GE

Entellisys™ Low-Voltage Switchgear

System Test Kit

User Manual

DEH-433

Warnings, Cautions, and Notes as used in this publication

Warnings

WARNING! Warning notices are used in this publication to emphasize that hazardous voltages, currents, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

Warning notices are also used for situations in which inattention or lack of equipment knowledge could cause either personal injury or damage to equipment.

Cautions

CAUTION: Caution notices are used for situations in which equipment might be damaged if care is not taken.

Notes

NOTE: Notes call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to ensure accuracy, the information contained herein does not cover all details or variations in hardware and software, nor does it provide for every possible contingency in connection with installation, operation, and maintenance. Features may be described in here that are not present in all hardware and software systems. GE Consumer & Industrial assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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Second Revision

How to contact us

Please have your Entellisys System Summary # and Sub # ready when calling. This information can be found on the Entellisys HMI on the **System Health** screen by clicking the **Job Info** button.

Post Sales Service
GE Switchgear
510 Agency Road
West Burlington, IA 52655

Phone (toll free): 1-888-437-3765

Additional information:
www.entellisys.com/support

Contents

System Test Kit

1.1 Introduction

The Entellisys™ System Test Kit is a portable test instrument designed for field testing of the Entellisys Low Voltage Switchgear System.

The test kit includes the following features:

- Compatible with all Entellisys versions
- Simulates power line characteristics for a single circuit breaker in the Entellisys Low Voltage System
- Verifies the function/operation of the protection system
  - Overcurrent Protection Tests – Long Time, Short Time, Instantaneous and Ground Fault Protection Tests
  - Single Point Relay Protection Tests (Overvoltage, Undervoltage, Over Frequency, Under Frequency, Power Reversal and Phase Loss, High Current Test)
- Verifies the calibration of the trip time current curve
- Verifies the operation of the circuit breaker actuation in “Trip mode”
- Performs tests without trips in “No Trip mode”
- Ground Fault Defeat function provides temporarily suspension of all Ground Fault protection in the system
- Automatically retrieves system configuration for increased productivity
- Displays a summary of all protection configuration
- Saves test results to be reviewed later
- Windows Interface for ease of use
- Operation from 120 Vac

The test kit Interface with the system is through the EntelliGuard™ Messenger protection unit. The interface consists of 7 analog and several digital channels representing actual power line characteristics. The signals are injected directly into the Messenger A/D converters. This tests the entire Entellisys System, excluding the CTs, the CT interface (burden resistors) inside the Messenger, and the PTs.

Figure 1-1 System Test Kit photograph

CAUTION: Tests conducted with the System Test Kit must be performed with the circuit breaker de-energized and racked-out to the test position. The test inputs will supersede the normal current and voltage inputs which disables normal protection, preventing response to fault conditions.

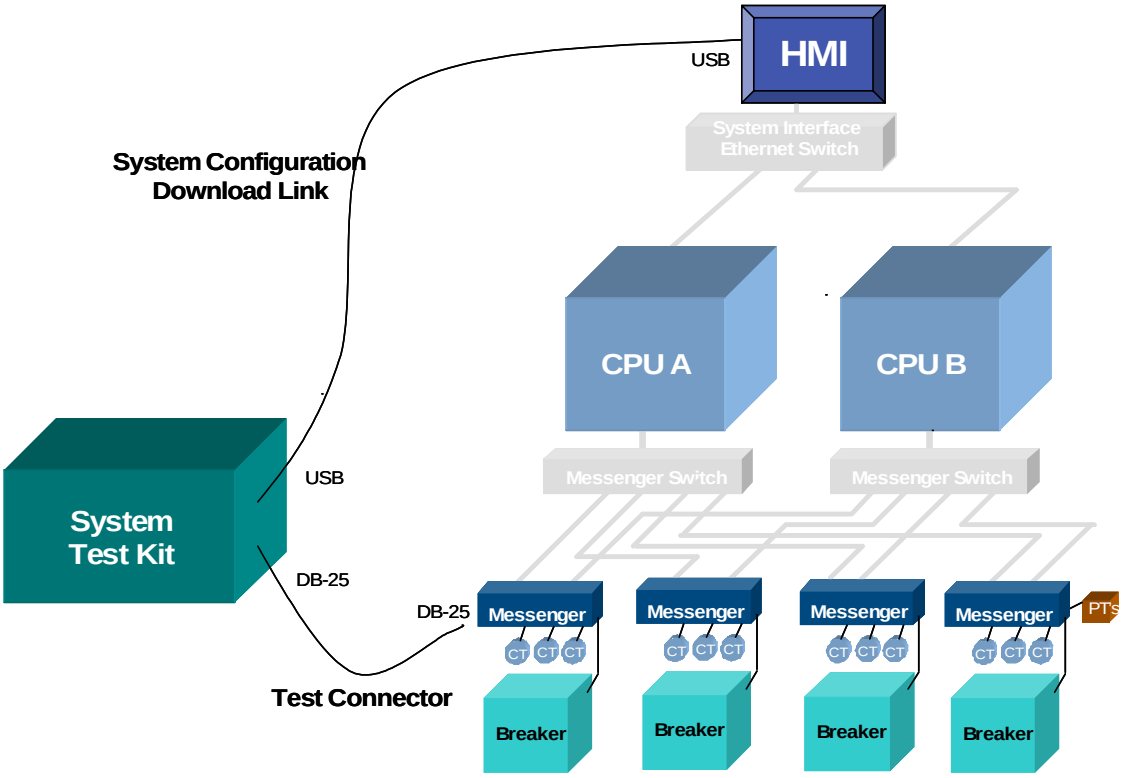
Figure 1-2 HMI screen showing circuit breaker in Test Mode

The HMI will indicate that the unit is in Test Mode. It will also display the output analog waveforms in response trip test.

1.2 Test overview/architecture

The System Test Kit uses the method of low voltage injection to perform its tests. The test kit drives these low level voltages (10V p-p) into individual test inputs of the Messenger's A/D converter. Basic protection scheme, Functional protection, and Single Point Relay protection of the entire system can be tested using low voltage injection from the System Test Kit.

Figure 1-3 Entellisys system architecture with System Test Kit



1.3 Test kit hardware/specs

All the digital signals given from the test kit and accepted from the test kit are active low TTL signals.

Table 1-1 Actual System Test Kit output accuracy

Sl.No	Parameter	Accuracy
1.	Voltage	±0.1%
2.	Frequency	±0.05 Hz
3.	Phase angle	±0.1
4.	Time Stamping	±0.5 ms

Required accuracy for protection testing is based on the accuracy of Entellisys System Accuracy.

Table 1-2 System accuracy with the test kit

Sl.No	Protection	Accuracy
1.	Current Protection 1X	±6.5%
2.	Relay Protection	±6.5%
3.	Ground Fault 0.2X	±2%

1.3.1 Test Unit PC

System Test Kit PC is a rugged Portable PC unit with multiple PCI slots. It uses two data acquisition cards to generate required test signals for injecting for testing protection elements in the Entellisys Low Voltage Switchgear system.

The test kit is entirely kiosked and runs on the Windows 2000 operating system.

1.3.2 Test kit power cord

The test kit power cord is designed with integrated surge protection equipment to protect the system from normal power anomalies.

Once the surge protector is triggered, it will be grounded (which can be detected by the surge protector; the LED will be ON). Once this occurs, the power cord will need to be replaced.

NOTE: The power cord must be replaced with the same cord to ensure proper operation.

Replacement Power Cord: GE CAT# ETSTESTKITCBLSRG

1.3.3 Test connector (System Test Kit to EntelliGuard Messenger cable)

The test connector is a 25-pin DB Type connector used for injecting signals to/from the Test Kit to the Messenger.

- Seven channels are analog outputs that represent three-phase voltages and currents plus a neutral. These –10V to +10V sinusoidal analog outputs are injected directly into a Messenger's A/D converter via the Messenger front panel. The test kit changes the waveform characteristics of these sinusoids to test the different protection schemes.

NOTE: If the cable is lost or broken, it must be replaced with the same cable to ensure proper operation.

Replacement “Test Connector” Cable: GE CAT# ETSTESTKITCBLMSR

1.3.4 USB-to-USB cable

The test kit communicates with the Entellisys Low Voltage HMI to download system configuration, preventing the operator from entering it manually.

A USB-to-USB cable, running a peer-to-peer network communication bridge, is used between the test kit and the HMI for communication. The USB-to-USB bridge arrives pre-configured in both the HMI and the test kit. See HMI setup on page 53 for configuration details.

To enable this communication, from the **Test Kit Administration** menu, enter the HMI IP address in the **HMI Setup** window.

NOTE: Special USB drivers for the cable supplied are preinstalled on the HMI. If the cable is lost or broken, it must be replaced with the same model.

Replacement USB to USB Cable: GE CAT# ETSTESTKITCBLUSB

1.4 Getting started

1.4.1 Start up

Start the test kit by pushing the **Power On** button on the right-side panel.

After the test kit boots, the following startup screen will be displayed:

Figure 1-4 Start Up screen

The System Test Kit is kiosked to prevent users from exiting the program and editing the system files and operating system. This provides added security to protect the system setup.

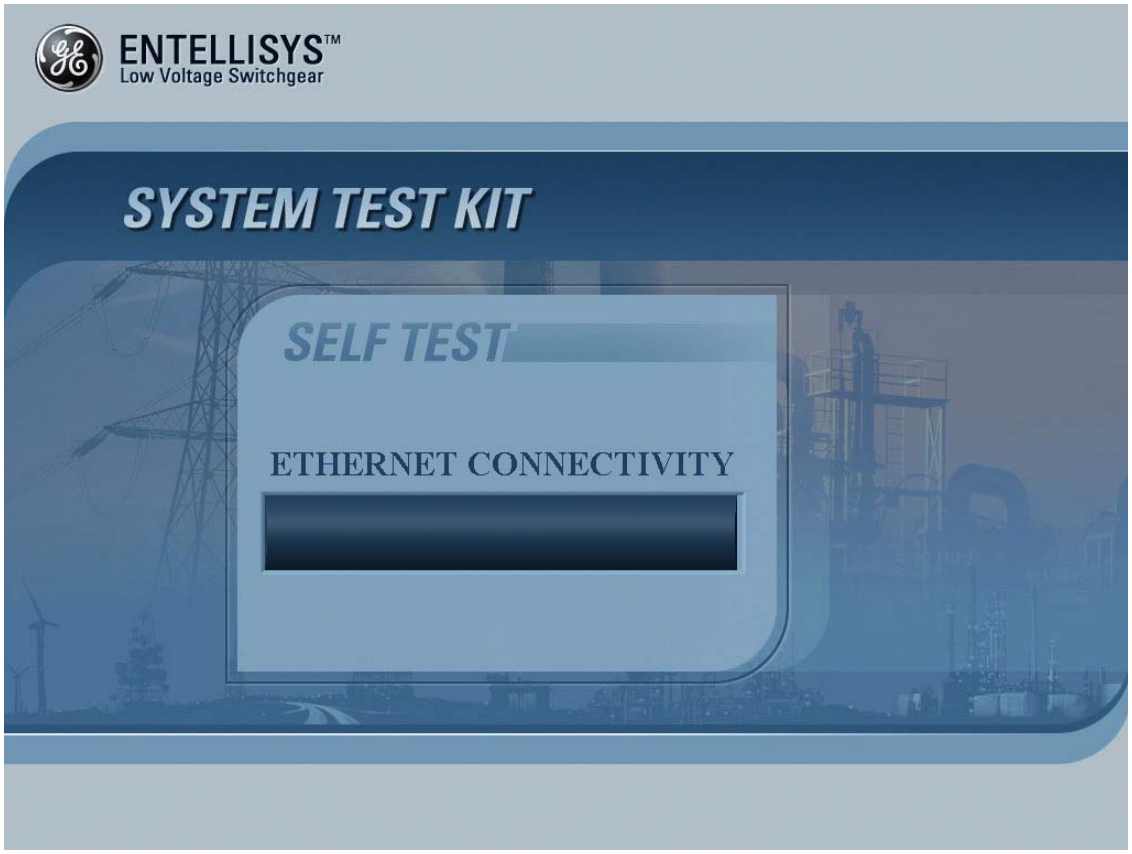
Press any key to continue.

1.4.2 Self Test

Each time the test kit is powered on, a Self Test is performed to verify the major components are functioning properly. The following tests are performed:

- Memory test – checks the physical memory in the system. At least 20 MB of free memory must be available after loading the application to ensure the system runs properly.
- Hardware configuration – checks the data acquisition card status. Two cards must be installed properly and have the proper device number.
- Test kit setup – checks the setup files and verifies the software and hardware version of the test kit.
- Ethernet connectivity – checks the Ethernet connectivity of the system to ensure the System Configuration Download Link (USB-to-USB Network Bridge) is working properly.

Figure 1-5 Self-Test screen

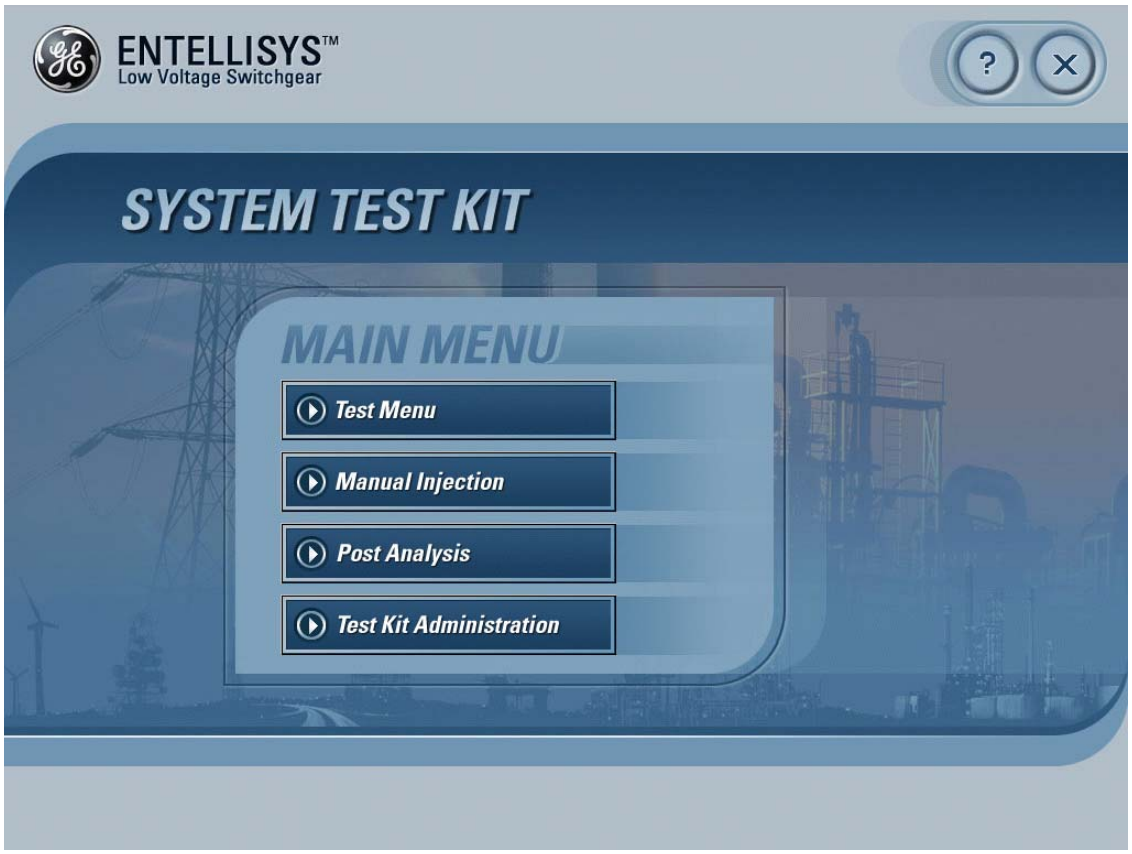


The test kit will display the test being performed on the screen. If any errors are encountered, the test kit will generate pop-up messages for the user regarding the type of error. Any issues must be corrected and the unit restarted before continuing. See Troubleshooting on page 60 for help diagnosing issues.

When the Self Test completes successfully, the Main Menu will be displayed.

1.4.3 Main Menu

Figure 1-6 Main Menu screen



On the Main Menu, the following choices are provided:

Test Menu

This option lets the user download the settings either from the HMI or from the previously downloaded settings.

Manual Injection

The Manual Injection screen can be used to inject the signals by manually setting the test kit. The Manual Injection screen will pop out to accept the settings for the test kit.

Post Analysis

Provides access to the test kit log files for off-line analysis of the test results.

Test Kit Administration

This option allows the user to perform various tasks regarding the test kit setup.

1.4.4 General navigation

X Quit

Quit allows the user to quit from the application and shut down the system.

? Help

Clicking Help provides the user with help on the selected screen.

Tips

Moving the mouse cursor over the control provides tips for that control.

Short Cut Keys

Short cut keys are provided for the following controls:

F1	Pressing F1 will display help
F4	Main Menu
Ctrl F4	Back
F10	Quit the application

1.5 Download switchgear configuration

The test kit requires information about the switchgear lineup under test. For example:

- Circuit breakers by name, for ease of identification
- For each circuit breaker:
  - Circuit breaker frame size, CT rating, and PT rating
  - Rating switch setting
  - Protection options enabled
  - Protection elements Pickup and Delay Band Settings

This data provides the operator valid selections when selecting tests, and provides the proper output levels for the “Pre-Defined” Tests.

Once downloaded, this step can be avoided by using the “Last Download” information—so long as no configuration or settings have changed.

In Entellisys 4.0 systems, care must be taken since their IOC, ST and LT relay settings may change if the current topology changes.

NOTE: To ensure the test kit has the correct configuration, download the configuration rather than using the “Last Download”.

1.5.1 Direct Connect Download from HMI

Select this option to download the System Configuration from the HMI.

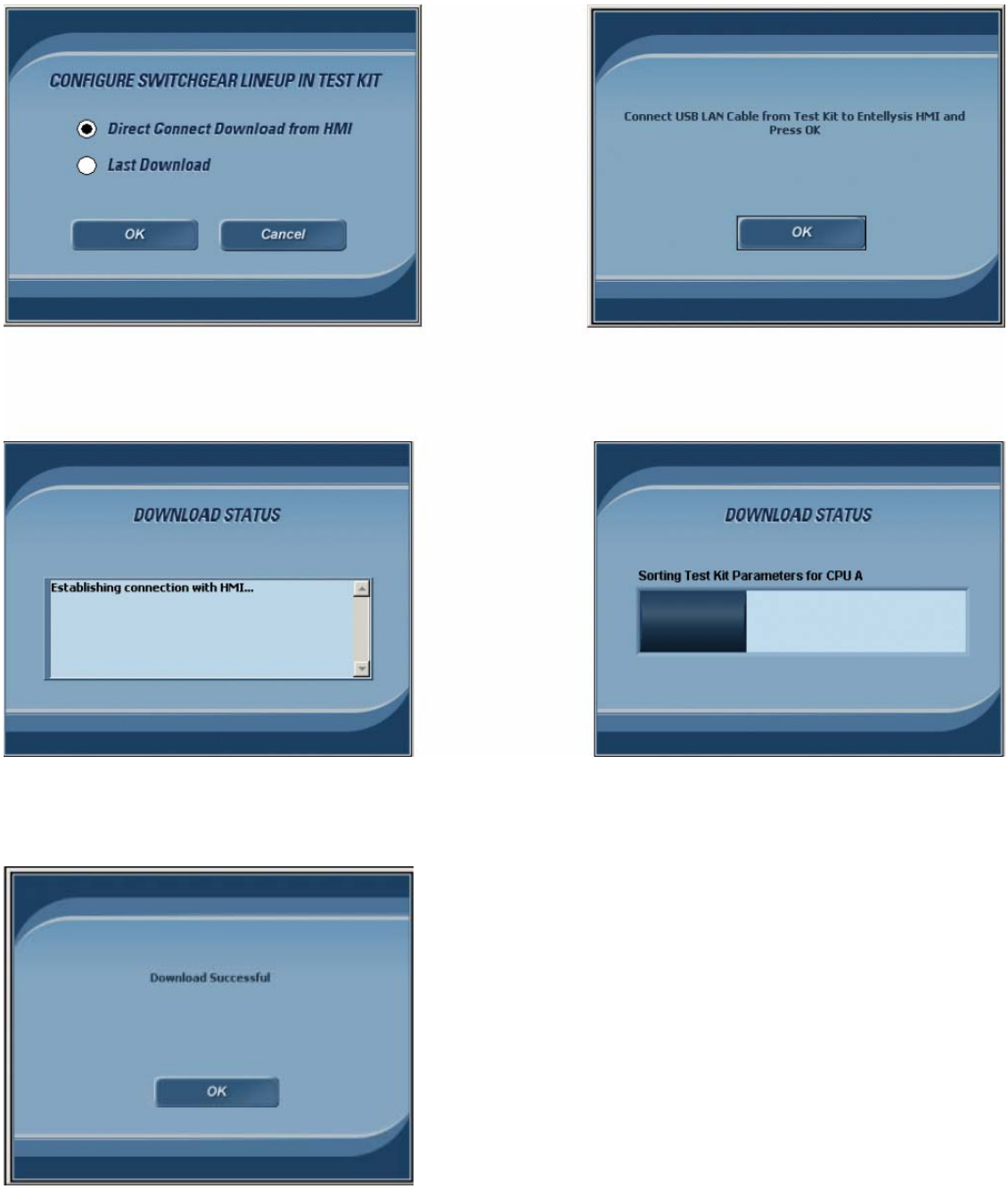
Before proceeding, connect the USB-to-USB cable between the HMI and the test kit. Figure 1-7 shows the USB port on the test kit. Note the white cable. Figure 1-8 shows the USB port on the HMI. Once the cable is connected, click **OK** to continue.

Figure 1-7 USB port on test kit

Figure 1-8 USB port on HMI

Figure 1-9 shows the screens that will be encountered during the Direct Connect Download from HMI.

Figure 1-9 Switchgear configuration download process



Download errors will be displayed for the following reasons:

- Settings are not available
- Communications are not established
- Communication is lost

1.5.1.1 System Configuration Download Link communication

The test kit communicates with the HMI over the System Configuration Download Link. This link is a USB-to-USB Network Bridge-Ethernet connection. The IP addresses are programmed by default into the test kit and the HMI and should not be changed. Download failure will result if these IP addresses are mismatched.

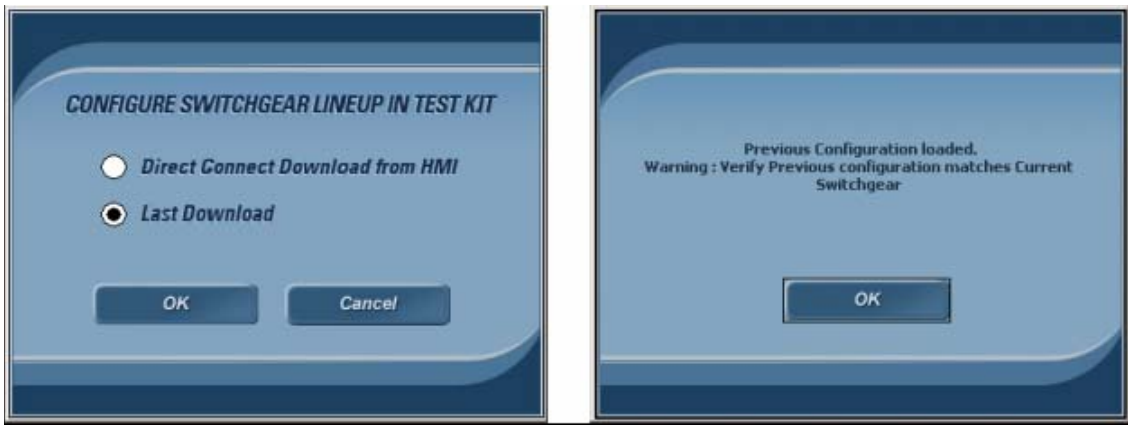
- Default HMI USB-to-USB Network Bridge IP address is 192.168.2.50.
- Default test kit USB-to-USB Network Bridge IP address is 192.168.2.25.

The HMI's IP address must be set in the test kit. To verify this is set properly, from the **HMI Setup** screen, go to the **Test Kit Administration**.

1.5.2 Last Download

Select this option to download the previously downloaded switchgear lineup configuration.

Figure 1-10 Process to download previous settings



Care should be taken before deciding to use previously downloaded settings.

- Is this the same lineup that was downloaded previously?
- Has anything changed since the configuration was downloaded previously?

NOTE: Mismatch in configuration and/or settings will result in incorrect test results.

1.6 Test Menu

Once the switchgear configuration has been loaded, the Test Menu will display.

Figure 1-11 Test Menu

Below is a brief description of each of the tests:

Overcurrent Protection Test

Allows operator to perform Overcurrent Protection tests.

Relay Protection Test

Allows operators to perform Relay Protection tests.

Ground Fault Defeat

Allows operator to temporarily Defeat/Disable or Resume Ground Fault protection. This may be required for Primary or Secondary injection testing outside the test kit.

Summary Of Protection

Provides the protection enabled at each circuit breaker.

1.6.1 Overcurrent Protection Test

1.6.1.1 Functions

Tests various Overcurrent Protection functions. The functions must be optioned and enabled in the system to perform the respective tests.

Long Time (LT) Overcurrent Protection

Verifies the long time overcurrent protection function for a circuit breaker in the system. It can be performed as either a trip or no trip test. To test LT, the test kit injects a sum-of-squares current value for any phase above the LT pickup setting. The result of the test is a trip time with an accuracy of 10% of the expected trip time.

Short Time (ST) Overcurrent Protection

Verifies the short time overcurrent protection function for a circuit breaker in the system. The test can be performed as either a trip or no trip test. To test ST, the test kit injects a sum-of-squares current value for any phase above the ST pickup setting. The result of the test is a trip time with an accuracy of 10% of the expected trip time.

Instantaneous (IOC) Overcurrent Protection

Verifies the instantaneous overcurrent protection function for a circuit breaker in the system. The test can be performed as either a trip or no trip test. To test IOC, the test kit provides an input current that exceeds the programmed IOC threshold. The result of the test is a trip time with an accuracy of 10% of the expected trip time.

Ground Fault (GF) Protection

Verifies Ground Fault protection function for a circuit breaker in the system. The test can be performed as either a trip or no trip test.

In a three-wire system, the test kit will provide three phase currents with vector sum greater than the pickup threshold.

In a four-wire, WYE-system, the test kit will provide three phase currents and a neutral with vector sum greater than the pickup threshold.

In either case, the result is a trip time with an accuracy of 10% of the expected trip time.

High Resistance Systems

For Predefined and Automatic trip time curve tests Neutral phase will not be available in Entellisys 4.0

For user defined tests, neutral current entered will be scaled to ground CT 10 and accordingly test kit output is calculated

Neutral phase will be available in Entellisys 3.0 for all the tests.

1.6.1.2 Test methods

There are three test methods:

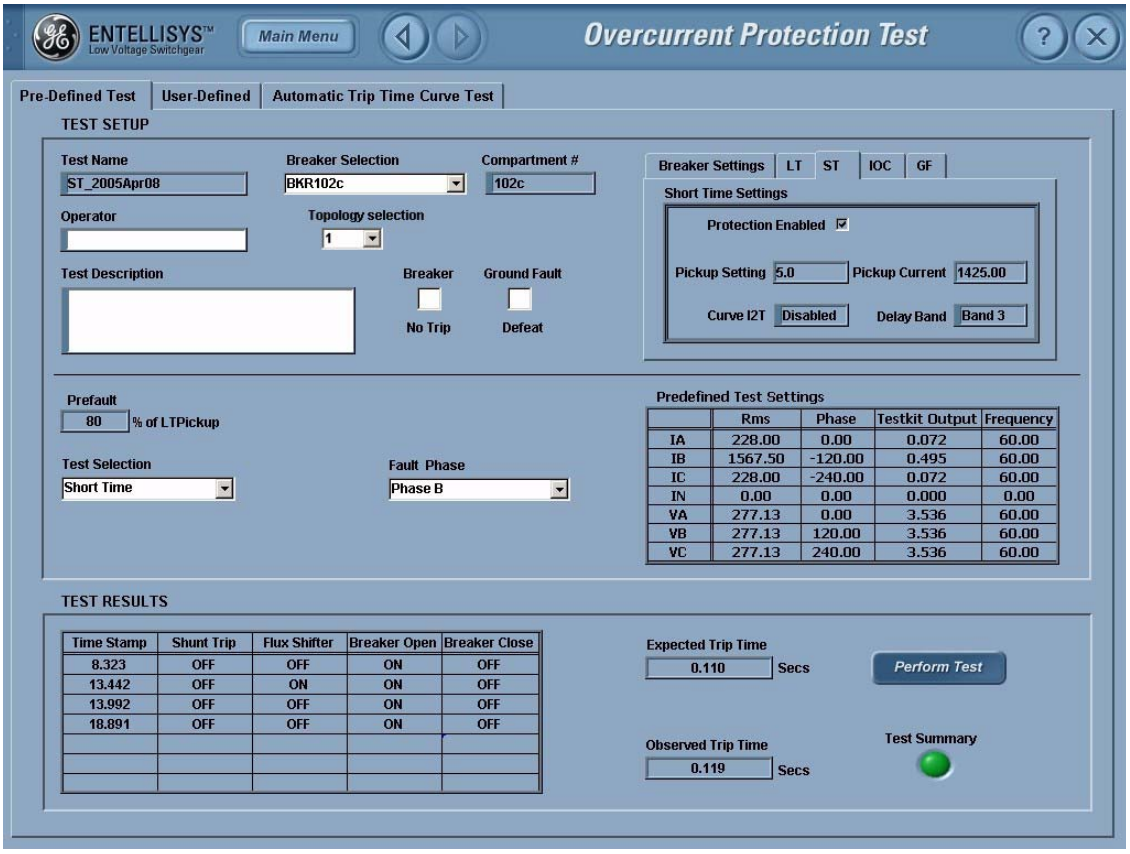
- Pre-Defined Test – Uses pre-defined fault levels for the test selected.
- User-Defined – Allows the operator to set fault levels for the test selected.
- Automatic Trip time Curve Test – Automatic Trip Time Curve will automatically compute the expected trip time curve for the circuit breaker under test depending on Protection elements enabled, Rating Switch, and CT rating of the circuit breaker connected. This will then automatically inject low voltage levels at different test points and graph the curve with expected and observed tested points.

The test kit requires the actual circuit breaker settings to compute the required fault levels and expected trip time for the selected protection test. The circuit breaker settings are read by the test kit during the Switchgear Configuration Download process described in Download switchgear configuration on page 16.

1.6.1.3 Pre-Defined Overcurrent Protection Test

Tests the various Overcurrent Protection functions using pre-defined fault levels for ease of use.

Figure 1-12 Pre-Defined Over Current Protection Test



Quick Test Guide

1. Enter Operator Name and Test Description.
2. Select a Circuit Breaker.
3. Select Breaker Trip or No Trip Test.
4. Select Ground Fault Defeat (or not) depending on Fault Phase(s) desired.
5. Select the Test Selection to perform.
6. Select the Fault Phase.
7. Click “Perform Test”.

Test setup field description

Table 1-3 Test setup field description

Test Name	Unique test identifier, assigned by the test kit, generated by the type of test selected and the date the test is performed.
Operator	Operator name entered by the Test Operator. (20-character limitation)
Test Description	Test description entered by the operator, to be stored in the log file. (150-character limitation)
Breaker Selection	Circuit breaker to be tested, selected by the operator.
Compartment #	Displays the Compartment number of the circuit breaker selected.
Topology Selection	Will display only when connected to Entellisys 4.0 lineups. Defaults to the current operating topology. Single point relays in Entellisys 4.0 and higher operate on 0-15 topologies depending on the switchgear configuration. Each topology state may have different settings. For example, topology 0 is reserved for Reduced Energy Mode and topology 1 is normal operation. After every test, the current topology should be verified in the breaker status screen at the HMI as the system topology may change (due to change in state of a topology breaker) and hence the settings will not be valid and the test may fail.
Breaker Trip	Specifies whether the test will physically trip the circuit breaker. ☑ – Circuit breaker will Trip ☐ – Circuit breaker will not Trip
Ground Fault	Allows users to temporarily Defeat Ground Fault during the test, or to Resume/Run Ground Fault as normal during the test. Ground Fault must be defeated for single phase tests—otherwise a trip on Ground Fault will occur. ☑ – GF will Resume/Run as Normal. ☐ – GF will be temporarily defeated during the test period. Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled in the selected circuit breaker.
Breaker Setting Table/Tabs	Displays the actual settings for the circuit breaker selected. This is for information only.

Table 1-3 Test setup field description

Test Selection	Specifies the type of test to perform. Operator selectable. Only enabled protection functions for the selected circuit breaker are provided in drop-down.
Pre-Defined Settings	Displays the pre-defined fault levels to be injected for the test and circuit breaker selected. Levels for Prefault, Fault, and Post faults are described in Table 1-4. These values are determined with respect to the circuit breaker selected and its protection settings.
Fault Phase	The phase(s) for fault injection. Operator selectable. Options for LT, ST, IOC Test Selection is: Phase A, Phase B, Phase C, Phase A & B, Phase B & C, Phase C & A, Phase A, B & C Option for GF Test Selection: Phase A, Phase B, Phase C, and Neutral

Pre-defined values for Overcurrent Protection tests

Table 1-4 Pre-defined values for Overcurrent Protection tests

Type of Test	Prefault (for all Phases)	Fault (for selected Phases)	Post Fault (for all Phases)
Long Time	80.00% of LT Pickup	135.00% of LT Pickup	0% of LTPickup
Short Time	80.00% of ST Pickup	110.00% of ST Pickup	0% of LTPickup
Instantaneous	80.00% of IOC Pickup	110.00% of IOC pickup	0% of LTPickup
Ground Fault	40% of CT	110.00% of GF Pickup	0% of GF Pickup

Test results

Table 1-5 Test results

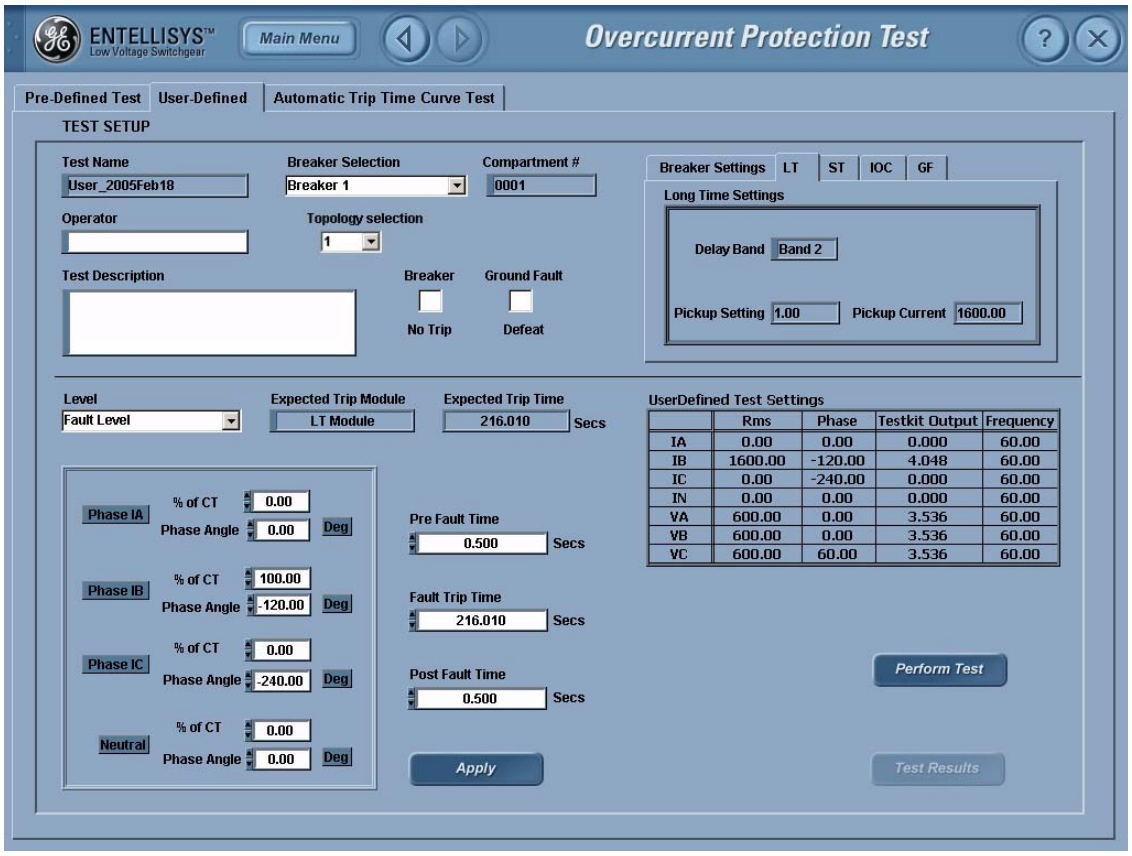
Time Stamp Table	Provides a time stamp history of the Breaker Status (Open or Closed) and the Breaker Actuation device involved in the trip (Flux Shifter or Shunt Trip).
Expected Trip Time	Expected trip time automatically calculated from the pickup & delay band settings and circuit breaker clearing time.
Observed Trip Time	Observed trip time displayed after the test is performed.
Test Summary LED	Specifies the test results by comparing the observed trip time with the expected trip time. Green Successful (within +/– 20% of expected time) Red Unsuccessful Gray Test Aborted

Test settings and results are saved to the hard drive with the report name as *Test Name_Time*.

1.6.1.4 User-Defined Overcurrent Protection test

Provides operators with a more advanced method for Overcurrent Protection testing. Operators set the Pre-Fault, Fault, and Post-Fault levels for the circuit breaker under test.

Figure 1-13 User-Defined Overcurrent Protection test



Quick Test Guide

1. Enter Operator Name and Test Description.
2. Select a Breaker.
3. Select Breaker Trip or No Trip Test.
4. Select Ground Fault Defeat or Resume depending on Fault Phase(s) desired.
5. Set the required fault levels.
   a. Select Level (Pre-Fault, Fault, or Post-Fault).
   b. Set the % of CT & Phase Angle for Phase IA, IB, IC, and Neutral.
   c. Repeat for each Level.
6. Set the Pre-Fault, Fault, and Post-Fault times.
7. Click **Apply** to save the test parameters.
8. Click **Perform Test**.

Test setup field description

Table 1-6 Test setup field description

Test Name	Unique test identifier, assigned by the test kit, generated by the type of test selected and the date the test is performed.
Operator	Operator name entered by the Test Operator. (20-character limitation)
Test Description	Test description entered by the operator, to be stored in the log file. (150-character limitation)
Breaker Selection	Circuit Breaker to be tested, selected by the operator.
Compartment #	Compartment number of the circuit breaker selected.
Topology Selection	Will display only when connected to Entellisys 4.0 lineups. Defaults to the current operating topology. Single point relays in Entellisys 4.0 and higher operate on 0-15 topologies depending on the switchgear configuration. Each topology state may have different settings. For example, topology 0 is reserved for Reduced Energy Mode and topology 1 is normal operation. After every test, the current topology should be verified in the breaker status screen at the HMI as the system topology may change (due to change in state of a topology breaker) and hence the settings will not be valid and the test may fail.
Breaker Trip	Specifies whether or not the test will physically trip the circuit breaker. ☑ – Circuit Breaker will Trip ☐ – Circuit Breaker will not Trip
Ground Fault	Allows users to temporarily Defeat Ground Fault during the test, or to Resume/Run Ground Fault as normal during the test. Ground Fault must be defeated for single phase tests—otherwise a trip on Ground Fault will occur. ☑ – GF will Resume/Run as Normal. ☐ – GF will be temporarily defeated during the test period. Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled in the selected circuit breaker.
Breaker Setting Table/Tabs	Displays the actual settings for the circuit breaker selected. This is for information only.
Level	Allows the user to set the required levels for the corresponding test (Pre-Fault, Fault, and Post-Fault).
% of CT	Percentage of the CT Rating to be injected for a given input (IA, IB, IC, and optionally Neutral) Max values: Pre-Fault: 10% of CT Fault: 28x CT Post-Fault: 10% of CT

Table 1-6 Test setup field description

Phase Angle	Phase angle to be injected. (Range between –360° to +360°)
Expected Trip Module	Type of trip that should be observed, calculated from the operator-entered fault levels.
Expected Trip Time	Trip time that should be observed, calculated from the operator-entered fault levels.
Pre-Fault Time	The time duration Pre-Fault levels will be injected from test kit. Operator selectable.
Fault Time	The time Fault levels will be injected. Operator selectable.
Post-Fault Time	The time duration Post-Fault levels will be injected. Operator selectable.
User-Defined Test Settings	Displays the currents and voltages that will be injected, calculated from the operator's selections (for the Fault Level currently displayed).

Test results

Prior to a test the “Test Results” button will be grayed out.

After a test is performed, the “Test Results” button will display. Once pressed, the following is displayed:

Figure 1-14 Overcurrent Protection Test Results

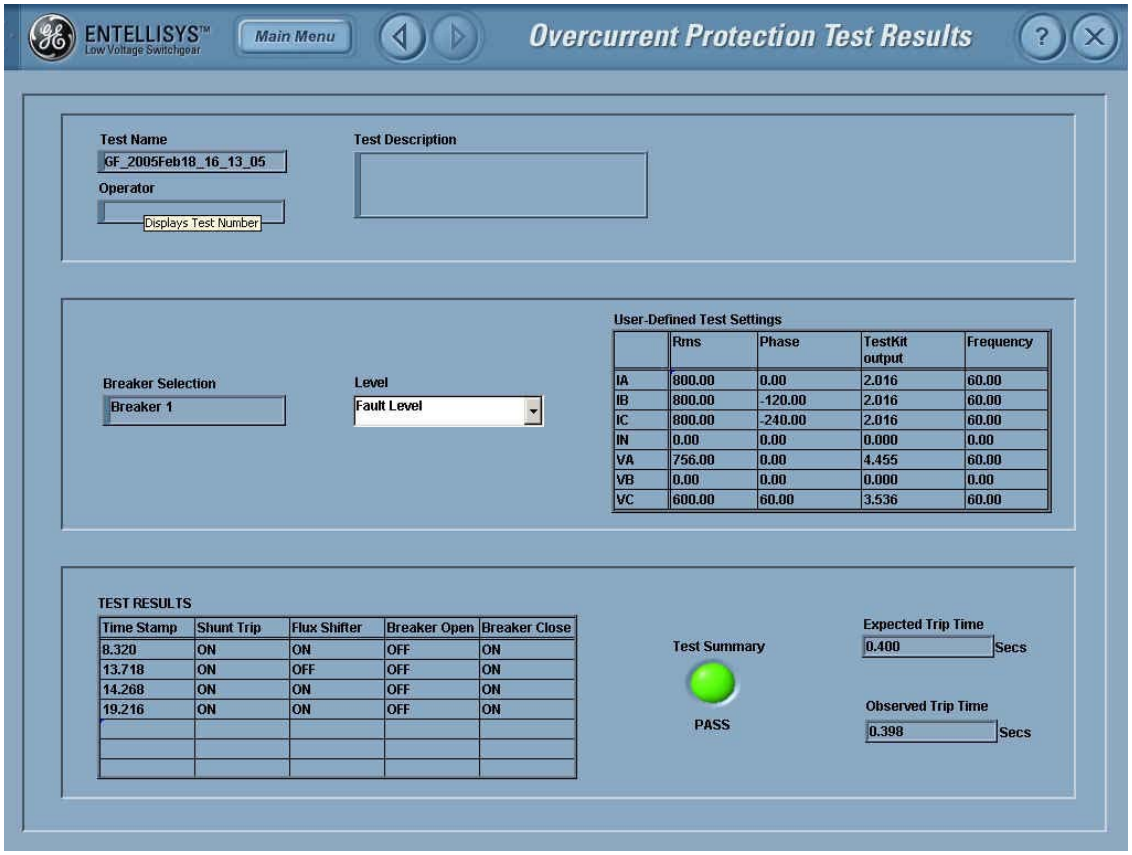


Table 1-7 Test results

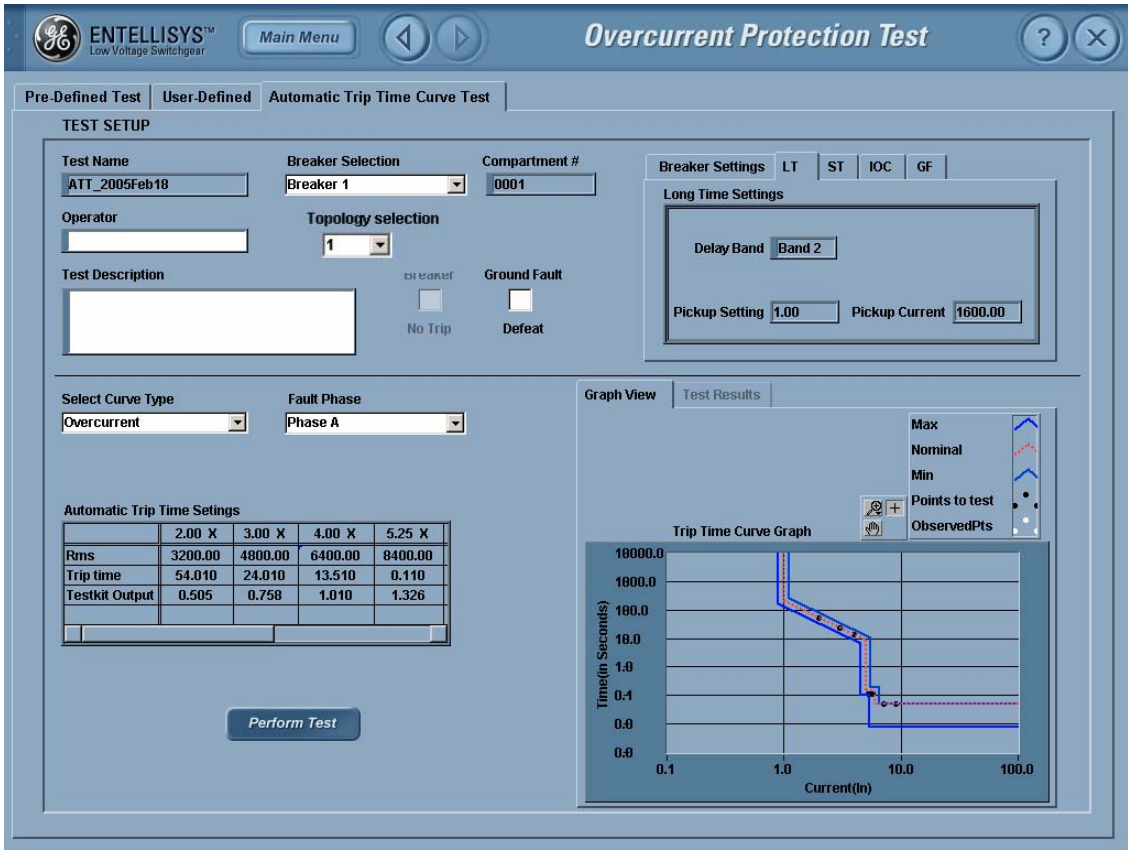
Level	User-Defined Test Settings are displayed separately for each Level (Pre-Fault, Fault, and Post-Fault). Use the pull-down menu to select the Level for the corresponding User-Defined Test Settings.
User-Defined Test Settings	Summarizes the test settings injected for the level shown.
Test Results	Once the test is performed, it displays the time sequence of circuit breaker status and the device that actuated the circuit breaker (Shunt Trip or Flux Shifter).
Expected Trip Time	Expected trip time automatically calculated from the pickup, delay band settings, and circuit breaker clearing time.
Observed Trip Time	Observed trip time displayed after the test is performed.
Test Summary LED	Specifies the test results by comparing the observed trip time with the expected trip time. Green Successful (within +/– 20% of expected time) Red Unsuccessful Gray Test Aborted

Test settings and results are saved to the hard drive with the report name as *Test Name_Time*.

1.6.1.5 Automatic Trip Time Curve Test

The automated trip curve test is a test that can automatically verify long time, short time, instantaneous, and ground fault functions based on the settings (ST, LT, IOC, frame size, etc.). The test kit will inject signals and measure the amount of time delay before the circuit breaker trips. It would then compare the timing to the circuit breaker trip-time curve to pass or fail each protection function. Trip time of the circuit breaker will determine the Pass or Fail for the protection test. It is a No Trip test that will not trip the circuit breaker.

Figure 1-15 Automatic trip time curve test



Quick Test Guide

1. Enter Operator Name and Test Description.
2. Select a Breaker.
3. Select Breaker Trip or No Trip Test.
4. Select Ground Fault Defeat or Resume depending on Fault Phase(s) desired.
5. Select the Curve Type.
6. Select the Fault Phase.
7. Click **Perform Test**.

Test setup field description

Table 1-8 Test setup field description

Test Name	Unique test identifier, assigned by the test kit, generated by the type of test selected and the date the test is performed.
Operator	Operator name entered by the Test Operator. (20-character limitation)
Test Description	Test description entered by the operator, to be stored in the log file. (150-character limitation)
Breaker Selection	Circuit Breaker to be tested, selected by the operator.
Compartment #	Compartment number of the circuit breaker selected.

Table 1-8 Test setup field description

Topology Selection	Will display only when connected to Entellisys 4.0 lineups. Defaults to the current operating topology. Single point relays in Entellisys 4.0 and higher operate on 0-15 topologies depending on the switchgear configuration. Each topology state may have different settings. For example, topology 0 is reserved for Reduced Energy Mode and topology 1 is normal operation. After every test, the current topology should be verified in the breaker status screen at the HMI as the system topology may change (due to change in state of a topology breaker) and hence the settings will not be valid and the test may fail.
Breaker Trip	Specifies whether the test will physically trip the circuit breaker. ☑ – Circuit Breaker will Trip ☐ – Circuit Breaker will not Trip
Ground Fault	Allows users to temporarily Defeat Ground Fault during the test, or to Resume/Run Ground Fault as normal during the test. Ground Fault must be defeated for single phase tests—otherwise a trip on Ground Fault will occur. ☑ – GF will Resume/Run as Normal. ☐ – GF will be temporarily defeated during the test period. Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled in the selected circuit breaker.
Breaker Setting Table/Tabs	Displays the actual settings for the circuit breaker selected. This is for information only.
Select Curve Type	Select one of two types of curves to generate—either “Overcurrent Trip Time Curve” or “Ground Fault Trip Time Curve”. Operator selectable.
Fault Phase	The phase(s) for fault injection. Operator selectable. Options for LT, ST, IOC Test Selection: Phase A, Phase B, Phase C, Phase A & B, Phase B & C, Phase C & A, Phase A, B & C Option for GF Test Selection: Phase A, Phase B, Phase C, and Neutral
Automatic Trip Time Settings	This table displays the amount of test kit voltages that will be injected with respect to the calculated trip time curve.

How trip time curve generated

For Overcurrent Protection test, three LT Points, three ST points, and two IOC Points are tested for generating the Automatic Trip time curve. Overcurrent test points are considered as multiples of LT pickup.

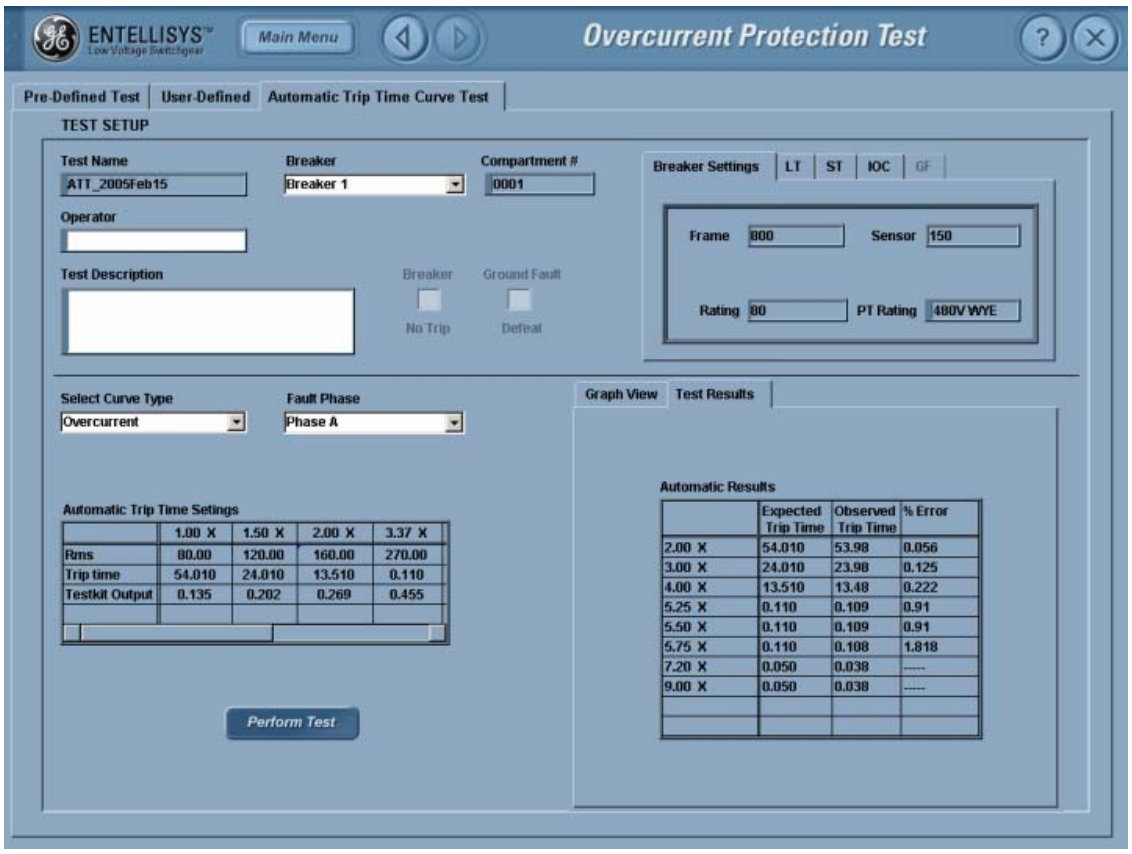
For Ground Fault Protection test, four points are tested when GFI2T curve is enabled and two points when disabled. Ground Fault test points are considered in multiples of GF pickup.

The setup required for Overcurrent Protection tests is based on Protection bits enabled.

Test Results

The Test Results tab will be enabled when all the test points are tested. The test kit will display the Expected, Observed, and the % error in the table.

Figure 1-16 Automatic Trip Time Test results



1.6.2 Relay Protection Test

The Relay Protection Test screen allows the user to perform various tests for Relay protection functionality based on the options enabled in the system. Possible tests are as follows:

- Over Frequency Test
- Under Frequency Test
- Overvoltage Test
- Undervoltage Test
- Phase Loss
- Power Reversal
- High Current Alarm

Over Frequency

Sets the frequency above the set point for the specified time delay.

Under Frequency

Sets the frequency below the set point for the specified time delay.

Overvoltage

Injects a phase voltage greater than the set point for the specified time delay. There are three options:

- One phase is above the pickup threshold
- Two phases are above the pickup threshold
- Three phases are above the pickup threshold

Undervoltage

Injects a phase voltage less than the set point for the specified time delay. There are three options:

- One phase is below the pickup threshold
- Two phases are below the pickup threshold
- Three phases are below the pickup threshold

Phase Loss

Injects a negative-phase-sequence voltage greater or less than the nominal 1X value of the system voltage.

Power Reversal

Injects waveforms that have the direction of the power reversed and the magnitude of the power greater than the set point for the specified time delay.

High Current Alarm

Injects waveforms that have currents greater than the programmed threshold for a time greater than the programmed delay to generate high current alarm.

NOTE: For the High Current Alarm test only, the test kit will not be able to provide any Test Results because the test kit does not receive any feedback from the Messenger. To verify the results, the operator must check for a High Current Alarm event in the Entellisys HMI, Sequence of Events screen.

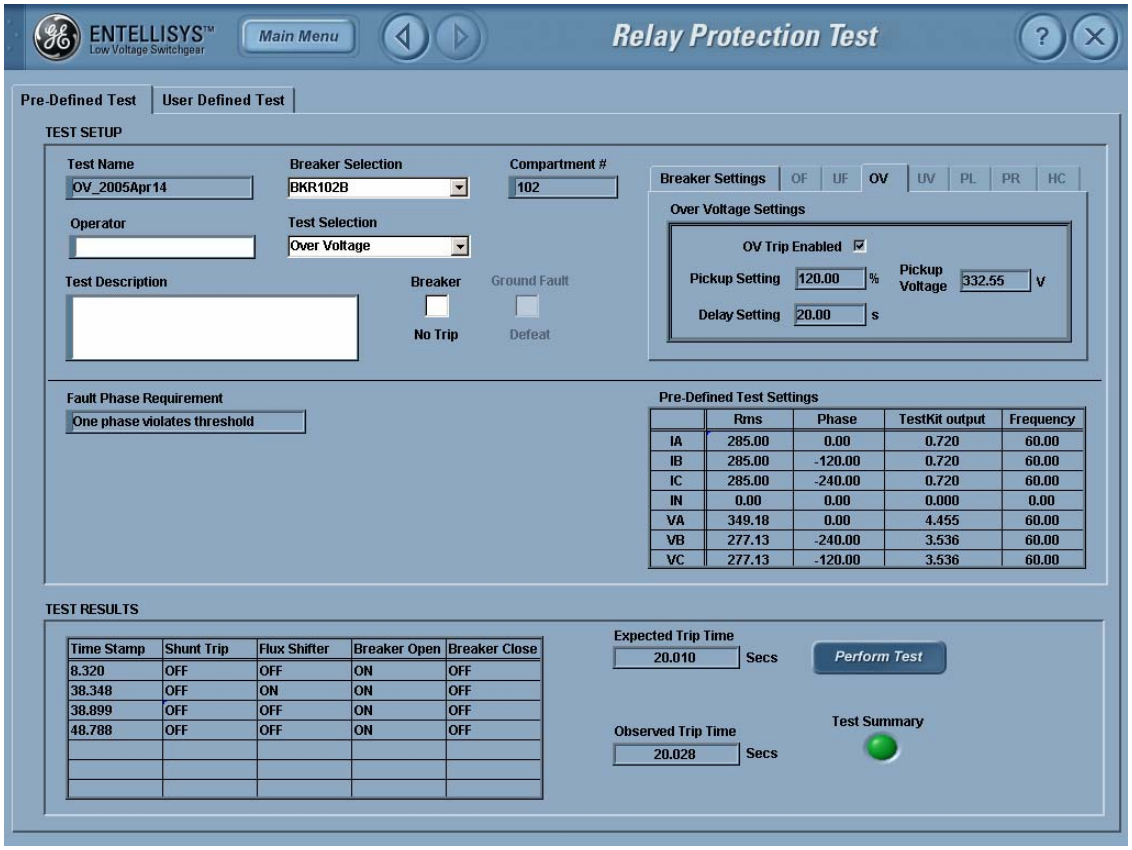
Two test methods are provided for Relay Protection:

- Pre-Defined Test – uses pre-defined fault levels for the test selected.
- User-Defined – allows the operator to set fault levels for the test selected.

1.6.2.1 Pre Defined Test

Tests the various Relay Protection functions using pre-defined fault levels for ease of use.

Figure 1-17 Pre-Defined Relay Protection Test



Quick Test Guide

1. Enter Operator Name and Test Description.
2. Select a Breaker.
3. Select Breaker Trip or No Trip Test.
4. Select Ground Fault Defeat or Resume depending on Fault Phase(s) desired.
5. Select the Test Selection to perform.
6. Select the Fault Phase.
7. Click **Perform Test**.

This screen has the following selections and controls available. A user can perform either trip or no trip single point protection relay function tests at the Messenger.

Table 1-9 Selections and controls

Test Name	Unique test identifier, assigned by the test kit, generated by the type of test selected and the date the test is performed.
Operator	Operator name can be entered here for the Reports. (20-character limitation)
Test Description	Operator enters test description to be stored in the log file. (150-character limitation)
Breaker Trip	Specifies whether the test will physically trip the circuit breaker. ☑ – Circuit Breaker will Trip ☐ – Circuit Breaker will not Trip
Ground Fault	Allows users to temporarily Defeat Ground Fault during the test, or to Resume/Run Ground Fault as normal during the test. Ground Fault must be defeated for single phase tests—otherwise a trip on Ground Fault will occur. ☑ – GF will Resume/Run as Normal. ☐ – GF will be temporarily defeated during the test period. Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled in the selected circuit breaker.
Compartment #	Switchgear compartment number of the circuit breaker selected for testing.
Breaker Selection	The circuit breaker to perform the test.
Test Selection	Test Selection will let the type of protection fault be generated.
Breaker Settings	Circuit Breaker settings will display the current settings of that selected circuit breaker.
Pre-defined Settings	This table displays the amount of test kit voltages that will be injected with respect to the present settings of the selected circuit breaker.
Fault Phase Requirement	Displays the present Fault Phase Requirement for the selected Relay protection: One phase is above the pickup threshold. Two phases are above the pickup threshold. Three phases are above the pickup threshold.
Breaker Settings	This will display the current circuit breaker settings on which the test will be performed.
Overvoltage Settings	This will display the current overvoltage settings of the system.
Undervoltage Settings	This will display the current undervoltage settings of the system.
Over Frequency Settings	Over Frequency settings will be displayed depending on the setting from CCPU.

Table 1-9 Selections and controls

Under Frequency Settings	Under Frequency settings will be displayed depending on the settings from CCPU.
Phase Loss settings	Phase Loss settings will be displayed depending on the settings from CCPU.
Power Reversal	Power Reversal settings will be displayed depending on the settings from CCPU.
High Current	High Current Settings will be displayed depending on the settings from CCPU.
Pre-Defined Settings	Depending on the current Messenger settings, Selected Level, Phase selected, Frequency or Multiplier value IA, IB, IC, IN, VA, VB, VC will be calculated and displayed on the screen.

Test results

Table 1-10 Test results

Time Stamp Table	Once the test is performed, it displays the time stamping of circuit breaker status and the device that actuated the circuit breaker (Flux Shifter or Breaker Open).
Expected Trip Time	Expected trip time automatically calculated from the pickup, delay band settings, and circuit breaker clearing time.
Observed Trip Time	Observed trip time displayed after the test is performed.
Test Summary LED	Specifies the test results by comparing the observed trip time with the expected trip time. Green Successful (within +/– 20% of expected time) Red Unsuccessful Gray Test Aborted

Table 1-11 Default values for pre-defined relay protection tests

Type of Test	Prefault	Fault	Post Fault
Over Frequency	System Frequency	Pickup *1.01	System Frequency
Under Frequency	System Frequency	Pickup * 0.99	System Frequency
Overvoltage	100% of PT	Pickup * 1.05	96% of PT
Undervoltage	100% of PT	Pickup * 0.95	100% of PT
Phase Loss	0%	Pickup + 1%	0%
Power Reversal	10 KW Positive Power	Pickup * 1.1 Reverse Power	10 KW Positive Power
High Current	Pickup * 0.5	Pickup * 1.1	Pickup * 0.5

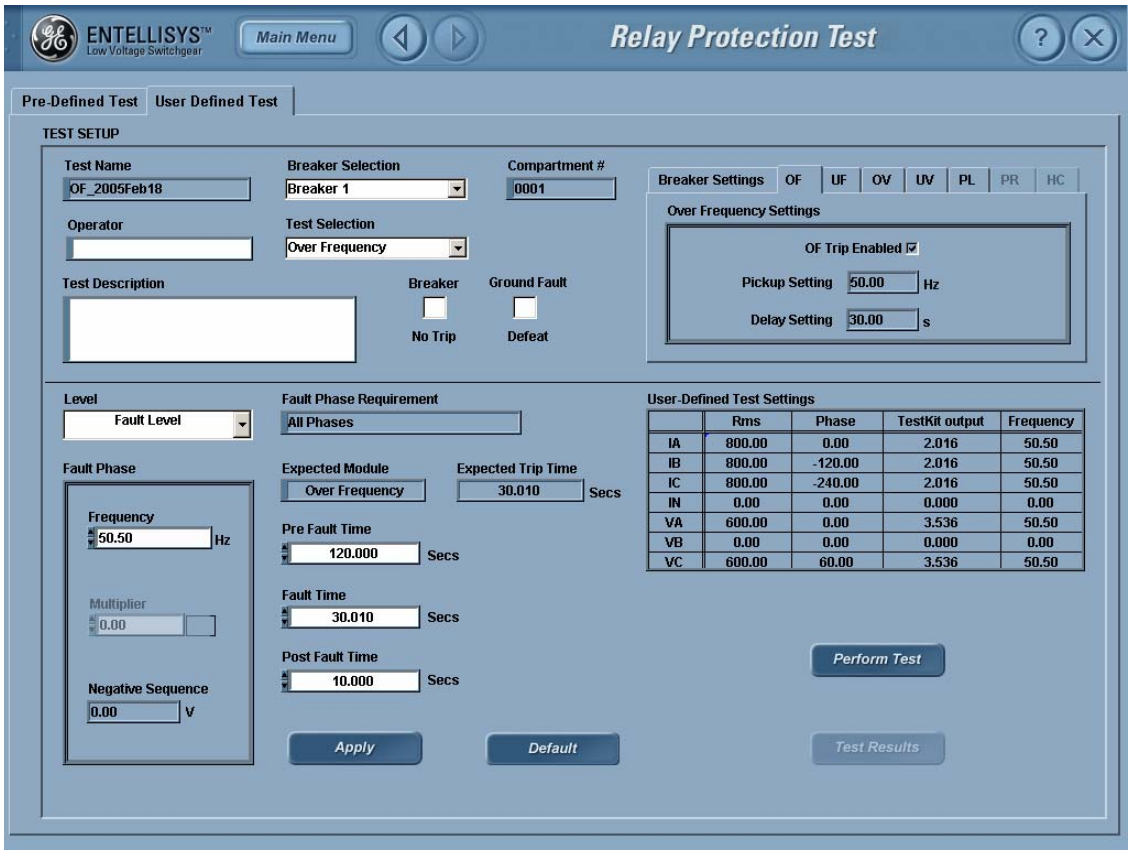
Table 1-12 Phase Selectors for pre-defined relay protection test

Type of Test	Phases Selected
Over Frequency	All Phases
Under Frequency	All Phases
Overvoltage	Depends on the Phase Requirement in HMI
Undervoltage	Depends on the Phase Requirement in HMI
Phase Loss	Phase VC
Power Reversal	Phase IA, IB, IC
High Current	All Phases

1.6.2.2 User Defined Test

This test method allows the operator to change the protection parameters and perform the test according to the user-intended settings.

Figure 1-18 User-defined Relay Protection Test



Quick Test Guide

1. Enter Operator Name, and Test Description.
2. Select a Breaker.
3. Select Breaker Trip or No Trip Test.
4. Select Ground Fault Defeat or Resume depending on the test desired.
5. Set the required fault levels:
   a. Select Level (Pre-Fault, Fault, or Post-Fault).
   b. Set the % Multiplier or KW or Frequency to change the Voltage or Phase or Frequency of Current signals (IA, IB, IC, & IN) or Voltage signals (VA, VB, VC) based on the selected protection test.
   c. Repeat for each level.
6. Set the Pre-Fault, Fault, and Post-Fault times.
7. Click **Apply** to save the test parameters.
8. Click **Perform Test**.

Setup

Table 1-13 Setup

Test Name	Unique test identifier, assigned by the test kit, generated by the type of test selected and the date the test is performed.
Operator	Operator name can be entered here for the reports. (20-character limitation)
Test Description	Operator enters test description to be stored in the log file. (150-character limitation)
Breaker Selection	Circuit Breaker selection on which the signals will be injected.
Compartment #	Compartment number of the system will be displayed depending on the circuit breaker selected for testing.
Breaker Trip	Specifies whether the test will physically trip the circuit breaker. ☑ – Circuit Breaker will Trip ☐ – Circuit Breaker will not Trip
Ground Fault	Allows users to temporarily Defeat Ground Fault during the test, or to Resume/Run Ground Fault as normal during the test. Ground Fault must be defeated for single phase tests—otherwise a trip on Ground Fault will occur. ☑ – GF will Resume/Run as Normal. ☐ – GF will be temporarily defeated during the test period. Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled in the selected circuit breaker.

Table 1-13 Setup

Breaker Settings	This will display the current circuit breaker settings on which the test will be performed.
Overvoltage Settings	This will display the current overvoltage settings of the system.
Undervoltage Settings	This will display the current undervoltage settings of the system.
Over Frequency Settings	Over Frequency settings will be displayed depending on the setting from CCPU.
Under Frequency Settings	Under frequency settings will be displayed depending on the settings from CCPU.
Phase Loss settings	Phase Loss settings will be displayed depending on the settings from CCPU.
Power Reversal	Power Reversal settings will be displayed depending on the settings from CCPU.
High Current	High Current Settings will be displayed depending on the settings from CCPU.
User-defined Settings	This table displays the amount of test kit voltages that will be injected with respect to the settings made by the operator.
Pre-Fault Time	This will be the time set for injecting the set pre-fault values.
Expected Trip Time	Trip time is calculated automatically from the pickup and the delay band settings. Entering Offset timing will prolong the output of the test kit for that duration.
Post-Fault Time	This will be the time set for injecting the set Post-Fault values.
Level	Level selection allows the user to set the required levels for the corresponding test. Based on the selected protection test. Currents IA, IB, IC, IN or Voltage signals VA, VB, VC along with phase angle can be modified using this selection.
Expected Trip module	Expected Trip module will display the type of trip that will happen when the fault levels for protection test are set.
Test Results	Test Results will display the current results after performing the test. This button will be grayed out if the test is aborted.
Apply	Apply will save the current settings to the selected Messenger.
Default	Default will set all the current settings for fault generation to default levels.

Table 1-14 Default values for user-defined relay protection tests

User-Defined	Frequency / Multiplier / KW Range		
	Prefault	**Fault**	**Post Fault**
Over Frequency	50 Hz – 60 Hz 0.1 Hz increment	50 Hz – 70 Hz 0.1 Hz increment	50 Hz – 60 Hz 0.1 Hz increment
Under Frequency	50 Hz – 60 Hz 0.1 Hz increment	44 Hz – 60 Hz 0.1 Hz increment	50 Hz – 60 Hz 0.1 Hz increment
Overvoltage	96% to 104% 0.5% increment	104% to 132% 0.5% increment	96% to 104% 0.5% increment
Undervoltage	96% to 104% 0.5% increment	47.5% to 95%* 8.5% to 95%** 0.5% increment	96% to 104% 0.5% increment
Phase Loss	0% to 7% 1% increment	7% to 51% 1% increment	0% to 7% 1% increment
Power Reversal	0 to 100 KW 10 KW increment	0 to 1000 KW 10 KW increment	0 to 100 KW 10 KW increment
High Current	0% to 100% 5% increment	45% to 205% 5% increment	0% to 100% 5% increment

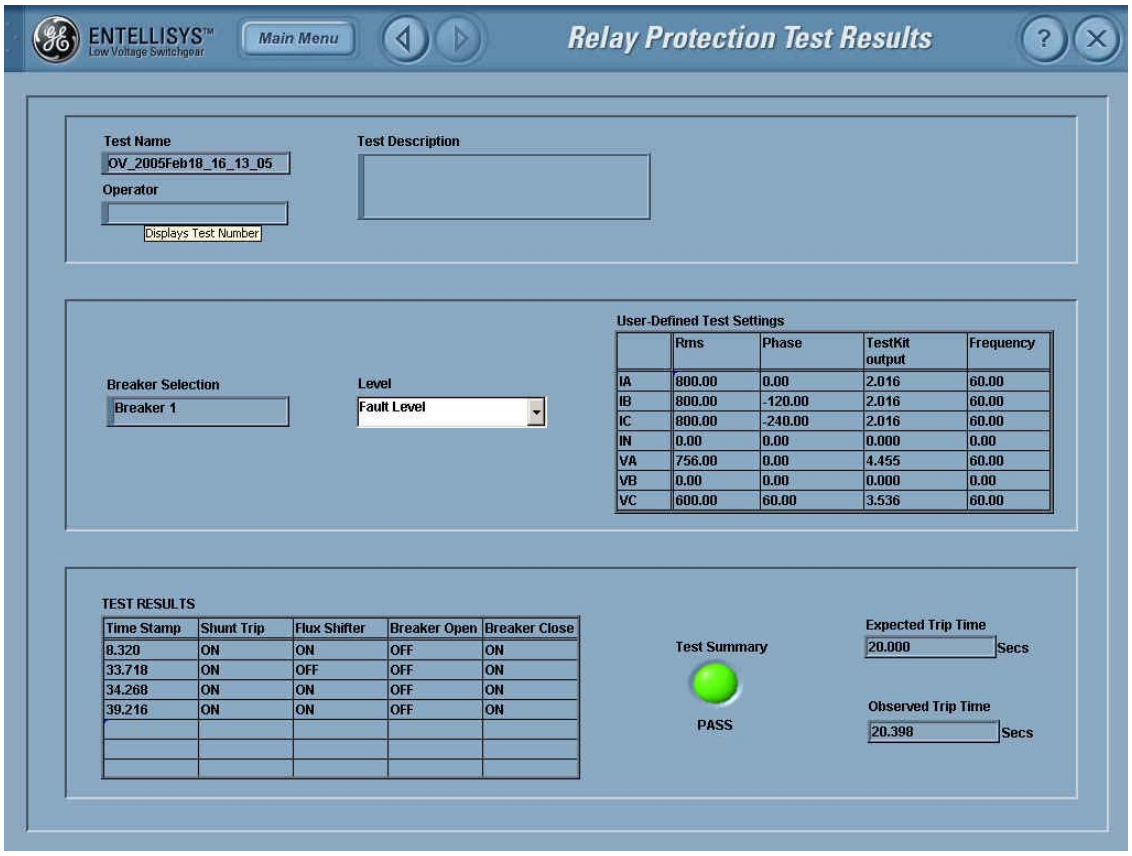
* Entellisys Version 3.0 systems

** Entellisys Version 4.0 systems

1.6.2.3 Relay Protection Test Results screen

The Relay Protection Test Results screen will display the results for the tests performed using the user-defined tests.

Figure 1-19 Relay protection test results screen



	Rms	Phase	TestKit output	Frequency
IA	800.00	0.00	2.016	60.00
IB	800.00	-120.00	2.016	60.00
IC	800.00	-240.00	2.016	60.00
IN	0.00	0.00	0.000	0.00
VA	756.00	0.00	4.455	60.00
VB	0.00	0.00	0.000	0.00
VC	600.00	60.00	3.536	60.00

Time Stamp	Shunt Trip	Flux Shifter	Breaker Open	Breaker Close
8.320	ON	ON	OFF	ON
33.718	ON	OFF	OFF	ON
34.268	ON	ON	OFF	ON
39.216	ON	ON	OFF	ON

Table 1-15 Selections and controls

Level	Select the fault level to display the test settings.
User-Defined Test Settings	Summarizes the test performed at the level shown.
Test Results	Once the test is performed, it displays the time sequence of circuit breaker status and the device that actuated the circuit breaker (Shunt Trip or Flux Shifter).
Expected Trip Time	Expected trip time automatically calculated from the pickup, delay band settings, and beaker clearing time.
Observed Trip Time	Observed trip time displayed after the test is performed.
Test Summary LED	Specifies the test results by comparing the observed trip time with the expected trip time. Green Successful (within +/– 20% of expected time) Red Unsuccessful Gray Test Aborted

Test settings and results are saved to the hard-drive with the report name as *TestNumber_Time*.

1.7 Ground Fault Defeat

Performing single phase tests may unintentionally trigger a Ground Fault trip in circuit breakers with Ground Fault protection enabled. This may not be desired when testing other protection functions (e.g., short time, single phase test).

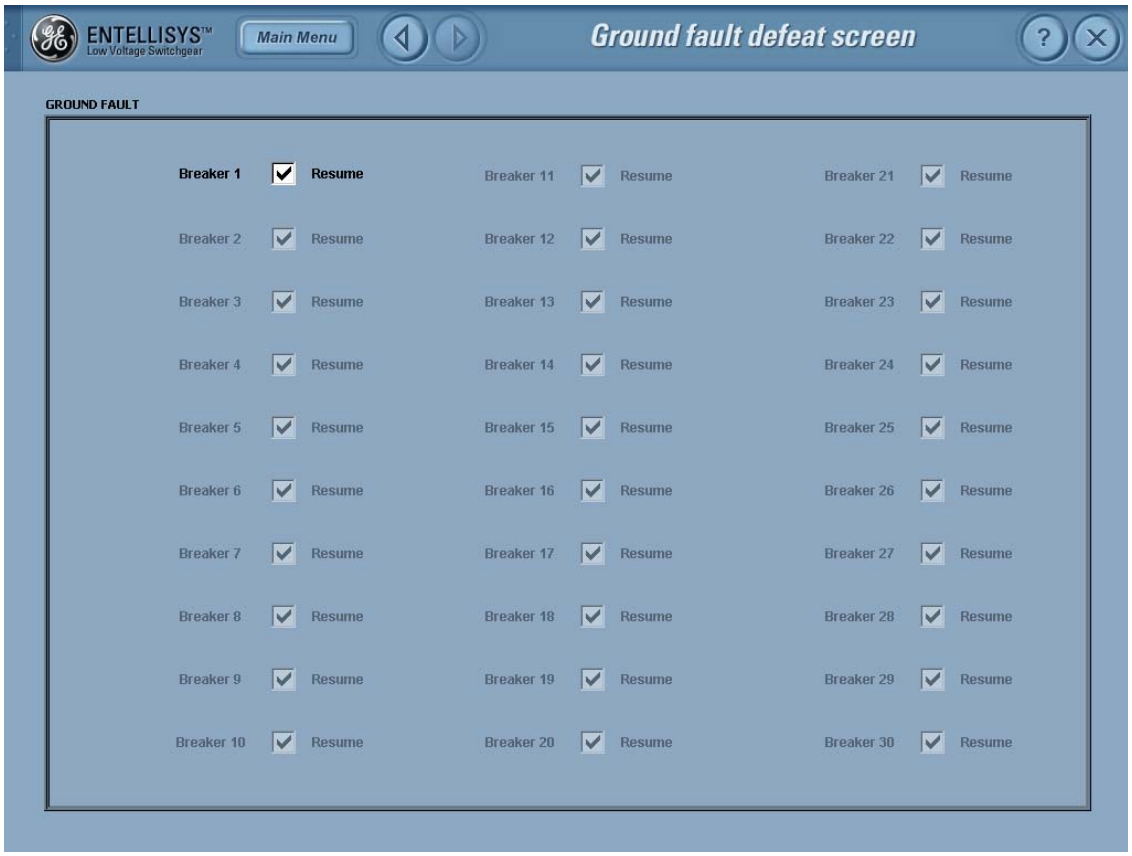
The Ground fault defeat screen allows the operator to “Defeat” or suspend Ground Fault protection temporarily for external Secondary or Primary Injection—single phase testing without Ground Fault trips.

Only circuit breakers with Ground Fault enabled are eligible for this. If GF is disabled, the Breaker and selection box will be grayed out.

NOTE: The test kit connector must be attached to the desired Messenger/circuit breaker to defeat Ground Fault.

Once the test connector is removed from the Messenger, the Ground Fault protection function resumes as normal.

Figure 1-20 Ground fault defeat screen



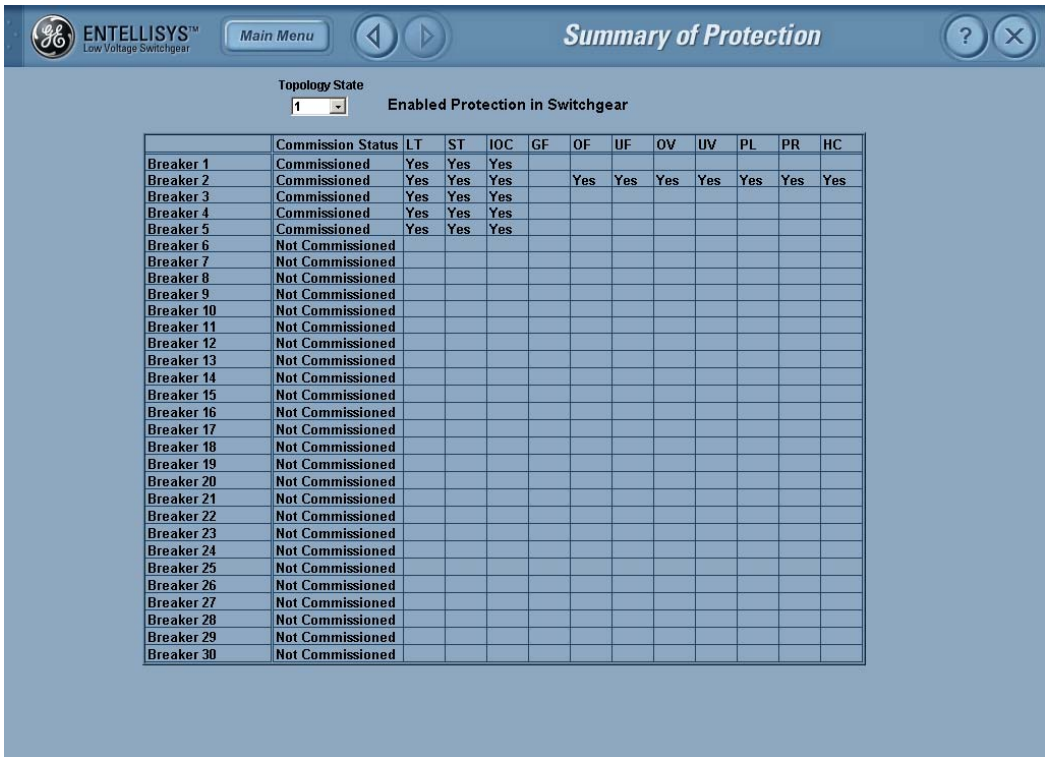
1.7.1 Setup

Circuit Breaker Name ☑ Resume	GF will Resume/Run as normal.
Circuit Breaker Name ☐ Defeat	GF will be temporarily defeated for the circuit breaker specified while the test kit's test connector is physically connected to the Messenger.

1.8 Summary of Protection

The Summary of Protection screen displays the list of circuit breakers in the system. Also displayed are the protection elements enabled for each circuit breaker to be used as a reference for the operator. The test kit will not allow tests for a protection function that is not enabled.

Figure 1-21 Summary of Protection



	Commission Status	LT	ST	IOC	GF	OF	UF	OV	UV	PL	PR	HC
Breaker 1	Commissioned	Yes	Yes	Yes								
Breaker 2	Commissioned	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Breaker 3	Commissioned	Yes	Yes	Yes								
Breaker 4	Commissioned	Yes	Yes	Yes								
Breaker 5	Commissioned	Yes	Yes	Yes								
Breaker 6	Not Commissioned											
Breaker 7	Not Commissioned											
Breaker 8	Not Commissioned											
Breaker 9	Not Commissioned											
Breaker 10	Not Commissioned											
Breaker 11	Not Commissioned											
Breaker 12	Not Commissioned											
Breaker 13	Not Commissioned											
Breaker 14	Not Commissioned											
Breaker 15	Not Commissioned											
Breaker 16	Not Commissioned											
Breaker 17	Not Commissioned											
Breaker 18	Not Commissioned											
Breaker 19	Not Commissioned											
Breaker 20	Not Commissioned											
Breaker 21	Not Commissioned											
Breaker 22	Not Commissioned											
Breaker 23	Not Commissioned											
Breaker 24	Not Commissioned											
Breaker 25	Not Commissioned											
Breaker 26	Not Commissioned											
Breaker 27	Not Commissioned											
Breaker 28	Not Commissioned											
Breaker 29	Not Commissioned											
Breaker 30	Not Commissioned											

If connected to an Entellisys 4.0 lineup, the topology can be selected. The screen will display the Protection elements enabled for each circuit breaker for that topology.

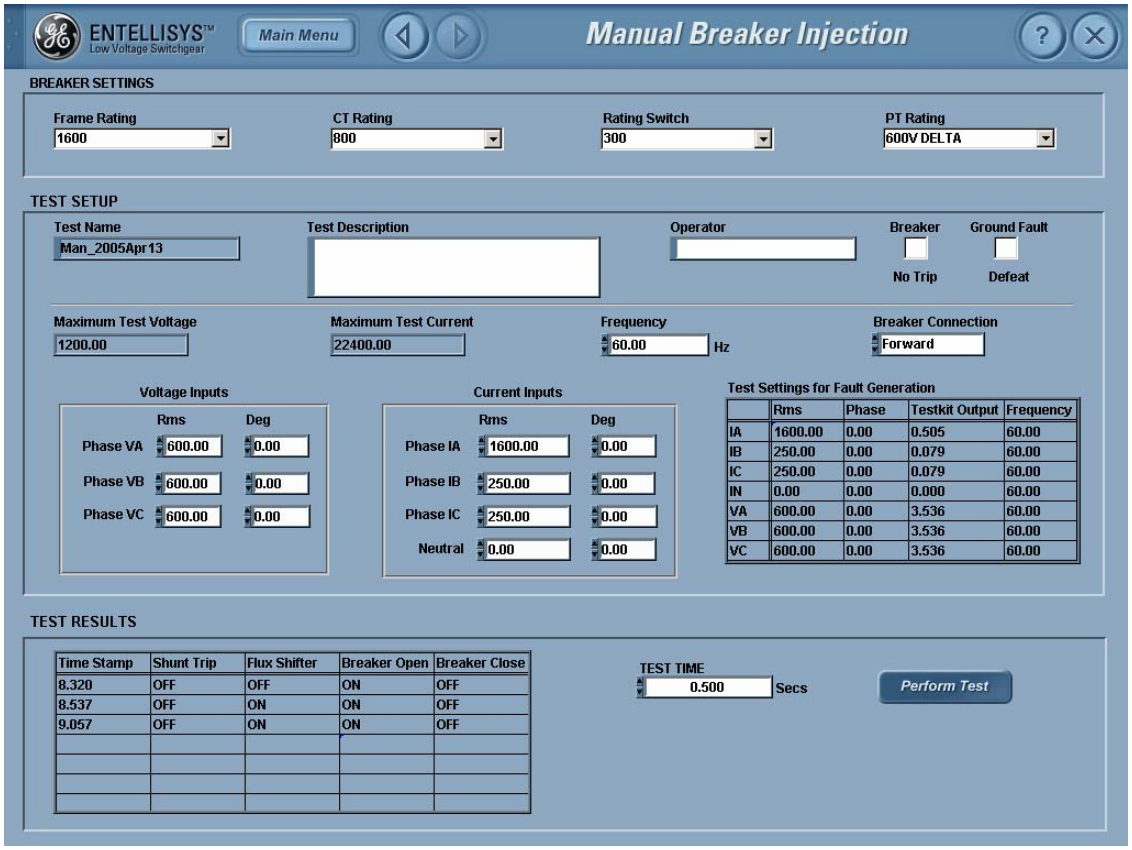
1.9 Manual Breaker Injection

The Manual Breaker Injection feature allows the operator to inject currents and voltages without knowledge of the Switchgear configuration.

Operators must enter the configuration of the circuit breaker under test and must calculate the levels required to generate the expected trip conditions.

NOTE: This feature is for the advanced operator who knows the configuration of the circuit breaker under test, and knows what levels to inject to test the desired protection functions.

Figure 1-22 Manual Breaker Injection



Quick Test Guide

1. Select the Frame Rating of the circuit breaker.
2. Select the CT rating.
3. Select the Rating Switch.
4. Select the PT rating of the system.
5. Enter the Test Description.
6. Enter the Operator name.
7. Select the Breaker Selection for Trip or Not Trip operation.

8. Select the Ground Fault Defeat or Resume depending on the Fault Level test required.
9. Enter the Frequency of the test kit output.
10. Enter the Breaker connection Forward or Reverse direction.
11. Enter the desired Voltage and Phase angle for Voltage phases.
12. Enter the desired Current and Phase angle for Current phases.
13. Enter the Test time for the test signals to be injected.
14. Press **Perform test** to perform the test.

1.9.1 Setup

Table 1-16 Setup

Frame Rating	Select Frame Rating.
CT Rating	Select CT Rating.
Rating Switch	Select Rating Switch.
PT Rating	Select PT Rating.
Test Name	Unique test identifier, assigned by the test kit, generated by the type of test selected and the date the test is performed.
Test Description	Lets the user enter the Test Description (150-character limitation)
Operator	Let the user enter the operator name (20-character limitation)
Breaker Trip	Specifies whether the test will physically trip the circuit breaker. ☑ – Circuit Breaker will Trip ☐ – Circuit Breaker will not Trip
Ground Fault	Allows users to temporarily Defeat Ground Fault during the test, or to Resume/Run Ground Fault as normal during the test. Ground Fault must be defeated for single phase tests—otherwise a trip on Ground Fault will occur. ☑ – GF will Resume/Run as Normal. ☐ – GF will be temporarily defeated during the test period. Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled in the selected circuit breaker.
Maximum Test Voltage	Displays Maximum Test Voltage that can be set for testing from Manual Injection.
Maximum Test Current	Displays Maximum Test Current that can be set for testing from Manual Injection.

Table 1-16 Setup

Frequency	Frequency of the Signal to be injected.
Breaker Connection	Flow current Forward / Reverse connected circuit breakers.
Voltage Inputs	Inputs for Voltage Phases.
Current Inputs	Inputs for Current phases.
Test Settings for Fault Generation	Display of Current and Voltage settings.
Test Results	Once the test is performed, it displays the time stamping of circuit breaker status and the device that actuated the circuit breaker (Flux Shifter or Breaker Open).
Test Time	Time entry for test kit execution.

1.9.2 Manual circuit breaker injection input range

Table 1-17 Manual circuit breaker injection input range

Parameter	Range
Voltage	0 to 2x PT Rating Volts
Current	0 to 28x CT Rating Amps
Phase Angle	–360° to +360°
Test Time	0.5 to 17000 secs

1.10 Post Analysis Selection screen

The Post Analysis feature allows users to analyze test results.

Users can generate reports and save to a USB Memory Stick. The reports are in HTML format.

NOTE: Upon exiting the Post Analysis screen, the USB drive will automatically eject. Users must re-insert the USB Memory stick before generating the next report.

1.11 Test Reports

System Test Kit Reports can be generated from the Post Analysis screen. Depending on the type of test for which the reports are generated, the output settings will change in the report.

All the reports are HTML reports and it will be generated on the USB Memory stick.

Following are the fields available in the Test Reports:

Table 1-18 Fields available in the test reports

General Test Information	
Test Name	Uniquely identified test kit-assigned name.
Operator Name	Operator name that was entered while performing test.
Test Description	Description of the test entered during testing.
Breaker Settings	Displays the circuit breaker settings depending on the type of test for which the report was generated. See Table 1-19 for the protection settings that will display with respect to the test.
Breaker Name	Name of the circuit breaker under test.
Compartment #	Compartment number of the circuit breaker.
Frame Rating	Prints the Frame rating of the circuit breaker.
CT Rating	Prints the CT rating of the circuit breaker.
Rating Switch	Prints the Rating switch value.
PT Rating	Outputs the PT rating value.
Test Settings	
Pre-Fault Settings	All the Pre-Fault settings will be reported.
Fault Settings	All the Fault settings that were injected during Fault time will be displayed.
Post-Fault Settings	All the Post-Fault settings that were injected during post-fault time will display.

Table 1-18 Fields available in the test reports

Test Results	
Trip Time Information	Displays all the Trip time Information.
Pre-Fault Time	Time for which the Pre-Fault signals are injected.
Expected Trip time	Expected trip time for the test.
Post-Fault Time	Time for which the Post-Fault signals are injected.
Observed Trip time	Observed Trip time for the test.
Digital Input Time Stamping	Time Stamping for Digital inputs.
Comments	Comments that are entered by the user while generating reports.
Prepared by	This is an empty field given for the operator to manually sign after report generation.
Date	Date is the report generated date.

Circuit Breaker Settings in report for Protection Test

Table 1-19 Circuit Breaker settings in report for Protection Test

LT Protection Test	
Pickup setting	Long time pickup setting.
Delay setting	Delay band setting.
Short Time Protection Test	
Status	ST Protection enabled or disabled condition.
Pickup Setting	Pickup setting of Short time protection.
I2T Status	Inverse trip time enabled status.
Delay setting	Delay setting of Short time protection.
Ground fault	
Status	GF Protection Enabled or Disabled condition.
Pickup Setting	Pickup setting of Short time protection.
I2T Status	Inverse trip time enabled status.
Delay setting	Delay setting of Short time protection.
IOC Protection Test	
Status	Enabled or Disabled status of the IOC Protection.
Pickup Setting	Pickup setting of IOC.

Table 1-19 Circuit Breaker settings in report for Protection Test

Over Frequency	
Status	Protection enabled condition.
Pickup Setting	Pickup Setting of the OF protection.
Delay Setting	Prints Delay Setting of OF protection.
Under Frequency	
Status	Protection enabled condition.
Pickup Setting	Pickup Setting of the UF protection.
Delay Setting	Prints Delay Setting of UF protection.
Overvoltage	
Status	Protection enabled condition.
Pickup Setting	Pickup Setting of the OV protection.
Delay Setting	Prints Delay Setting of OV protection.
Undervoltage	
Status	Protection enabled condition.
Pickup Setting	Pickup Setting of the PL protection.
Delay Setting	Prints Delay Setting of PL protection.
I2T	Inverse Trip time enabled or disabled for Undervoltage protection.
Phase Loss	
Status	Protection enabled condition.
Pickup Setting	Pickup Setting of the PL protection.
Delay Setting	Prints Delay Setting of PL Protection.
Power Reversal	
Status	Protection enabled condition.
Pickup Setting	Pickup Setting of the PR protection.
Delay Setting	Prints Delay Setting of PR protection.

1.12 Test kit administration

Figure 1-23 Administration menu

1.12.1 HMI setup

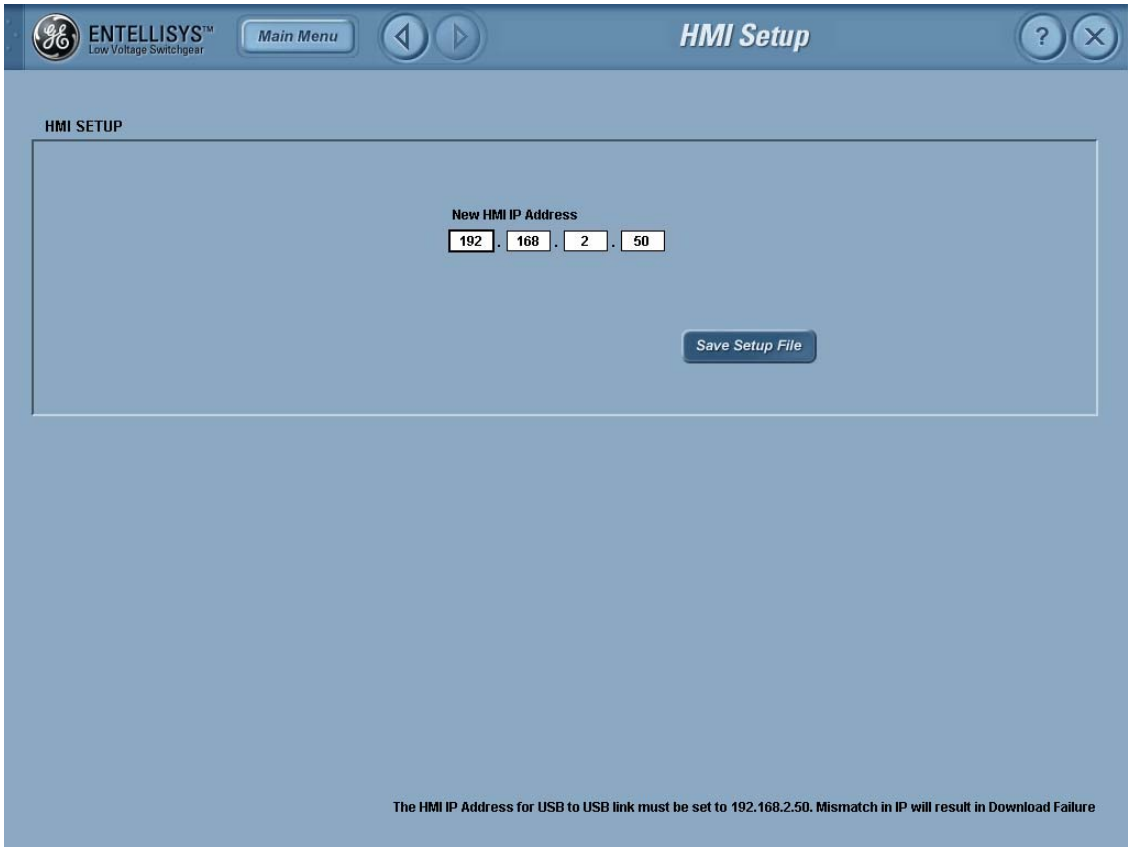
The test kit communicates with the Entellisys Low Voltage HMI to download system configuration, preventing the operator from entering it manually.

A USB-to-USB cable, running a peer-to-peer network communication bridge, is used between the test kit and the HMI for communication. Both the HMI and test kit have dedicated LAN connections enabled for this. The test kit must know the HMI IP address. These IP addresses have been pre-set and should not be changed.

In the event the addresses must be changed, this screen provides the ability to enter the HMI USB-to-USB Network Communication Bridge IP address.

NOTE: For most systems the HMI IP address for the USB-to-USB bridge should remain at the default setting of 192.168.2.50. Modify this setting only if it was changed in the HMI.

Figure 1-24 HMI Setup screen



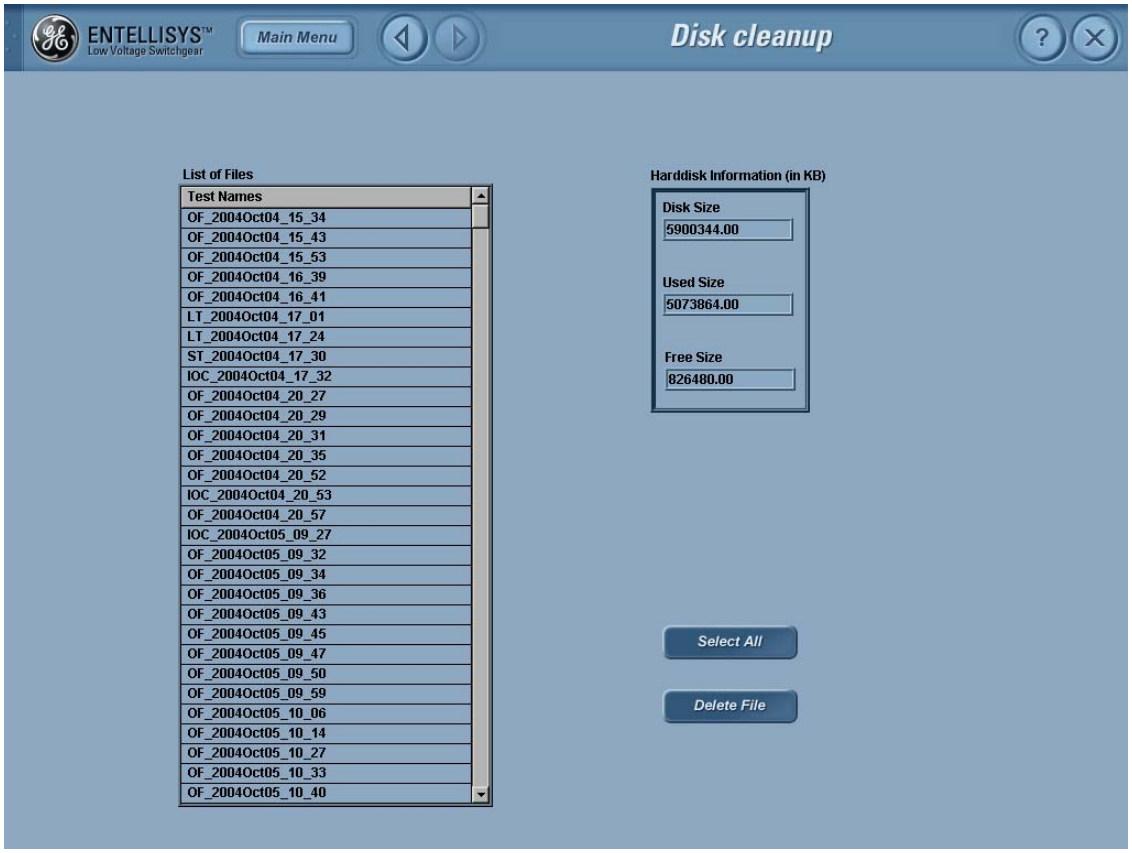
Enter the IP address in the X.X.X.X format, where X = 0 to 255. The maximum value that can be entered is 255.255.255.255.

1.12.2 Disk cleanup

This option enables operators to delete unwanted test reports from the System Test Kit. This should be done periodically to prevent the hard drive from filling up.

NOTE: It is recommended to have at least 50,000 KB of free space at all times.

Figure 1-25 Disk cleanup screen



List of Files – displays the test reports available in the test kit.

To select files:

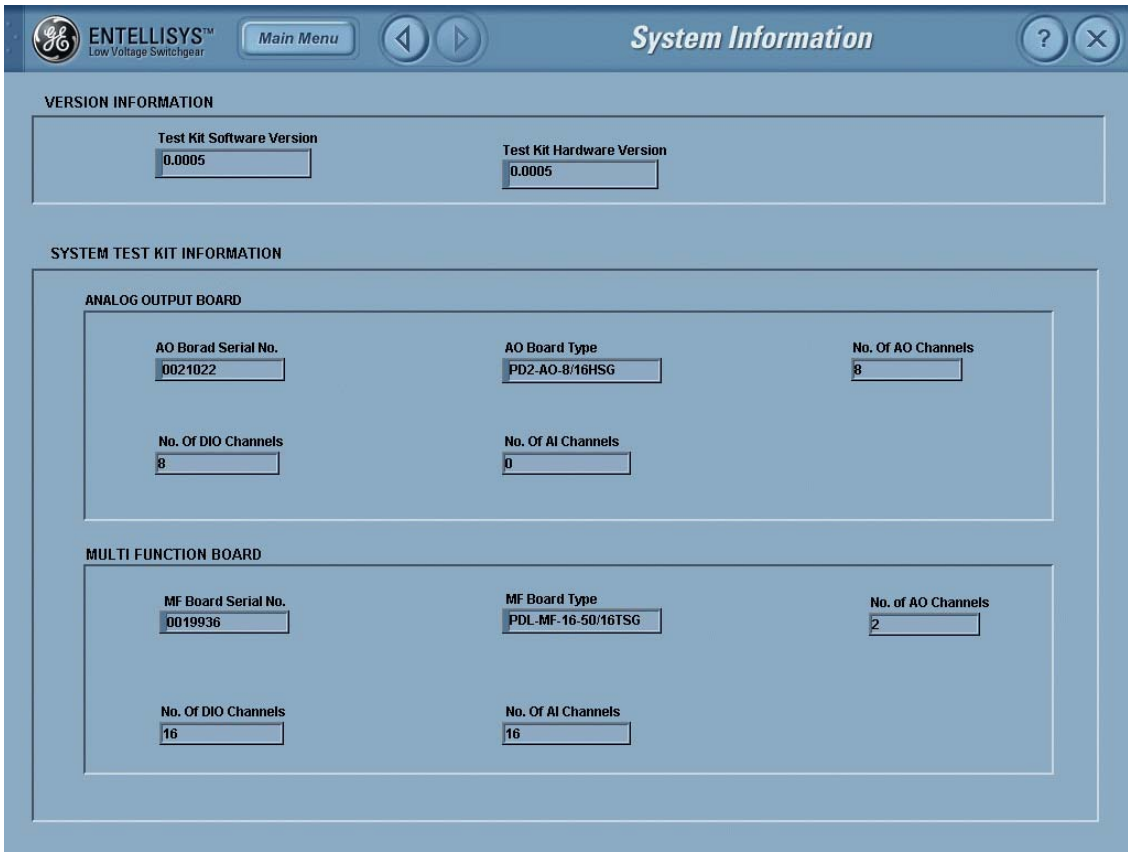
- Click an individual file.
- Press **Shift** to select multiple files.
- Or click **Select All** to select all files.

Delete File – prompts the operator with a confirmation to delete the selected files. The Delete File button will be grayed out if no files are selected.

1.12.3 System Information

This function displays the hardware version and data acquisition card information for the hardware present in the test kit. It is provided for technical support information only.

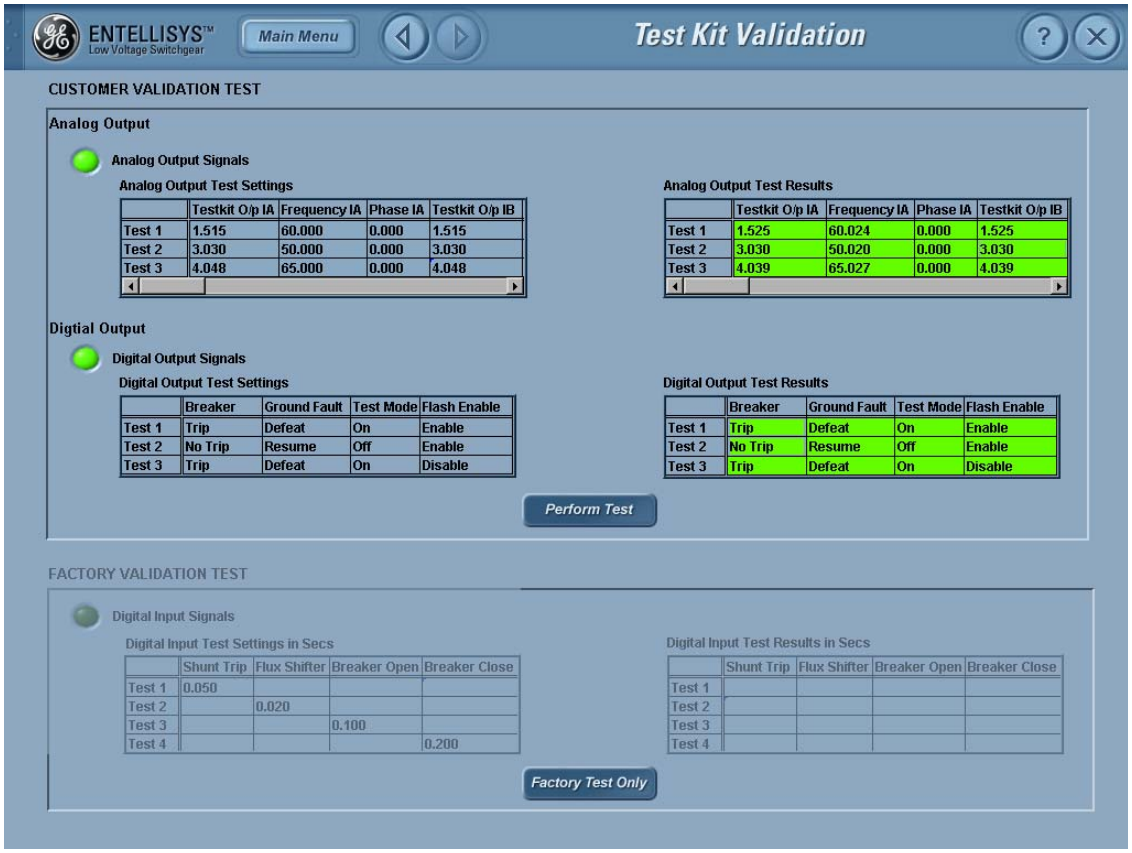
Figure 1-26 System Information screen



1.12.4 Test Kit Validation Test

This feature provides internal tests to validate the test kit hardware.

Figure 1-27 Test Kit Validation screen



1.12.4.1 Customer Validation Tests

These tests are provided for the customer to validate the test kit hardware. The pre-set tests check both the analog output and the digital output signals.

To perform tests

1. Remove the "Test Kit Output Connector" from the Messenger.
2. Press **Perform Test**.

NOTE: Remove the test kit connector from the Messenger during Test Kit Validation tests to prevent false results and to prevent test signals from being injected into the Messenger.

Test Results

The results are summed up in the two LED indicators on the left-hand side of the screen.

- Green = Pass (indicating the hardware is working properly).
- Red = Failure (indicating there is a hardware problem). More detailed data is available on the left-hand side. For any failures, contact GE Post Sales Service for technical help (see How to contact us on page 2).

1.12.4.2 Factory Test only

The Factory Tests are provided for factory personnel only and should not be performed by customers. This test requires special production test hardware and will fail without the proper equipment.

NOTE: Remove the test kit connector from the Messenger during factory test kit validation tests to prevent false results and to prevent test signals from being injected into the Messenger.

1.13 Long-term maintenance

The following preventative maintenance is recommended for the long-term care of your test kit.

- Keep the system in a cool, dry, and dust-free environment.
- Power ON the system at least once every 3 months to recharge the CMOS battery.
- Make sure the system is OFF whenever it is shifted from one place to another.

1.13.1 Motherboard battery maintenance

The CMOS or Complementary Metal Oxide Semiconductor battery is an on-board semiconductor chip. This chip is used to store system information and configuration settings while the computer is off and on.

Lifetime: The standard lifetime of a CMOS battery is around 10 Years, however this amount of time can change depending on the use and environment that the computer resides.

Detection: A Low battery can be detected by checking the time stamping of test results. See Troubleshooting on page 60 for help diagnosing the issues.

Corrective action

- Replace the CMOS battery. Follow the manufacturer's instructions for proper battery disposal.
- Make sure that the polarity of the battery is right before inserting inside the slot.
- Reload the saved CMOS Setup Details. (There are no special settings for the System Test Kit, so this step can be skipped.)

Figure 1-28 CMOS battery on motherboard

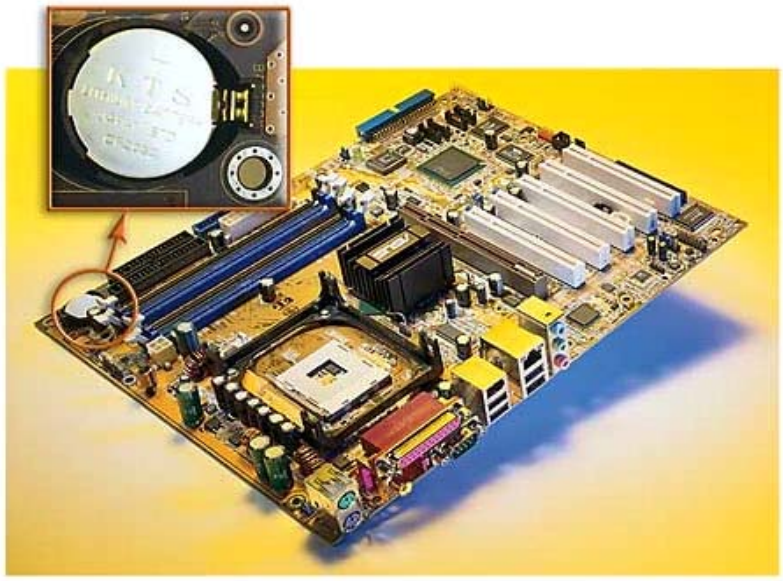


FIGURE 1: The CMOS battery on your motherboard may need to be replaced after four or five years.

1.13.2 Test kit care

The following outlines tips for taking good care of your test instrument.

1.13.2.1 Handling the test kit

Make sure that the keyboard assembly is properly closed onto the SAX before transporting it. This will ensure you do not lose the keyboard as well as protecting the LCD screen. The handle is located securely to the strongest part of the machine and distributes the load of the SAX evenly to allow easy carriage and proper balance.

1.13.2.2 Cables

All cables should be treated with care. Do not over extend any cable as this could result in internal breakage in the cable. It is essential that the cable and its plug be handled in the proper manner without force.

1.13.2.3 Power

Always make sure the power cord is in top condition before using them with the SAX. Make sure the power source is reliable and of proper standard. The power supply is capable of handling 100-240 V and 50-60 Hz. Do not use on an already overloaded circuit.

1.13.2.4 Cleaning the LCD screen

- Do not use cleaner that contains alcohol.
- Do not use cloth that could be abrasive to the surface of the LCD.
- Always gently wipe the LCD surface when cleaning.

Do not use any abrasive material to scratch the LCD screen, as they can leave marks on the surface. Do not apply any pressure to the surface of the LCD screen either with objects or hands; this will ensure that the screen do not suffer from internal damage or cracks.

1.13.2.5 Cleaning the keyboard

- Do not spill any liquid on to the keyboard.
- Do not drop particles into the spacing between keys.
- Use a compressed air cleaner to remove the dust within the keyboard.

The keyboard is essential in that it helps protect the LCD during transportation. Avoid liquid spills or small objects entering the keyboard. The touch pad surface should be kept dry and clean.

1.13.2.6 Cleaning the fan filter

- Remove the filter from its housing.
- Use a compressed air cleaner to blow off the dust from the filter.

If necessary, wash the filter material and dry completely before reinserting it.

1.14 Troubleshooting

Table 1-20 Troubleshooting

Error	Potential Cause	Suggested Fix
Main Menu—Test Menu and Manual Injection Button grayed out	When there is a problem in the Power DAQ driver or with the Hardware cards, these buttons will not be available to inject signals from the test kit.	Check System information in the Test Kit administration. Contact GE Post Sales Service for technical support (see How to contact us on page 2).
Self Test Error—Memory Failure	Correct the Physical Memory problem and restart the machine.	Have User Administrator check physical memory space. Or, send unit for repair. Contact GE Post Sales Service for technical support (see How to contact us on page 2).
Self Test Error—Hardware Configuration Error	Problem in Hardware Wrong Power DAQ drivers	Check System information in the Test Kit administration. Contact GE Post Sales Service for technical support (see How to contact us on page 2).
Self Test Error—Test Kit Setup	Invalid File Setting requires reinstallation of test kit software. Mismatch in the installed software and hardware versions.	Check System information in the Test Kit administration. Contact GE Post Sales Service for technical support (see How to contact us on page 2).
Self Test Error—Ethernet Connectivity	Cable not connected.	Verify USB cable is connected to both the System Test Kit and the HMI.
	HMI USB-to-USB Network Bridget IP Address is not set properly in the test kit.	Verify the address in Test Kit Administration, HMI Setup. Default address is 192.168.2.50, which matches the HMI setup. Only in rare cases should this be changed. See DEH-230 Entellisys Low Voltage Switchgear System Administrator Manual for details.
	Verify USB port enabled.	Requires User Admin to log onto unit.
Download Switchgear Configuration from HMI		
Error Msg—"Download Failed. Check the USB cable and verify the IP address configuration of HMI and System Test Kit"	Cable not connected.	Verify USB cable is connected to both the System Test Kit and the HMI.

Table 1-20 Troubleshooting

Error	Potential Cause	Suggested Fix
	HMI IP Address incorrect.	Check the HMI IP address in HMI Setup, under the Test Kit Administration. This should be the same IP address as set in the HMI (by default, HMI IP address is set at 192.168.2.50).
	Communication failed between HMI and test kit. Note: This download should only be done between In-Gear or Near-Gear touchscreen HMIs (and not remote HMIs).	The test kit uses a fixed User, ELVSTESTKIT to login to the HMI. Make sure the user is still set up in the test kit and the HMI, with the same passwords and administrator rights.
Download from HMI failed due to improper access/non availability of settings file	Problem in Settings files of HMI.	Improper User access from test kit to HMI. Missing or No Settings files in HMI for download.
Error Msg—No Files are available for retrieving. Check/Connect USB cable and verify the IP address of HMI and System Test Kit for a new download.	There are no valid previous settings available.	The settings must be downloaded from the HMI.
Error Msg—Default CPU is not Commissioned. Please check and try again.		Contact GE Post Sales Support for help (see How to contact us on page 2).
Error Msg—No breakers Available for testing	Configuration downloaded successfully, but there are no commissioned Messengers/circuit breakers available for testing.	Call GE Post Sales Support for help (see How to contact us on page 2).
Test Menu		
Current Protection Test is grayed out	No Frame or CT Rating is configured for the commissioned circuit breakers.	
Relay Protection Test is grayed out	None of the relay protection functions are optioned in the system.	Relay protection functions must be purchased separately from GE.
	Relay protection functions may be optioned, but they are all disabled in Settings.	Enable the protection functions in the HMI, User Settings Menu.
	No Frame and CT Rating is configured.	Check for Frame and CT configurations.
GF Defeat Button is grayed out	Ground Fault protection is disabled in all the circuit breakers.	Depending on the type of system purchased, GF may be enabled in the HMI under User Settings or it may need to be optioned in the Compartment ID Button. Contact GE for details.

Table 1-20 Troubleshooting

Error	Potential Cause	Suggested Fix
OverCurrent Test		
Pre-Defined Overcurrent Test-Short Time /Instantaneous/Ground Fault feature grayed out in Test Selection in pre-defined tests	Protection elements not optioned and/or enabled for the circuit breaker selected.	Verify that the Protection enabled for that circuit breaker in system based on Table 1-4.
	Incorrect Switchgear Configuration used?	Check if settings downloaded were same as in HMI.
Observed trip time reads zero	Test cable not connected to either the test kit or the EntelliGuard Messenger.	Verify the test kit connector is attached to the desired circuit breaker.
User-Defined Mode—Trip module displays as No trip		Verify that the fault current entered is greater than any of the LT/ST/IOC Pickups.
User-Defined Overcurrent—% Test Results button grayed out	Test has not been run yet.	
	Test was aborted.	
Pre-Defined Overcurrent Protection—Test Summary is grayed out	Test has not been run yet.	
	Test was aborted.	
Pre-Define Overcurrent Protection test failed unexpectedly	Gear is operating in a different topology than what the test kit expects	Download settings from the HMI again and repeat
Automatic Trip Time Curve—Ground Fault curve feature grayed out in select curve type	Ground fault is not enabled for the selected circuit breaker.	
% Error is displayed as 100		Verify that the System Test Kit cable is connected to the selected circuit breaker on which the test is performed and that observed trip time is not zero.
% Error is displayed as ___		Verify that the point tested is IOC trip and that trip time is less than 50/60 ms.

Table 1-20 Troubleshooting

Error	Potential Cause	Suggested Fix
Time Stamp is incorrect	• System time is incorrect.	• To check system time, pull up the task bar by moving the mouse at the bottom of the screen (or press CTRL - ESC to open the task bar). Double-click the clock to view or reset system time.
	• Potential problem with CMOS battery on computer motherboard.	• Change CMOS Battery. Details in Section 1.14.1.

A Definition of terms

The terms listed and defined are displayed in the Test Kit and are used throughout this guide.

Table A-21 Definition of terms

Term	Definition
ATT	Automatic Trip Time Test.
CT	Current Transformer—a sensor that measures current. There are normally 3 CTs, one for each phase, and an optional neutral CT.
CT Compensation	The system is designed to compensate for particular characteristics of the CTs used in the Entellisys System in order to improve accuracy. If a user is testing the system through secondary injection (input into the CT inputs of the EntelliGuard Messenger), then the unique compensation algorithm must be disabled or test results will be incorrect.
CT Rating	Rating of connected Current Transformer for that circuit breaker.
DAQ	Data Acquisition
Fault/Fault Level	The period of time and/or the voltage current condition during a fault.
Flux Shifter	One of two means to actuate the circuit breaker. The flux shifter is used to open (and lockout) the circuit breaker when the CPU or EntelliGuard Messenger issues a trip signal.
Frame Rating	Frame Size or Rating of the Circuit Breaker.
GF	Ground Fault overcurrent protection function
GF Defeat	Some tests like single phase tests, will trigger GF trips unintentionally. Therefore, it may be desirable to disable or defeat GF temporarily during these tests.
HC	High Current Alarm protection function
HMI	Human Machine Interface
IOC	Instantaneous overcurrent protection function
LT	Long Time overcurrent protection function
Manual Breaker Injection	User must manually setup the circuit breaker configuration and power line characteristics to be injected into the system. Might be desired for a quick test.
NAN	Not a number—error message that gets displayed.
No Trip Test	A test that does not cause the circuit breaker to trip
OF	Over frequency relay protection function
OV	Overvoltage relay protection function

Table A-21 Definition of terms

Term	Definition
Phase or Phase Angle	Phase angle rotation that can be set from test kit. Range of Phase angle is –360° to +360°.
PL	Phase Loss relay protection function
Post-Fault / Post-Fault Level	The period of time or the voltage/current condition following a fault.
PR	Power Reversal relay protection function
Pre-Fault / Pre-Fault Level	The period of time and/or the voltage/current condition preceding a fault.
PT Rating	Rating of Potential Transformer of the circuit breaker.
Rating Switch	Rating switch value of the circuit breaker.
RMS	Root Mean Square—calculation used to measure voltage or current.
Secondary Injection	Current (and voltage) injection into the system through the CT (and PT) connections of the EntelliGuard Messenger.
Shunt Trip	One of two means to actuate the circuit breaker. Shunt trip is used to open the circuit breaker when users manually open the circuit breaker from the HMI.
ST	Short Time overcurrent protection function
Trip Test	A test that causes the circuit breaker to trip
Trip Time Curve	Trip time curve of the connected circuit breaker for different protection schemes.
UF	Under frequency relay protection function
USB	Universal Serial Bus
UV	Undervoltage relay protection function