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930i Ground Integrity Analyzer



Operating & Maintenance Manual

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930i Operating & Maintenance Manual

Introduction

The Vitrek 930i Ground Integrity Analyzer is a compact, easy-to-use high current milli-ohmmeter. The 930i's standard capabilities include: selectable AC output current from 3A to 30A, 4-wire Kelvin terminal configuration, 2-wire lead compensation, and earth continuity measurement down to 10 micro-ohms of resolution. Frequently repeated tests may be stored in non-volatile memory for easy recall. Remote control is available using the VICL / IEEE-488.2 (GPIB) or RS232C communication ports.

Vitrek has taken advantage of advanced microprocessor and ASIC technologies in order to reduce the size and complexity of the 930i while increasing reliability and functionality when compared to traditional ground bond testers. Operating the 930i is easier than ever before due to extensive menu prompting on the unit's brilliant 40 character display. Built-in test procedure storage and edit capability increases test throughput and reduces test development time. Internal diagnostics ensure that the 930i is properly functioning at all times while the automatic calibration capability maintains the highest possible system accuracy.

The Vitrek 930i is capable of generating dangerous currents if used contrary to its design. Please read this manual carefully before operating the instrument. Should you then have any questions, contact your local Vitrek Service Center or Vitrek Customer Satisfaction Department at
9880 A Via Pasar, San Diego, CA 92126
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SAFETY PRECAUTIONS

The following general safety precautions must be observed during all phases of operation, service and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture and intended use of the instrument. Vitrek Corporation assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument must be connected to an electrical ground. This should be accomplished through the earth ground pin of the instrument's power connector and power cord.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Operation of any electrical instrument in the presence of flammable gases, fumes or particles constitutes a definite safety hazard.

DO NOT REMOVE COVERS

Operating personnel must not attempt component replacement or internal adjustment. Dangerous voltages may exist internally even when the power is switched off. Because of the dangers of introducing additional hazards, do not install substitute parts or perform any unauthorized modifications to the instrument. Refer the unit to qualified maintenance personnel or to your nearest Vitrek Service Center.

DANGER! HIGH CURRENT!

Use extreme caution! High currents can weld conductive jewelry such as rings and watches, causing severe burns. Never handle, insert or remove test leads from the 930i or the load while high current is present. Use only test lead materials that have an adequate current rating. Inspect test leads regularly for signs of wear and abrasion.

READ AND UNDERSTAND THE MANUAL

Prior to operating this instrument, the user must be familiar with the operating procedures, controls and precautions.

Certification

Vitrek Corporation certifies that this instrument was thoroughly tested and inspected and found to meet published specifications when shipped from the factory. Vitrek Corporation further certifies that the calibration of this instrument is traceable to the National Institute of Standards and Technology to the extent allowed by NIST's calibration facility.

Limited Warranty

The warranty period for this instrument is stated on your invoice and packing list. Please refer to these documents to determine appropriate warranty dates. Vitrek warrants to the original purchaser that this product will be free from defects in material and workmanship under normal use throughout the warranty period, provided that such defects are not determined by Vitrek to have been caused by abuse, misuse, alteration, improper installation, neglect or environmental conditions. Vitrek Corporation's liability under this warranty is limited solely to the repair or replacement of this instrument during the warranty period, provided it is returned to the factory freight prepaid with a return authorization number.

No other warranty is expressed or implied. Vitrek Corporation is not liable for incidental, consequential, direct or indirect damages nor for costs, losses or expenses of any kind. A return authorization number must be obtained directly from the factory for warranty repairs. No liability will be accepted if returned without factory authorization number.

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Unpacking

If the shipping carton is damaged, request that the carrier's agent be present when the instrument is unpacked. If the instrument appears damaged, notify the carrier's agent for repair authorization before returning the instrument to Vitrek.

It is also necessary to notify Vitrek and receive a RETURN MATERIALS AUTHORIZATION NUMBER before returning the instrument.

Even if the instrument appears undamaged, it may have suffered internal damage in transit that may not be evident until operated or tested to verify performance. If the instrument fails to operate, notify the carrier's agent and Vitrek or your local Vitrek Service Center. Retain the shipping carton for the carrier's inspection.

.....

Initial Adjustments

The only adjustments required prior to operation of the 930i are selection of the local power source voltage and verification that the correct fuse for this voltage is fitted. The supply voltages and fuses are listed below:

105 to 125 VAC 50/60Hz 5 Amp Slo Blo Fuse
210 to 250 VAC 50/60Hz 2.5 or 3 Amp Slo Blo Fuse

Unless specifically requested, all units shipped to North American locations are factory set for 115VAC. Check the rear panel slide switch to ensure that the proper line voltage has been selected prior to applying power to the 930i.

1 930i Getting Started

This section gives brief descriptions of front panel controls for the 930i. It should not be used as a sole source of operating instructions. Also refer to the chapters that follow for more complete operating instructions.

Front Panel Layout

The 930i front panel includes the following items:

1. Main Display
2. Power Switch
3. Function Keys
4. LED Indicators
5. Mode Keys
6. Numeric Entry Keys
7. Calibration Enable Switch
8. Front Measurement Terminals



1.) ***Main Display:*** The 930i utilizes a 2 row by 20 Character LCD display. The color of the display is easy on the eye, while the design provides extremely low power consumption.

2.) ***Power Switch:*** The 930i features an ergonomic rocker style power switch. The switch has a built-in euro-green indicator when in the power-on position.

3.) ***Function Keys:*** The keypad grouping immediately below the main display contains 11 function keys. The functions are (from left to right, top row first): High Current Enable, Direct Mode (manual), Automatic Mode, Left Arrow, Right Arrow, Stop, Zero, Range, Up Arrow, Down Arrow and Enter. The Stop key is highlighted in bright red for easy identification. This key may be used at any time to disable the high current output and return the instrument to a safe operating state.

4.) ***LED Indicators:*** The 930i is equipped with 10 front panel LED status/warning indicators. They are defined as follows (from top to bottom):

- High Current Present
- High Current Enabled

1 930i Getting Started

- Voltage Range Hold
- 3V Range Selected
- 300mV Range Selected
- 30mV Range Selected
- 3mV Range Selected
- REMOTE Operation
- TALK (Information to controller)
- LISTEN (Information from controller)

5.) ***Mode Keys:*** The two columns of keys to the right of the status indicators are the MODE keys. The 10 MODE keys (from left to right, top row to bottom row) are defined as follows:

MEMORY	Recall Test Program	Edit Test Program
OPTIONS	Print	Menu
SYSTEM	System Test	System Configure
CALIBRATE	Internal Calibration	External Calibration
REMOTE	Address	Local

6.) ***Numeric Entry Keys:*** The numeric entry keys are located to the right of the Mode keys. They consist of 0 through 9, +/-, Decimal Point (.), Enter, Clear and Reset.

7.) ***Calibration Enable Switch:*** The calibration enable switch is recessed behind the front panel and is located to the right of the numeric entry keys. The calibration enable switch may be secured by a calibration sticker that must be broken in order to engage the switch.

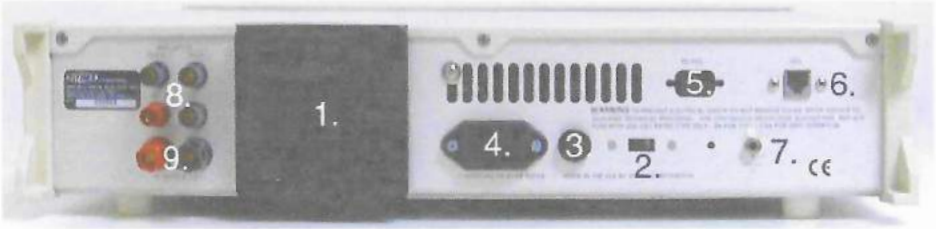
8.) ***Front Measurement Terminals:*** The 930i provides front mounted stimulus and measurement terminals. Warning! The large protruding terminals have the ability to provide dangerous current levels. Read and understand all safety precautions before connecting to these terminals.

1 930i Getting Started

Rear Panel Layout

The 930i rear panel includes the following items:

1. Fan Filter Assembly
2. Line Voltage Selector
3. Power Fuse
4. Line Power Receptacle
5. RS232 Port
6. VICL Port
7. Chassis Ground Terminal
8. Rear Measurement Terminals
9. 944i Chassis Sense Terminals



1.) ***Fan Filter Assembly:*** The 930i uses a removable fan filter to clean the air used for cooling. Refer to the Maintenance section of this manual for instructions regarding periodic removal and cleaning.

2.) ***Line Voltage Selector:*** To allow selection between 115VAC and 230VAC line voltage operation, the 930i provides a built-in line voltage selector switch. Refer to the "Initial Adjustments" instructions located earlier in this section of the manual prior to changing switch positions.

3.) ***Power Fuse:*** The 930i is equipped with a line power fuse to protect the unit from fire in the event of an internal short. Refer to the "Initial Adjustments" instructions located earlier in this section of the manual for fuse replacement information.

4.) ***Line Power Receptacle:*** Power is provided to the 930i through a three-prong power receptacle. A power cord that mates with this receptacle is provided with the 930i.

5.) ***RS232 Port:*** The 930i uses a female DB9-pin connector for serial communications.

6.) ***VICL Port:*** The 930i is equipped with a proprietary serial control port. This serial port is provided for communication with a host instrument such as a PC or the Vitrek 944i Dielectric Analyzer.

1 930i Getting Started

7.) ***Chassis Ground Terminal:*** This banana jack provides convenient access to the 930i's chassis ground.

8.) ***Rear Measurement Terminals:*** The 930i provides rear mounted stimulus and measurement terminals. Warning! The large protruding terminals have the ability to provide dangerous current levels. Read and understand all safety precautions before connecting to these terminals.

9.) ***944i Chassis Sense Terminals:*** These terminals are used to perform integrated testing when connected to a Vitrek 944i Dielectric Analyzer.

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Instructions for Bench Use

The 930i is delivered ready for bench top operation. The unit is equipped with front tilt feet to adjust the viewing angle. The 930i is also equipped with side handles to assist in carrying the unit. Use caution when lifting! The 930i is surprisingly heavy. Always verify that the power cord is equipped with a three-terminal connector before applying power to the 930i.

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Instructions for Rack Mounting

Optional rack mounting brackets are available to allow installation of the 930i in a standard 19" equipment rack. The size and weight of the 930i require that the unit should be supported on both sides along its entire length by the use of trays or slides. If it is to be transported while mounted in a rack, it must be supported to prevent upward or downward movement.

To install the RM-1 rack mount kit, remove the two forward flathead screws on each side of the 930i. Position the rack ears in place and install with the provided #8-32 x 5/8" flathead screws. CAUTION! Longer screws may damage the unit. The specifications for the 930i become degraded at high temperatures; therefore it is recommended that sufficient room be allowed for airflow around the 930i. This may be achieved by placing at least 1.75" blank panels above and below the 930i in the rack. Under no circumstances

should the ambient air temperature surrounding the 930i be allowed to exceed 50EC while in operation or 70° C while not in operation.

Earth Ground Connection

The 930i's AC line power connector is a three-contact device meeting the safety requirements of the environment in which the 930i may be used. It should only be mated with a three-contact connector where the third contact provides a continuous ground connection. If the power is provided through an extension cable, the ground connection must be continuous throughout this cable to the 930i.

FAILURE TO PROVIDE A CONTINUOUS GROUND CONNECTION TO THE 930i MAY RENDER THE UNIT UNSAFE FOR USE.

2 930i Test Connections

The 930i may be used as a 4-wire or 2-wire ohmmeter. In the 4-wire configuration, errors caused by test lead resistance and contact resistances are reduced to a level that is insignificant. This configuration is recommended for most applications. If a 4-wire setup is not practical, the 930i may be used as a 2-wire ohmmeter. Both wiring styles are discussed below.

4-Wire Measurements

In the 4-wire resistance measurement technique, test lead resistance errors are virtually eliminated because the sensing of the voltage drop is done directly across the load by a high impedance voltmeter. The 4-wire Kelvin measurement technique provides consistent, reliable and repeatable results.

To configure for a 4-wire measurement, connect the HI (red) SENSE and SOURCE terminals to one side of the DUT (device under test). Connect the LO (black) terminals to the other side of the DUT. For test currents of 25 amps or greater the Source cables should of 10 AWG or larger wire. A Direct or Automatic Mode test may now be performed.

The Option K-4 lead set is ideal for most general-purpose applications. For other applications involving the 944i or Vitrek prewired harnesses, please refer to the illustrations in this chapter.

2-Wire Measurements

The 930i may also be used as a 2-wire ohmmeter. In this configuration the voltage sensing is done at the SOURCE terminals. Measurements will be subject to changes in test lead impedance and contact resistances and may vary significantly depending upon the test conditions. Errors become more pronounced with higher test currents.

The 930i has the ability to eliminate most of this error by "nulling out" the resistance of the test leads prior to measurement. Performance of the nulling procedure is highly recommended whenever the 930i is powered, reset, the

test leads are changed, or the test current is changed. Nulling is best performed using the same test leads as will be used in making ground continuity measurements.

To begin, connect the test leads to the SOURCE terminals on the front or rear of the 930i, depending on which will be used for measurements. For currents of 25 amps or more the test leads should be 10AWG or larger. Short the ends of the test leads together with a high quality short such as a large copper busbar. Connect all leads to the busbar, NOT to each other. Press the ZERO key. The following prompt will appear:

ENTER ZEROING
TEST CURRENT 10 AMPS

This step determines the amount of test current that will be used to null the leads. Enter the same amount of current as will be used in making continuity tests, from 3 to 30 amps. Follow the prompts and the 930i will automatically null the lead resistance. This correction factor remains in effect until the unit is reset or powered down.

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Test Connection Safety Precautions

The Vitrek 930i Ground Integrity Analyzer is capable of generating up to 30 amperes of alternating current. It is extremely important that the user observe safe operating procedures to avoid damage that can be caused by these DANGEROUS CURRENT LEVELS. Overheating of the test leads and connecting terminals is of primary concern. In addition to using common sense handling techniques for high current operation, the following precautions should be taken into consideration whenever operating the 930i:

1. Use only test lead materials with appropriate current ratings for connection to the output terminals, labeled "Source".
2. Inspect leads regularly for signs of wear and abrasion.
3. Avoid contact with the output signal (at terminals, leads and DUT) at all times during testing.
4. Always ensure that the 930i is properly earth grounded before applying power.
5. Watch for signs or smells of overheating test leads or DUT and immediately disable the output current (press STOP).

2 930i Test Connections

Connecting to Devices with Earth Grounds

Earth grounded devices must be isolated from earth ground when conducting tests with the 930i. This will ensure that all of the test current flows through the DUT and is not diverted to ground, which would cause the resistance to be improperly measured.

When testing devices for ground bond integrity, the test path should be from the earth ground pin to any exposed conductive surfaces (chassis). The 930i is capable of conducting this test in several different modes. The basic connection to test an instrument' s ground integrity is as follows:

1. Connect the "HI" Source and Sense terminals of the 930i to the DUT earth ground pin.
2. Connect the "LO" Source and Sense terminals of the 930i to any exposed conductive surface of the DUT's chassis.

3 930i Direct Mode Operation

Operating in the Direct Mode the Vitrek 930i acts as a versatile 4-wire milli-ohmmeter. The 930i permits the user to manually control the output current up or down while monitoring the load resistance. When operating in the Direct Mode the user is in full control of the measurement process. Test current, dwell time, minimum and maximum load resistances are a function of the operator. A maximum current limit is preset by the user to prevent accidental excursion beyond a safe output level.

.....

Direct Mode Measurement

A Direct (or manual) Mode test is setup via a series of menu prompts. To accept the default value of any step, press the ENTER key. To backup 1 or more steps, press the CLR key. To conduct manual low resistance measurements, first press the DIRECT key. The following prompt appears:

ENTER MAX CURRENT:
25 AMPS AC RMS

This step gives the user the choice of setting a Ado not exceed@ test current to avoid accidentally damaging the DUT while making manual measurements. A default current level of 25 amps is suggested. To select a different current, key in a value from 3 to 30 amps using the numeric keypad and press ENTER. The following prompt appears:

ENTER FREQUENCY:
60 HERTZ

The frequency of the test current may be adjusted at this step. The default frequency is 60 hertz. To select another frequency enter its value (from 30 to 400 Hz) using the numeric keypad and press ENTER. The following prompt appears:

I ENABLE
REQUIRED

This safety interlock requires the user to confirm that a current output is desired. This prevents inadvertent output of potentially damaging currents.

3 930i Direct Mode Operation

When connections have been checked, the user should press the I ENABLE key. At this point he has 3 seconds in which to press ENTER to start the test. After 3 seconds the safety interlock returns to standby.

Upon pressing ENTER, an attention beep (or beeps) will sound as an additional warning of current application. This feature may be customized or disabled in the CNFG menu discussed in a later chapter. The Direct Mode measurement screen then appears. A typical display is shown below:

```
3A     60 Hz
|  {bar graph}  |     123.45m  Ω
```

The display shows the present test current level, the test current frequency, and the measured value of resistance. The test current level may be adjusted using the up and down arrow keys (▲▼). The bar graph indicates the approximate percentage of available test current that is being provided. This percentage is relative to "do not exceed" limit entered in the setup menu.

Flashing asterisks in the measurement area indicate a value of resistance that exceeds the compliance voltage of the current source. In this situation, either the test current or the load resistance must be reduced. Flashing asterisks may also indicate improper connections or an open circuit.

The test may be stopped at any time by pressing the STOP key. Under certain conditions of prolonged high current measurements, the 930i may detect an unsafe internal operating temperature and abort the test. Should this happen, allow the 930i to run in idle mode with the fan operating in order to cool the internal circuits. It is also a good idea to check for obstruction of the cooling fan filter.

4 930i Automatic Mode Operation

In the Automatic Mode the Vitrek 930i is a powerful, high volume test system in one compact package. Whether operating from the front panel or via the control of a Vitrek 944i Dielectric Analyzer, the 930i can quickly execute a wide variety of tests. Test routines can easily be entered, stored, recalled and edited using the 930i's built-in procedure generator. When the test is completed, hard copy test results are available at the touch of a button via the 944i' s printout routine.

Automatic Mode Measurement

Connections for the Automatic Mode are similar to those used in Direct Mode testing. Please review the previous chapter for connection information.

An Automatic Mode test is setup via a series of menu prompts. To accept the default value of any step, press the ENTER key. To backup 1 or more steps, press the CLR key. To begin setup of an Automatic Mode test, press the AUTO key. The following prompt appears:

ENTER TEST CURRENT:
25 AMPS AC RMS

If the default value of 25 amps is not the desired level of test current, use the numeric keypad to enter the new value. The allowable range of test currents is from 3 to 30 amps. Upon entering the test current level, a prompt for test current frequency appears:

ENTER FREQUENCY:
60 HERTZ

Use the same procedure as described above to input the desired frequency of the test current (from 30 to 400 Hz). The next step sets up the upper limit value (tolerance) for the measured resistance, above which the test will result in a failed DUT:

ENTER MAX RES:
100.0 m OHMS

Use the numeric keypad to enter the maximum value of the measured resistance. The up/down arrow keys (▲▼) may be used to switch between

milli (m) and micro (μ) ohms. The next step sets the lower limit for the measured resistance:

ENTER MIN RES:
000.0 m OHMS

A minimum resistance value is typically used to verify that the load is actually in the test circuit, and that correct connections have been made. With the minimum limit set to zero, the limit is not active. Accept or change this value as in the previous step. The next step sets the test or "dwell" time:

ENTER TEST TIME:
5.0 SECONDS

Enter the desired test time, which may be from 0.5 to 99 seconds. The next step determines what action will be taken with the test that was just setup:

SELECT:
RUN ADD STORE

For now, only the running of the test will be discussed. The ADD and STORE options regarding storage of frequently used tests are discussed later in this chapter.

With the cursor on the RUN selection, press ENTER to start the test. The following prompt appears:

I ENABLE
REQUIRED

This safety interlock requires the user to confirm that a current output is desired. This prevents inadvertent output of potentially damaging currents. When connections have been checked, the user should press the I ENABLE key. At this point he has 3 seconds in which to press ENTER to start the test. After 3 seconds the safety interlock returns to standby.
Upon pressing ENTER, an attention beep (or beeps) will sound as an additional warning of current application. This feature may be customized or disabled in the CNFG menu discussed in a later chapter. The Automatic Mode measurement screen then appears. A typical display is shown below:

25A 60 Hz TIME 23.5

4 930i Automatic Mode Operation

| {bar graph} | 123.45m Ω

The display shows the present test current level, the test current frequency, a countdown timer, and the measured value of resistance. The bar graph indicates an approximation of the measured value of resistance relative to the maximum limit. The maximum limit was entered during the test setup.

Upon completion of the test the 930i will display a result for the DUT. It will indicate that one of three things happened: pass, failure due to exceeding the maximum resistance limit, or failure due to "high resistance" indicating an over compliance condition. If the failure was due to high resistance, recheck connections to the 930i and the DUT. A typical message is shown below:

PASS FINAL 104.91m Ω
QUIT PRINT RETEST

At this point it should be noted that the user has four options. Selecting QUIT will end testing and all settings will be lost if they were not previously stored. Selecting PRINT will generate a printout of the test results provided that the 930i is connected to a Vitrek 944i with printout capability. Selecting RETEST will repeat the test again. If RETEST is selected, the 930i proceeds straight into testing and another current enable is not required.

The fourth option is not listed in the menu but is perhaps one of the most useful during test development. At the menu screen shown above, pressing the CLR key will backup one screen to the RUN/ADD/STORE menu. If the test proceeded as desired, it may now be stored or added to others (discussed later). If not, pressing CLR again will allow the user to edit steps in the test setup and re-run the test.

Note: If the user continues backwards beyond a specific item of the test setup, it returns to its default value. For example, if the maximum resistance limit was too low and the user presses CLR to return and change it, the "minimum resistance" and "test time" will be reset to their defaults.

4 930i Automatic Mode Operation

Storing Tests

An individual test or chained program may be stored in non-volatile memory for future use. Any stored tests are saved even upon power shutdown and may be easily recalled. The 930i is capable of storing up to 20 test programs with a maximum total of 50 test steps. The maximum number of steps in any one program is 5. This feature is selected at the following menu:

SELECT:
RUN ADD STORE

To store the test that was just setup, use the arrow keys to highlight STORE and press ENTER to select. The 930i will then provide the following prompt:

ENTER PROGRAM NO. 1
NEXT AVAILABLE 01

The 930i requests an identifying test number. The "next available" number is shown based on the number of tests that have already been stored. If the next available number is an acceptable number for the program, press ENTER. If not, enter a program number from 01 to 20. After the program number has been selected the following prompt will be displayed:

ENTER PROGRAM NAME
_ _ _ _ _ _ _ _ _ _

Stored programs may be identified by the program number or the program name. Often it is easier to identify a test by its name than its number. This prompt allows the user to enter a descriptive name for the program.

Alphanumeric characters (A-Z and 0-9) may be entered using the up/down arrow keys to select the desired character. Use the left/right arrow keys to move from one position to another. When finished, press ENTER to store the program. Numeric characters alone may be entered using the numeric keypad. In this case the cursor automatically moves to the next position.

4 930i Automatic Mode Operation

Recalling Test Programs

Stored programs may be recalled by referring to the program number or to its name. To recall a test which has been stored in the 930i=s database, press the RECALL key. The following prompt will appear:

RECALL PROGRAM NO _ _
USE -> <- TO SCROLL

If the desired program number is known, use the numeric keypad to enter the program number and press ENTER. If the program number is not known, use the left/right arrow keys to scroll through the program directory. Both the program number and program name will be shown. When the desired program name and number are displayed, press ENTER. The stored program is now placed into memory as an Automatic Mode test.

Editing Existing Test Programs

Stored programs may be changed without the need to re-enter the entire test. To change a step in a stored program, press the EDIT key. The following prompt will be displayed:

ENTER PASSWORD

_ _ _ _

A password is used to deter unauthorized personnel from accessing the test routine database. The password consists of pressing the following keys in the order shown: TEST 1 2 3

For security purposes it may be advisable to obscure the above password and store it in an alternate location, or to blank the password and photocopy this page. Once the password has been successfully entered the following prompt will appear:

RECALL PROGRAM NO _ _
USE -> <- TO SCROLL

4 930i Automatic Mode Operation

Use the same technique as described previously for recalling tests to find the desired program to be edited. Press ENTER when the program is displayed. The following prompt will appear:

SELECT EDIT TYPE
DELETE CHANGE

To delete a test step, move the cursor to DELETE and press ENTER. This will remove the test from the 930i's program memory. To alter a step of the program, move the cursor to CHANGE and press ENTER. After each change the 930i restores the database.

Aborting an Automatic Mode Test

If at any time the user needs to abort a test being run in the Automatic Mode, just press the STOP key. The following menu will be displayed:

FAILED ABORTED
QUIT PRINT RETEST

Selecting QUIT will end the test and remove it from memory unless it has been stored previously in non-volatile memory. Selecting PRINT will print a test report if the 930i is being operated with a Vitrek 944i. Selecting RETEST will re-run the test without requiring another "I ENABLE". Move the cursor to the desired option and press ENTER.

5 930i Advanced Features

The Vitrek 930i Ground Integrity Analyzer has been designed to provide maximum user safety, reliability, and test throughput. To achieve this, the 930i is equipped with a built-in self-test capability, and a variety of user configurable test options. This chapter discusses some of the unique features that make the 930i stand out as a leader in the ground continuity testing world.

Self-Test Function

The self-test function checks a variety of digital and analog functions of the 930i. It should be performed if any unusual error message is observed, before critical testing, or to check the internal operating temperature. To execute a self-test, press the TEST key. A series of messages will be displayed as the 930i proceeds through the test. If any problem is detected, the 930i will alert the user at the end of the test.

System Configuration

The system configuration function allows the user to control the warning beeper and to select digital filtering for reading stability. To access the configuration control menu, press the CNFG key. The following prompt appears:

CONFIGURE:
BEEPS AVERAGES

To set the quantity of warning beeps that will be sounded prior to high current output, place the cursor on BEEPS and press ENTER. The following prompt will appear:

HC WARNING BEEPS
1 2 3 4 5 NONE

The cursor will highlight the present setting of the warning beeper. To select a new number of warning beeps, move the cursor to the desired quantity and

press ENTER. The user may also use the numeric keys to select a number. Selecting NONE will disable the warning beeper.

The digital filtering of the 930i allows the user to obtain a more stable resistance reading on the display by averaging a number of measurements together. This feature is normally disabled. To activate it, select AVERAGES from the CNFG menu shown previously. Move the cursor and select the desired number of averages. A higher number will average more readings and react more slowly to changes in the load.

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Advanced User Note

To increase throughput and reduce the number of keystrokes required to achieve the desired results, the Vitrek 930i allows a shortcut method for selecting items displayed in a user menu. The menu items may be thought of as "fields" that are numbered from left to right. To select field number 1 (far left), press the 1 key. To select the middle field, press the 2 key. For example, assume that the following message is displayed:

PASS FINAL 104.91m Ω
QUIT PRINT RETEST

If the user desires to run the test again, he may press the 3 key to select RETEST. If he desires to print the test results, he may press the 2 key. The 1 key will select QUIT.

6 930i Remote Operation

The Vitrek 930i has been designed to operate as a stand-alone device or as a slave unit of the Vitrek Model 944i Dielectric Analyzer. As a stand-alone instrument, the 930i has remote control available via its built-in serial (RS232C) interface. When connected to a master 944i via the proprietary VICL interface, the 930i may be setup and run without ever having to push a key on the unit itself. This is done by enabling the 930i commands in the LOΩ function of the 944i. Test results and readings are also returned to the 944i so that the user never even has to look at the 930i. For more details, please refer to the 944i Operation Manual.

Using the VICL interface, the 930i may also be controlled remotely by taking advantage of the 944i's IEEE-488 (GPIB) interface. The 930i is also able to generate hard copies of test results via the 944i's printer output.

This chapter discusses connections and command protocol for operating the 930i via its RS232C and VICL interfaces. In all sections of this chapter it is assumed that the user has full knowledge of the operation of the 930i from the front panel as described in previous chapters. If the programmer is unfamiliar with a particular function, please refer to the appropriate section as listed in the Table of Contents.

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VICL Connection and Operation

Using the proprietary VICL (Vitrek Instrument Control Loop) interface the user will be able to take advantage of the IEEE-488 and printer ports of a master Vitrek 944i. Connections are made using a 6-conductor telephone style cable. Connect one end to the 930i's VICL input, and the other end to the 944i's VICL port.

Once connections have been made, two things need to happen. The operator must enable the 930i's VICL port and must also activate the "930i" menus in the 944i. To enable the 930i's VICL port, press the
ADDR key of the 930i. The following prompt appears:

VICL ADDRESS:
1 2 3 RS232

6 930i Remote Operation

Select the address 1 to enable VICL. This only needs to be done once unless the user also uses the RS232 port. Note that the VICL port cannot be used simultaneously with the RS232C port.

On the 944i, enable the 930i menus by selecting 930I in the Accessories screen of the CNFG LOΩ menu. Connection may be verified by resetting the 944i and verifying that the 930i also resets.

Once connection has been made, the 930i may be setup by pressing the 944i's LOΩ key and following the same prompts as would appear on the 930i. When finished, the results may be printed by pressing the PRINT key.

IEEE-488 functions are available by issuing 930i commands as listed in the 944i Operation Manual.

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RS232C Connection and Command Protocol

Connections to the serial RS232C interface require a male DB9-pin connector (not provided). The 930i is configured as a terminal device (DTE). A pin-to-pin cable is used when connecting to the COM port of a controller such as a PC. The 930i uses the following communication protocol:

Baud Rate: 9600	Stop Bits: 1
Parity: none	Handshaking: no
Word width: 8	Echo Mode: half-duplex (echo on)

Once connections have been made, the RS232C port of the 930i must be enabled. To enable the RS232C port, press the ADDR key. The following prompt appears:

VICL ADDRESS:
1 2 3 RS232

Select RS232 to enable the serial port. This only needs to be done once unless the user also uses the VICL port. Note that the VICL port cannot be used simultaneously with the RS232C port.

6 930i Remote Operation

Command Set for RS232C

You will notice that some commands are single words, but others consist of a root command followed by one or more variables, also called "arguments". Arguments may be used to set-up multiple items such as current, frequency and test time. For commands with multiple arguments such as AUTO and CNFG, the root command must be separated from the first argument by a comma, and all arguments must be separated by commas.

"Query" commands, which usually end in a question mark, always provide a response to the query. Other commands are execute-only commands that do not provide a response. Note that each command *must* be terminated with a semi-colon (;) followed by a carriage-return (`r`). It is also recommended that a minimum 100ms delay be allowed following the `r`.

The 930i's RS232C command set is listed below. Commands and arguments may be sent in upper or lower case. The commands are listed in alphabetical order.

The 930i will respond with an asterisk "*" if it does not understand the command you have sent to it.

AMPS? : Amps Query

This query is used to question the 930i as to its present output current level. The value is returned in scientific notation, in amps.

AMPS : Ampere Output Command

This command is used to change the test current while the 930i is performing a Direct Mode test. The 930i must already be operating in Direct Mode as set up by the DIRC command.
The command is in the format:

AMPS,<current>;

6 930i Remote Operation

Explanation of Arguments:

<current> determines the current output in amperes, 3 to 30 amps

Sample Amps command:

AMPS,15;

This command will set the test current to 15 amperes.

AUTO : Run an Automatic Mode Test

This command is used to setup and run an Automatic Mode test. It is used with the OHMS? query to obtain the resistance reading. The STOP command may be used to abort the test. The RSLT? query may be used to determine the overall test results.

The command is in the format:

AUTO,<current>,<freq>,<max_res>,<min_res>,<time>;

Explanation of Arguments:

<current>	sets the test current level, integer 3 to 30 amps
<freq>	sets the test current frequency, integer 30 to 400 Hz
<max_res>	sets the maximum resistance, scientific notation ohms
<min_res>	sets the minimum resistance, scientific notation ohms
<time>	sets the test time, scientific notation seconds up to 99

Sample AUTO command:

AUTO,25,60,1.1e-1,0,1.0e+1;

This command will run an Automatic Mode test at 25 amps, 60Hz for 10 seconds. The maximum allowable resistance is 110mΩ and the minimum resistance function is disabled.

6 930i Remote Operation

CNFG : Configure the 930i

This command is used to setup the 930i operating configuration including the number of high-current warning beeps and the digital averaging factor.

The command is in the format:

CNFG,<beeps>,<average>;

Explanation of Arguments:

<beeps>	sets the number of beeps, integer 0-5 beeps
<average>	sets the digital averaging factor, integer 0-6 averages

Sample CNFG command:

CNFG,2,0;

This command will set the number of warning beeps to 2 and disable the digital averaging feature.

DIRC : Run a Direct Mode Test

This command is used to setup and run a Direct Mode test. It is used with the OHMS? query to obtain the resistance reading. The STOP command is used to end the test.

The command is in the format:

DIRC,<current>,<freq>;

Explanation of Arguments:

<current>	sets the test current level, integer 3 to 30 amps
<freq>	sets the test current frequency, integer 30 to 400 Hz

6 930i Remote Operation

Sample DIRC command:

DIRC,5,100;

This command will start a Direct Mode test at 5 amps, 100Hz and run until the STOP or RESET command is issued.

OHMS? : Resistance Query

This query returns the present measured value of resistance as indicated on the display of the 930i. It may be used during a Direct or Automatic Mode test. The resistance is returned in scientific notation, in ohms.

RESET : Reset the 930i

This command will wait 300ms for current shutdown and then cause a firmware reset of the 930i. It will also stop any test in progress.

RSLT? : Test Results Query

This query may be used to obtain the results of an Automatic Mode test. The response to this query is a code corresponding to the table below. You can use the "STAT?" query to determine when the test is complete before sending the "RSLT?" query. The "RSLT?" query will return a "2" if sent during a test.

Result Code	Definition
0	No fault, test passed with existing limits
1	Test failed due to exceeding maximum resistance limit
2	Test failed due to exceeding minimum resistance limit
3	Test load exceeded the resistance range
4	Test failed due to an over compliance condition of the current source
5	System fault
6	930i detected high resistance (possibly open leads)
7	Test aborted by user (STOP command or front panel key press)

6 930i Remote Operation

SELF? : Self-test initiation and Results Query

This query may be used to initiate a self-test. After completion of the test the unit will return a result code corresponding to the table below. A twenty second time-out should be allowed for completion of the test before the result is returned. No other commands should be sent to the unit while a self-test is in progress.

Result Code	Definition
0	Timer error
1	A-to-D converter fault
2	Power supply fault
3	Output system fault
4	Database error
5	Overtemp warning of output stage

STAT? : Test Status Query

This query may be used to monitor the progress of a test. The response to this query is a 0 if the test is still in process or a 1 if the test is complete.

STOP : Disable Current/Abort Test

This command is used to end a Direct Mode test or to abort an Automatic Mode test in progress. It will immediately shut down the current output of the 930i.

6 930i Remote Operation

TEMP? : Operating Temperature Query

This query may be used to monitor the internal operating temperature of the output stage of the 930i. This is recommended during extended high-current Direct Mode testing or during high volume Automatic Mode tests. The highest temperature is returned in scientific notation, in degrees Fahrenheit.

TIME? : Failure Time Query

If a failure occurs during an Automatic Mode test, this query may be used to determine the time at which the failure occurred as indicated on the 930i's countdown timer.

7 930i Options and Accessories

TL-115HC: Test Leads with 115V Outlet

For direct plug-in test convenience, this accessory provides a standard 3-prong North American power outlet (NEMA 5-15) in a handy compact enclosure with mating leads for the 930i and the 944i.

K-4: Kelvin (4-wire) Test Lead Set

This heavy-duty, 4-wire lead set features 10 AWG source leads terminated with spade lugs for connection to the 930i terminals. The booted alligator clips are rated to 40 amperes for load connection.

RM-1: Rack Mount Kit

Option RM-1 permits the 930i to be used in a standard 19" equipment rack. Instructions for installing the RM-1 are provided in the "Getting Started" section of this manual.

K-2: Two-Wire Test Lead Set

This heavy-duty lead set is similar in design and construction to the Option K-4 lead set. In the K-2, however, there are only two clips at the end for connection to the test load. The two HI leads and the two LO leads are terminated at the end of the cable at the alligator clips. This provides most of the benefits of a four-wire cable with the convenience of a two-wire lead set. The ZERO function of the 930i should be utilized for maximum accuracy whenever using this cable.

40AMP: 40 Amp output

Option 40AMP increases the output current limit to 40 Amps AC. The compliance voltage is reduced from >3 VAC to >2 VAC. The standard 10AWG 6 foot cables will further reduce compliance voltage. It is

recommended that the K-4HD or K-2HD leads be used or that you shorten the 10AWG leads to 1 or 2 feet in length if you are testing at 40 Amps.

K-4HD: Kelvin (4-wire) Heavy Duty Test Lead Set

This heavy-duty, 4-wire lead set features 4 AWG source leads terminated with spade lugs for connection to the 930i terminals. The booted alligator clips are rated to 40 amperes for load connection.

K-2HD: Kelvin (2-wire) Test Lead Set

This heavy-duty, 2-wire lead set features 4 AWG source leads terminated with spade lugs for connection to the 930i terminals. The booted alligator clips are rated to 40 amperes for load connection.

RSS-1: Remote Start Switch

This option provides an external switch for starting tests when using the unit as a stand-alone high volume production tester. This reduces wear and tear on the keypads and allows the user to place the start switch closer to their work area.

8 930i Maintenance

Routine Inspection and Maintenance

The 930i is equipped with a fan to cool the internal electronic circuitry. It is advisable to inspect the filter assembly located on the rear panel monthly. In areas where there is a high level of dust or other airborne particulate matter, the inspection of this filter should be conducted more often. If the filter is allowed to become restricted, overheating can occur causing damage to the electronic components.

Should the filter require cleaning, the finger guard snaps off to provide easy access to the filter element. Clean with compressed air to dislodge build-up. For heavily soiled filters a thorough rinsing in a warm soapy water solution should remove any build-up. After thorough drying, insert the filter element back into the finger guard and snap into place. Note that the finger guard has two tabs, which should line up with the two indentions on the fan mounting bracket.

The test leads should be inspected daily for wear and tear. Corrosion and wire breakage can adversely affect the compliance voltage and accuracy of the 930i.

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Performing an Internal Calibration

The Vitrek 930i is designed with the ability to check drift and offset in certain circuits relative to internal references. The procedure is automatic and should be conducted once daily or whenever the unit experiences a large change in temperature from its external calibration temperature.

To initiate an internal calibration, remove all output lead connections and press the INTRL key in the CALIBRATE row.

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Performing an External Calibration

In order to maintain the accuracy specifications of the 930i it is necessary to calibrate the unit against external standards on a periodic basis. Vitrek

recommends a calibration interval of one year. A calibration seal/sticker may be placed over the CAL enable hole in order to prevent unauthorized access to the external calibration routine. Before performing an External Calibration, allow a one hour warm-up time at the calibration temperature. Equipment required will be as follows:

1.) 1Ω, 10W carbon resistor with known value to within □0.05%
2.) 0.1Ω, 100W wire wound resistor with known value to within □0.05%
3.) Semi-precision AC voltmeter (□0.1%); 3V and 300mV ranges
4.) High-current lead set

To begin, press the EXTRNL key in the CALIBRATE row. The 930i automatically performs an Internal Calibration. To continue, press the recessed CAL button in the front panel. The following prompt appears:

CONNECT 1.0Ω ACROSS
OUTPUT TERMINALS

Using a 4-wire configuration, connect the 1Ω resistor to the 930i. Monitor the voltage drop across the resistor with the voltmeter. Press ENTER to continue. The following prompt appears:

ENTER TERMINAL VOLTS
(H) 3V 3.00000 V

Use the numeric keypad to enter the voltage as read on the voltmeter and press ENTER. The following prompt appears:

ENTER TERMINAL VOLTS
(L) 0.3V.30000 V

Once again, use the numeric keypad to enter the voltage as read on the voltmeter and press ENTER. The 930i will then display its stored calibration constants. Press enter until the following prompt appears:

CONNECT 0.1Ω ACROSS
OUTPUT TERMINALS

Using a 4-wire configuration connect the 0.1Ω resistor to the 930i. Monitor the voltage drop across the resistor with the voltmeter. When ready, press ENTER. The following prompt appears:

ENTER TERMINAL VOLTS
2.50000V

Calculate a target voltage based on the formula:

25 x {the value of the 0.1Ω resistor}

Use the up/down arrow keys (▲ ▼) to adjust the output of the 930i so that the voltage indicated on the voltmeter matches the target voltage as closely as possible. Once adjusted, press ENTER. The following prompt appears:

ENTER TERMINAL VOLTS
0.50000V

Calculate a target voltage based on the formula:

5 x {the value of the 0.1Ω resistor}

Use the up/down arrow keys to adjust the output of the 930i so that the voltage indicated on the voltmeter matches the target voltage as closely as possible. Once adjusted, press ENTER. This completes calibration. The process may now be verified using the procedure that follows.

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8 930i Maintenance

930i Calibration Sheet

Nominal Values	Std Resistor Value	60 Hz Incoming Reading	60 Hz Outgoing Reading	Actual Deviation	Maximum Tolerance
1Ω 3A	1.0062Ω				± 15mΩ
100mΩ 3A	100.55mΩ				± 6mΩ
100mΩ 10A	100.55mΩ				±2.5mΩ
100mΩ 25A	100.55mΩ				±1.6mΩ
100mΩ 30A	100.55mΩ				±1.5mΩ

930i Performance Verification Procedure

This procedure may be used to verify overall accuracy at any time or to verify calibration. The same high-power resistors will be required as for the External Calibration, but the voltmeter is not required. Note: Allow a 60 minute, covers-on warm-up period at ambient temperature (within □5± C° from the calibration temperature).

9 930i Specifications

Prior to conducting the following verification procedure, run a Self-test and Internal Calibration of the 930i. Should any errors be detected, consult your Vitrek Service Center. In the event that the unit fails to perform within the given uncertainty levels, an External Calibration to local standards may be required. For all low resistance measurements use a 4-wire lead set of adequate current rating. Accuracy may be verified in Direct or Automatic Mode, at any frequency within the 930i's range.

Standard	Test Current	Range	Tolerance
0.1 Ω	30A	100mΩ	± 1.25mΩ
0.1 Ω	10A	300mΩ	± 1.75mΩ
1.0 Ω	3A	1Ω	± 12.5mΩ

The accuracy specifications for the 930i are valid following a 1 hour warm-up at the calibration temperature □±5°C for a period of 1 year following External Calibration. An Internal Calibration must have been performed within the preceding 24 hours. Connection technique must be 4-wire Kelvin. 2-wire measurements are subject to test lead resistance, contact resistance, and various other factors and are therefore not specified.

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Resistance Measurement Specifications

Resistance Limit: Digitally displayed, user programmable
Resistance Range: 1Ω at 3 amps linearly decreasing to 100mΩ @ 30A
Resistance Resolution: 10μΩ
Measurement Accuracy: ±□1.0% of reading ±□.5% of range (40 Hz to 100 Hz). Above 100 Hz add .01% of range per Hz

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Current Output Specifications

Range: 3 to 30 amperes RMS, programmable
Resolution: 1 amp
Output Frequency: 40 Hz to 400 Hz
Compliance Voltage: >3 volts RMS
Regulation: ±□0.25%, no load to full load

9 930i Specifications

General

Memory:	Non-volatile storage of up to 20 test routines
Test time:	Digital countdown timer, programmable 0.5 to 99 seconds
Terminals:	Four-wire Kelvin, alternate two-wire configuration
Isolation:	Output isolated to 500MΩ for dielectric testing
Remote Interfaces:	VICL and serial RS232C communications ports for control via PC or 944i
Display:	40 character dot matrix display
Indicators:	L.E.D. status indicators
Alarms:	Audible and visible alarms alert user to high-current conditions
Limits:	Test is automatically aborted when preprogrammed maximum value is exceeded
Diagnostics:	Built-in self-diagnostics test ROM, RAM, and output system
Calibration:	Traceable to the National Institute of Standards and Technology (NIST).
Accuracy:	Specifications apply for I year, □5□C from the cal temp within 20□C to 30□C
Temperature:	0°C to 50°C operating; -20°C to 70°C storage
Humidity:	90% RH, 0°C to 40°C, non-condensing
Power:	115 or 230 VAC ±□10%, 500VA max
Dimensions:	89mmH x 432mmW x 457mmD (3.5 "H x 17"W x 18"D)
Weight:	11 Kg (24 lb) net / 15Kg (34 lb) shipping

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