.

⚠ CAUTION

These controls are designed to work exclusively with G&W Vacuum Interrupter mechanisms. Use of these controls for any other purpose may cause damage to the control or other equipment.

The Type 3 is a stand-alone unit and does not require any maintenance. The unit is powered by the measured phase current(s). The control does not require any external power supply or battery for normal over current detection and operation. The Type 3 utilizes a Vacuum Fluorescent Display (VFD) for setting configuration and load information. A 9 VDC Lithium Battery is provided to activate the VFD when the control is not otherwise powered.

The device requires minimal installation and is easy to set up and use. There are two main physical components: a front control panel with interface board and a printed circuit board (PCB). Both of these are mounted within a fiberglass industrial grade enclosure with strain relief clamps used for cable entry.

The control front panel contains the VFD, six sealed selection buttons, an external power jack, DB9 serial port, manual trip push button, Ready LED, and 9 VDC Lithium Battery (located behind a cover). (Figure 3.1)

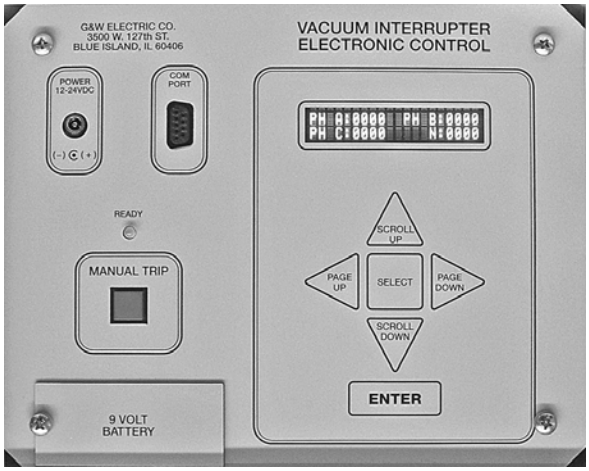


Figure 3.1

⚠ CAUTION

Improper connection of the control to the switch can cause misoperation or non-operation of the vacuum interrupter. Check for proper operation of the control after installation.

3.2 Operation Mode

There are two operational modes that can be observed using the LED marked "Ready Lamp". If the current flow is less than the amount shown in Table 2, the Type 3 will be un-powered and the LED light will not be illuminated. The normal operation of the device is defined by a phase current that is lower than the selected minimum trip current and high enough to power the device. In this operational mode, the device is monitoring the current and flashes the "Ready Lamp" LED green once every 3 seconds. If the trip output connector (J13) is not properly wired, or installed, the "Ready Lamp" will flash green *twice* every 3 seconds.

The second operational mode performs time delay execution. The "Ready Lamp" will illuminate as a solid Red indicating that the Type 3 will initiate a trip after executing the corresponding time delay. When the Type 3 sends the trip signal to the Vacuum Fault Interrupting mechanism, the "Ready Lamp" will be off.

Ready Lamp Function	**Meaning**
Non-illuminated	The Type 3 is not powered.
Flash Green once every 3 seconds	The Type 3 is powered (refer to Section 5.2) and is capable of performing a trip function.
Flash Green twice every 3 seconds	The Type 3 is powered (refer to Section 5.2), but the trip circuit is not properly connected.
Illuminate Solid Red	The Type 3 is powered (refer to Section 5.2) and is timing based upon an over current condition and/or time delay.

Table 1 - Function of Ready Lamp

3.3 Powering the Type 3

There are three ways to power the Type 3 – primary current flowing through the current transformers, auxiliary power through the front panel jack, or through an external power input (see Section 3.5).

Primary Current

The Type 3 can be powered by the measured phase current(s). The current levels needed to power the control are shown in Table 2. The control is powered when the Ready Light is flashing green once every 3 seconds.

CT Ratio	Primary Current Available on Any 1 Phase	Primary Current Available on All 3 Phases with the VFD Not illuminated
500:1 (15-300 Minimum Trip Range)	15 Amps	10 Amps per Phase
1000:1 (30-600 Minimum Trip Range)	25 Amps	15 Amps per Phase

Table 2 – Amount of Primary Current Necessary to power the Type 3

Auxiliary Power

The Type 3 is equipped with a front panel power jack (Figure 3.2) for illuminating the VFD or powering the Manual Trip feature in situations where there is insufficient primary current on the CTs for the device to be self powered, such as after a trip or when primary currents are extremely low. This jack is Mode Electric part number 31-154M-0.

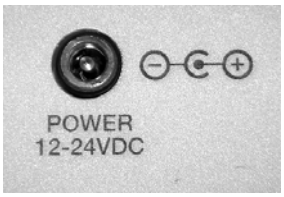


Figure 3.2

The mating plug is Mode Electronics part number 31-143-0 (center pin 2.5mm, outside diameter 4.3mm, barrel length 9mm).

The Type 3 front panel shows the necessary polarity of the mating plug (center is positive, outer ring is negative).

⚠ CAUTION

Improper polarity connections to the auxiliary power jack could cause damage to the control.

3.4 Manual Trip

When the Type 3 is powered, and the "Manual Trip" button (Figure 3.3) is pressed, the Type 3 sends a trip signal to all three phases of the Vacuum Interrupter mechanism.

If the Vacuum Fault Interrupter mechanism is suitably equipped, the user can use the Operational Page menus to trip each phase individually. (See Section 4.4)

Figure 3.3

3.5 External Power Input

The Type 3 provides terminals on the PCB for an external power input. The external power input accepts many voltage options. By default the input accepts a DC voltage between 12 and 24VDC (Figure 3.4a). Additional options include 120 or 220VAC (Figure 3.4b) and 48VDC (Figure 3.4c). Utilizing this feature allows the control to remain powered up in situations when there is insufficient primary current on the CTs for powering of the device. This may be advantageous when utilizing the external trip input, the Cause of Last Trip LEDs, or RS485 communication.

3.6 External Trip Input

The Type 3 provides terminals (Figure 3.4) on the PCB for an external trip input from a source such as a relay or RTU. The external trip input can be either a dry or wetted contact and is active when the external power input is active. When the closed contact is applied to the terminals, the Type 3 sends a trip signal to all three phases of the Vacuum Interrupter Mechanism.

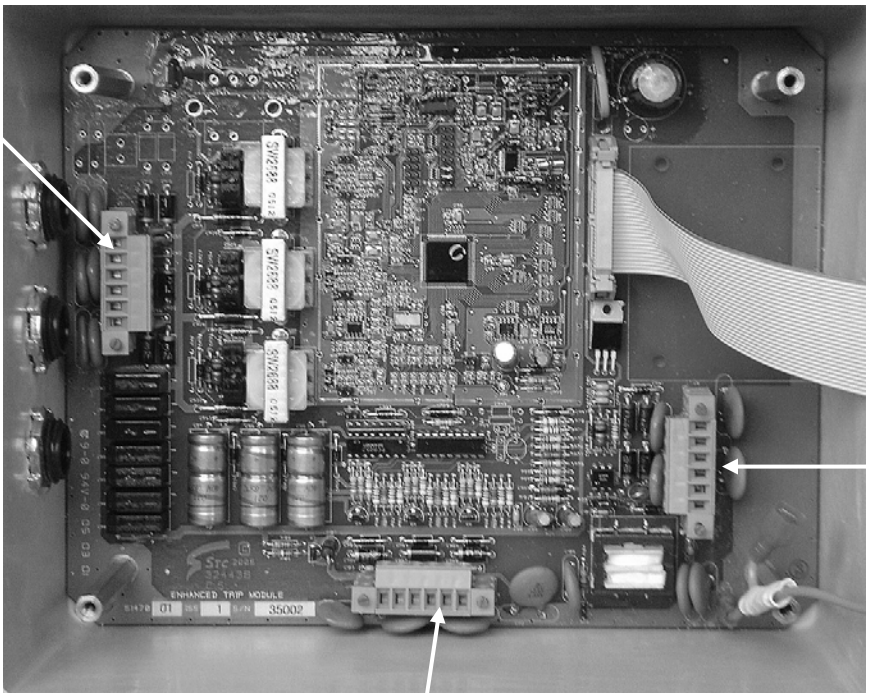
⚠ CAUTION

The Type 3 contains devices sensitive to Electrostatic Discharge (ESD). When working on the Type 3 with the faceplate removed, work surfaces and personnel must be properly grounded or equipment damage may result.

⚠ CAUTION

The NEMA rating of the Type 3 control housing is dependent on the type of cable entrance used. It is the responsibility of the individual installing new cable entrances to maintain the sealing integrity of the control housing. Failure to do so may cause damage to the control.

Terminal Block J1
Current Transformer Connections
(Factory Connected)



Terminal Block J5
External Power Input, External Trip Input, and RS485 Connections
(May be field or factory connected)

Terminal Block J13
Trip Signal Connections
(Factory Connected)

Figure 3.4a - Unit with default 12-24VDC External Power

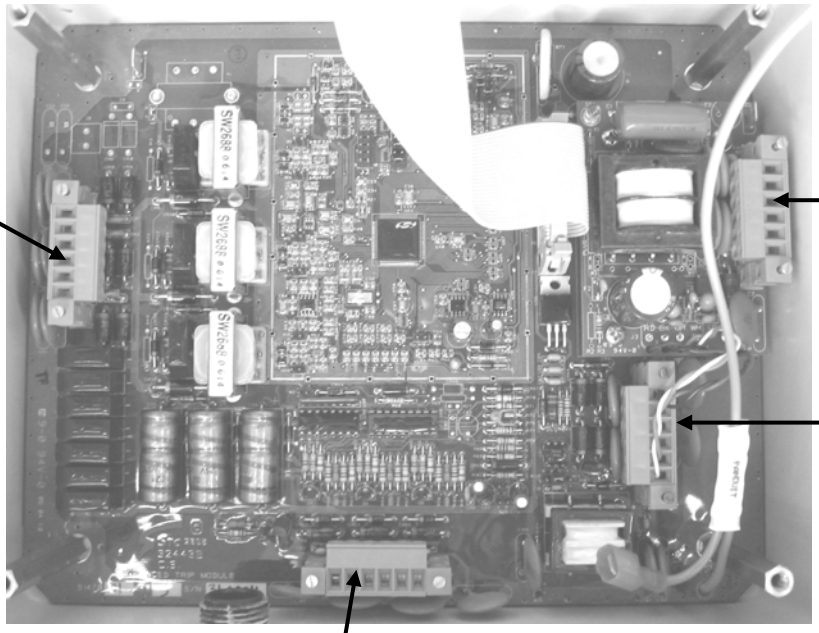


Figure 3.4b – Unit with 120VAC or 220VAC External Power Option

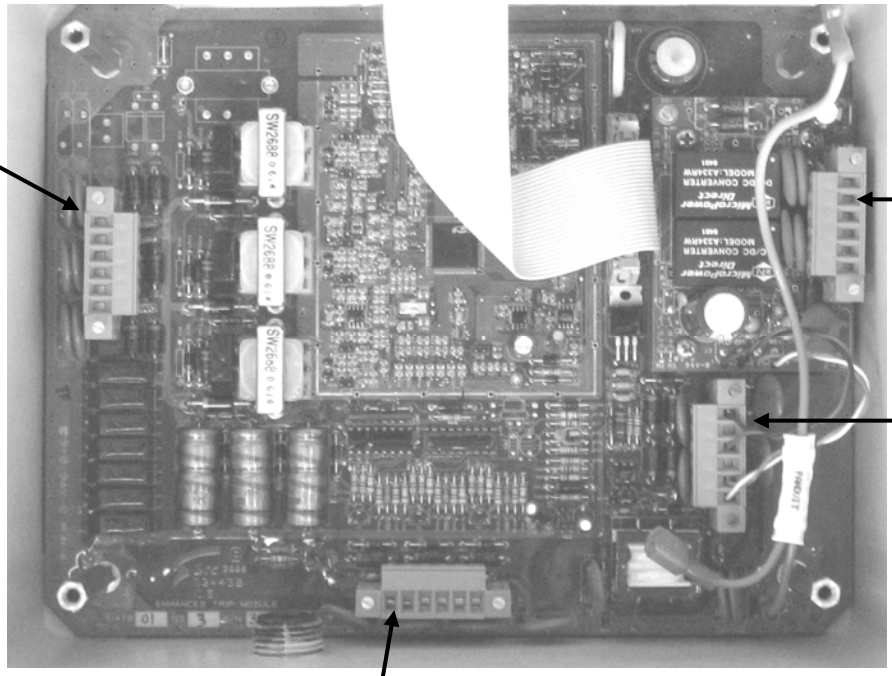


Figure 3.4c – Unit with 48VDC External Power Option

Connection to the external power input and/or external trip input is via connectors on the main PCB. If the control was equipped at the factory for access to the external power input and/or external trip input, access is via strain relief clamps located on the control housing. Note that the NEMA rating of the control housing depends on proper installation of the strain relief clamps and installation of the cable through the strain reliefs. Install the cable through the strain relief and connect as indicated in Figure 3.6 (a, b, c, d, or e). After the cable has been installed and connections made, tighten the strain relief securely on the cable. If the control was not factory equipped for access to the external power and external trip, a suitable strain relief may be installed through the side of the control housing to gain access to the connectors. Note, the NEMA rating of the control housing is dependent on the strain relief clamp used. To maintain the integrity of the control housing a strain relief clamp having the appropriate sealing capabilities must be used.

Figure 3.5a – Strain Relief

Most Type 3 controls use a strain relief (Figure 3.5a) for the CT and trip circuit connections. Refer to Figure 3.6a for the connection color code.

Some controls use a 10 pin connectorized interface (Figure 3.5b) for the CTs and trip circuit connections. Refer to Figure 3.6b for the connector color code.

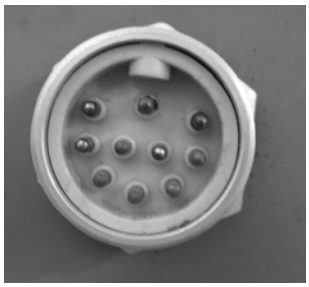


Figure 3.5b – 10 Pin Connector

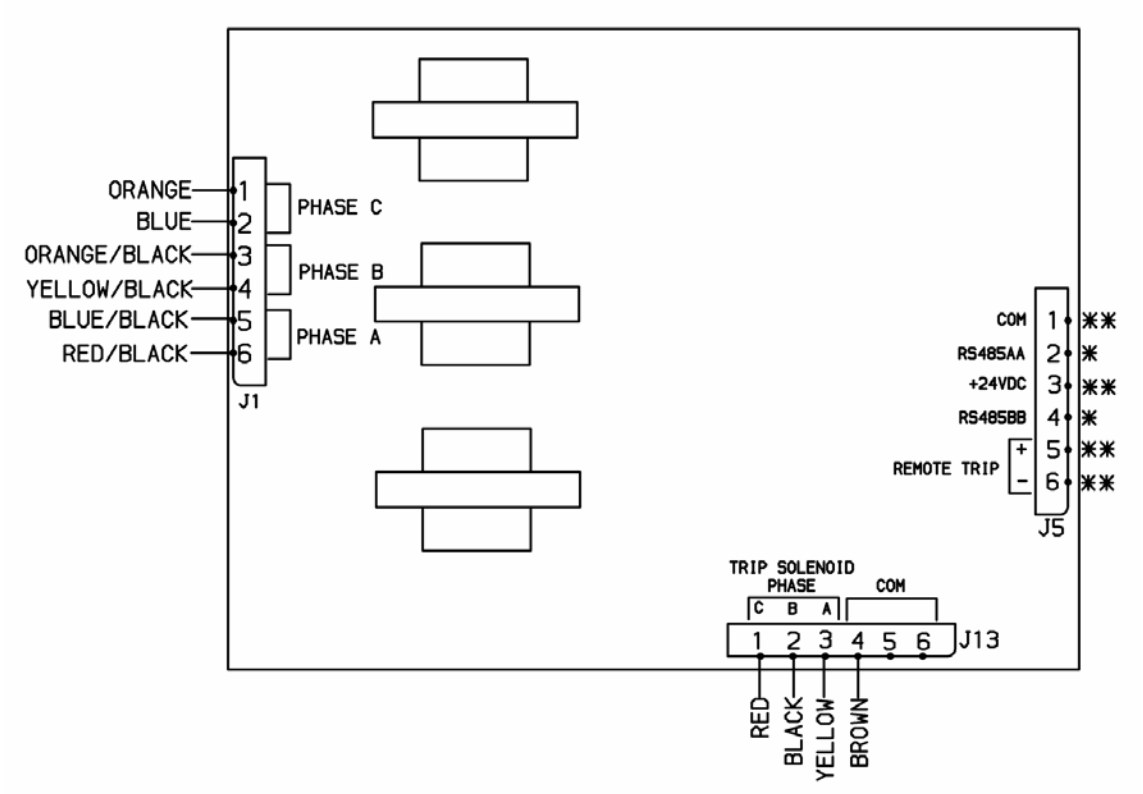


Figure 3.6a – Connections to the Type 3 using a Hardwired Cable with 12-24 VDC External Power

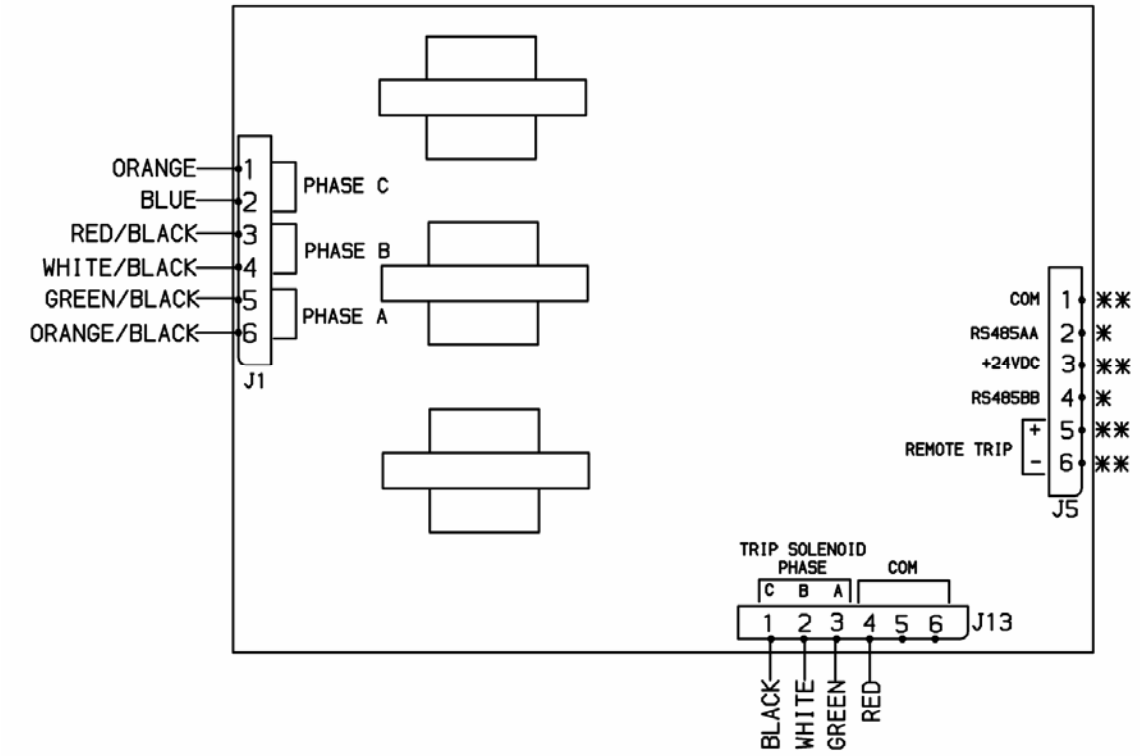


Figure 3.6b – Connections to the Type 3 using a 10 Pin Connector with 12-24 VDC External Power

Figure 3.6a and 3.6b Terminal J5 Connection Details:

* RS485

When using RS485, a 100Ω terminating resistor must be connected across terminals 2 and 4.

** External Power Input and External Trip Input Connection Guidelines

For Dry Contacts

1. Jumper terminal 3 to terminal 5.
2. Connect the power source positive lead to terminal 3, and the power source common to terminal 1.
3. Connect the dry contact leads between terminal 1 and terminal 6.

For Wetted Contacts

1. Connect the power source positive lead to terminal 3, and the power source common to terminal 1.
2. Connect the positive side of the contact to terminal 5 and the negative side of the contact to terminal 6.

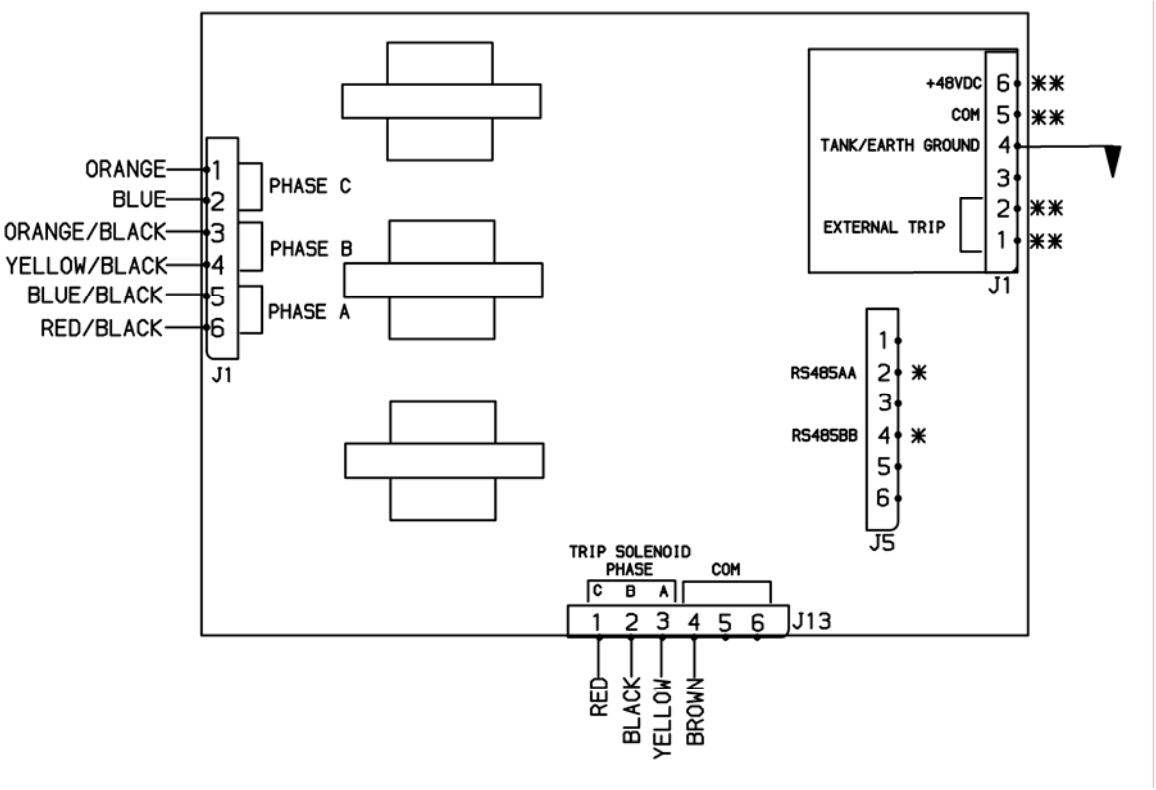


Figure 3.6c – Connections to the Type 1 using a hardwired cable and with 48 VDC External Power

Figure 3.6c Terminal J5 and J1 Connection Details:

* RS485

When using RS485, a 100Ω terminating resistor must be connected across terminals 2 and 4.

** 48VDC External Power Input and Dry Contact External Trip Input Connection Guidelines

J1 1 and 2: Dry contact
J1 3: not connected
J1 4: Tank/Earth Ground
J1 5: 0VDC
J1 6: 48VDC

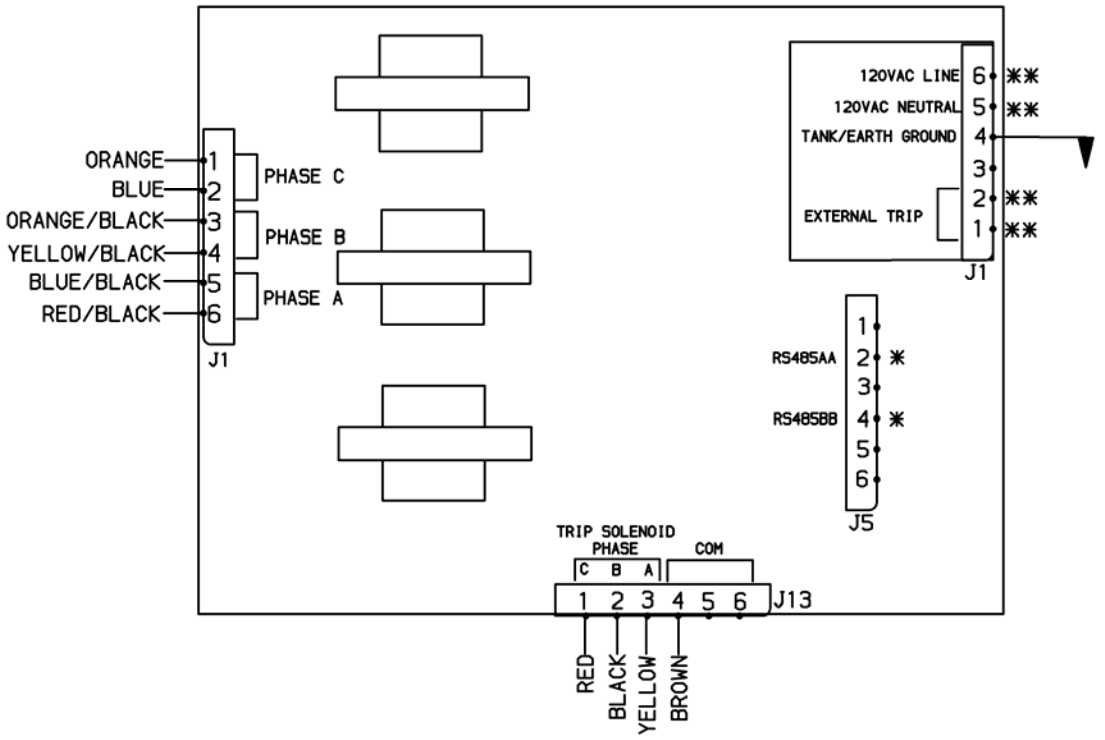


Figure 3.6d – Connections to the Type 1 using a hardwired cable and with 120 VAC External Power

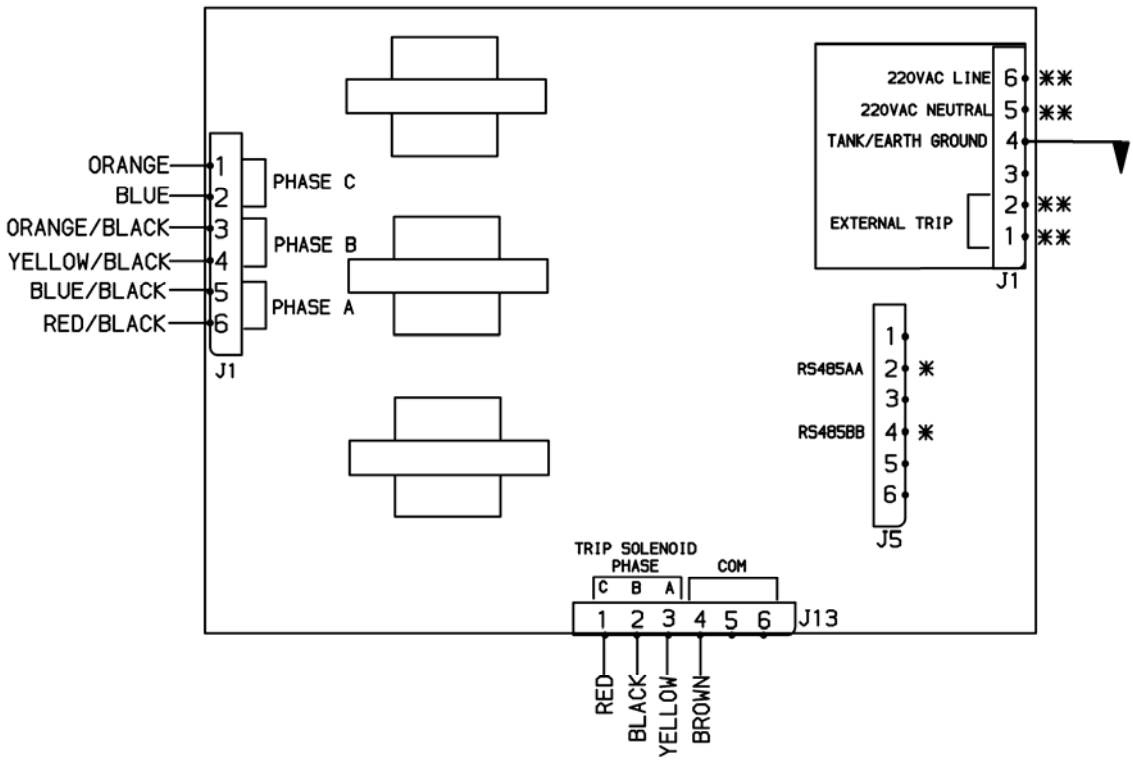


Figure 3.6e – Connections to the Type 1 using a hardwired cable and with 220 VAC External Power

Figure 3.6d and 3.6e Terminal J5 and J1 Connection Details:

* RS485

When using RS485, a 100Ω terminating resistor must be connected across terminals 2 and 4.

** 120VAC or 220 VAC External Power Input and Dry Contact External Trip Input Connection Guidelines

J1 1 and 2: Dry contact
J1 3: not connected
J1 4: Tank/Earth Ground
J1 5: AC Neutral
J1 6: AC Line

3.7 RS485 Communication

The Type 3 is capable of communicating through a serial line - RS485 when provided with external power. See Figure 3.6a or 3.6b for connection details.

The software driver uses the MODBUS RTU protocol. This protocol is provided with sum control, timeout and frame checking.

The following actions can be performed when the Type 3 is not performing a timing trip and if the Type 3 is powered.

- reading of load current on all three phases
- reading cause of trip and fault current
- reading of present parameters
- setting new parameters

The default factory settings for communications are: interface – RS485, address – 1.

Refer to Appendix A for protocol information.

⚠ CAUTION

Improper curve selection, minimum trip settings or other Type 3 setting selections can result in miscoordination with other devices on the system. Check coordination of settings with other system devices before applying.

⚠ CAUTION

Curve selection and trip settings must be selected so as not to exceed the ratings of equipment on the system. Improper settings can cause damage to equipment on the system.

⚠ CAUTION

Switch bushing selection or cable size may limit acceptable trip setting selection. Trip setting must be selected so as not to exceed ratings of bushings or cable. Improper settings can cause damage to equipment on the system.

4.1 General

The Vacuum Fluorescent Display (VFD) interface is composed of three "Pages" or sets of screens. Four of the sealed selection buttons are used to navigate between and within the pages. "Page Up" and "Page Down" navigate between the pages. "Scroll Up" and "Scroll Down" navigate within the pages (between the screens). Appendix B shows a representation of the different screens within each page. This information is also located inside the lid of the Type 3 enclosure.

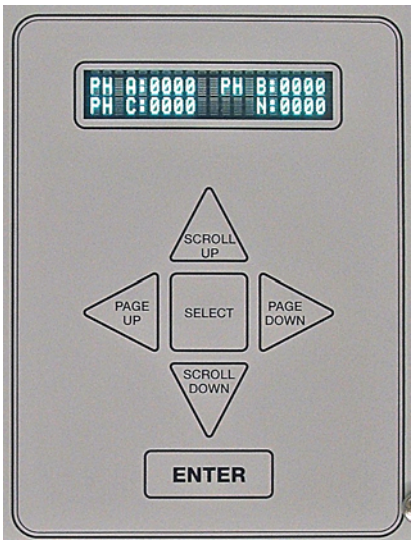


Figure 4.1

4.2 Display Page

The Display Page provides information on the unit and system status – including:

- Load Current
- Last Cause of Trip, Date, and Time
- Firmware Version
- CT Ratio and Operating Frequency
- Unit's time and date setting
- Tripping Circuitry Connection Status

To view the Display Page, press and hold the "Select" Key until the Display illuminates. (Figure 4.1)

The first screen within the Display Page shows the Load Current on each phase (PH) (Figure 4.2) as the current transformers within the switchgear are measuring it.

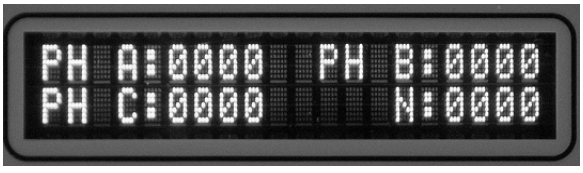


Figure 4.2

Note: To access other screens within this page, press the Scroll Up or Scroll Down selection buttons. All screens are shown in the order they would appear with the Scroll Down option.

The next screen within the Display page is the Last Cause of Trip. This screen shows the approximate Time and Date of the last Trip command as well as the cause and approximate current that led to the trip.

Figure 4.3

Figure 4.3 shows an example of this screen. In this instance, the Last Cause of Trip was due to 213 Amps on B Phase at 5:02 PM (17:02) Eastern Standard Time on August 29, 2006.

The succeeding screens show the Firmware version (Figure 4.4) currently installed in the Type 3, the CT Ratio (Figure 4.5), and the time currently set in the Type 3 (Figure 4.6).

Figure 4.4

Figure 4.5

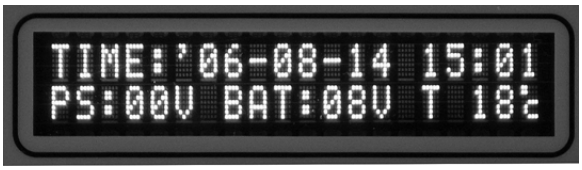


Figure 4.6

Figure 4.7

In Figure 4.6 the user can see that the Type 3 is currently set for August 14, 2006 and the time is 3:01 PM (15:01) EST. In addition, the control is not powered by the CTs, auxiliary power, or external power (PS: 00V). The 9VDC Lithium battery is measuring 8V, and the control is reading an external temperature of 18ºC.

The final screen in the Display Page shows the status of the connections (Figure 4.7). S1, S2, and S3 indicate whether or not the tripping circuitry is connected to the Type 3. S1 indicates the connection to J13-1 (typically C phase); S2 is for J13-2 (typically B phase), and S3 is for J13-3 (typically A phase). If C1, C2, and C3 are above 7 Volts, this indicates that the internal circuitry has enough power to trip open the Vacuum Interrupter mechanism.

Note: To access other Pages, press the Page Up or Page Down selection buttons. From the Display Page, pressing Page Up will move to the Parameter Page (Section 4.3), while Page Down (or Page Up two times) will take the user to the Operational Page (Sections 4.4 and 4.5)

4.3 Parameter Page

The Parameter Page allows the user to see all of the settings in the Type 3 without affecting the protection features. Each of the possible settings is explained in detail in Section 4.5.

To view all of the settings, use the Scroll Up and Scroll Down buttons to move through the screens.

4.4 Operational Page (Protection Mode)

The Operational Page consists of two parts, the “Protection Mode” discussed in this section and the “Set-Up Mode” discussed in Section 4.5. The Protection Mode allows the users to perform specific operations while the Type 3 continues to monitor the primary current and initiate trip commands.

The Manual Trip Feature of the Operational Page consists of either three (Figures 4.10 – 4.12) or six screens (Figures 4.8 – 4.12). If the Type 3 is set for Single Phase Trip, all of the following screens are shown. (If the Type 3 is set for Three Phase Trip, Figures 4.8, 4.9, and 4.10 are not applicable.)

To use the Manual Trip Feature, select the Operational Page, and then one of the four Trip Screens. If the control is properly powered to trip the vacuum fault interrupting mechanism open, the screen will say “Press Manual Trip” instead of “Insufficient Power”. At that time, press the red Manual Trip push button, and the selected phases(s) will trip open.

Figure 4.8 (Manual Trip Option for Phase A when the Type 3 is set for Single Phase Trip)

Figure 4.9 (Manual Trip Option for Phase B when the Type 3 is set for Single Phase Trip)

Figure 4.10 (Manual Trip Option for Phase C when the Type 3 is set for Single Phase Trip)

Figure 4.11 (Manual Trip Option for all Three Phases)

Figure 4.12
To Clear the Last Cause of Trip information seen in Figure 4.3, press the Enter Key at this screen.

The next screen in the Operational Page (Protection Mode) is the Mode Selection screen (Figure 4.13). At this point, the user can choose to continue through the Operational Page in the Over Current Protection Mode (by pressing Scroll Down), or Enter the Set-Up Portion of the Operational Page. Section 4.5 covers the screens available in the Operation Page (Set Up).

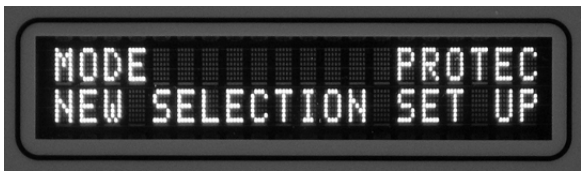


Figure 4.13

The final screen in the Operational Page (Protection Mode) is the Time and Date Set-Up screen. This screen (Figure 4.14) allows the user to change the existing time in the control. All controls leave the factory pre-set for Eastern Standard Time. The format of the date is YY-MM-DD (Year-Month-Day) and is displayed using the 24 hour mode. It is suggested that if the time is changed, that the control is labeled with the proper time zone for analyzing future sequence of event records. The control does not automatically adjust for daylight savings time.

Figure 4.14

To change the date or time in the control, use press Page Up or Page Down to select the portion of the date or time to be changed. Figure 4.15 shows the "Year" selected. Figure 4.16 shows the "Hour" selected.

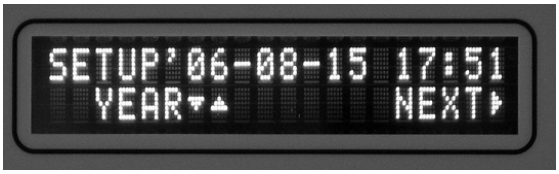


Figure 4.15

Figure 4.16

When all changes have been made, press Page Down until the Enter/Quit screen is shown. (Figure 4.17) To save the changes, press Enter.

Figure 4.16

4.5 Operational Page (Set-Up Mode)

The Operational Page consists of two parts, the "Protection Mode" discussed in Section 4.4 and the "Set-Up Mode" discussed in this section. The "Set-Up Mode" allows the users to change the over current protection settings of the device. While in the "Set-Up Mode", the Type 3 may be powered by the Current Transformers but will not initiate trip commands.

To enter the "Set-Up Mode", press the Enter key.

Figure 4.17a

Figure 4.17b

⚠ CAUTION

Over current protection is disabled when in the Set-Up mode. Unexpected operations may occur as upstream devices become responsible for over current protection.

When setting the Type 3, the current setting is shown in the top right corner of the screen. For example Figure 4.17a shows the word “PROTEC” in the top right corner of the screen. This indicates the control is currently in the “Protection Mode”. The setting options are shown in the bottom right hand corner of the screen. (In Figure 4.17a this is “SET UP”.) Pressing the Select Button will scroll through all possible setting options. When the preferred option is shown in the bottom right hand corner of the screen, press the Enter button to choose the setting. Note: The setting is not active in the control at this time. All setting options (except the decision to enter the “Set-Up Mode”) must be chosen and saved before the settings become active.

4.5.1 Single/Three Phase Trip

The Type 3 may be set for one of two trip modes, Single or Three Phase Trip. When set for Single Phase Trip, and the input current exceeds the pre-selected limit on any phase, the Type 3 will trip the corresponding mechanism phase (depending on style of mechanism). When selecting Three Phase Trip, the Type 3 will trip all three phases when the input current exceeds the lowest pre-selected limit set on any of the individual phase. Figure 4.18a shows the Type 3 set for Single Phase Trip, with a new selection of Three Phase Trip. To accept the Three Phase Trip setting, press the Enter Button. Conversely, Figure 4.18b shows the Type 3 set for Three Phase Trip, with a new selection of Single Phase Trip.

Figure 4.18a

Figure 4.18b

4.5.2 Time/Current Characteristic Curves (TCC) Selection

There are 30 curves selectable via the VFD. The Type 3 TCCs are stored in internal nonvolatile memory. Each TCC is stored as a series of 512 data points in a tabular format. A TCC is a table that provides for different time delays at different current values. The G&W TCCs are emulation curves. Of these, some of the TCCs emulate relay curves – for example, the CO-8, CO-9, CO-11, and GE-IAC53. The other TCCs are fuse curve emulations. None of the emulations is meant to represent one specific manufacturer; instead, data was used from multiple manufacturers. All emulations meet ANSI standards. Figure 4.19 shows the control set for the E Speed Slow (E-SLOW) TCC, with the new selection as E Speed Standard (E-STD)

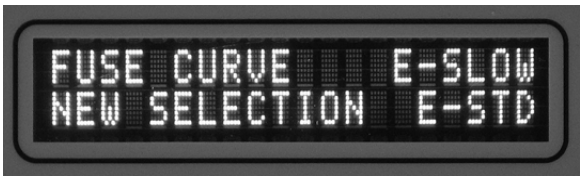


Figure 4.19

Note: For Time Current Curves, reference G&W website at www.gwelec.com

4.5.3 Minimum Trip Current Selection

There are four possible screens for setting the minimum trip value, three are used when the Type 3 is set for Single Phase Trip (Figures 4.20 a-c); the last (Figure 4.21) is used when the Type 3 is set for Three Phase Trip. Each screen permits the user to select from 12 trip values per phase ranging from 15 – 300 Amps or from 30 – 600 Amps. The 15-300 Amp minimum trip style control uses 500:1 CTs mounted within the G&W Switch. The 30-600 Amp minimum trip style control uses 1000:1 CTs.

Figures 4.20a (A Phase), 4.20b (B Phase), and 4.20c (C Phase) show the screens for setting the Minimum Trip Selection for Single Phase Trip. Figure 4.21 shows the screen that would appear for setting the Minimum Trip Selection for Three Phase Trip. Either Figures 4.20a, 4.20b, and 4.20c or Figure 4.21 will appear – not all four.

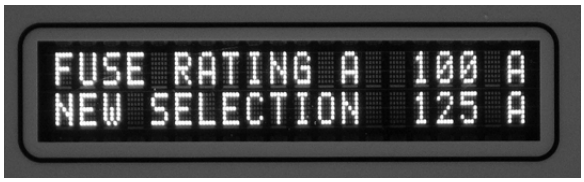


Figure 4.20a

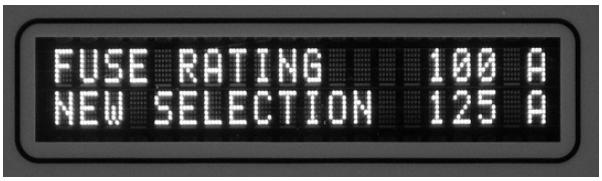


Figure 4.21

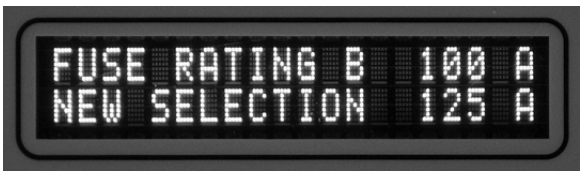


Figure 4.20b

Figure 4.20c

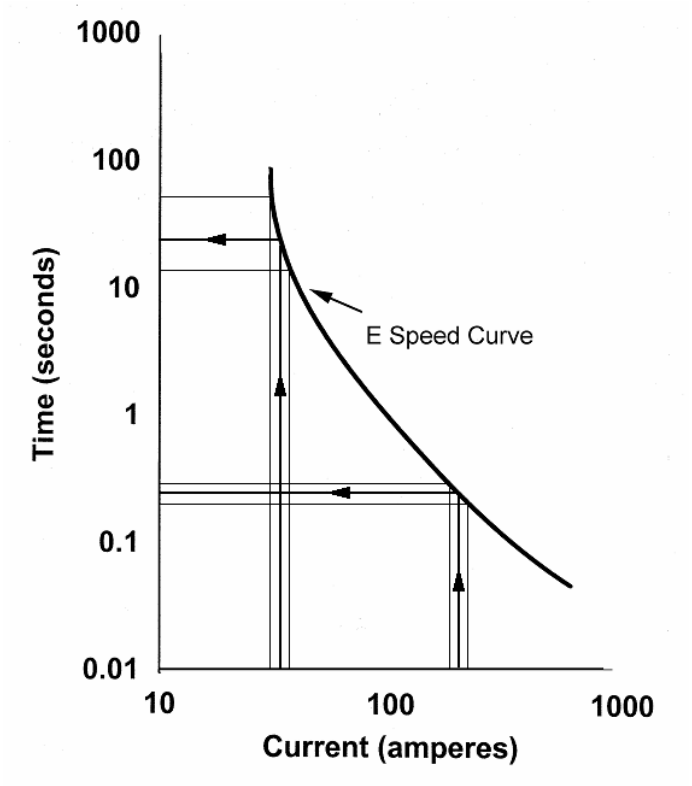


Figure 4.22

The Type 3 operates by measuring the primary current and comparing it to values stored in a table. If the current, on any phase, is above the minimum trip threshold, then timing begins. A trip command is sent when the measured time exceeds the stored value for the time associated with the measured current level.

Figure 4.22 depicts the process by which the trip timing is determined based on the measured input current. As shown in Figure 4.22, the accuracy of the timing is dependent on the slope of the TCC. The steeper the slope the greater the error band due to the accuracy of the current measurement. If the primary current is greater than 250 amperes, the typical current measurement accuracy is +/-2%. If the primary current is less than 250 amperes, the typical current measurement accuracy is +/-5 Amps. Variations in the primary current during the timing phase will also affect the final trip time. If during the timing phase the primary current falls

below 85% of the minimum trip current the timing is reset to zero. If the primary current is above 85% of the minimum trip current, a reverse timing algorithm is employed until the timing is reset to zero.

The Type 3 has a dynamic range of 20 on the current measurement. This means that the TCC table has trip times for currents ranging from the minimum trip to 20 times the minimum trip. The control does not stop measuring if the current level exceeds 20 times the minimum trip value. It simply uses the fastest trip time on the selected TCC for current levels above 20 times the minimum trip. For example, for a minimum trip equal to 15 amperes, the TCC maximum current is 300 amperes. For a minimum trip equal to 600 amperes, the TCC maximum current is 12,000 amperes.

4.5.4 Ground Fault (Phase Imbalance) (Only applicable if Three Phase Trip is chosen)

The ground fault feature can be used to protect against excessive phase imbalances that may result in damage to equipment.

The Type 3 performs an analog sum of the three individual phase currents. The analog sum takes the current amount as well as the phase angle into account. If the sum is not zero, there is a phase imbalance present.

The ground fault feature is set as a percentage (10% to 50%) of the minimum trip value. (Figure 4.23) If the phase imbalance is more than the selected ground fault value, the Type 3 will begin to time using the same TCC curve as the Minimum Trip Setting.

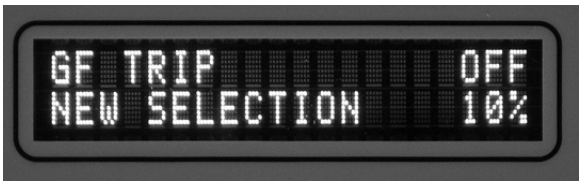


Figure 4.23

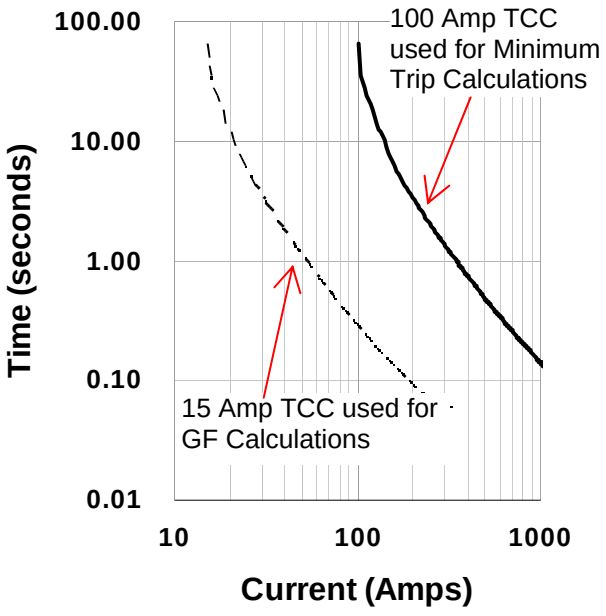


Figure 4.24

For Example:
With the Type 3 set for E Speed Slow, with the minimum trip value set for 100 Amps, the ground fault for 15% of the minimum trip value, and all other settings inactive:

The Type 3 will compare a phase imbalance current to the E Speed Slow TCC with a 15 Amp minimum trip setting (100 Amp x 15% = 15A). Therefore, if the phase imbalance current value is 30 Amps the Type 3 will initiate a trip command after 3.39 seconds. (The normal trip time for 30 Amps, on a 15 Amp minimum trip is 3.39 Seconds.) (Figure 4.24)

4.5.5 Instantaneous Trip Multiplier

The instantaneous trip multiplier aids in customizing the protection capabilities of the Type 3 control. This screen (Figure 4.25) allows the user to select between nine settings. The first setting, OFF, disables this feature. The other settings affect how the Type 3 times for over current conditions. When any phase exceeds the current value defined by the minimum trip setting times the instantaneous trip multiplier, the Type 3 will initiate a trip command to all three phases within half a cycle, 8.3 msec at 60 Hz (10 msec at 50 Hz).

Figure 4.25

The dotted line in Figure 4.26 shows how the E Speed Slow Curve has been modified by an x3 instantaneous trip multiplier.

For Example:
With the Type 3 set for E Speed Slow, 60 Hz, the minimum trip value set for 25 Amps, the instantaneous trip multiplier set for x3 and all other settings inactive:

If the primary current on A phase is 60 Amps, the control will trip as normally defined by the TCC. For example: for a 25 Amp minimum trip – the trip time will normally be 2.13 seconds. If the current is 80 Amps, the normal TCC trip time would be 1.16 seconds. Because the 80 Amps is above the instantaneous setting of 75 Amps (25 x 3), the Type 3 will initiate a Trip command within 8.3 msec.

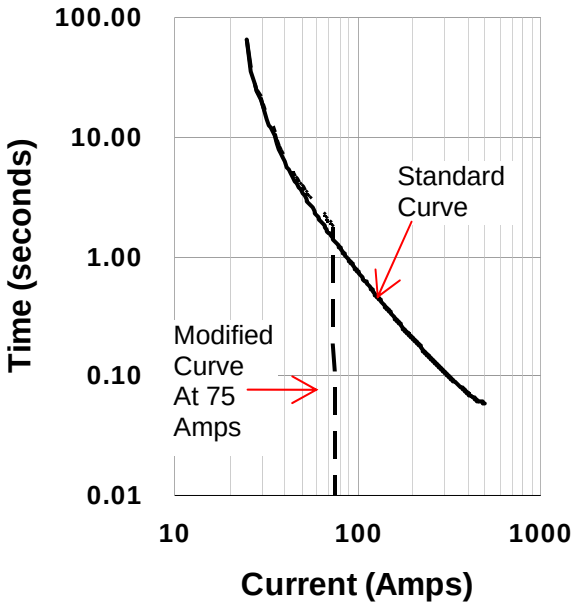


Figure 4.26

4.5.6 Phase Time Delay

The phase time delay has eleven delay choices (from 0.03 seconds to 0.50 seconds) (Figure 4.27) which may be helpful when coordinating the Type 3 with other protection devices. When the measured current level exceeds the minimum trip value, the Type 3 will add the selected phase time delay to the TCC time for the measured current level. After both the TCC and phase time delay have elapsed, the Type 3 will initiate a trip command to all three phases of the mechanism. The phase time delay may be disabled by selecting 0.0.

Figure 4.27

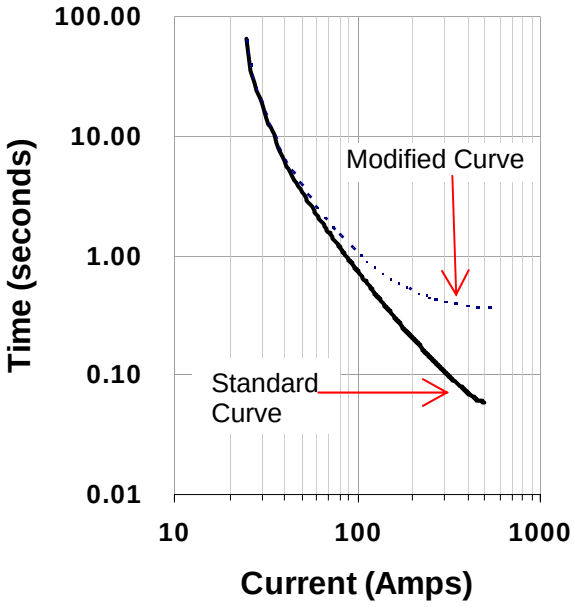


Figure 4.28

The dotted line in Figure 4.28 shows how the E Speed Slow Curve has been modified by a 0.30 second phase time delay.

To calculate the expected trip time, add the phase time delay to the normal trip time.

For Example:
With the Type 3 set for E Speed Slow, 60 Hz, minimum trip value set for 25 Amps, the phase time delay set for 0.30 seconds, and all other settings inactive:

If the primary current on A phase is 60 Amps: for a 25 Amp minimum trip – the trip time will normally be 2.13 seconds. If the current on phase A remains at 60 Amps for longer than 2.43 (2.13 + 0.30) seconds, the Type 3 will initiate a trip command.

4.5.7 Minimum Response Time

With ten options including OFF (and delays from 0.050 to 0.580 seconds), the Minimum Response Time feature allows the user to ensure that the Vacuum Interrupter will not trip open before a specific time. This feature will work in conjunction will all other features of the Type 3 except the Ground Fault (Phase Imbalance Feature).

Figure 4.29

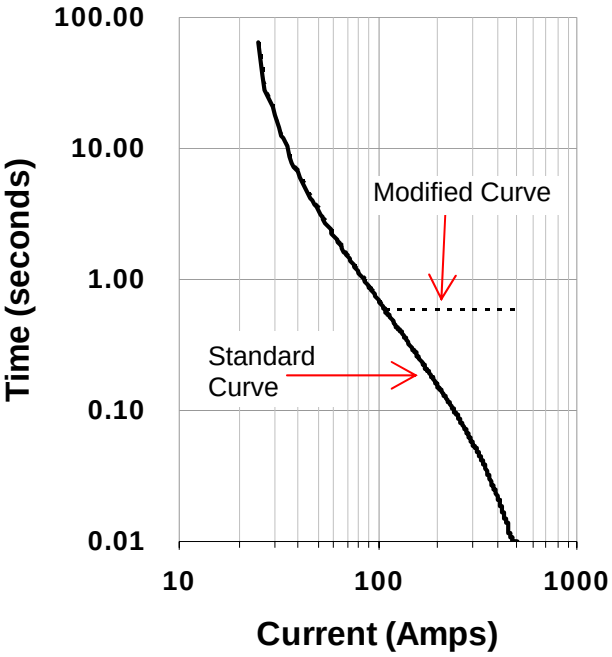


Figure 4.30

The dotted line in Figure 4.30 shows how the E Speed Slow Curve has been modified by a 0.580 second Minimum Response Time.

For Example:
With the Type 3 set for E Speed Slow, 60 Hz, minimum trip value set for 25 Amps, the Minimum Response Time set for 0.580 seconds, and all other settings inactive:

If the primary current on A phase is 60 Amps: for a 25 Amp minimum trip – the trip time will be as normal - 2.13 seconds. If the primary current is 120 Amps, the normal trip time would be 0.515 seconds. Since the Minimum Response Time is set for 0.580, the trip command will not initiate until 0.580 seconds.

4.5.8 Inrush Restraint

The inrush restraint function consists of two selectable parameters, the Inrush Trip Multiplier (Figure 4.31a) and the Inrush Time Delay (Figure 4.31b)

Figure 4.31a

Figure 4.31b

The inrush restraint function is helpful in preventing nuisance trips due to cold load pickup. The inrush restraint function is activated by the average primary current level (of all three phases) exceeding 7.5 Amps (15-300 Amp controls) or 15 Amps (30-600 Amp controls.) Once the inrush restraint is activated, the control will increase the minimum trip value for the selected time delay duration.

Figure 4.32 shows an example of this function, where the dotted line shows the temporary curve modification that is active during the inrush time delay.

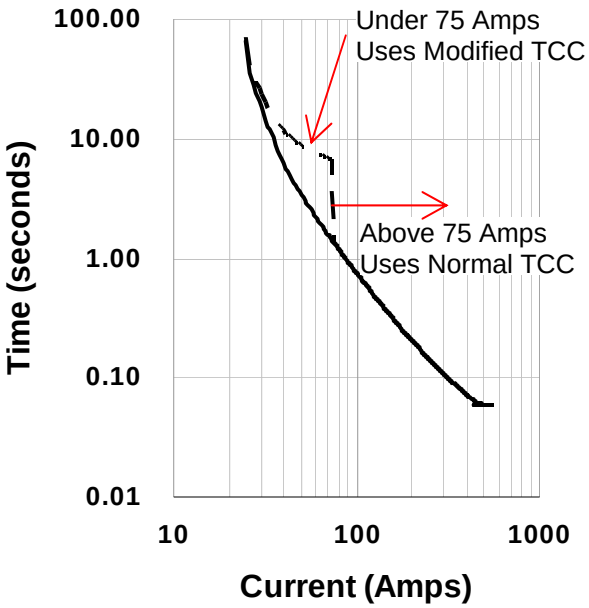


Figure 4.32

If the minimum trip setting is 25 Amps on a 15-300 Amp style control, the inrush trip multiplier is x3, and there is a 5.25 second inrush time delay, the Type 3 will ignore any currents up to 75 Amps (25 x 3) for 5.25 seconds after the average three phase primary current exceeds 7.5 Amps.

For Example:
With the Type 3 set for E Speed Slow, the minimum trip value set for 25 Amps, the inrush multiplier for x3, the inrush delay set for 5.25 seconds, and all other settings inactive:

If the primary current on A phase is 60 Amps: for a 25 Amp minimum trip – the trip time will normally be 1.53 seconds. If the current on phase A remains at 60 Amps for longer than 6.78 (1.53 + 5.25) seconds, the Type 3 will initiate a trip command.

If the current on phase A goes above 75 Amps, the Inrush Restraint Function is disabled. The control will initiate timing using the normal TCC.

The Inrush Restraint Function is disabled after the Inrush Time Delay expires, or any phase exceeds the Inrush Trip Multiplier value.

Once disabled, the Inrush Restraint Function will not be reactivated unless the average three phase primary current drops below 7.5 Amps (15-300 Amp controls) or 15Amps (30-600 Amp controls.)

4.5.9 Communication Address

The communication address is used when multiple Type 3 controls are connected together and communicating using the RS485 interface. Up to 15 Type 3 controls can be connected together as each will be identified by it's own address. The screen shown in Figure 4.33 is used to set the address specific to each control. The factory default setting is Address = 1.

Figure 4.33

4.5.10 Communication Interface

The Communication Interface (Figure 4.34) allows the user to choose between the front panel DB9 serial port (using RS232) or the main circuit board connections (using RS485) See Section 3.7

Figure 4.34

4.5.11 Save Selections

In order to make all of the selections active in the Type 3, they must be stored to the control. On the final screen, press the Select button until "Store" appears in the bottom right hand corner of the screen (Figure 4.35), then press "Enter".

Figure 4.35

⚠ CAUTION

Verify the TCC setting prior to use. Improper settings or changing the settings while the switch is energized can cause unexpected operations of the Vacuum Interrupter Mechanism.

System parameters may have changed while the Type 3 was in the "Set-Up" mode. The Type 3 may initiate timing or a trip command once the settings have been stored.

SECTION 5 SPECIFICATIONS

Power Requirements

Powered by measured current from the current transformers when current is more than 6 Amps per phase (for 500:1 CTs) or 10 Amps per phase (for 1000:1 CTs) Refer to Section 5.2

External Power Requirements

12-24 VDC, 48VDC, 120VAC, 220VAC through the External Power Input (Section 4.7) or through the Auxiliary Power Jack (Section 5.2)

Minimum Trip Setting Options (500:1 CT)

15 Amps (7 Amp Fuse Equivalent)	75 Amps (33 Amp Fuse Equivalent)
20 Amps (9 Amp Fuse Equivalent)	100 Amps (43 Amp Fuse Equivalent)
25 Amps (11 Amp Fuse Equivalent)	125 Amps (55 Amp Fuse Equivalent)
35 Amps (15 Amp Fuse Equivalent)	175 Amps (80 Amp Fuse Equivalent)
45 Amps (20 Amp Fuse Equivalent)	225 Amps (100 Amp Fuse Equivalent)
60 Amps (26 Amp Fuse Equivalent)	300 Amps (132 Amp Fuse Equivalent)

Minimum Trip Setting Options (1000:1 CT)

30 Amps (13 Amp Fuse Equivalent)	150 Amps (67 Amp Fuse Equivalent)
40 Amps (18 Amp Fuse Equivalent)	200 Amps (90 Amp Fuse Equivalent)
50 Amps (22 Amp Fuse Equivalent)	250 Amps (110 Amp Fuse Equivalent)
70 Amps (31 Amp Fuse Equivalent)	350 Amps (155 Amp Fuse Equivalent)
90 Amps (40 Amp Fuse Equivalent)	450 Amps (200 Amp Fuse Equivalent)
120 Amps (54 Amp Fuse Equivalent)	600 Amps (270 Amp Fuse Equivalent)

Communications

RS485 using Modbus Protocol (Section 4.9, Appendix A)

Enclosure

NEMA 4X (IP56) Fiberglass Enclosure (Standard)
NEMA 6P (IP67) Fiberglass Enclosure (Optional)
Contact your local representative for more options

Frequency

60 Hz (Standard)
50 Hz (Optional)

Environment

Operating Temperature	-40ºC to +65ºC
Storage Temperature	-50ºC to +85ºC
Humidity	10% to 95%

Type Tests

Electrostatic Discharge test: IEC 60255-22-2 Level 4 contact discharge

Radiated Electromagnetic Field Disturbance test: IEC 60255-22-3 Level 3

Radiated Electromagnetic Interference: IEEE C37.90.2-1995
10V/m
35V/m

Surge Withstand: ANSI/IEEE C37.60

Vibration

IEC 60255-21-1 First Edition – 1988 (EN 60255-21-1 First Edition – 1995)
Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment; Section One – Vibration tests (sinusoidal); Severity: Class 1 Endurance; Class 2 Response.

IEC 60255-21-2 First Edition – 1988 (EN 60255-21-2 First Edition – 1995)
Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment; Section Two – Shock and Bump tests. Severity Level: Class 1 Shock withstand, Bump; Class 2 Shock Response

APPENDIX A RS485 MODBUS-RTU PROTOCOL

A.1 Communication Settings

1. Baud rate : 1200
2. Parity : odd
3. Error check : CRC - 16
4. Hardware : RS 485.
5. Slave address : 1

A.2 Function definitions

The communication driver has implemented the following functions:

1. Read Holding Registers - code 03
   Definition: Obtain the current binary value in one or more holding registers.

   This function can read all but 2 settings. The settings for slave address and communication interface are not accessible.

2. Read Input Registers - code 04
   Definition: Obtain the current binary value in one or more input registers.

   This function can access information regarding last cause of trip, the fault current and the load current on all 3 phases plus the calculated neutral current.

A.3 Register definitions

Trip Module Controller has implemented the following 16 – bit registers:

Input registers - function code 04:
Start address: 0
Number of registers : 6
Stored information :

calculated neutral current,	reg. - 0000
load current phase C,	reg. - 0001
load current phase B,	reg. - 0002
load current phase A,	reg. - 0003
cause of the last trip,	reg. - 0004
fault current of the last trip,	reg. - 0005

The binary values of currents (fault/load) represent the current in Amps in the primary circuit. The value is scaled according to the Min Trip setting and ratio of the transformer.

Interpretation of the 'cause of the last trip' message:

Code: 0x00	cause of trip: Ground Fault
Code: 0x01	cause of trip: Phase C
Code: 0x02	cause of trip: Phase B
Code: 0x03	cause of trip: Phase A
Code: 0x05	cause of trip: Phase C - instantaneous
Code: 0x06	cause of trip: Phase B - instantaneous
Code: 0x07	cause of trip: Phase A - instantaneous
Code: 0x21	cause of trip: Phase C – Current over the dynamic range of 20.
Code: 0x22	cause of trip: Phase B – Current over the dynamic range of 20.
Code: 0x23	cause of trip: Phase A – Current over the dynamic range of 20.
Code: 0x08	cause of trip: Manual
Code: 0xFF	cause of trip: Memory clear

Holding registers - function code 03 (reading):
Start address : 0
Number of registers: 13
When these registers are read the following information is received:

The setting of phase C	reg. - 0000
The setting of phase B	reg. - 0001
The setting of phase A	reg. - 0002
The multiplier of Instant Trip	reg. - 0003
The threshold of Ground Fault Trip	reg. - 0004
Reserved – read 0	reg. - 0005
The time for Time Delay Adder	reg. - 0006
The time for Minimum Response	reg. - 0007
The multiplier for Inrush Restraint	reg. - 0008
The timer for Inrush Restraint	reg. - 0009
Fuse Curve	reg. - 0010
The setting for 1/3 Phase Trip	reg. - 0011
Transformer ratio and option flags	reg. - 0012

Holding registers - function code 06 (writing):
If a writing operation is performed the following information will be stored:

The new setting of phase C,	reg. - 0000
The new setting of phase B,	reg. - 0001
The new setting of phase A,	reg. - 0002
The new multiplier of Instant. Trip,	reg. - 0003
The new threshold of Ground Fault Trip,	reg. - 0004
Reserved – write 0x00	reg. - 0005
The time for Time Delay Adder	reg. - 0006
The time for Minimum Response	reg. - 0007
The multiplier for Inrush Restraint	reg. - 0008
The timer for Inrush Restraint	reg. - 0009
The new Fuse Curve,	reg. - 0010
The setting for 1/3 Phase Trip	reg. - 0011
Transformer ratio and option flags	reg. - 0012

A.4 Exception Definitions

The Type 3 has implemented the following exception codes:

1. Illegal function - code 01. The message function received is not an allowable action.
   This message is sent if the Type 3 received any request other than implemented functions (code 3, code 4, and code6).

2. Illegal data address - code 02. The address referenced in the address field is not valid.
   The Type 3 will respond with this message if the register address is not implemented.

3. Illegal data value - code 03. The value referenced in the data field is not valid.
   If a CRC error is detecting, the Type 3 will not respond.
   The implementation of the communication driver does not support parity bit checking.
   If the waiting time between two characters is longer than 32.5 milliseconds the message will be ignored and no response will be send.

A.5 Interpretation of stored data

The stored data is kept in registers (as defined in A.3). To interpret the stored data, compare the number returned to the Index number in the following tables. For example: To read the B phase Minimum Trip Setting, read Function code 03, Register 0001. If the number returned is “8”, and the control is equipped for 500:1 CTs, the setting is 125A.

1. Setting of phase A / B / C

Index	(500 : 1)	(1000 : 1)
0	15 A	30 A
1	20 A	40 A
2	25 A	50 A
3	35 A	70 A
4	45 A	90 A
5	60 A	120 A
6	75 A	150 A
7	100 A	200 A
8	125 A	250 A
9	175 A	350 A
10	225 A	450 A
11	300 A	600 A

2. Instantaneous Trip Multiplier:

Index	Multiplier
0	OFF
1	1
2	3
3	5
4	7
5	9
6	11
7	13
8	15

3. Ground Fault (Phase Imbalance) Setting:

Index	Setting
0	OFF
1	10 %
2	15 %
3	20 %
4	25 %
5	30 %
6	35 %
7	40 %
8	45 %
9	50 %

4. Time Current Curve:

Index	TCC
0	E-SLOW (E Speed Slow)
1	E-STD (E Speed Standard)
2	OFC (Oil Fuse Cut Out)
3	K (K Speed)
4	KEAR Q (Kearney QA Speed)
5	EF (EF Speed)
6	NX-C (NC35-C)
7	CO11-1 (CO11 – Time Dial 1)
8	CO11-2 (CO11 – Time Dial 2)
9	T LINK (T Speed Slow/ T Link)
10	CO9-1 (CO9 – Time Dial 1)
11	CO9-2 (CO9 – Time Dial 2)
12	280ARX (280 ARC Recloser Curve)
13	CO9-4.5 (CO9 – Time Dial 4.5)
14	CENT A (Centerior A)
15	KEARKS (Kearney KS Speed)
16	IAC53 (GE IAC53 Relay)
17	F (F Speed)
18	CO8-.5 (CO8 – Time Dial 0.5)
19	CO8-1 (CO8 – Time Dial 1)
20	CO8-2 (CO8 – Time Dial 2)
21	CO8-3 (CO8 – Time Dial 3)
22	CO8-4 (CO8 – Time Dial 4)
23	CO8-5 (CO8 – Time Dial 5)
24	CO8-6 (CO8 – Time Dial 6)
25	CO8-7 (CO8 – Time Dial 7)
26	CO8-8 (CO8 – Time Dial 8)
27	CO8-9 (CO8 – Time Dial 9)
28	CO8-10 (CO8 – Time Dial 10)
29	CO8-11 (CO8 – Time Dial 11)
30	Effuse (EF Fuse Equivalent)

5. Inrush Restraint multiplier

Index	Inrush Multiplier
0	x1
1	x2
2	x3
3	x4
4	x5
5	x6
6	x7
7	x8
8	x9
9	x11
10	x13
11	x15

6. Inrush Restraint Time Adder

Index	Time Adder
0	0.00 Seconds
1	1.75 Seconds
2	3.50 Seconds
3	5.25 Seconds
4	7.00 Seconds

7. Time Delay adder

Index	Time Delay
0	0.00 Seconds
1	0.03 Seconds
2	0.06 Seconds
3	0.10 Seconds
4	0.15 Seconds
5	0.20 Seconds
6	0.25 Seconds
7	0.30 Seconds
8	0.35 Seconds
9	0.40 Seconds
10	0.45 Seconds
11	0.50 Seconds

8. Single or Three Phase trip

Index	Trip Setting
0	Single Phase Trip
Any other	Three Phase Trip

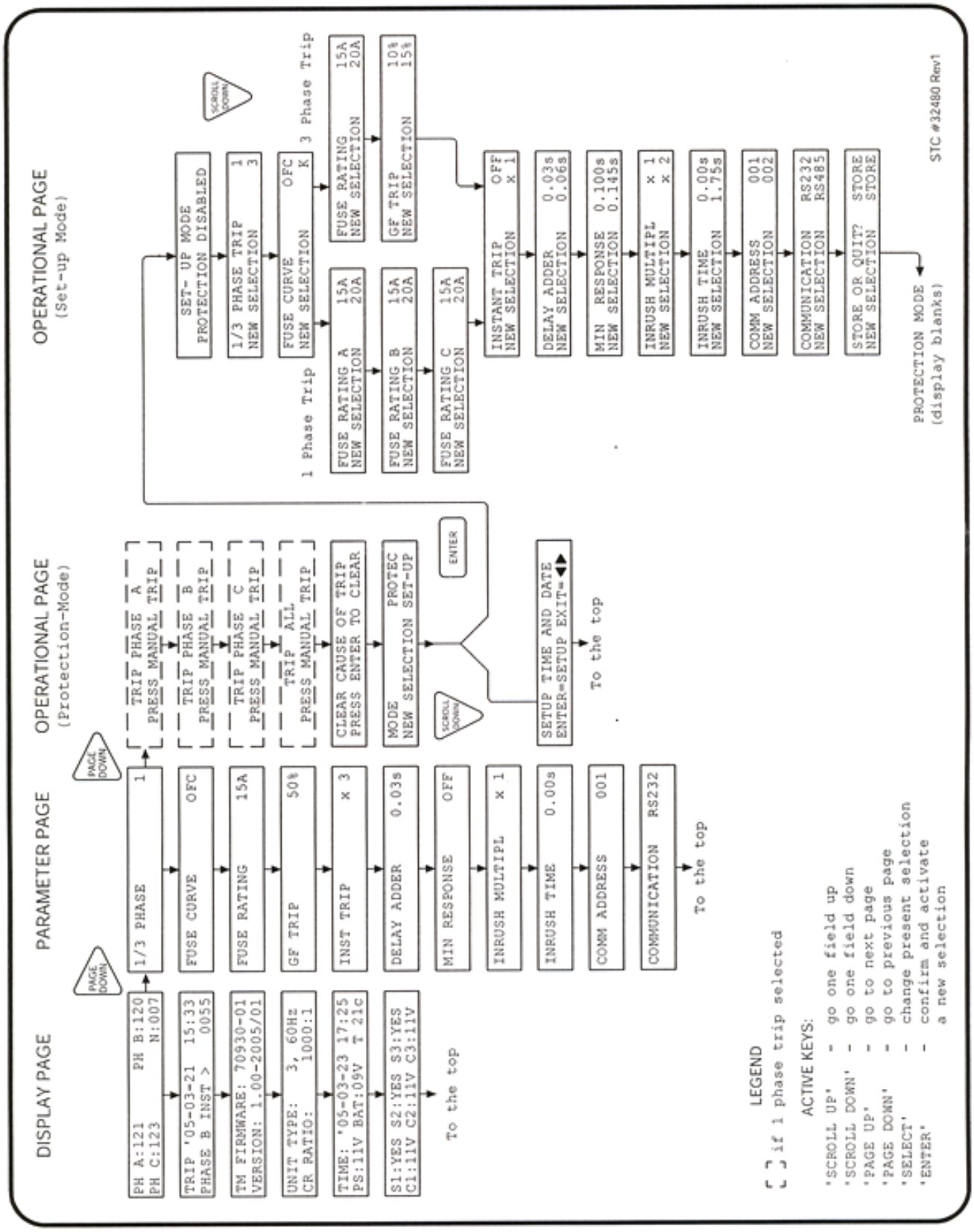
9. Minimum Response time

Index	Minimum Response Time
0	OFF
1	0.050 Seconds
2	0.100 Seconds
3	0.145 Seconds
4	0.205 Seconds
5	0.260 Seconds
6	0.335 Seconds
7	0.405 Seconds
8	0.495 Seconds
9	0.580 Seconds

A.6 Transformer ratio and option flags:
Most significant byte reads 0x00, low significant byte according to table A1.

Bit	Interpretation	
1	0 – CT ratio 500:1	Read only
2	0 – CT ratio 1000:1	Read only
3	1 – Block All Trips/ 0 – Enable All Trips	Read / Write
4	0 – Enable Block all trips	Read only
5	0 – CT Correction Old	Read only
6	0 – CT Correction New	Read only
7	Read ‘1’	Read only
8	0 – Block Ground Fault trip	Read only

Table A1


DISPLAY PAGE
PARAMETER PAGE
OPERATIONAL PAGE
(Protection-Mode)
OPERATIONAL PAGE
(Set-up Mode)
PAGE DOWN
SCROLL DOWN
ENTER
PH A:121 PH B:120
PH C:123 N:007
TRIP '05-03-21 15:33
PHASE B INST > 0055
TM FIRMWARE: 70930-01
VERSION: 1.00-2005/01
UNIT TYPE: 3, 60Hz
CR RATIO: 1000:1
TIME: '05-03-23 17:25
PS:11V BAT:09V T 21c
S1:YES S2:YES S3:YES
C1:11V C2:11V C3:11V
To the top
1/3 PHASE 1
FUSE CURVE OFC
FUSE RATING 15A
GF TRIP 50%
INST TRIP x 3
DELAY ADDER 0.03s
MIN RESPONSE OFF
INRUSH MULTIPL x 1
INRUSH TIME 0.00s
COMM ADDRESS 001
COMMUNICATION RS232
To the top
TRIP PHASE A
PRESS MANUAL TRIP
TRIP PHASE B
PRESS MANUAL TRIP
TRIP PHASE C
PRESS MANUAL TRIP
TRIP ALL
PRESS MANUAL TRIP
CLEAR CAUSE OF TRIP
PRESS ENTER TO CLEAR
MODE PROTEC
NEW SELECTION SET-UP
SETUP TIME AND DATE
ENTER=SETUP EXIT=◄►
To the top
SET- UP MODE
PROTECTION DISABLED
1/3 PHASE TRIP 1
NEW SELECTION 3
FUSE CURVE OFC
NEW SELECTION K
1 Phase Trip
3 Phase Trip
FUSE RATING A 15A
NEW SELECTION 20A
FUSE RATING B 15A
NEW SELECTION 20A
FUSE RATING C 15A
NEW SELECTION 20A
FUSE RATING 15A
NEW SELECTION 20A
GF TRIP 10%
NEW SELECTION 15%
INSTANT TRIP OFF
NEW SELECTION x 1
DELAY ADDER 0.03s
NEW SELECTION 0.06s
MIN RESPONSE 0.100s
NEW SELECTION 0.145s
INRUSH MULTIPL x 1
NEW SELECTION x 2
INRUSH TIME 0.00s
NEW SELECTION 1.75s
COMM ADDRESS 001
NEW SELECTION 002
COMMUNICATION RS232
NEW SELECTION RS485
STORE OR QUIT? STORE
NEW SELECTION STORE
PROTECTION MODE
(display blanks)
STC #32480 Rev1
LEGEND
if 1 phase trip selected
ACTIVE KEYS:
'SCROLL UP' - go one field up
'SCROLL DOWN' - go one field down
'PAGE UP' - go to next page
'PAGE DOWN' - go to previous page
'SELECT' - change present selection
'ENTER' - confirm and activate a new selection