HILT-9300
Handheld Inductive Loop Tester

User's Manual
Revision 1.1
July 2024

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1. Introduction

1.1. Warnings

These safety warnings are provided to ensure the safety of personnel and proper operation of the HILT-9300.

- The HILT-9300 must not be operated beyond its specified operating range.
- The HILT-9300 should only be used by qualified and authorized traffic signal technicians or engineers who are familiar with generally accepted electrical safety practices as well as local and national safety codes.
- Safety is the responsibility of the operator.

1.2. Receiving Your Shipment

Upon receiving your shipment, be sure that the contents are consistent with the packing list. Notify your distributor or factory of any missing items. If the equipment appears to be damaged, file a claim immediately with the carrier and notify your distributor at once, giving a detailed description of any damage. Save the damaged packing container to substantiate your claim.

1.3. Packaging

The HILT-9300 Inductive Loop Tester is shipped with a hard carrying case, one set of test leads with clips, one 9V battery (not installed), and a user manual. Depending on whether you purchased the HILT-9300 only or the complete Loop Test Kit, you may have additional items included.

2. General Description

The HILT-9300 is designed to measure characteristics of an inductive loop at different frequencies, measure working parameters of the loop system, and simulate the detector by measuring the change of inductance. Additionally, megohmmeter functionality facilitates DC resistance measurements of insulation. The measurement modes can be easily switched by pressing the corresponding buttons on the keypad.

The following tests can be run to verify the condition of the loop:

- L, Q, and R_{DC} of the loop
- Change of inductance of the loop ($\Delta L/L$)
- Operating parameters of the loop system: operating mode, frequency (f_{OP}), and peak-to-peak voltage (V_{pp})
- Insulation resistance (measured in MΩ)

Where,

Q = quality factor (dimensionless)
L = inductance (μH)
R_{DC} = DC resistance (Ω)
f_{OP} = operating frequency (kHz)
V_{pp} = peak-to-peak voltage (V)

The tester offers a user-selectable frequency at which L and Q are measured. Upon receiving the HILT-9300, the default frequency is 50kHz. The frequency can easily be adjusted in the range of 20-80kHz in 1kHz increments using the keypad (see **Settings/Set, Up & Down Arrows** within the Function Controls below).

An inductance change ($\Delta L/L$) can be measured to assess the real life behavior of the loop. In this mode, the tester displays the current (live) value of the inductance change and the maximum observed change which

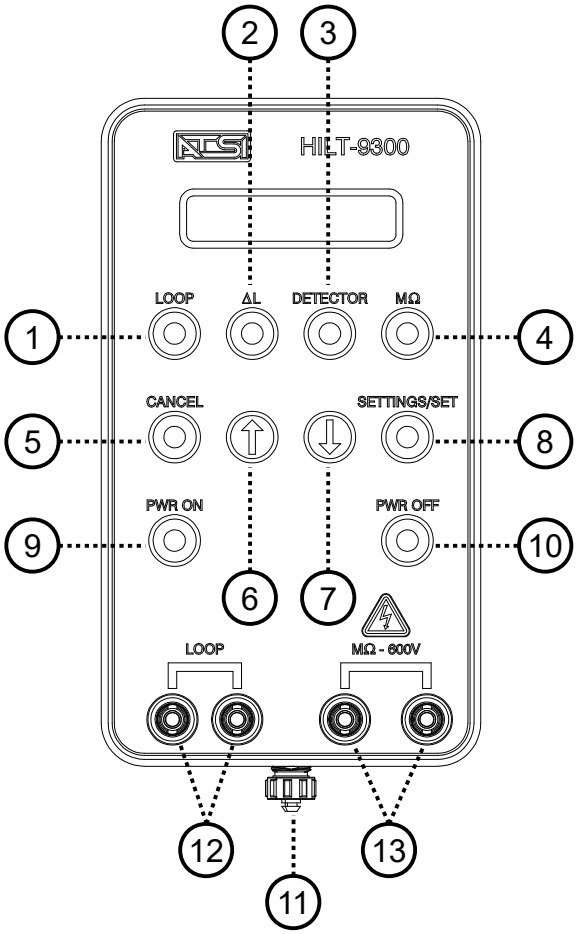
can be reset by pressing the ↓ button on the keypad.

When the loop is connected to a detector, the tester can measure the oscillating frequency and peak-to-peak voltage of the signal. In addition, the tester detects the operating mode and indicates if it is a continuous (single channel) or scanning (for most multi-channel detectors).

The tester has a 20x2-character LCD for presenting the measured values to the user. The control keypad has 8 command buttons and 2 dedicated power buttons (**PWR ON** & **PWR OFF**). The tester requires one standard 9V alkaline battery. There is an additional slot for a spare battery in the battery compartment as well. To extend the life of the battery, the tester shuts off automatically after 45 seconds of non-use.

3. Overview of HILT-9300 Controls

Figure 1



1. **LOOP:** Measures L, Q, and R_{DC}. If Q>15, the HILT will simply display "Q>15" due to resolution contraints at higher Q values
2. **ΔL:** Measures % change in inductance
3. **DETECTOR:** Measures operating parameters of the loop system: V_{pp}, Oscillating frequency, and mode
4. **MΩ:** Measures DC resistance in the range of 5-500MΩ at 500V
5. **CANCEL:** Cancels current test or returns to Home Screen from Settings Menu
6. ↑ **UP ARROW:** Navigate up in Settings or increment
7. ↓ **DOWN ARROW:** Navigate down in Settings or decrement
8. **SETTINGS/SET:** Dual purpose button used to enter Settings Menu and then used as a SET/SELECT button
9. **PWR ON:** Powers on tester when pressed and held
10. **PWR OFF:** Powers off tester when pressed
11. **USB INPUT:** USB Mini-B connection for potential future firmware updates
12. **LOOP BANANA JACKS:** Connection point for LOOP, ΔL, and DETECTOR modes
13. **MΩ BANANA JACKS:** Connection point for MΩ mode

4. Specifications

General Specifications	
Battery	1x 9V Alkaline (extra slot for spare battery)
Display	2x20 Character COG LCD | FSTN+ Display with White Backlight

Loop Test	
Measurement Type	Range & Accuracy
Inductance (L)	Range: 20 – 2400 [µH] L < 100µH: Accuracy = ±(3% of reading + 0.1µH) L >= 100µH: Accuracy = ±(3% of reading + 1µH)
Quality Factor (Q)	Range: 0 – 15 [unitless] Q <= 15: Accuracy = ±(20% of reading + 0.1) Q > 15: Q guaranteed to be > 12
DC Resistance (R_{DC})	Range: 0 – 999 [Ω] R_{DC} < 3Ω: Accuracy = ±(3% of reading + 0.3Ω) R_{DC} < 100Ω: Accuracy = ±(3% of reading + 0.1Ω) R_{DC} >= 100Ω: Accuracy = ±(3% of reading + 1Ω)

Detector Test	
Measurement Type	Range & Accuracy
Peak-to-Peak Voltage	Range: 5 – 40 [V_{pp}] Absolute Max Input Voltage: ±20V Accuracy = ±(10% of reading + 0.1V)
Frequency	Range: 20 – 80 [kHz] Accuracy = ±(1% of reading + 0.1kHz)

MΩ Test	
Measurement Type	Range & Accuracy
Megohmmeter High Voltage DC Resistance (MΩ)	Regulated Megohmmeter Output: 500V Max Megohmmeter Output: 600V Range: 5 – 500 [MΩ] < 100MΩ: Accuracy = ±(5% of reading + 0.1MΩ) >= 100MΩ: Accuracy = ±(5% of reading + 1MΩ)

5. Function Controls

PWR ON

PWR ON

To turn the tester on, press & hold the **PWR ON** button until the tester serial number and firmware version is displayed (Figure 2). If the tester has invalid or missing calibration data, the following message will be displayed next: **EEPROM calibration data corrupted! HILT accuracy cannot be ensured! Contact ATSI for service.** If this warning message is seen, the HILT will still report measurements, but the measurements will be uncalibrated raw data. When the HILT powers up normally, you will see the Home Screen (Figure 3) immediately after the serial number and firmware version screen (Figure 2). If the battery is low (< ~7.5V), the Home Screen will be slightly modified to read **LOW BATTERY Make a Selection** and will be accompanied by 3 quick beeps.

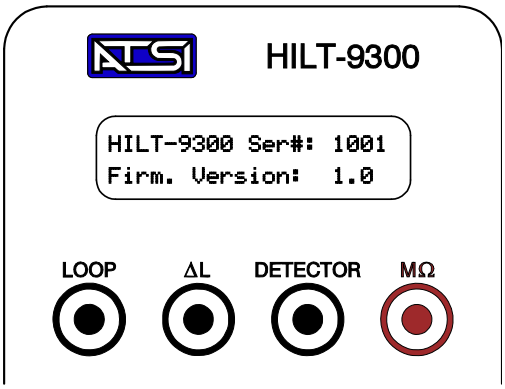


Figure 2

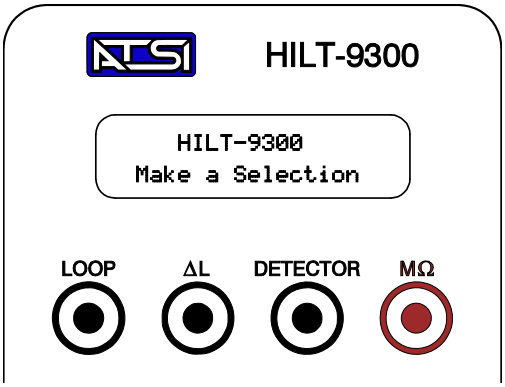


Figure 3

PWR OFF

PWR OFF

To power off the tester, press the **PWR OFF** button. The tester can be turned off at any time (unless USB is connected) by pressing the **PWR OFF** button. The tester shuts powers off automatically after 45 seconds of non-use.

SETTINGS/SET

SETTINGS/SET, UP & DOWN ARROWS

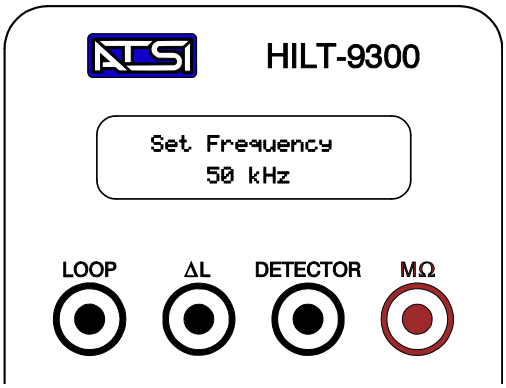


Figure 4

The **SETTINGS/SET** button functions as follows. When pressed from the Home Screen (Figure 3), the Settings Menu is entered. Within the Settings Menu, the **UP** and **DOWN ARROWS** can be used to navigate between 'Set Frequency', 'LCD Contrast', and 'Restore Setting Defaults'. Pressing **CANCEL** while in the Settings Menu will return to the Home Screen. If 'Set Frequency' or 'LCD Contrast' is shown, pressing **SETTINGS/SET** will enable Parameter Editing by use of the **UP** and **DOWN ARROWS**, which can be used to increment/decrement the parameter (see Figure 4 for frequency Parameter Editing display and Figure 5 for LCD Contrast Parameter Editing display). If 'Restore Setting Defaults' is shown, pressing **SETTINGS/SET** will reset the frequency and LCD constrast to their default settings and return to the Home Screen. Once the frequency or LCD constrast has been satisfactorily modified, pressing **SETTINGS/SET** one last time applys the change and returns to the Home Screen. Additionally, applied settings are always

preserved even when powering off the tester or changing batteries.

The tester comes with 50kHz set as the default frequency for LOOP tests. Using the flow listed above, the frequency can be changed to any value between 20 kHz and 80 kHz with 1 kHz resolution.

Besides adjusting the Settings, the **SETTINGS/SET**, **UP ARROW**, and **DOWN ARROW** have no use elsewhere, except during the **ΔL** test, where the **DOWN ARROW (↓)** can be used to reset the maximum and live values.

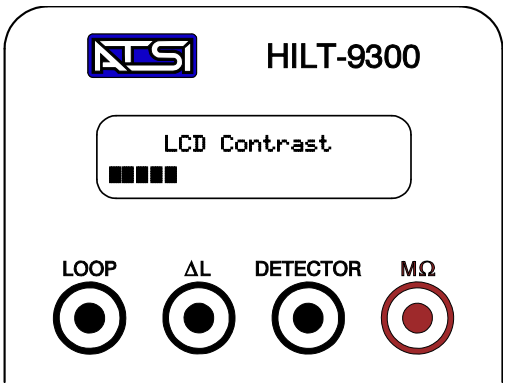


Figure 5

The **CANCEL** button can be used to exit all tests and return to the Home Screen, except for the LOOP test. Also, the **CANCEL** button can be used to exit the Settings Menu and return to the Home Screen.

Disconnect the detector from the loop before running this test. Ensure the leads are connected to the LOOP banana jacks and are twisted as shown in Figure 7. For reference, 33 twists are recommended. Failure to twist the leads can very easily add an extra 10% error to the L and Q measurements.

Attempting to switch to a different test while the measurements are being generated for the LOOP test will cancel the test. Only after the test is canceled or the results of the LOOP test are displayed can a different test be performed.

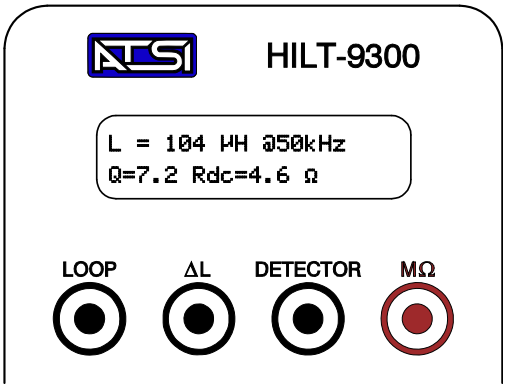


Figure 6

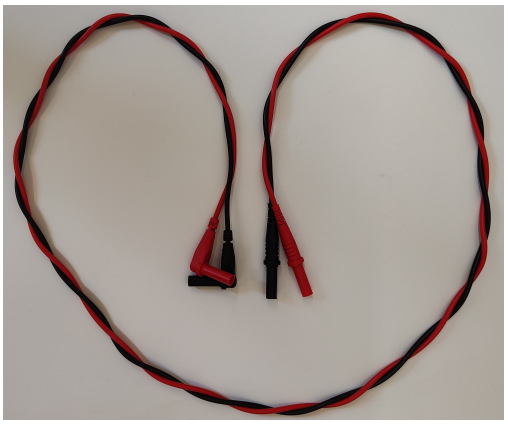


Figure 7

Connect the test leads to the loop. If there is a poor connection, the tester displays the message **Loop is not connected!** Press the **LOOP** button to begin the test. After the measurements are complete, the tester displays the results (inductance, quality factor, and DC resistance) formatted as shown in Figure 6. Note that the frequency at which L and Q were measured is also displayed. Once the test results are displayed, the button functionality is the same as if on the Home Screen.

The **LOOP** test can measure a maximum Q of 15. If Q is greater than 15, the tester displays **Q>15,** indicating a healthy Q for the loop.

Upon receiving the HILT-9300, the default frequency is 50kHz. The frequency can easily be adjusted in the range of 20-80kHz in 1kHz increments (see **Settings/Set, Up & Down Arrows** section above). The keypad sequence necessary to adjust the frequency is:

Settings/Set → *Set Frequency* → *Settings/Set* → Use ↑ & ↓ arrows to select frequency → *Settings/Set*

In this mode, after the test results are displayed, the tester will shut off automatically after 45 seconds if no buttons are pressed.

ΔL

Change of Inductance (ΔL)

Disconnect the detector from the loop before running this test. Ensure the leads are connected to the LOOP banana jacks.

Attempting to switch to a different test while the ΔL test is running will cancel the test. To exit the ΔL test, press CANCEL or wait for the test to timeout.

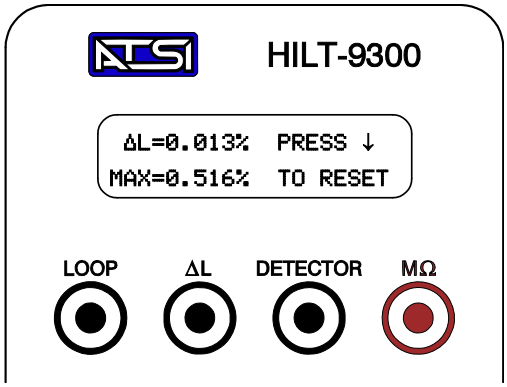


Figure 8

In this mode, the tester simulates a detector by measuring the relative change in the inductance and displaying the results.

Connect the test leads to the loop and press the **ΔL** button on the keypad. The display will appear as shown in Figure 8. The top line indicates the live change of inductance (relative to the start of the test) and the bottom line indicates the maximum live change of inductance measured. To reset the maximum and live values while the test is running, press the **DOWN ARROW** (↓) keypad button.

If there is a poor connection, the tester displays the message **No loop found!** Make sure that the test leads are properly connected. If the leads are connected to the loop and the message is still present, it means that Q of the loop is too low to generate the oscillation or the inductance is out of range. This can be verified by performing the LOOP test.

In this mode, the tester will exit the test and return to the Home Screen after 5 minutes if no buttons are pressed.

DETECTOR

DETECTOR

Verify the Loop is connected to the detection system before running this test. Ensure the leads are connected to the LOOP banana jacks. Do NOT attempt to measure a signal with a peak voltage of more than 20V in magnitude.

Disconnect the detector from the loop before running a LOOP or ΔL test.

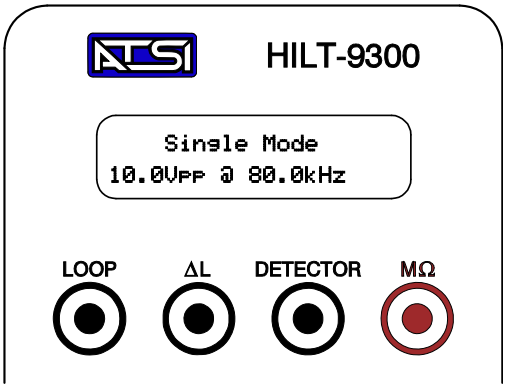


Figure 9

The purpose of this test is to measure the operating parameters of the working loop while it is connected to the detector.

Connect the test leads to the loop and press the **DETECTOR** button. During this test the measurements are constantly updated displaying the operating mode, peak-to-peak voltage, and the operating frequency as shown in Figure 9. Do NOT attempt to measure a signal with a peak voltage of greater than 20V in

magnitude. If the signal is not present or the signal is weak, the tester displays the message **No Signal**.

In this mode, the tester will exit the test and return to the Home Screen after 2 minutes if no buttons are pressed.

MΩ MEGOHMMETER

Ensure the leads are connected to the MΩ - 600V banana jacks.

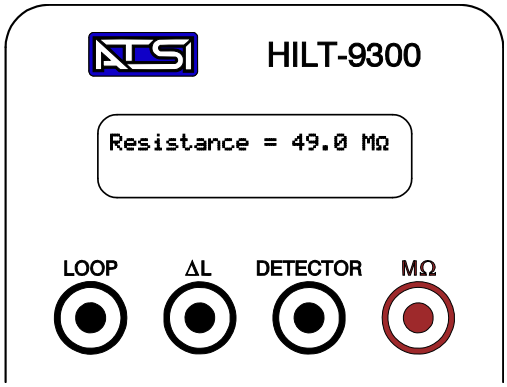


Figure 10

WARNING:

- **The megohmmeter is a source of high voltage (up to ~600V), as are the connected leads. All persons performing or assisting in the tests must employ safety precautions to prevent electrical shock to themselves and to others.**
- **Tests are to be carried out only on dead circuits. Check for live circuits before running this megohmmeter measurement.**
- **When testing capacitive samples, make sure that they have been properly discharged and that they are safe to touch.**
- **The megohmmeter should never be used in an explosive environment.**

The purpose of this test is to measure the DC insulation resistance (@ ~500V) of the loop & lead-in wire combo which for healthy insulation is on the order of MΩ. The range of measurement is from 5 to 500MΩ. If <5MΩ is measured, **Low Resistance** is displayed. If >500MΩ is measured, **High Resistance** is displayed. In this mode, readings are continually taken and reported to the display as shown in Figure 10. If the measurement is drifting due to the parasitic capacitance of the loop & lead-in wire combo, it may be necessary to wait for the measurement to stabilize before considering the measurement to be accurate.

In this mode, the tester will exit the test and return to the Home Screen after 1 minute if no buttons are pressed.

6. Function Controls Summary

Button	Description	Comments*
LOOP	Used to measure L, Q, and R_{DC} of the loop. Q measurements up to 15 are reported. If Q is greater than 15, **Q > 15** is reported.	The loop must be **disconnected** from the detector to run this test. Connect the leads to the **LOOP banana jacks**. Another test can be run after the results are displayed.
ΔL	Used to measure loop inductance change in inductance on a percentage basis.	The loop must be **disconnected** from the detector to run this test. Connect the leads to the **LOOP banana jacks**. Another test can be run after the test times out or to exit the test, press **CANCEL**.
DETECTOR	Used to measure operating parameters of the loop system: V_{pk}, oscillating frequency, and mode.	The loop must be **connected** to the detector to run this test. Connect the leads to the **LOOP banana jacks**. Another test can be run after the test times out or to exit the test, press **CANCEL**.
MΩ	Used to measure DC insulation resistance in the range of 5 to 500MΩ.	Connect the leads to the **MΩ banana jacks**. Another test can be run after the test times out, or to exit the test, press **CANCEL**.
CANCEL	Exit and return to the Home screen during a test or while in the Settings Menu.	
↑ and ↓	Used to navigate Settings menu and increment/decrement settings' parameters	The **Down Arrow** (↓) can also be used to reset the maximum and live values while the ΔL test is running.
SETTINGS/ SET	Used to enter the settings menu and to set/confirm a setting parameter	
PWR ON	Powers on tester	Be sure to **press and hold** until the tester serial number and firmware version is displayed.
PWR OFF	Powers off tester	The tester can be turned off at any time, except when the tester is connected to USB.

7. Overview of Traffic Loop Detection Systems

The inductive loop represents the most commonly used method to detect vehicles. The inductive loop is simply a coil of wires embedded into the pavement and can be characterized by several parameters, L (inductance), Q (quality factor), R (active resistance, measured using AC signal), and R_{DC} (DC resistance). These parameters are affected by the type of pavement, number of turns in the loop, type of wire, length and type of the lead-in cable, shape and dimension of the loop, and presence of any objects near the loop.

A detector is connected to the loop and is used to measure the AC characteristics of the loop and change of those. A part of the circuitry in the detector and the loop creates an oscillating circuit. The oscillating frequency of this circuit depends on the parameters of the loop and the parameters of the detector. When a vehicle or other metallic mass is located above the loop almost all of the characteristics (except DC resistance R_{DC}) are altered. This change causes the oscillating frequency to drift which in turn is detected by the detector.

Unfortunately, the deterioration of the loop begins virtually from the moment of installation. There appear to be two basic mechanisms for loop degradation, mechanical and chemical. Under daily and seasonal temperature variations, the pavement is constantly flexing. To this may be added the pounding of heavy vehicles, particularly at the approaches to signalized intersections where loops are often located. These mechanical factors cause flexure of the wires comprising the loop, especially at the juncture between pavement and berm, leading initially to fine cracks in the insulation, and perhaps ultimately to actual breakage of the wires. After insulation failure occurs (fine cracks or breakage), there is a path for water intrusion. While water itself is a poor conductor, its conductivity is greatly increased by the highly ionic de-icing salts which saturate the berm and all cracks and fissures of the pavement. Aside from the ground leakage which results, these highly active solutions can actually erode the copper conductors by displacement, aided by electrolysis of even the small potentials of the wire to ground. Lead-in wires are also vulnerable, especially on long pulls through conduit, because of the high probability of minor insulation failures due to chafing and stretching during installation.

To guarantee a reliable oscillation in the loop system the quality factor (Q) of the loop with the lead-in wires should be above some value, determined by the amplifiers inside the detector. Deterioration of the loop and lead-in wires reduces Q and eventually prevents the system from oscillating even with a known good detector.

8. Battery Replacement

NEVER OPEN THE BATTERY COMPARTMENT WHILE THE HILT-9300 POWER IS ON.

The message **LOW BATTERY Make a Selection** will be displayed, accompanied by 3 quick beeps, to indicate when the battery in the HILT-9300 requires replacement. One 9V alkaline battery powers the HILT, but there is an additional slot for a spare battery in the battery compartment as well. Recommended replacement type is Alkaline (IEC 6LF22, 6LR61 or NEDA 1604A).

To replace the batteries, lay the tester face-down on a flat table, making sure that there is nothing underneath the tester that can accidentally turn the tester on. Next, remove the battery cover on the backside of the tester by pushing in on the notched tab while simultaneously pulling up. This will give access to the slots for the battery and spare battery. Installation is the reverse of this procedure.

All other types of services needed for the HILT-9300 should only be performed by an ATSI factory technician. Any attempt at servicing the tester yourself or by someone other than a ATSI technician will void the factory warranty. See the Warranty statement at the end of this manual for full details.

9. Using the Rack Interface Card

The Rack Interface Card (Figure 11) is designed to accommodate NEMA TS1 and TS2 rack-mount detectors, as well as FHWA/Caltrans 222 and 224 detectors. Remove the detector and insert the Rack Interface Card. Insert the HILT test leads into the jacks on the front of the card. Use the rotary selector switch to select the loop to test.

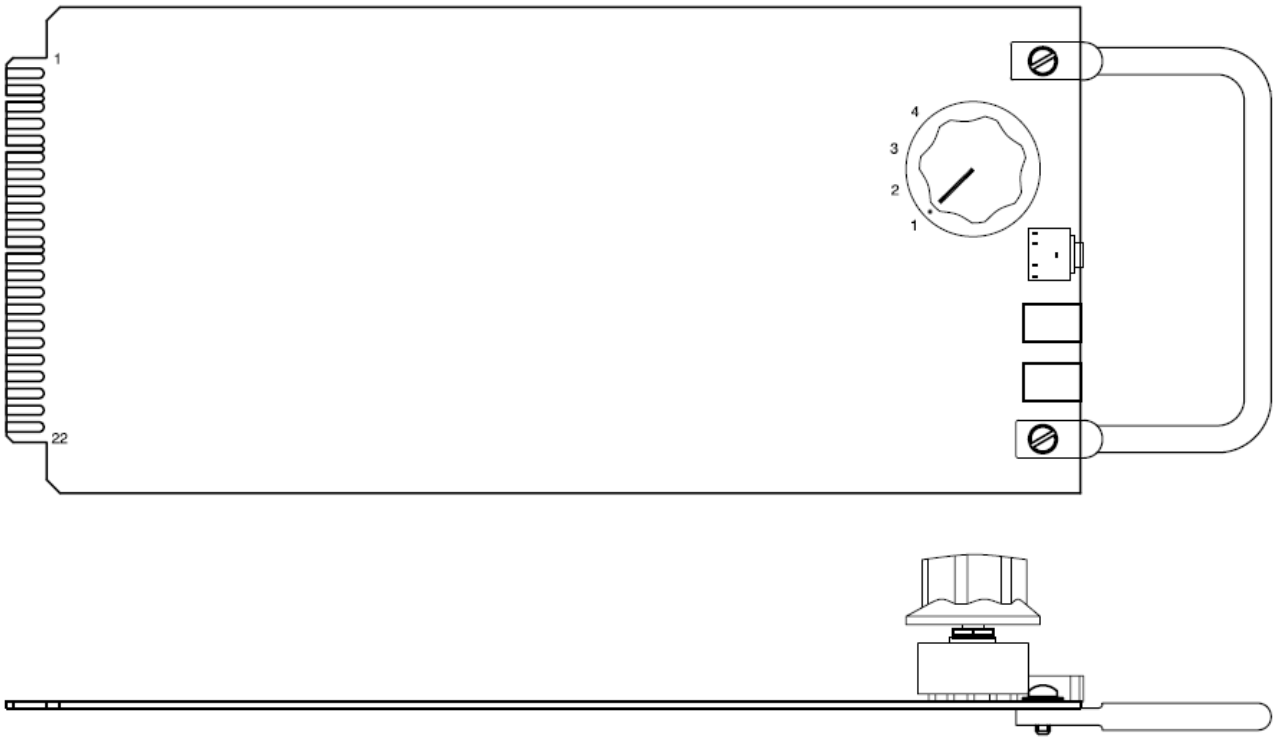


Figure 11

NOTE: Only connect a HILT-9300 to the Rack Interface Card. Be sure that the HILT leads are connected to the HILT's LOOP banana jacks and not the MΩ banana jacks. Also, never connect a megohmmeter or any other device.

10. Commonly Asked Questions

*Q. Why do I have to disconnect the detector from the loop before running a **Loop** or **ΔL** test?*

A. During Loop and ΔL test, the tester is applying its own signal to the loop. The tester verifies there is no signal on the loop before running these tests. However, with a scanning detector connected to the loop, there are time intervals during which the loop does not have a signal applied. If the verification occurs during that time interval, the HILT will not "see" that there is another source of voltage connected to the loop and will begin the actual test. Presence of another voltage on the loop will result with incorrect measurements or potentially damage the tester.

11. Repair and Calibration

To ensure that your instrument meets factory specifications, we recommend that it be returned to our factory at one-year intervals for calibration service. In addition to calibration of the test parameters, this service includes replacement of batteries and firmware updates. Please contact the factory for price and scheduling information on this service.

Request a Return Merchandise Form by phone or by fax from our Service Department (or complete the form on our website at www.atsi-tester.com), then return the tester along with the completed RM Form. Return the tester, postage or shipment pre-paid to:

ATSI
8157 US Route 50 • Athens, OH 45701
(740) 592-2874
(740) 594-2875 - Fax
service@atsi-tester.com

Caution: To protect yourself against in-transit loss, we recommend you insure your returned materials.

The HILT-9300 is sold with a one-year limited warranty to the original purchaser, as defined by the limited warranty on the inside back cover of this manual. No other warranties, expressed or implied, apply to the HILT-9300 or associated components.

After the first year, ATSI will continue to provide repairs to the tester on a parts-plus-labor basis. A phone call describing the problem may allow ATSI to make a nonbinding estimate of repair costs, but the surest approach is to send back the tester for a comprehensive evaluation and a binding repair estimate.

12. Technical and Sales Assistance

If you are experiencing any technical problems, or require any assistance with the proper operation or application of your tester, please call, fax, or e-mail our technical support staff using the contact information above.

13. Limited Warranty

The HILT-9300 (“Product”), distributed by Athens Technical Specialists, Inc. (ATSI), is warranted to the original purchaser (“Purchaser”) to be free of defects in materials and workmanship for a period of one year from the purchase date stated on the invoice. Within this period, in the event of a defect, malfunction, or other failure of the product while in the custody of the purchaser, ATSI will remedy the defect or cause of failure without charge to the Purchaser. Purchaser’s sole remedy is restoration of product operation. ATSI accepts no liability for incidental or related expenses. Under no circumstances will ATSI’s liability exceed the purchase price for items claimed to be defective.

This Limited Warranty does not extend to any Product that has been damaged or rendered defective (a) as a result of accident, misuse, or abuse: (b) by modification of the product: or (3) as a result of service by anyone other than ATSI.

EXCEPT AS EXPRESSLY SET FORTH IN THIS WARRANTY, ATSI MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. ATSI EXPRESSLY DISCLAIMS ALL WARRANTIES NOT STATED IN THIS LIMITED WARRANTY.ANY IMPLIED WARRANTIES THAT MAY BE IMPOSED BY LAW ARE LIMITED TO THE TERMS OF THIS EXPRESS LIMITED WARRANTY.

YOU CAN NOW REGISTER ONLINE AT:
www.atsi-tester.com

14. Warranty Repair

What you must do to return the tester for Warranty Repair:

Request a Return Merchandise Form by phone or by fax from our Service Department (or complete the form on our website at www.atsi-tester.com), then return the tester along with the completed RM Form. Return the tester, postage or shipment pre-paid to:

ATSI
8157 US Route 50
Athens, OH 45701
(740) 592-2874
(740) 594-2875 - Fax
service@atsi-tester.com

Caution: To protect yourself against in-transit loss, we recommend you insure your returned materials.