

# Entellisys 5.0 Low Voltage Switchgear Test Kit User Manual



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# DEH-503

## Warnings, Cautions, and Notes as used in this publication

### Warnings

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**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.

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### Cautions

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

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### Notes

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

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

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

Additional information:

[www.entellisis.com/support](http://www.entellisis.com/support)

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# Contents

- 1 Quick start guide
  - 1.1 Installing the application..... 1
  - 1.2 Running the application for the first time ..... 2
  - 1.3 Import settings from the Entellisys archive..... 2
  - 1.4 Select and run a test..... 3
  
- 2 Introduction
  - 2.1 Test architecture ..... 8
  - 2.2 System Requirements ..... 9
    - 2.2.1 Test Kit software requirements..... 9
    - 2.2.2 Test kit hardware specification..... 9
    - 2.2.3 Calibration ..... 10
    - 2.2.4 Replacement parts ..... 11
  
- 3 System Test Kit
  - 3.1 Importing System Settings ..... 13
    - 3.1.1 Directly from the CPU ..... 13
    - 3.1.2 Import settings from an Entellisys archive ..... 15
    - 3.1.3 Manually configuring a lineup ..... 16
  - 3.2 User Interface ..... 17
    - 3.2.1 Lineup Information ..... 17
      - 3.2.1.1 Controls..... 17
    - 3.2.2 Breaker Settings..... 18
      - 3.2.2.1 Controls..... 18
      - 3.2.2.2 Manually configuring breakers..... 19
  - 3.3 Single point testing tab ..... 20
    - 3.3.1 Breaker Settings..... 20
    - 3.3.2 Test Kit Settings ..... 21
    - 3.3.3 Test Selections ..... 22
      - 3.3.3.1 Overcurrent Tests (IOC/ST/LT/GF)..... 22
      - 3.3.3.2 Voltage and frequency relays ..... 23
      - 3.3.3.3 Messenger Backup Tests (LT / ST / GF) ..... 24
      - 3.3.3.4 Ramp up Test ..... 24
  - 3.4 Custom Testing tab..... 25
    - 3.4.1 Creating a test sequence ..... 26
  - 3.5 Test History and Reporting tab ..... 27
  - 3.6 System Information tab..... 29
  
- A Definition of terms

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# 1 Quick start guide

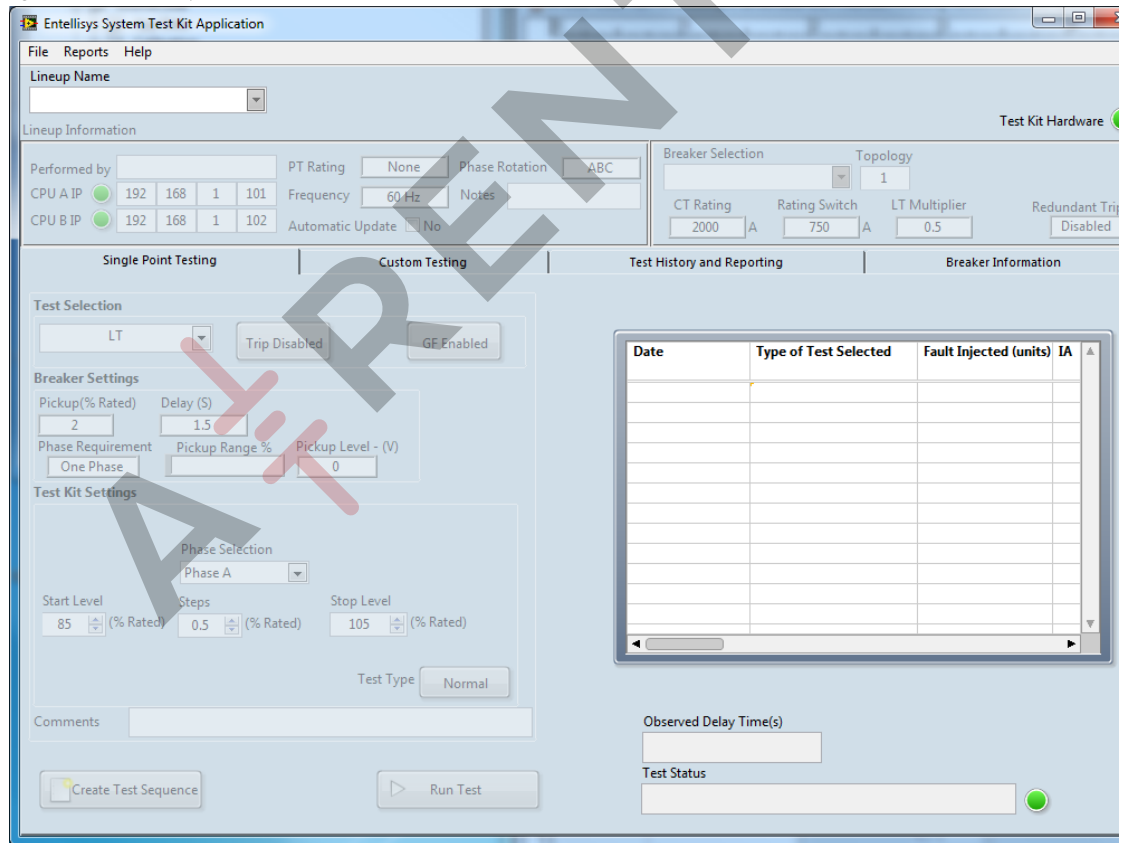
To quickly get to testing a breaker, this guide will require a current Entellisys archive to determine breaker configuration and relay settings.

## 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



## 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.

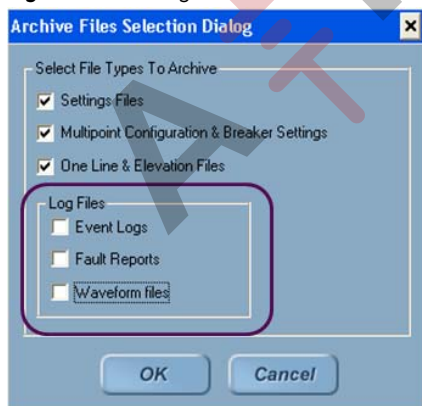
Figure 1-2 Configuring a new lineup

The screenshot shows the 'Configure Breakers' dialog box. The 'Lineup Name' field is highlighted with a red box. 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' (None), 'Frequency' (60 Hz), 'Phase Rotation' (ABC), and 'Automatic Update' (No). The 'Breaker Selection' section includes 'Breaker Selection' (CompID1-Breaker1), 'Topology' (1), 'CT Rating' (Invalid A), 'Rating Switch' (Invalid A), and 'LT Multiplier' (1.0). A 'Test Kit Hardware' status indicator is visible in the top right.

## 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

The screenshot shows the software interface for selecting and running a test. The 'Breaker Selection' pulldown is set to '0007-Breaker 7'. The 'Test Selection' pulldown is open, showing a list of tests including 'ST', 'LT', 'GF', and various alarm tests. The 'Run Test' button is highlighted. A 'Trip Time Curve' graph is visible on the right, showing Trip Time (s) vs Current (A).

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

The screenshot shows the 'Trip Test in Progress...' dialog box. The dialog displays 'Running ST Test - 1 of 1' and 'Calibrating & Executing Pre-Fault Condition'. A red square indicates the test is in progress. A 'Stop Test' button is visible, with a tooltip that says 'Click to terminate the testing process'.

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## 2

# 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 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



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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.

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



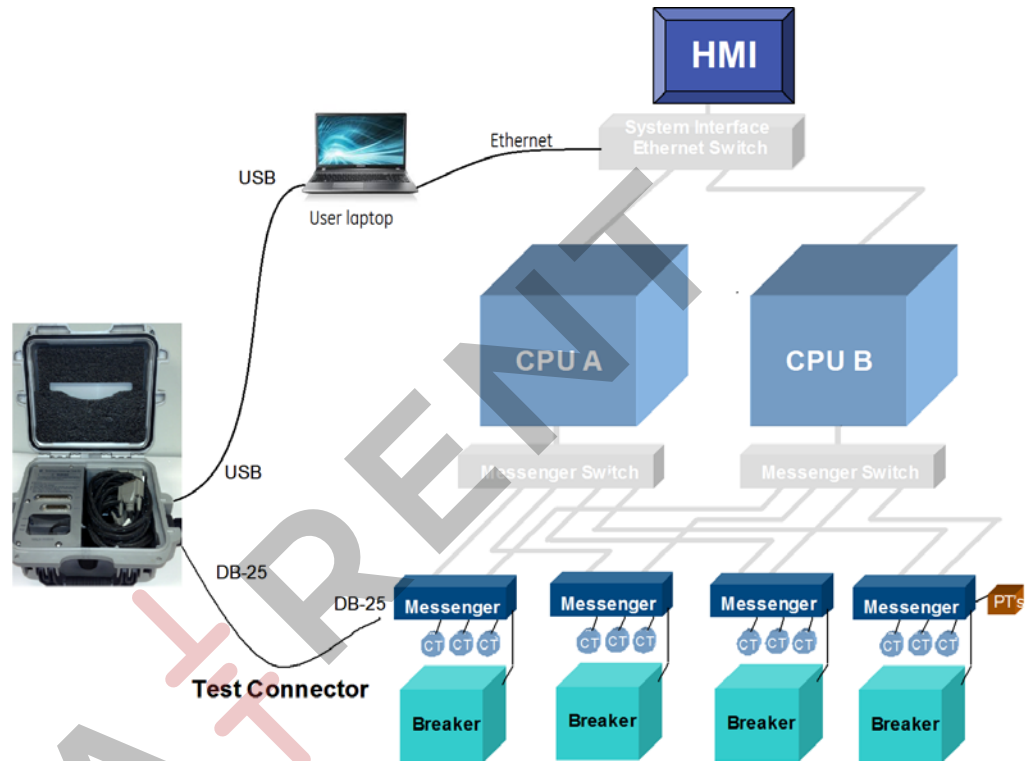
The HMI will indicate that the unit is in Test Mode. It will also record the analog test signals and trip responses in the waveform capture (viewable in the HMI event log).

## 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.

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## 2.2 System Requirements

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### 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)

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### 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	±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 Entellisis System Accuracy.

**Table 2-3** 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%

## 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'. Under 'Lineup Information', 'Performed by' is empty, 'CPU A IP' is 192.168.1.101, and 'CPU B IP' is 192.168.1.102. 'PT Rating' is 480V WYE, 'Frequency' is 60 Hz, and 'Phase Rotation' is ABC. 'Automatic Update' is set to 'No'. Under 'Breaker Selection', 'Breaker Selection' is 0007-Breaker 7, 'Topology' is 1, and 'Configure Breakers' is a button. 'CT Rating' is 1600 A, 'Rating Switch' is 1600 A, 'LT Multiplier' is 1.0, and 'Redundant Trip' is Enabled. A 'Test Kit Hardware' status indicator is green.

**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

**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](http://www.entellisys.com/support)

**Table 2-5** Replacement part numbers

Description	GE Part Number
Entellisys System Test Kit	ETSTESTKIT03
Custom Messenger Test Cable	ETSMGRCABLE
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

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# 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 software window titled "Lineup Information". It contains several input fields and a table. The "Automatic Update" checkbox is checked and highlighted with a red box.

Performed by	Field Engineer	PT Rating	None	Phase Rotation	ABC
CPU A IP	192 168 1 101	Frequency	60 Hz	Notes	
CPU B IP	192 168 1 102	Automatic Update	<input checked="" type="checkbox"/> Yes	More Info	

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

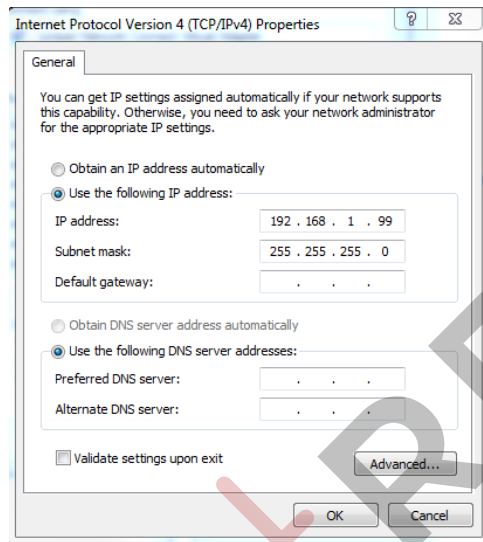
**Modbus TCP/IP network connectivity:**

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

Entellisis 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 Entellisis 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 Entellisis system:

1. Go to the Entellisis 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 Entellisis CPUs. The right most number must be unique.

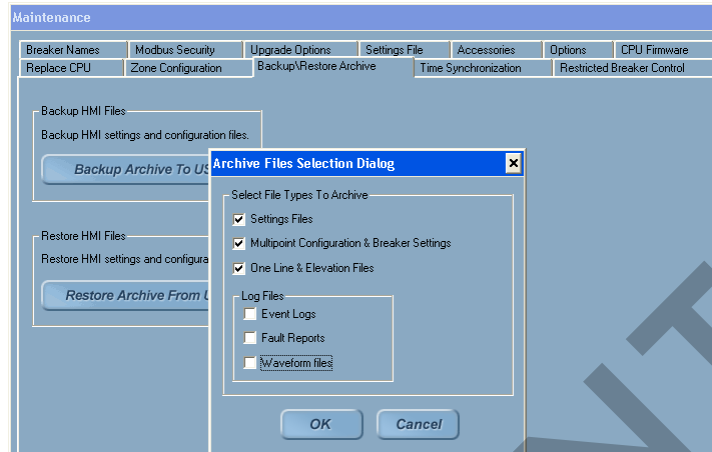


### 3.1.2 Import settings from an Entellisis archive

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

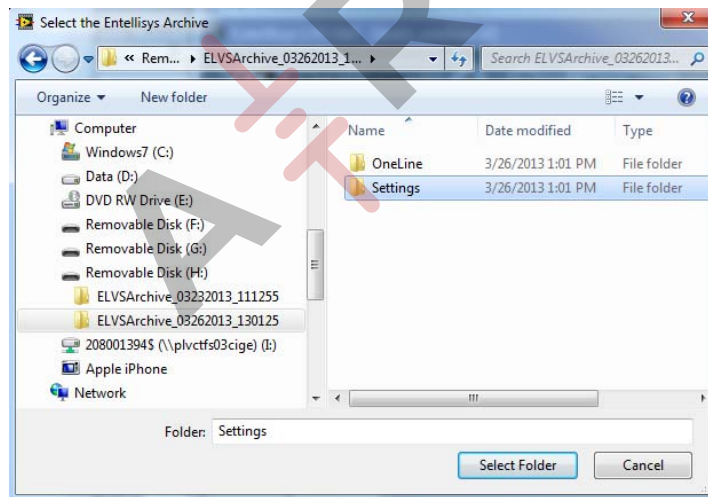
On the Entellisis HMI create an archive from the **Backup\Restore Archive** tab.

**Figure 3-2** Taking an archive from the Entellisis 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 Entellisis archive



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

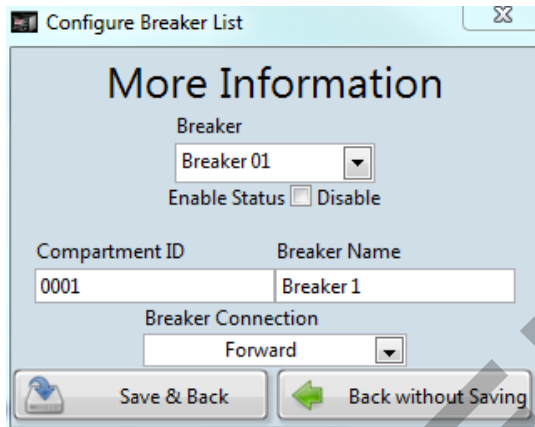
### 3.1.3 Manually configuring a lineup

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

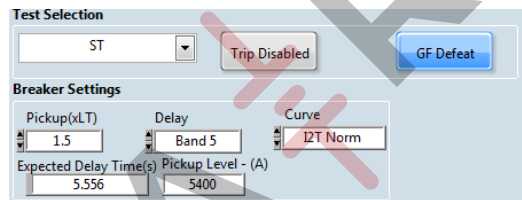


The screenshot shows a software window titled "Configure Breaker List". Inside, there is a section titled "More Information". It contains the following fields and controls:

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



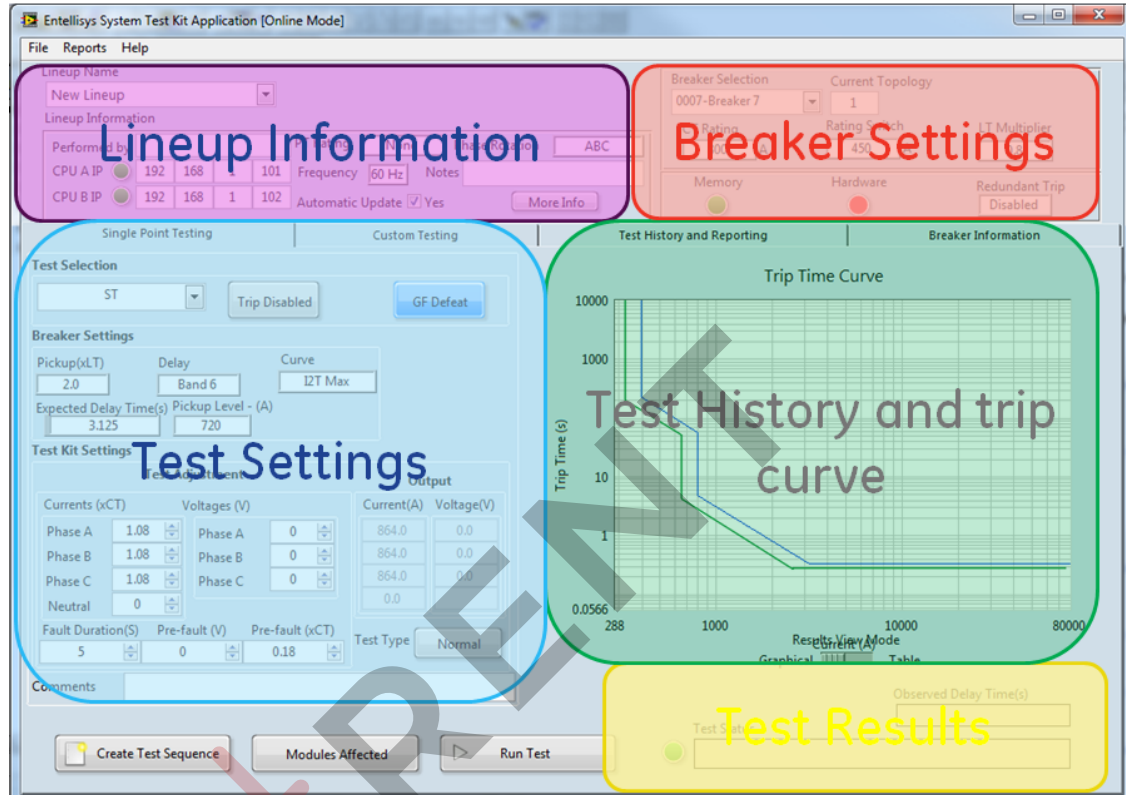
The screenshot shows a software window titled "Test Selection". It contains the following fields and controls:

- Test Selection:** A dropdown menu with "ST" selected, a "Trip Disabled" button, and a "GF Defeat" button.
- Breaker Settings:** A section with three columns of settings:
  - Pickup(xLT):** A spin 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 spin box set to "5.556".
  - Pickup Level - (A):** A spin 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.

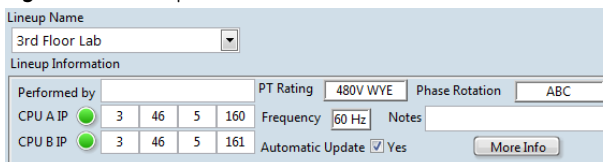
Figure 3-6 The mainscreen overview



### 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 Entellisis lineup as a whole.

Figure 3-7 Lineup Information



#### 3.2.1.1 Controls

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

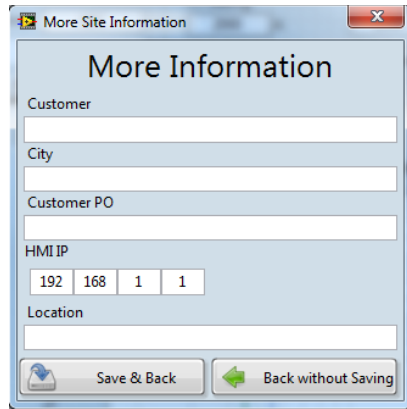
**CPUA and CPUB IP address controls:** Enter the IP address of the Entellisis CPUs

**PT Rating, Frequency and Phase rotation controls:** Global Entellisis 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

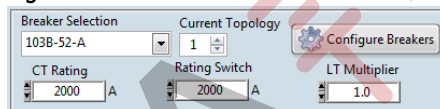


## 3.2.2 Breaker Settings

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



### 3.2.2.1 Controls

**Breaker Selection:** Select the breaker to be tested.

**Current Topology:** For Entellisis 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. Entellisis 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 Entellisis 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.

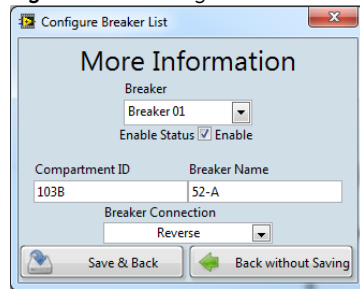
**Rating Switch and LT Multiplier:** The rating switch and LT Multiplier will reflect the position of the rating switch and LT Settings knob located on the front of the Messenger.



**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



### 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.

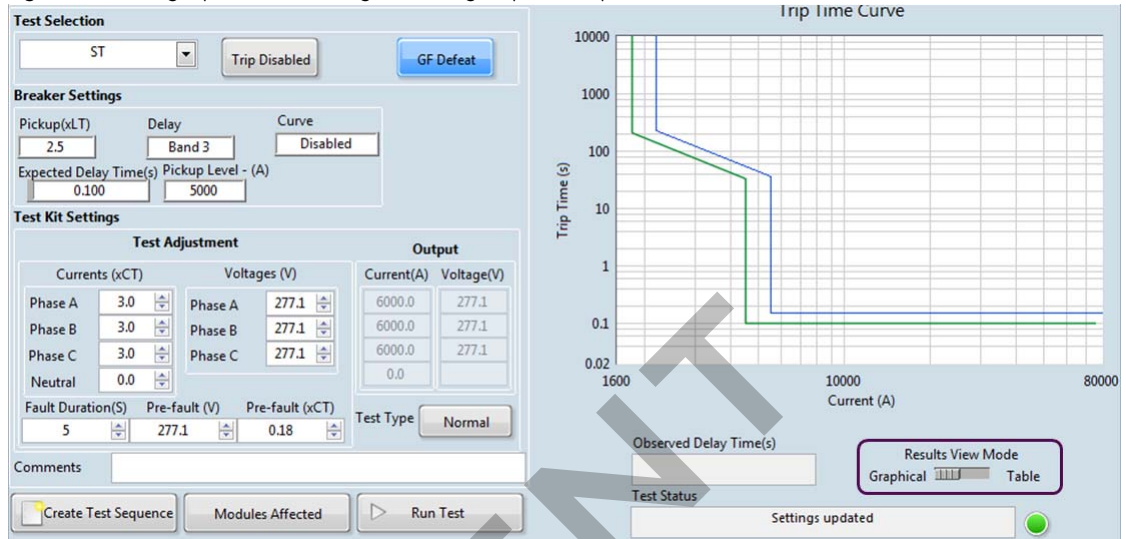
**Note:** Manual settings will be overwritten when an archive is imported or the test kit software is communicating to the CPU.

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## 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

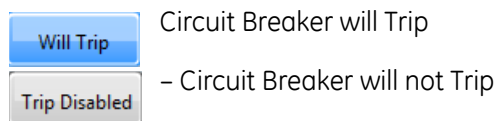
The relevant breaker settings are displayed for each test and can be changed when the Customer Test Kit is off-line from the Entellisys CPUs.

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.

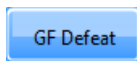
#### Expected Delay Time and Pickup Level

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

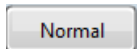
**Currents (xCT)** Fault currents are given in xCT. Range: 0-28x.

**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.

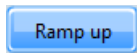
**Fault Duration (S)** Number of seconds the fault current will be injected into the Messenger.

**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.

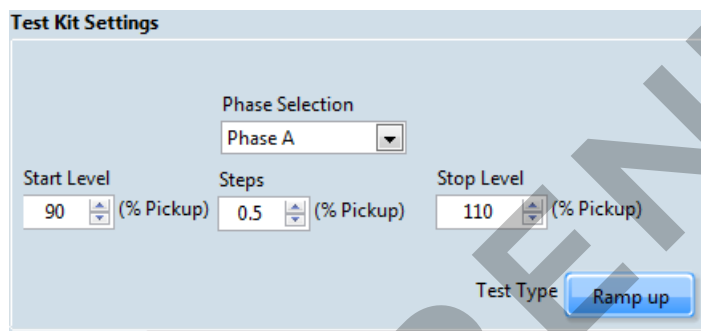
To test the overcurrent relays running locally on the Messenger, the **Messenger Backup Tests** output fault currents until the CPU detects a trip generated from the Messenger.

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

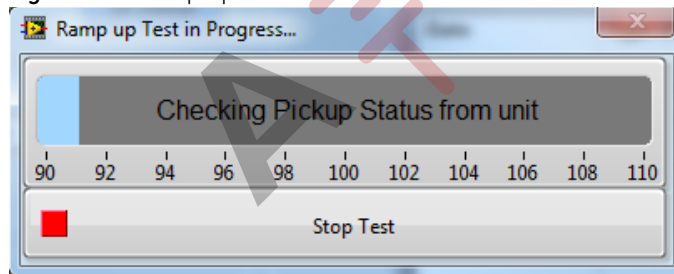
Each of the tests have a ramp-up function. The ramp-up test will begin at an adjustable start level and will test at each current level until the trip signal is detected.

Figure 3-12 Ramp-up Test controls



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.

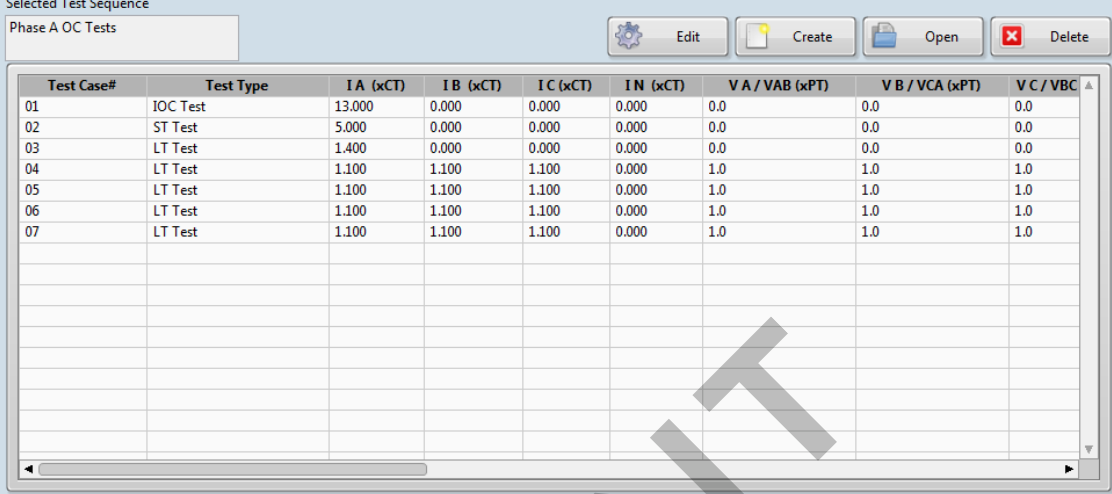
Figure 3-13 Ramp-up test



## 3.4 Custom Testing tab

The customer test kit provides the capability to create test scripts. The user can store and recall test sequences comprised of custom settings or multiple tests.

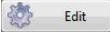
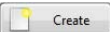
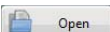
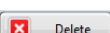
**Figure 3-14** The Custom Testing Interface



The screenshot shows a software window titled "Selected Test Sequence" with a sub-header "Phase A OC Tests". At the top right are four buttons: "Edit" (gear icon), "Create" (document icon), "Open" (folder icon), and "Delete" (red X icon). Below these is a table with the following data:

Test Case#	Test Type	I A (xCT)	I B (xCT)	I C (xCT)	I N (xCT)	V A / VAB (xPT)	V B / VCA (xPT)	V C / VBC
01	IOC Test	13.000	0.000	0.000	0.000	0.0	0.0	0.0
02	ST Test	5.000	0.000	0.000	0.000	0.0	0.0	0.0
03	LT Test	1.400	0.000	0.000	0.000	0.0	0.0	0.0
04	LT Test	1.100	1.100	1.100	0.000	1.0	1.0	1.0
05	LT Test	1.100	1.100	1.100	0.000	1.0	1.0	1.0
06	LT Test	1.100	1.100	1.100	0.000	1.0	1.0	1.0
07	LT Test	1.100	1.100	1.100	0.000	1.0	1.0	1.0

### Controls

-  Edit Edit current test - can also double click on any of the records.
-  Create Create new custom test script.
-  Open Open an existing test sequence
-  Delete Delete an existing test sequence.

**CAUTION:** The test entries can be rearranged by highlighting and dragging. They can also be copied by pressing the CTL key while moving.

### Running a test sequence

To run a test sequence, click the **Open** button to open a saved test sequence. Click **Run Tests** to run all the tests OR highlight one or more of the tests to run a subset.

### 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 screenshot shows the 'Create New Test Sequence' dialog box. It has a title bar and several sections. The 'Test Selection' section has a dropdown menu with 'IOC' selected, and two buttons: 'Trip Disabled' and 'GF Enabled'. A tooltip points to these buttons with the text 'Sets the options for the test selected'. Below this is a 'Wait for Trip or Alarm' checkbox which is unchecked. The 'Pre-fault load(xCT)' is set to 0.18 and 'Pre-fault Voltage(x Rated)' is set to 1.05. The 'Test Kit Settings' section has two columns: 'Current (xCT)' and 'Voltage (xRated)'. The 'Current (xCT)' column has values for Phase A (1.1), Phase B (1.1), Phase C (1.1), and Neutral (0). The 'Voltage (xRated)' column has values for Phase A/AB (1), Phase B/CA (1), and Phase C/BC (1). To the right of these is a 'Min Fault Duration (s)' field set to 5. At the bottom, there are three buttons: 'Back', 'Save', and 'Add new test'.

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

Date	Tester	Breaker	Type of Test	Pickup Setting (units)	Delay Setting	Curve(I2T/IT/Const/NA..)	Blocking Vol
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

Figure 3-17 Example Test Report

## Test Report

Date: Wed, Jun 05, 2013 Customer Site: \_\_\_\_\_ City Customer PO: \_\_\_\_\_  
 Time: 8:53 AM Test Config: \_\_\_\_\_

Performed by: \_\_\_\_\_  
 Notes: \_\_\_\_\_

**Equipment Data:**

Breaker Name:	<u>Breaker 7</u>	Cubicle Number:	<u>7</u>
Substation:	_____	Manufacturer:	<u>GE</u>
Type:	<u>EG</u>	Serial Number:	_____
Cat:	_____	Voltage Rating:	<u>480V WYE</u>
Control Voltage Rating:	<u>120V AC</u>	Phases:	<u>3</u>
Messenger Cat #:	_____	Messenger Serial #:	<u>MF0A11000086</u>

**Trip Device Data/Settings:**

<b>Topology</b>	<u>1</u>	Sensor Size:	<u>800 A</u>
Frame Size:	<u>800 A</u>	Current Switch Setting:	<u>0.8</u>
Rating Switch Setting:	<u>450 A</u>	Instantaneous Setting:	<u>NA</u>
Long Time Delay:	<u>Band 2</u>	Short Time Delay:	<u>Band 6 / I2T Max</u>
Short Time Setting:	<u>2</u>	Ground Fault Delay:	<u>Band 3 / I2T ON</u>
Ground Fault Setting:	<u>0.24</u>	Under Voltage Delay:	<u>30.0 Sec / Const Curve</u>
Under Voltage Pickup:	<u>50.00%</u>	Over Voltage Delay:	<u>30.0 Sec</u>
Over Voltage Pickup:	<u>120.00%</u>	Phase Loss Delay:	<u>30.0 Sec</u>
Phase Loss Pickup:	<u>8.00%</u>	Reverse Power Delay:	<u>30.0 Sec</u>
Reverse Power Pickup:	<u>990 KW</u>	Over Frequency Delay:	<u>30.0 Sec</u>
Over Frequency Pickup:	<u>50.0 Hz</u>	Under Frequency Delay:	<u>30.0 Sec</u>
Under Frequency Pickup:	<u>45.0 Hz</u>	Under Voltage Alarm Delay:	<u>15.0 Sec / Const Curve</u>
Under Voltage Alarm Pickup:	<u>50.00%</u>	Over Voltage Alarm Delay:	<u>15.0 Sec</u>
Over Voltage Alarm Pickup:	<u>120.00%</u>	Phase Loss Alarm Delay:	<u>15.0 Sec</u>
Phase Loss Alarm Pickup:	<u>8.00%</u>	Reverse Power Alarm Delay:	<u>15.0 Sec</u>
Reverse Power Alarm Pickup:	<u>990 KW</u>	Over Frequency Alarm Delay:	<u>15.0 Sec</u>
Over Frequency Alarm Pickup:	<u>50.0 Hz</u>	Under Frequency Alarm Delay:	<u>15.0 Sec</u>
Under Frequency Alarm Pickup:	<u>45.0 Hz</u>	High Current Alarm Delay:	<u>15 Sec</u>
High Current Alarm Pickup:	<u>200%</u>		

Perform the following tests using the Entellisis Test Kit.

	Test Settings		Test Current		Expected Delay Time	Measured Delay Time		
	Pick-up	Delay	% CT	Amps		A	B	C
Long Time	360.0 A	Band 2	81	648.0 A				
Short Time	720.0 A	Band 6 / I2T Max	99	792.0 A				
Instantaneous	NA	NA	NA	NA				
Ground Fault	192.0 A	Band 3 / I2T ON	26	211.2 A				

	Test Current	Expected Delay Time	Measured Delay Time
Long Time Backup	612.0 A	311.4187(239.6367-395.6574)	Test Stopped by operator
Short Time Backup	3888.0 A	0.4000(0.3840-0.4160)	Backup Trip Not Observed
Ground Fault Backup			

	Test Settings		Test Value	Expected Delay Time	Measured Delay Time
	Pick-up	Delay			
Under Voltage	50.00%	0.0 Sec / Const Curv			
Over voltage	120.00%	30.0 Sec			
Phase Loss	8.00%	30.0 Sec			
Reverse Power	990 KW	30.0 Sec			
Under frequency	45.0 Hz	30.0 Sec			
Over frequency	50.0 Hz	30.0 Sec			

	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	CCPU ID	CCPU Commissioned	CCPU Name	System Frequency	Phase Rotation
Relay Settings	CCPU "A"	Enabled	CPU-A	60	ABC
	107B-52-A	107B-52-B	105B-52-T1@#\$%^&*0	101B-52-E-N/C	102B-52-E1
GF Protection Switch	Disabled	Disabled	Disabled	Disabled	Disabled
GF Protection Trip Delay Band Setting	Band 3	Band 3	Band 3	Band 3	Band 3
GF Protection Trip IZT Curve	Disabled	Disabled	Disabled	Disabled	Disabled
GF Protection Trip Pickup Setting	0.24	0.24	0.24	0.24	0.24
IOC Enabled	No	No	No	No	Yes
IOC Pickup Setting Multiplier	6.0	6.0	6.0	6.0	6.0
IOC Type	Standard	Standard	Standard	Standard	Standard
Long Time Delay Band Setting	Band 2	Band 2	Band 2	Band 2	Band 2
NodeProt Ground Fault Setting	Disabled	Disabled	Disabled	Disabled	Disabled
NodeProt IOC Threshold Setting	0.0	0.0	0.0	0.0	6.0
NodeProt Long Time Setting Multiplier	1.00	0.50	0.50	0.50	0.50
NodeProt Rating Switch	2000	800	750	200	1500
NodeProt Short Time Setting	Enabled	Enabled	Enabled	Enabled	Enabled
OF Alarm Blocking Voltage Enable	Disabled	Disabled	Disabled	Disabled	Disabled
OF Alarm Enable	Disabled	Disabled	Disabled	Disabled	Disabled
OF Alarm Pickup Setting	50.0 %	50.0 %	50.0 %	50.0 %	50.0 %
OF Alarm Time Delay	15.0 Sec	15.0 Sec	15.0 Sec	15.0 Sec	15.0 Sec
OF Trip Blocking Voltage Enable	Disabled	Disabled	Disabled	Disabled	Disabled

A++RENT

# 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

<b>Term</b>	<b>Definition</b>
Phase or Phase Angle	Phase angle rotation that can be set from test kit. Range of Phase angle is $-360^{\circ}$ 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