

Entellisys 5.0

Low Voltage Switchgear

Test Kit User Manual



imagination at work



DEH-503

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.

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Second Revision

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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

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510 East Agency Road

West Burlington, IA 52655

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

Additional information:

www.entellisys.com/support

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To quickly get to testing a breaker, this guide will require a current Entellisys archive to determine breaker configuration and relay settings.

1.1 Installing the application

Included in the test kit there is a USB thumb drive with the test kit application. Insert the thumb drive in the designated laptop and install.

After the installer has completed installing both the Test Kit application and the National Instruments runtime engine, run the application.

Figure 1-1 Start Up screen

Entellisys System Test Kit Application

File
Reports
Help

Lineup Name

Lineup Information

Performed by

PT Rating

None

Phase Rotation

ABC

CPU A IP

192

168

1

101

CPU B IP

192

168

1

102

Frequency

60 Hz

Notes

Automatic Update
☐ No

Breaker Selection

Topology

1

CT Rating

2000

Rating Switch

750

LT Multiplier

0.5

Redundant T

Disabled

Test Kit Hardware

Single Point Testing

Custom Testing

Test History and Reporting

Breaker Information

Test Selection

LT

Trip Disabled

GF Enabled

Breaker Settings

Pickup(% Rated)

2

Delay (S)

1.5

Phase Requirement

One Phase

Pickup Range %

Pickup Level - (V)

0

Test Kit Settings

Phase Selection

Phase A

Start Level

85

(% Rated)

Steps

0.5

(% Rated)

Stop Level

105

(% Rated)

Test Type

Normal

Comments

Create Test Sequence

Run Test

Observed Delay Time(s)

Test Status

Date

Type of Test Selected

Fault Injected (units)

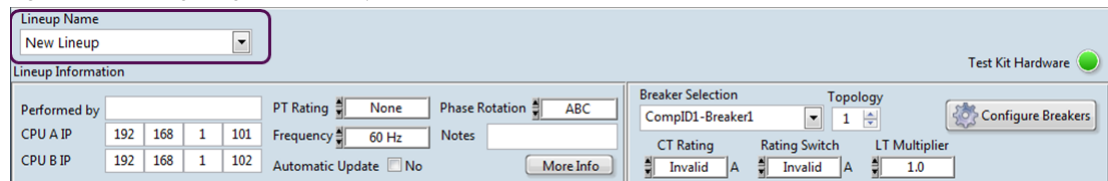
IA

1.2 Running the application for the first time

To begin testing with the Customer Test Kit:

- On the test kit, connect the AC power supply and plug the USB cable to the PC or laptop running the test kit application.
- Start the test kit application. The test kit application will check for connectivity to the test kit. It will prompt the user if test kit is not detected and will check continuously until it is found.
- Once the application is open, create a new lineup by typing the lineup name in the **Lineup Name** text box. The line up and breaker controls will then be enabled.

Figure 1-2 Configuring a new lineup

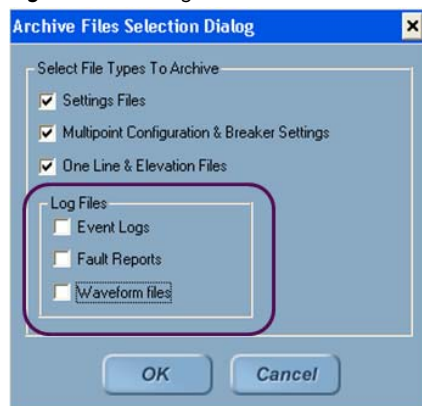


The screenshot shows the 'New Lineup' configuration window. At the top, there is a 'Lineup Name' dropdown menu with 'New Lineup' selected. Below this is the 'Lineup Information' section, which includes fields for 'Performed by', 'CPU A IP' (192.168.1.101), 'CPU B IP' (192.168.1.102), 'PT Rating' (None), 'Phase Rotation' (ABC), 'Frequency' (60 Hz), and 'Notes'. There is also an 'Automatic Update' checkbox set to 'No' and a 'More Info' button. To the right is the 'Breaker Selection' section, showing 'CompID1-Breaker1' selected, a 'Topology' dropdown set to '1', and a 'Configure Breakers' button. Below this are fields for 'CT Rating' (Invalid), 'Rating Switch' (Invalid), and 'LT Multiplier' (1.0). A 'Test Kit Hardware' status indicator with a green light is in the top right corner.

1.3 Import settings from the Entellisys archive

On the Entellisys HMI, sign in as an administrator and insert a thumb drive into the Entellisys HMI and navigate to the **Backup \ Restore Archive** tab and deselect the **Log Files** and click **Ok**. (For more information on the taking an archive, see the Entellisys user manual).

Figure 1-3 Taking an archive on the Entellisys HMI.



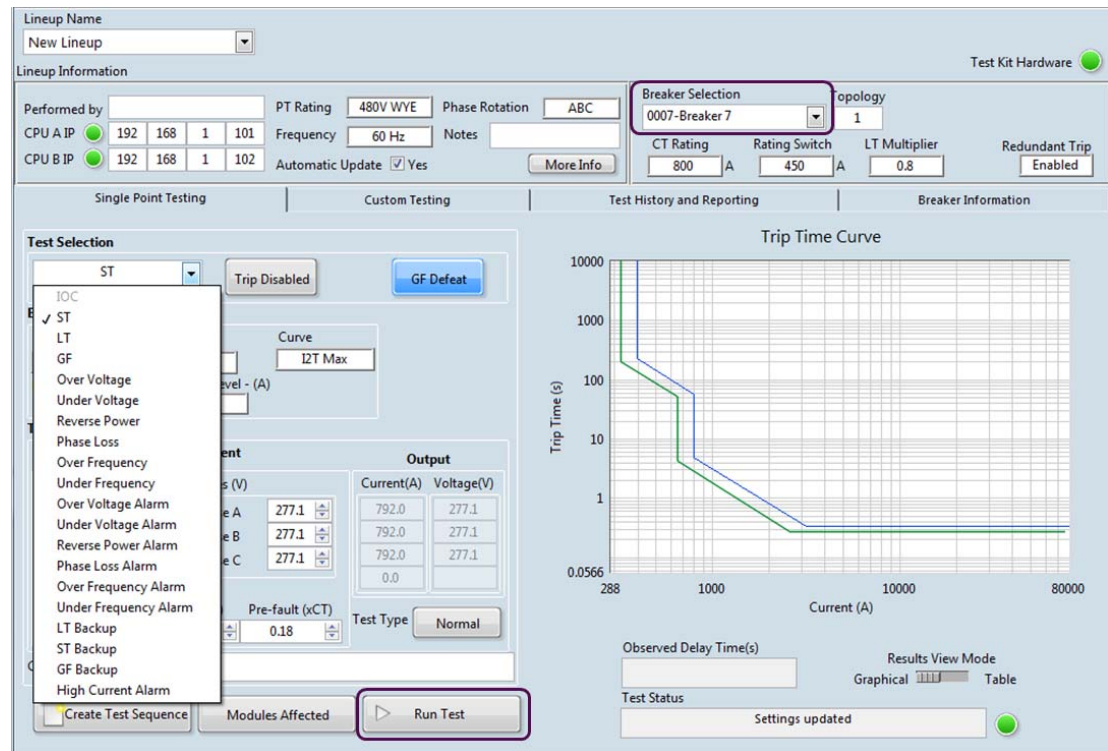
In the test kit application, select **Import Settings from Archive** from the **File** menu and navigate to the archive directory taken from the HMI previously.

The test kit application will configure the breaker names and relay settings. These settings can be changed if desired. The available default protection tests are also enabled in the **"Test Selection"** pulldown.

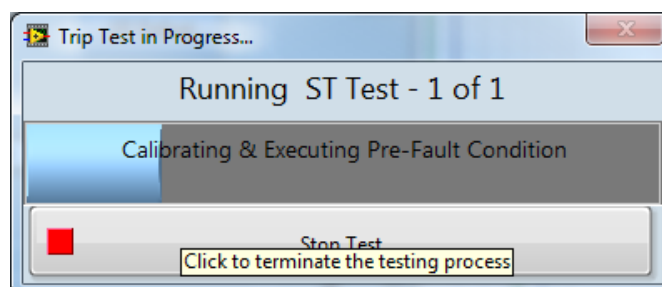
1.4 Select and run a test

Select the desired breaker from the **Breaker Selection** pulldown and select the desired test from the **Test Selection** pulldown.

Figure 1-4 Selecting a test in the test selection pulldown



Check current levels and click **Run Test**.



The Entellisys™ System Test Kit is a portable test instrument designed for field testing of the Entellisys Low Voltage Switchgear System. The test kit is controlled by an application loaded on the user's laptop.

The test kit will produce sinusoidal current and voltage waveforms which are injected into the Entellisys Messenger through the front test port.

The overview of 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 temporary suspension of all Ground Fault protection in the breaker
- Automatically retrieves system configuration for increased productivity
- Displays a summary of all protection configurations
- Saves test results to be reviewed later
- Windows Interface for ease of use
- Operation from 120 Vac

The test kit will interface with the system through the EntelliGuard™ Messenger located above each circuit breaker. 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.

*Entellisys 3.0 systems must use an archive to import settings.

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



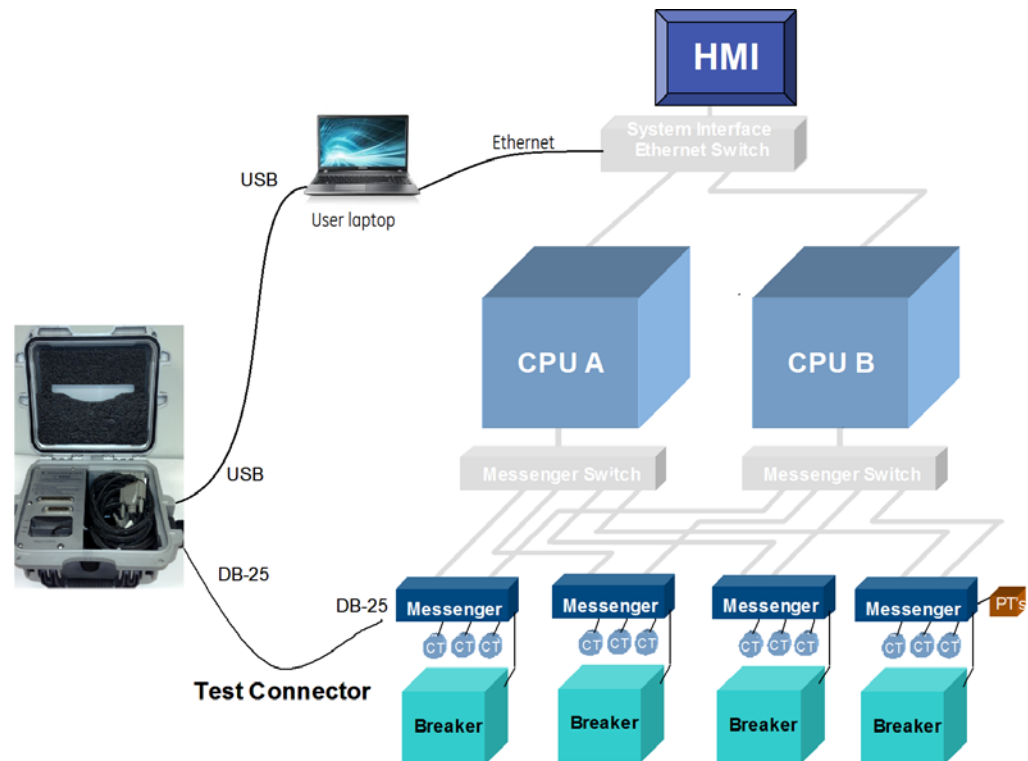
The HMI will indicate that the unit is in Test Mode. It will also record the analog test signals and trip responses in the waveform capture (viewable in the HMI event log).

2.1 Test architecture

The System Test Kit injects synchronized analog sinusoidal waveforms for each current and voltage phase to perform its tests. When in test mode, the Messenger will switch out the CT and PT inputs for the test signals before the A/D converters.

All Single Point voltage and current alarming and protection relays can be tested using low voltage injection from the System Test Kit.

Figure 2-3 Entellisys system architecture with System Test Kit



The Test Kit requires its application to be loaded on a Windows laptop. The Entellisys test kit application will control the test kit to inject specific currents and voltages into the messenger via the DB-25 Messenger cable.

Messenger trip output is timed and reported back to the user interface.

The Test Kit application can obtain the system settings from either an Ethernet connection or from an archive.

2.2 System Requirements

2.2.1 Test Kit software requirements

Table 2-1 Minimum system requirements

Spec	Minimum requirements
Processor	Pentium III/Celeron 1GHz or equivalent
RAM	1GB (32-bit) / 2GB (64-bit)
Screen resolution	1024x768
Operating system	Windows 8/7/Vista (32-bit and 64-bit) Windows XP SP3 (32-bit) Windows Server 2003 R2 (32-bit) Windows Server 2008 R2 (64-bit)
Additional Software	Microsoft Excel 2010 (for reporting)

2.2.2 Test kit hardware specification

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

Table 2-2 Actual System Test Kit output accuracy

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

Accuracy for protection testing is based on the Entellisys System Accuracy.

Table 2-3 System accuracy with the test kit

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

2.2.3 Calibration

The calibration on the NI 9264 analog output card on the test kit should be verified once per year. The complete calibration procedure can be found [NI.com\calibration](http://NI.com/calibration).

Recommended calibration device: use a multiranging 6 1/2 digit DMM with an accuracy of 40 ppm.

Creating a breakout cable: Modify a Female DB37 pin cable to provide accessibility to pins 1 - 7 and 21.

Table 2-4 NI 9264 Verification Test Limits

Test Point	Test Kit Setting	Pin # on DB37 connector	Peak Output (V)	1-Year Limits Lower	Sensor type
Current: Phase A	1.6xCT	1	+9.14V	+0.01V	
Current: Phase B	1.6xCT	2	+9.14V	+0.01V	
Current: Phase C	1.6xCT	3	+9.14V	+0.01V	
Current: Neutral	1.6xCT	4	+9.14V	+0.01V	
Voltage Phase A	480V	5	+8.66V	+0.01V	480 Wye
Voltage Phase B	480V	6	+8.66V	+0.01V	480 Wye
Voltage Phase C	480V	7	+8.66V	+0.01V	480 Wye
Analog Ground	--	21	--	--	--

Calibration Procedure:

Step 1: Create a new lineup named “Calibration” and set the breaker CT Size, rating, LT Setting and PT Rating to 1600, 1600, 1.0 and 480 Wye.

Figure 2-4 Lineup settings for calibration

The screenshot shows the 'Lineup Name' dropdown set to 'Calibration'. Below it, the 'Lineup Information' section includes fields for 'Performed by', 'CPU A IP' (192.168.1.101), 'CPU B IP' (192.168.1.102), 'PT Rating' (480V WYE), 'Frequency' (60 Hz), 'Phase Rotation' (ABC), 'Automatic Update' (No), and 'Notes'. The 'Breaker Selection' section shows '0007-Breaker 7' selected, with 'Topology' set to 1. The 'CT Rating' is 1600 A, 'Rating Switch' is 1600 A, 'LT Multiplier' is 1.0, and 'Redundant Trip' is Enabled. A 'Configure Breakers' button is visible.

Step 2: Set the test settings to match **Figure 2-5**. Set the “Fault Duration” to 300 seconds.

Figure 2-5 Test settings for calibration

The screenshot shows the 'Test Kit Settings' window. It has two main sections: 'Test Adjustment' and 'Output'.
Test Adjustment:
 - **Currents (xCT):** Phase A, B, C, and Neutral are all set to 1.6.
 - **Voltages (V):** Phase A, B, and C are all set to 480. Neutral is empty.
 - **Fault Duration(S):** Set to 300.
 - **Pre-fault (V):** Set to 277.1.
 - **Pre-fault (xCT):** Set to 0.18.
Output:
 - **Current(A):** Phase A, B, and C are all set to 2560.0. Neutral is empty.
 - **Voltage(V):** Phase A, B, and C are all set to 480.0. Neutral is empty.
Test Type: A button labeled 'Normal'.

Step 3: Run the test and measure the min and max voltages on the pins listed in Table 2-4 relative to the analog ground. Verify they meet the calibration standards.

Adjustment: If the device measures outside the desired specifications shown in Table 2-4, the analog output card must be factory calibrated by National Instruments.

2.2.4 Replacement parts

Contact GE Post Sales Service for replacement parts:

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

Additional information:

www.entellisys.com/support

Table 2-5 Replacement part numbers

Description	GE Part Number
Entellisys System Test Kit	ETSTESTKIT03
Custom Messenger Test Cable	ETMSGRCABLE
4 Slot Compact DAQ Chassis	ETSK03CHASSIS
8-Channel, 100 ns, TTL Digital Input/Output Module	ETSK038IOCARD
±10V, 25 kS/s per Ch 16-Bit, Analog Output Module, DSUB	ETSK03ACARD

3 System Test Kit

3.1 Importing System Settings

The Entellisys test kit requires specific details about the lineup, it's sensors, number of breakers, relays that are enabled, the settings of each of the relays and other settings so that the test kit can determine the default values to test each of the relays as well as the correct pass / fail criteria.

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

The test kit software provides three different methods to enter the lineup configuration.

- Directly from the CPU
- Imported from an Entellisys archive
- Manually configured

Entellisys Version Compatibility

The Customer test kit can connect to and read settings from Entellisys 4.0 systems and later. Entellisys 3.0 settings must be imported through an archive. ([See section 3.1.2](#))

3.1.1 Directly from the CPU

The Entellisys settings can be downloaded by the test kit via Ethernet TCP/IP. There are two modes: Automatically update, yes or no.

Automatic Update will continuously monitor the Entellisys system and will automatically update any of the ratings or protection settings if changed by the user at Entellisys HMI or rating/LT pickup settings changed at the Messenger.

Discover CPU IP addresses from HMI: On the Entellisys HMI, go to **Main Menu, User Settings, HMI Preferences**).

Figure 3-1 Automatically update test kit from CPU.

The screenshot shows a 'Lineup Information' dialog box with the following fields and values:

Field	Value
Performed by	Field Engineer
PT Rating	None
Phase Rotation	ABC
CPU A IP	192 168 1 101
CPU B IP	192 168 1 102
Frequency	60 Hz
Notes	
Automatic Update	☒ Yes

A 'More Info' button is located at the bottom right of the dialog box.

Enter the CPU IP addresses for each CPU. If the test kit can communicate to the CPUs, the status light will indicate green.

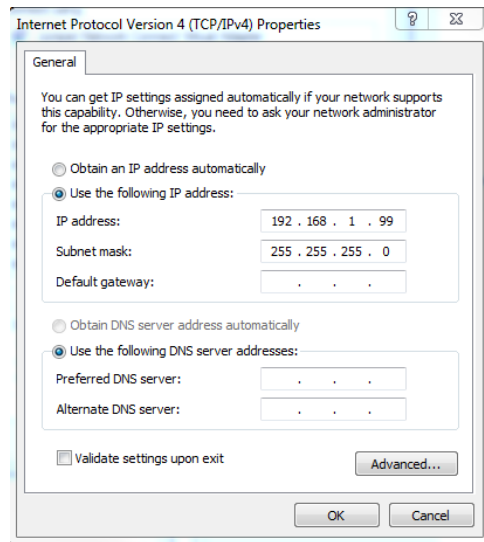
Modbus TCP/IP network connectivity:

Each Entellisys LV switchgear is equipped with a customer interface firewall device. Most laptops will be connected to the customer interface VPN via a Ethernet cable.

Entellisys LV switchgear is shipped from the factory with static CPU Ethernet IP addresses to **192.168.1.101 and 102**. The CPUs IP addresses may have been changed during commissioning to adhere to an existing addressing scheme.

Before connecting the Customer Test Kit application to the Entellisys LV switchgear, the PC running the Customer Test Kit software must be manually configured to a unique IP address on the same subnet as the CPUs. To configure connectivity to an Entellisys system:

1. Go to the Entellisys HMI and determine the CPU IP addresses (**Main Menu / User Settings / HMI preferences**)
2. Connect the Customer Test Kit PC to the VPN switch, open the control panel and navigate to the Networking area. Select the correct network adapter and modify the **TCP/IPv4** properties.
3. Check the **"Use the following IP address:"** check box and update the IP address field making sure the three left most numbers are identical to the Entellisys CPUs. The right most number must be unique.

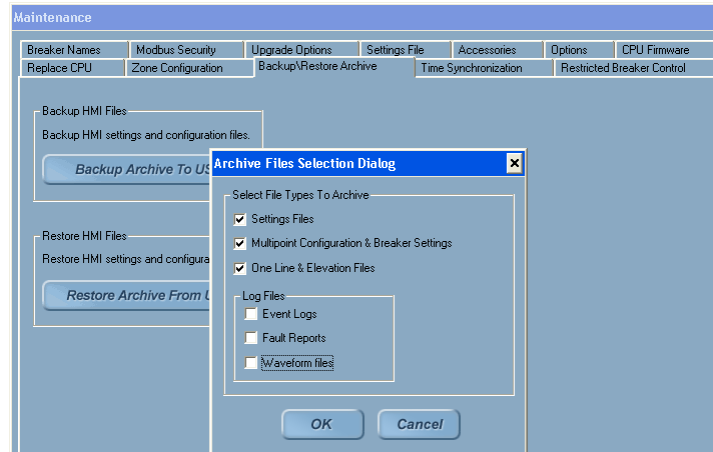


3.1.2 Import settings from an Entellisys archive

If there are issues connecting to the CPUs directly, an archive can be used to import the equipment configuration and settings.

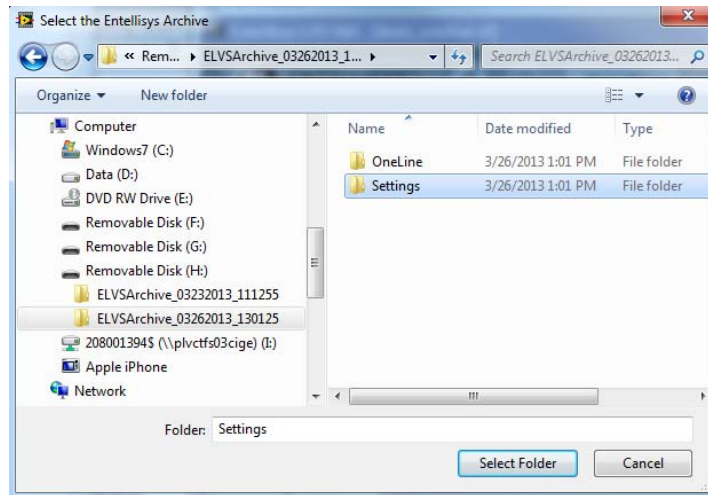
On the Entellisys HMI create an archive from the **Backup\Restore Archive** tab.

Figure 3-2 Taking an archive from the Entellisys HMI



Once archive is complete, insert the USB into the PC running the test kit software and choose the "Import Settings from Archive" from the "File" menu. Select the archive directory and click **Select Folder**

Figure 3-3 Importing an Entellisys archive



Enter a new name for the imported lineup and click Ok.

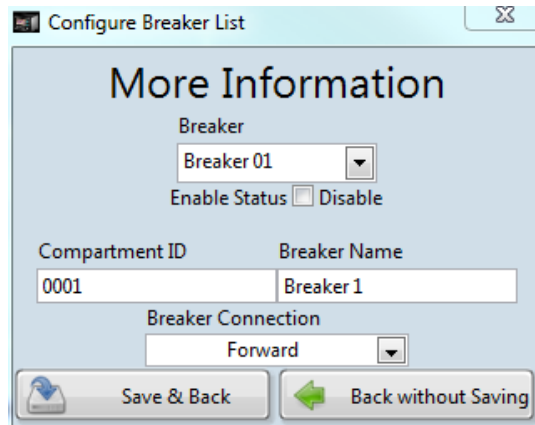
3.1.3 Manually configuring a lineup

Finally, if network connectivity or Entellisys archive is unavailable, then the system can be configured manually. To configure a lineup manually, settings and rating must be manually configured for each breaker.

NOTE: Any errors in the breaker or relay settings could result in apparent test failures.

1. Create a new lineup and fill in the **Lineup Information**.
2. Click on "Configure Breakers" and enable each breaker in the system and set the Compartment name and Breaker name. Leave power connection as Forward. When completed, click "Save and Back."

Figure 3-4 Manually configuring breakers

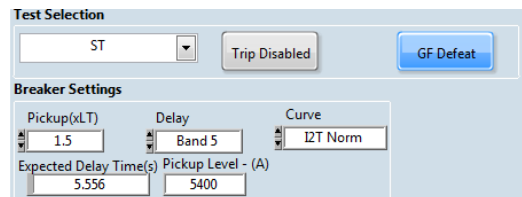


The screenshot shows a window titled "Configure Breaker List" with a close button in the top right. The main content area is titled "More Information" and contains the following fields and controls:

- Breaker:** A dropdown menu with "Breaker 01" selected.
- Enable Status:** A checkbox labeled "Disable" which is currently unchecked.
- Compartment ID:** A text field containing "0001".
- Breaker Name:** A text field containing "Breaker 1".
- Breaker Connection:** A dropdown menu with "Forward" selected.
- Buttons:** At the bottom, there are two buttons: "Save & Back" (with a blue folder icon) and "Back without Saving" (with a green left arrow icon).

3. Manually set Pickup, delay and type for each overcurrent function or relay to be tested.

Figure 3-5 Manually set trip settings in test kit



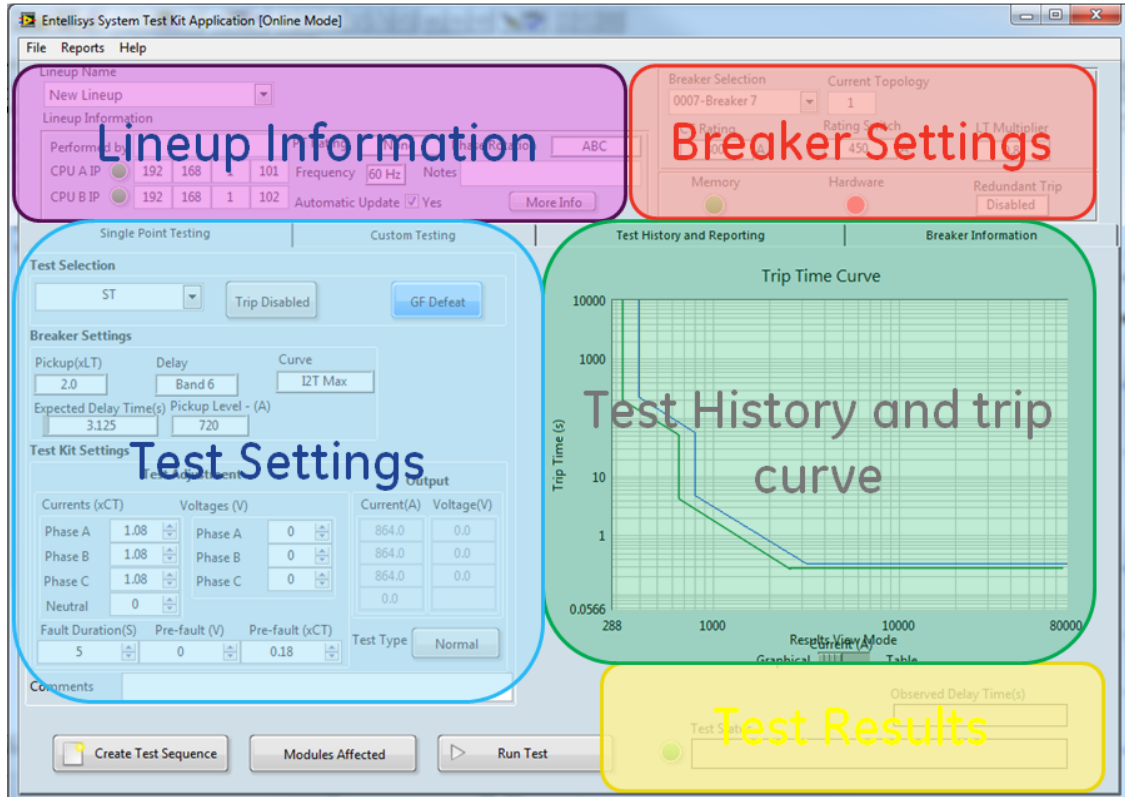
The screenshot shows a window titled "Test Selection" with the following elements:

- Test Selection:** A dropdown menu with "ST" selected, a "Trip Disabled" button, and a "GF Defeat" button.
- Breaker Settings:** A section containing several input fields:
 - Pickup(xLT):** A spinner box set to "1.5".
 - Delay:** A dropdown menu with "Band 5" selected.
 - Curve:** A dropdown menu with "I2T Norm" selected.
 - Expected Delay Time(s):** A spinner box set to "5.556".
 - Pickup Level - (A):** A spinner box set to "5400".

3.2 User Interface

The user interface is organized so all the information is available to the user. Also, the user has the ability to change any of the parameters during the testing process.

Figure 3-6 The mainscreen overview



3.2.1 Lineup Information

The Customer Test Kit allows for creation of unique line ups. Each lineup, will consist of it's own set of breakers and site configuration. The lineup information control group stores all information related to the Entellisys lineup as a whole.

Figure 3-7 Lineup Information

The screenshot shows the 'Lineup Information' form. It includes a 'Lineup Name' dropdown menu with '3rd Floor Lab' selected. Below this is a 'Lineup Information' section with a 'Performed by' field, a 'PT Rating' dropdown (480V WYE), and a 'Phase Rotation' dropdown (ABC). There are also input fields for 'Frequency' (60 Hz) and 'Notes'. At the bottom, there is an 'Automatic Update' checkbox checked and a 'More Info' button.

3.2.1.1 Controls

Lineup Name: Select from any number of previously configured lineups. Type in text to create a new lineup.

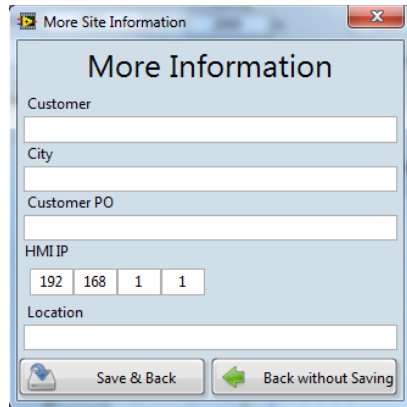
CPUA and CPUB IP address controls: Enter the IP address of the Entellisys CPUs

PT Rating, Frequency and Phase rotation controls: Global Entellisys settings that affect which tests are enabled, the output frequency and phase relationships of the output signals of the test kit.

Performed by and Notes fields: Optional fields. Enter the test engineer’s name and any misc information.

More Info: Provides fields to add additional site specific information

Figure 3-8 More information dialog

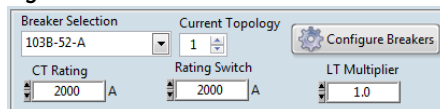
A screenshot of a software dialog box titled "More Site Information". The dialog has a light blue header with the title "More Information". Below the header, there are several input fields: "Customer", "City", "Customer PO", and "Location", each with a text box. Below these is a section for "HMI IP" with four small input boxes containing the values "192", "168", "1", and "1". At the bottom of the dialog, there are two buttons: "Save & Back" with a floppy disk icon and "Back without Saving" with a green arrow icon.

3.2.2 Breaker Settings

The breaker settings control group gives all breaker related information. Select the breaker of interest in the pulldown and the **Test Settings** will be populated.

In the offline mode, the user can also configure breakers manually.

Figure 3-9 Breaker Selection

A screenshot of a software control group titled "Breaker Selection". It contains a pulldown menu showing "103B-52-A". To the right of the pulldown is a "Current Topology" section with a small display showing "1" and a "Configure Breakers" button with a gear icon. Below the pulldown, there are three input fields: "CT Rating" with a value of "2000 A", "Rating Switch" with a value of "2000 A", and "LT Multiplier" with a value of "1.0".

3.2.2.1 Controls

Breaker Selection: Select the breaker to be tested.

Current Topology: For Entellisys 4.5 and later, each single point relay can have different settings depending on the topology. Generally speaking, the source and tie breakers are considered “topology breakers” and are assigned a topology for each possible state combination. Entellisys provides individual settings for each topology. Therefore, the topology should be known when determining the correct pickup and delay settings.

When **Automatic Update** is enabled, the topology will be automatically updated from the CPU. In **manual mode**, the current topology can be viewed in the overcurrent overview screen in the Entellisys HMI. (**Main menu / User Settings / Overcurrent Protection**)

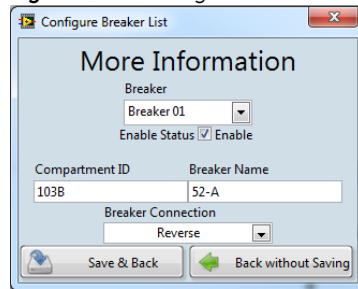
CT Rating: The rating of the current sensors installed in the breaker cubical. Refer to table on switchgear front view drawing or from the HMI Overcurrent Protection screen.

Rating Switch and LT Multiplier: The rating switch and LT Multiplier will reflect the position of the rating switch and LT Settings knob located on the front of the Messenger.

Configure Breakers button will be displayed if the system is off-line from the CPUs, each breaker of interest must be added to the test kit configuration manually. Select the breaker, check the “Enable Status” checkbox and update the desired breaker name fields.

Click “**Save & Back**” to return to the main screen.

Figure 3-10 Configure Breakers



The screenshot shows a window titled "Configure Breaker List" with a sub-header "More Information". It contains the following fields and controls:

- Breaker:** A dropdown menu currently showing "Breaker 01".
- Enable Status:** A checkbox labeled "Enable" which is checked.
- Compartment ID:** A text field containing "1038".
- Breaker Name:** A text field containing "52-A".
- Breaker Connection:** A dropdown menu currently showing "Reverse".
- Buttons:** At the bottom, there are two buttons: "Save & Back" (with a blue arrow icon) and "Back without Saving" (with a green arrow icon).

3.2.2.2 Manually configuring breakers

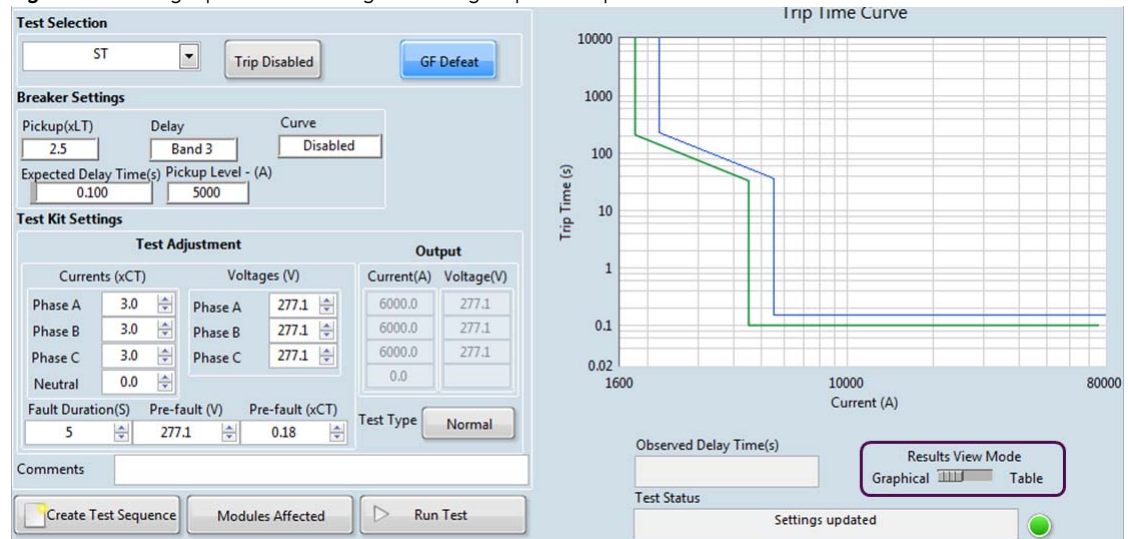
When off-line from the CPUs, breakers can be named manually. **CT Rating, Rating Switch, and LT Multiplier** can all freely be changed. Once a breaker is configured, the Test Settings will become active.

Note: Manual settings will be overwritten when an archive is imported or the test kit software is communicating to the CPU.

3.3 Single point testing tab

The Customer Test kit application will pre-populate the “Breaker Settings” parameters relevant to the selected test. The current and voltage output settings are pre-set to values that are 10% above the pickup threshold. The settings are adjustable by the user for any test.

Figure 3-11 Single point test settings control group with trip time curve



For overcurrent relays, the associated trip time curve is drawn.

Results View Mode: The test results can also be shown in table form.

3.3.1 Breaker Settings

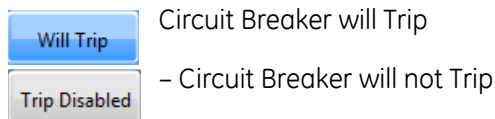
The relevant breaker settings are displayed for each test and can be changed when the Customer Test Kit is off-line from the Entellisys CPUs.

If off-line, care must be taken to ensure that the pickup, delay and curve settings match the breaker under test to successfully execute a test.

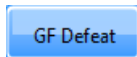
Expected Delay Time and Pickup Level

The Customer Test Kit software will automatically compute the expected trip time for the circuit breaker under test depending on Protection elements and update **Expected Delay Time** and the **Trip Time Curve** on the right.

Trip Disabled Button specifies whether or not the test will physically trip the circuit breaker.



GF Defeat button 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 be temporarily defeated during the test period.



– GF will Resume/Run as Normal.

Note: After the test has concluded, Ground Fault will resume automatically. This feature is enabled only when Ground Fault is enabled on the selected circuit breaker.

3.3.2 Test Kit Settings

The software will update the test kit settings according to test and relay settings selected in **Test Selection** and in **Breaker Settings**.

Each test sequence there is a “pre-Fault” time period, then a “Fault”

Test Adjustment

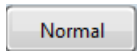
Currents (xCT) Fault currents are given in xCT. Range: 0-28x.

Voltages (V) Fault voltages are given in Volts. Range: 0 - 1.9 x PT rating for Delta PTs and 1.9xPhase voltages on WYE PTs.

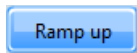
Fault Duration (S) Number of seconds the fault current will be injected into the Messenger.

Pre-Fault (V) & Pre-Fault (xCT) Voltage & current levels for the pre-fault portion of the test. Should be below the pickup threshold of any active protection relay.

Test Type: Select between Normal or ramp-up



– Normal single point test



– Ramp-up test

3.3.3 Test Selections

The Test kit software will detect which relays are available to be tested for the selected breaker. The available relays will be enabled in the **Test Selection** pulldown.

3.3.3.1 Overcurrent Tests (IOC/ST/LT/GF)

The overcurrent tests verify the overcurrent protection functions for a circuit breaker in the system. The test can be performed as either a trip or no trip test.

Instantaneous Overcurrent (IOC) 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.

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.

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.

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.

- IOC
- ✓ ST
- LT
- GF
- Over Voltage
- Under Voltage
- Reverse Power
- Phase Loss
- Over Frequency
- Under Frequency
- Over Voltage Alarm
- Under Voltage Alarm
- Reverse Power Alarm
- Phase Loss Alarm
- Over Frequency Alarm
- Under Frequency Alarm
- LT Backup
- ST Backup
- GF Backup
- High Current Alarm

3.3.3.2 Voltage and frequency relays

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.

3.3.3.3 Messenger Backup Tests (LT / ST / GF)

The Entellisys architecture provides redundant overcurrent protection through Messenger backup. LT/ST/GF overcurrent relays are running on both CPUs and locally at each Messenger. However, the Messenger's trip signal is typically generated by the CPUs as it is running with smaller delay settings and therefore the Test Kit's trip signal originates from the CPU.

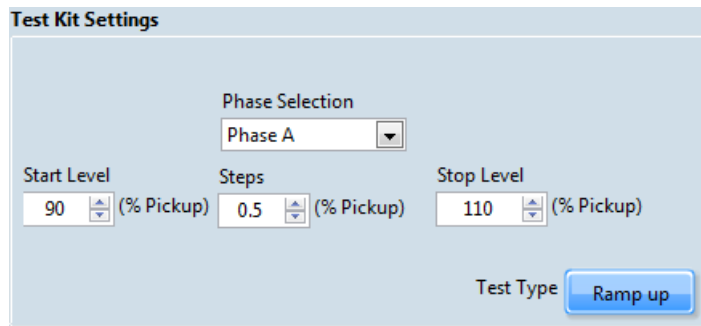
To test the overcurrent relays running locally on the Messenger, the **Messenger Backup Tests** output fault currents until the CPU detects a trip generated from the Messenger.

The backup tests test the Messenger's local LT/ST and GF test settings. The settings are pre-configured and require connectivity to the CPU.

3.3.3.4 Ramp up Test

Each of the tests have a ramp-up function. The ramp-up test will begin at an adjustable start level and will test at each current level until the trip signal is detected.

Figure 3-12 Ramp-up Test controls

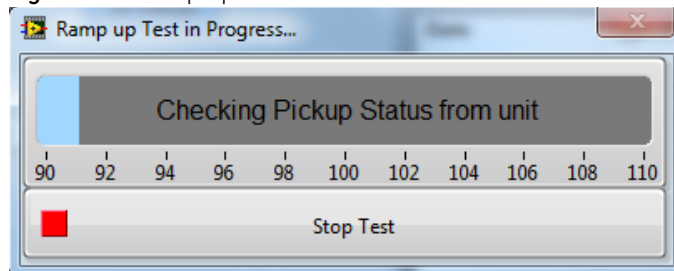


The 'Test Kit Settings' dialog box contains the following controls:

- Phase Selection:** A dropdown menu currently set to 'Phase A'.
- Start Level:** A numeric input field set to '90' with a unit label '(% Pickup)'.
- Steps:** A numeric input field set to '0.5' with a unit label '(% Pickup)'.
- Stop Level:** A numeric input field set to '110' with a unit label '(% Pickup)'.
- Test Type:** A button labeled 'Ramp up'.

Adjust the start, step and stop parameters. Click the **Run Test** button. The Test application will run through each of the tests until a trip signal is detected.

Figure 3-13 Ramp-up test

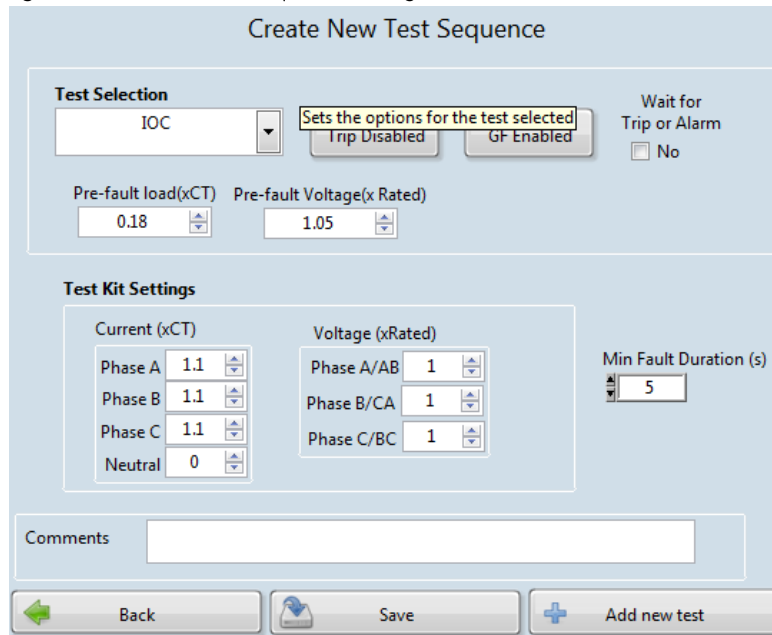


3.4.1 Creating a test sequence

From the “**Custom Testing**” tab, click the **Create** or **Edit button**. The custom testing dialog will appear as shown in Figure 3-15 with default values.

Alternatively, after selecting one of the default tests in the **Single Point Testing** tab, click on the **Create Test Sequence** button on the same tab and the test sequence will appear with values configured in the **Test Kit Settings**.

Figure 3-15 Create test sequence dialog



The dialog box is titled "Create New Test Sequence". It contains several sections for configuring a test sequence.

- Test Selection:** A dropdown menu is set to "IOC". To its right are two buttons: "Trip Disabled" and "GF Enabled". A tooltip "Sets the options for the test selected" points to these buttons. Further right is a checkbox labeled "Wait for Trip or Alarm" with the value "No".
- Pre-fault load(xCT):** A spinner box set to "0.18".
- Pre-fault Voltage(x Rated):** A spinner box set to "1.05".
- Test Kit Settings:**
 - Current (xCT):** A table with four rows: Phase A (1.1), Phase B (1.1), Phase C (1.1), and Neutral (0). Each value is in a spinner box.
 - Voltage (xRated):** A table with three rows: Phase A/AB (1), Phase B/CA (1), and Phase C/BC (1). Each value is in a spinner box.
 - Min Fault Duration (s):** A spinner box set to "5".
- Comments:** A text input field.
- Buttons:** At the bottom are three buttons: "Back" (with a left arrow), "Save" (with a floppy disk icon), and "Add new test" (with a plus icon).

The test sequence dialog will appear first. Configure the first test. Select the test from the **Test Selection** pulldown and then configure:

- **Pre-fault Voltage:** Given in xPT Rating
- **Test Kit Currents:** Given in xCT
- **Test Kit Voltages:** Given in xPT Rating
- **Min Fault Duration:** Time the fault current will be injected into the Messenger.
- **Wait for Trip or Alarm:** Indicates to the Customer Test Kit application that must wait for trip or alarm events from the Entellisys CPU before continuing.

Add new test: Add a new test to the current test sequence.

Save: Save the test sequence.

Back: Exit to the main user interface.

3.5 Test History and Reporting tab

The Customer Test Kit software will retain the entire test history for each breaker installed in each lineup. The **Generate Report** button will generate an Excel report and requires Microsoft Excel 2010 or later.

Figure 3-16 The test history tab

Filter Results

View All Results

Selected Breaker(s) ☐ Current Breaker

Generate Report

Date	Tester	Breaker	Type of Test	Pickup Setting (units)	Delay Setting	Curve(I2T/IT/Const/NA..)	Blocking Volt
06/04/13 17:21:36		0007-Breaker 7	Over Voltage Alarm Test	120.00 % (333 V)	15.0 sec	NA	NA
06/04/13 17:19:27		0007-Breaker 7	ST Test	2.00 (720 A)	Band 6	I2T Max	NA
06/04/13 16:42:12		0007-Breaker 7	Under Frequency Alarm Test	45.00 Hz	15.0 sec	NA	Disabled
06/04/13 16:36:22		0007-Breaker 7	LT Backup Test	0.80 (360 A)	Band 4	NA	NA
06/04/13 16:35:26		0007-Breaker 7	Over Voltage Alarm Test	120.00 % (333 V)	15.0 sec	NA	NA
06/04/13 16:34:00		0007-Breaker 7	ST Test	2.00 (720 A)	Band 6	I2T Max	NA
06/04/13 16:19:30		0007-Breaker 7	ST Test - Rampup	2.00 (720 A)	Band 6	I2T Max	NA
06/04/13 16:17:59		0007-Breaker 7	Over Voltage Alarm Test	120.00 % (333 V)	15.0 sec	NA	NA
06/04/13 16:12:53		0007-Breaker 7	Over Voltage Alarm Test	120.00 % (333 V)	15.0 sec	NA	NA
06/04/13 16:11:41		0007-Breaker 7	ST Test	2.00 (720 A)	Band 6	I2T Max	NA
06/04/13 16:00:36		0007-Breaker 7	Over Voltage Alarm Test	120.00 % (333 V)	15.0 sec	NA	NA
06/04/13 15:41:25		0007-Breaker 7	Over Voltage Alarm Test	120.00 % (333 V)	15.0 sec	NA	NA
06/04/13 15:38:22		0007-Breaker 7	LT Test	0.80 (360 A)	Band 2	NA	NA
06/04/13 15:36:34		0007-Breaker 7	ST Test	2.00 (720 A)	Band 6	I2T Max	NA
06/04/13 15:22:21		0007-Breaker 7	LT Backup Test	0.80 (360 A)	Band 4	NA	NA

Clicking on Generate report, a popup dialog will ask for the selected breaker or all breakers.

Selected Breaker: Will open an Excel worksheet and create a tab for the selected breaker breaker.

All Breakers: Will open an Excel worksheet and create a tab for each breaker installed and an additional tab for the complete test history.

The breaker report includes the breaker details such as CT Rating and settings for each of the configured relays. The report will also give the latest test data for each of the overcurrent relays.

When the report is run, the Customer Test Kit Application updates the report with the observed trip time and the timestamp of when the test was performed. The application will search the test history and use the last test that matches the test type and test current

Test Report

	Test Settings		Test Value	Expected Delay Time	Measured Delay Time
	Pick-up	Delay			
Under Voltage Alarm	50.00%	5.0 Sec / Const Curv			
Over voltage Alarm	120.00%	15.0 Sec	365.8 V	15.0000(14.9000-15.1000)	Test Completed No Alarm Observed
Phase Loss Alarm	8.00%	15.0 Sec			
Reverse Power Alarm	990 KW	15.0 Sec			
Under frequency Alarm	45.0 Hz	15.0 Sec	42.8 Hz	15.0000(14.9000-15.1000)	Test Completed No Alarm Observed
Over frequency Alarm	50.0 Hz	15.0 Sec			
High Current Alarm	200.00%	15 Sec			

3.6 System Information tab

System wide information is available under the **System Information tab** arranged in sections that are selectable from the **Settings** pulldown.

Messenger Information: Includes Messenger serial number, MAC address, firmware version, and sensor ratings.

Relay Settings: Relay parameters for all single point relays.

All Settings: Messenger Information and Relay Information combined

Figure 3-18 Messenger information

Settings
Relay Settings

CCPU ID	CCPU Commissioned	CCPU Name	System Frequency	Phase Rotation
CCPU "A"	Enabled	CPU-A	60	ABC

103B-52-A	107B-52-B	105B-52-T!@#\$\$%^&*()	101B-52-E N/C	102B-52-E1
GF Protection Switch	Disabled	Disabled	Disabled	Disabled
GF Protection Trip Delay Band Setting	Band 3	Band 3	Band 3	Band 3
GF Protection Trip IZT Curve	Disabled	Disabled	Disabled	Disabled
GF Protection Trip Pickup Setting	0.24	0.24	0.24	0.24
IOC Enabled	No	No	No	Yes
IOC Pickup Setting Multiplier	6.0	6.0	6.0	6.0
IOC Type	Standard	Standard	Standard	Standard
Long Time Delay Band Setting	Band 2	Band 2	Band 2	Band 2
NodeProt Ground Fault Setting	Disabled	Disabled	Disabled	Disabled
NodeProt IOC Threshold Setting	0.0	0.0	0.0	6.0
NodeProt Long Time Setting Multiplier	1.00	0.50	0.50	0.50
NodeProt Rating Switch	2000	800	750	1500
NodeProt Short Time Setting	Enabled	Enabled	Enabled	Enabled
OF Alarm Blocking Voltage Enable	Disabled	Disabled	Disabled	Disabled
OF Alarm Enable	Disabled	Disabled	Disabled	Disabled
OF Alarm Pickup Setting	50.0 %	50.0 %	50.0 %	50.0 %
OF Alarm Time Delay	15.0 Sec	15.0 Sec	15.0 Sec	15.0 Sec
OF Trip Blocking Voltage Enable	Disabled	Disabled	Disabled	Disabled

A

Definition of terms

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

Table A-1 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-1 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 $+360^{\circ}$.
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