ViTREK

964i

OPERATING & MAINTENANCE MANUAL

ABOUT THIS MANUAL

This manual has been created with "clickable" links. Where a reference is made to another section of the manual, the user may click on the section name reference and the document will automatically go to that section.

The table of contents is "clickable". The user may click on any of the entries to go to that section.

The table of contents is also made available as Bookmarks for Adobe Reader or Acrobat, allowing the user to permanently display the table of contents alongside the document and navigate by clicking on each section needed.

WARRANTY INFORMATION

This ViTREK instrument is warranted against defects in material and workmanship for a period of 1 year after the date of purchase (extended up to a total of 3 years with registration and annual calibrations at ViTREK). ViTREK agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during the warranty period. ViTREKs obligation under this warranty is limited solely to repairing any such instrument, which in ViTREKs sole opinion proves to be defective within the scope of the warranty, when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by the purchaser. Shipment should not be made without prior authorization by ViTREK.

This warranty does not apply to any products repaired or altered by persons not authorized by ViTREK or not in accordance with instructions provided by ViTREK. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

ViTREK assumes no responsibility for its products being used in a hazardous or dangerous manner, either alone or in conjunction with other equipment. Special disclaimers apply to this instrument. ViTREK assumes no liability for secondary charges or consequential damages, and, in any event, ViTREKs liability for breach of warranty under any contract or otherwise, shall not exceed the original purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by ViTREK or its representatives, for uses of its products are based on tests believed to be reliable, but ViTREK makes no warranties of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied and no representative or person is authorized to represent or assume for ViTREK any liability in connection with the sale of our products other than set forth herein.

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SECTION 1 – PRODUCT INFORMATION

FEATURES

- Complete flexibility. The user can order custom combinations of relay cards, terminals and wiring. Up to 64 relays and 65 terminals can be installed in a single chassis.

- Front Panel Connections for easy connection to a ViTREK 95x series, V7X series, 944i or V series High Voltage Safety analyzer. Optional rear panel terminals available also.

- Easy Debugging when Programming. The presently commanded relay states are available on the front panel display, making debugging a safety test procedure easy. The user is also able to manually control the relays.

- Self-Testing. Continuously checks that each relay is being driven according to the last received command. A hardware failure in the 964i is detected and an error is raised. Continuously checks that sufficient DC power is applied to the relays to ensure correct operation.

- Reliable high speed operation. Relay states can be changed in as little as 5ms; the 964i automatically provides all of the required timing.

- Warns when maintenance is required. Accumulates counts of relay operations for each relay and warns the user if any relay is approaching (or beyond) its life expectancy.

- High voltage and current capability. Relay Cards up to 15KV are available. Relay Cards up to 40Arms are available. Both high voltage and high current relay cards can be in the same 964i.

- Can be controlled directly by a ViTREK 944i, 95x, or V7X series Safety Tester. The 95x and V7X series can control up to 4 964i's.

- QuickTest Pro software available for the PC for total system control; 95x, V7X, or V series Safety Tester and up to 16 964i's.

- Choice of interfaces. The standard 964i comes with RS232 and VICL interfaces, the user can add an optional GPIB interface.

AVAILABLE 964i OPTIONS

INTERFACING OPTIONS

Option **GP-964** adds a GPIB interface.

RACK MOUNTING OPTION

Option **RM-1** allows for standard 19" rack mounting.

CABLE OPTIONS

Option **VICL-2** provides a 6ft VICL cable for use between a 964i and either a 95x, V7X, or another 964i.

Option **RS-2** provides a 6ft RS232 cable for use with either a 95x or a computer.

Option **GP-1** and **GP-2** provides a 1m or 2m GPIB cable.

SECTION 2 – TERMINALS, RELAYS AND BANKS

Terminal Numbers

The rear panel terminals are numbered from 1 through 60, the user should consult the relay and terminal configuration document supplied with the specific 964i for the use of each terminal.

Relay Numbers and Relay Bank Numbers

The relays within the 964i are numbered from 1 through 64, the user should consult the relay and terminal configuration document supplied with the specific 964i to determine the use of each relay.

Relays are internally grouped into eight banks (or cards) of eight relays each. These banks are numbered 0 through 7.

Relay bank #0 contains relay numbers 1 through 8.
Relay bank #1 contains relay numbers 9 through 16.
Relay bank #2 contains relay numbers 17 through 24.
Relay bank #3 contains relay numbers 25 through 32.
Relay bank #4 contains relay numbers 33 through 40.
Relay bank #5 contains relay numbers 41 through 48.
Relay bank #6 contains relay numbers 49 through 56.
Relay bank #7 contains relay numbers 57 through 64.

HEXADECIMAL CODE TABLE

Table 1 - Hexadecimal Relay Code Table is a useful reference to the hexadecimal codes used throughout this manual. The relay numbers shown are for bank #0; see above for the relay numbers in other banks.

When the hexadecimal code is shown for more than four relays, the leftmost code is for the highest numbered relays and the rightmost code is for the lowest numbered relays in all cases.

Table 1 - Hexadecimal Relay Code Table

| Code | Relay 8 | Relay 7 | Relay 6 | Relay 5 |
	Relay 4	Relay 3	Relay 2	Relay 1
0	Open	Open	Open	Open
1	Open	Open	Open	Closed
2	Open	Open	Closed	Open
3	Open	Open	Closed	Closed
4	Open	Closed	Open	Open
5	Open	Closed	Open	Closed
6	Open	Closed	Closed	Open
7	Open	Closed	Closed	Closed
8	Closed	Open	Open	Open
9	Closed	Open	Open	Closed
A	Closed	Open	Closed	Open
B	Closed	Open	Closed	Closed
C	Closed	Closed	Open	Open
D	Closed	Closed	Open	Closed
E	Closed	Closed	Closed	Open
F	Closed	Closed	Closed	Closed

SECTION 3 – RELAY CARDS

Each 964i is custom manufactured to user requirements. Consult the relay and terminal configuration document supplied with the specific 964i for details regarding relay content, terminal configuration and internal wiring.

HV SERIES

The HV series cards are 8:1, 4:1, 2:1, dual 4:1 and dual 2:1 multiplexing cards handling low currents at voltages up to 7, 10 or 15KVdc or 5, 7 or 10KVrms. Figure 1 shows the configurations available (other configurations are available, contact ViTREK with your specific requirements).

Figure 1

- As standard, cards are populated from the lowermost numbered relay positions upwards. Dual multiplex cards use the lowermost four positions for one multiplexer and the uppermost four for the other.

- Except for the MX2 series cards, as standard the individual multiplex connections are on terminals with the same number as the relay. A letter can be appended to the end of the part number indicating the color of the terminal (R = red, B = black or W = white).

- For the MX2 series cards, as standard the individual multiplex connections are on the front panel terminals (HV and SENSE+).

- The common connection to each multiplexer is connected to a user specified point (e.g. a terminal or an internal bussed connection).

Table 2 shows the ordering codes for each variant.

Table 2

Function	7KVdc/5KVrms	10KVdc/7KVrms	15KVdc/10KVrms
8:1 Multiplex	HV7-8	HV10-8	HV15-8
4:1 Multiplex	HV7-4	HV10-4	HV15-4
2:1 Multiplex	HV7-MX2	HV10-MX2	HV15-MX2
Dual 4:1 Multiplex	HV7-4x2	HV10-4x2	HV15-4x2
Dual 2:1 Multiplex	HV7-MX2x2	HV10-MX2x2	HV15-MX2x2

Specifications -

Voltage	Between any two connections: See Table 2.
	Any connection to ground: See Table 2.
Frequency	<500Hz.
Carrying Current	<1Arms continuous, <2Arms for <1 second.
Switching Power	HV7-xxx and HV10-xxx : <50W (resistive).
	HV15-xxx : <10W (resistive).
Switching Time	<5ms (including bounce).
Expected Life	<1mA, <100V resistive switching: 500,000 operations.
	At max. switching power: 1,000 operations.
Contact Resistance	At terminals, <50% expected life operations (add 0.1Ω for <100% life).
	<0.25Ω (uncompensated).
	<0.1Ω (compensated).
	<±0.1Ω difference between lowest and highest.
Leakage Resistance	Any individual connection to ground: >500GΩ at <30C.
	Common connection to ground: >100GΩ at <30C.
	Between any two connections: >1TΩ at <30C.
Leakage Capacitance	Any individual connection to ground: 15pF (typical).
	Common connection to ground: 50pF (typical).
	Between any two connections: 5pF (typical).
Thermal EMF	<1mV.
Coil Power	Holding closed: 0.3W (typical)
	Closing: 1.25W for 5ms (typical)

LV SERIES

The LV series cards are 8:1, 4:1, 2:1, dual 4:1 and dual 2:1 multiplexing cards handling medium currents at voltages up to 3KVdc or 2KVrms. Figure 2 shows the configurations available (other configurations are available, contact ViTREK with your specific requirements).
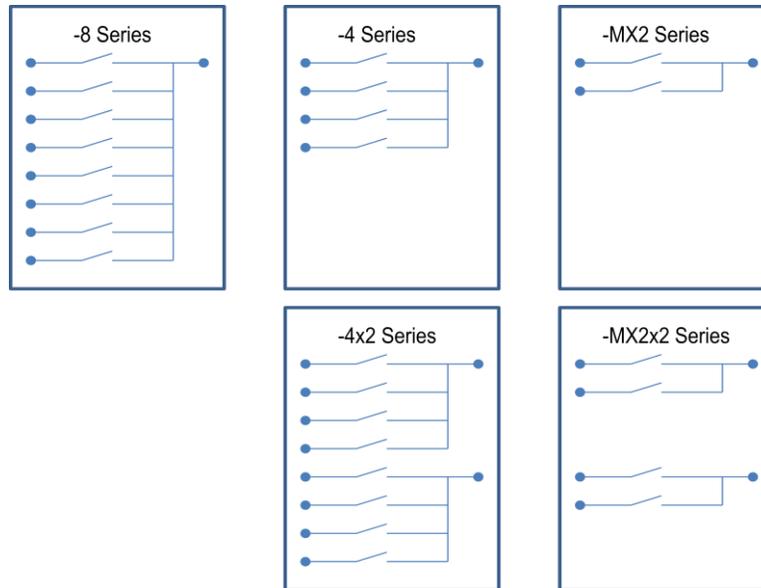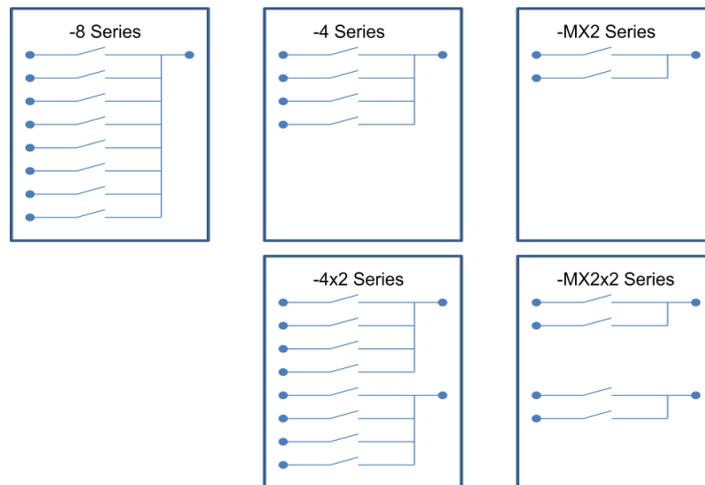

Figure 2

- As standard, cards are populated from the lowermost numbered relay positions upwards. Dual multiplex cards use the lowermost four positions for one multiplexer and the uppermost four for the other.

- As standard the individual multiplex connections are on terminals with the same number as the relay. A letter can be appended to the end of the part number indicating the color of the terminal (R = red, B = black or W = white).

- The common connections are connected to a user specified point (e.g. a terminal or an internal bussed connection).

Table 3 shows the ordering codes for each variant.

Table 3

Function	
8:1 Multiplex	LV-8
4:1 Multiplex	LV-4
2:1 Multiplex	LV-MX2
Dual 4:1 Multiplex	LV-4x2
Dual 2:1 Multiplex	LV-MX2x2

Specifications -

Voltage	Between any two connections: 3KVdc/2KVrms. Any connection to ground: 5KVdc/3KVrms.
Frequency	<500Hz.
Carrying Current	<1Arms continuous, <8Arms for <1 second.
Switching Power	<500W (resistive).
Switching Time	<10ms (including bounce).
Expected Life	<1mA, <100V resistive switching: 5,000,000 operations. At max. switching power: 100,000 operations.
Contact Resistance	At terminals, <50% expected life operations (add 0.05Ω for <100% life). <0.175Ω (uncompensated). <0.05Ω (compensated). <0.075Ω difference between lowest and highest.
Leakage Resistance	Any individual connection to ground: >1GΩ at <30C. Common connection to ground: >200MΩ at <30C. Between any two connections: >1GΩ at <30C.
Leakage Capacitance	Any individual connection to ground: 15pF (typical). Common connection to ground: 50pF (typical). Between any two connections: 10pF (typical).
Thermal EMF	<200uV.
Coil Power	Holding closed: 0.12W (typical) Closing: 0.5W for 5ms (typical)

HC-4

The HC-4 card is a dual 4:1 multiplexing card; one multiplexer handles current up to 40Arms, and the other handles low currents. These are designed to multiplex AC Ground Bond measurements. Figure 3 shows the configuration available (other configurations are available, contact ViTREK with your specific requirements).
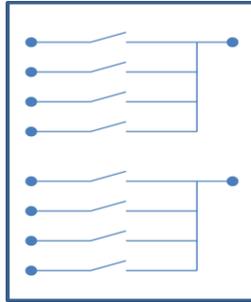
Figure 3

- The lower numbered set of four relays is the high current type. The higher numbered set of four relays is the low current type.

- As standard the individual multiplex connections are on terminals with the same number as the relay. A letter can be appended to the end of the part number indicating the color of the terminal (R = red or B = black).

- The common connections are connected to a user specified point (e.g. a terminal or an internal bussed connection).

High Current Specifications -

Voltage	Between any two connections: 1.5KVdc/1KVrms.
	Any connection to ground: 1.5KVdc/1KVrms.
Frequency	<500Hz.
Carrying Current	<40Arms continuous, <60Arms for <1 second.
Switching Power	<500W (resistive).
Min Switching Current	>0.5Arms.
Switching Time	<20ms (including bounce).
Expected Life	1 to 10Arms resistive switching: 500,000 operations.
	At max. switching power: 10,000 operations.
Contact Resistance	<0.025Ω (at terminals, <100% expected life operations).
Leakage Resistance	Any individual connection to ground: >20MΩ at <30C.
	Common connection to ground: >5MΩ at <30C.
	Between any two connections: >20MΩ at <30C.
Coil Power	Holding closed: 0.6W (typical)
	Closing: 2.5W for 25ms (typical)

Low Current Specifications -

Voltage	Between any two connections: 1.5KVdc/1KVrms.
	Any connection to ground: 1.5KVdc/1KVrms.
Frequency	<500Hz.
Carrying Current	<1Arms continuous, <2Arms for <1 second.
Switching Power	<30W (resistive).
Switching Time	<5ms (including bounce).

Expected Life	<1mA, <100Vdc switching : 5,000,000 operations.
	At max. switching power : 100,000 operations.
Contact Resistance	At terminals, <50% expected life operations (add 0.05Ω for <100% life).
	<0.15Ω (uncompensated).
	<0.05Ω (compensated).
Leakage Resistance	Any individual connection to ground: >100GΩ at <30C.
	Common connection to ground: >10GΩ at <30C.
	Between any two connections: >100GΩ at <30C.
Leakage Capacitance	Any individual connection to ground: 15pF (typical).
	Common connection to ground: 50pF (typical).
	Between any two connections: 10pF (typical).
Thermal EMF	<100uV.
Coil Power	Holding closed: 0.06W (typical)
	Closing: 0.25W for 5ms (typical)

SECTION 4 – SAFETY

The user should be aware of these safety warnings at all times while using the 964i.

WARNING - THE 964i CAN BE USED WITH VOLTAGES AND CURRENTS WHICH MAY BE LETHAL, UNSAFE OPERATION MAY RESULT IN SEVERE INJURY OR DEATH.

WARNING - IF THE 964i IS USED IN A MANNER NOT SPECIFIED BY VITREK, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED AND SAFETY MAY BE COMPROMISED.

POWER AND GROUNDING

WARNING – THE 964i GROUND MUST BE PROVIDED BY THE USER BY SECURELY GROUNDING THE PROTECTIVE GROUND TERMINAL ON THE REAR PANEL. ANY GROUND PROVIDED BY THE DC POWER SOURCE OR BY AN INTERFACE SHOULD NOT BE RELIED UPON FOR SAFETY PURPOSES.

TERMINALS AND WIRING

WARNING - THE 964i CAN BE USED WITH VOLTAGES AND CURRENTS WHICH MAY BE LETHAL, ENSURE NO VOLTAGE OR CURRENT IS PRESENT WHEN CONNECTING TO OR DISCONNECTING FROM THE TERMINALS OR DUT.

WARNING - THE 964i CAN BE USED WITH VOLTAGES OF UP TO 10kVrms. THE USER MUST ENSURE THAT CONNECTIONS TO THESE TERMINALS HAVE SUFFICIENT INSULATION FOR THESE VOLTAGES. EVEN WHEN SUFFICIENT INSULATION IS PRESENT, THE USER SHOULD NOT PUT ANY PART OF THEIR BODY IN CLOSE PROXIMITY TO THE CONNECTIONS WHILE HIGH VOLTAGES ARE PRESENT.

The insulation of the wiring to the terminals of the 964i must be rated for at least the highest voltage expected.

When using high AC voltages, even if there is sufficient insulation, there may be significant capacitive coupling which can cause an unsafe current to flow to nearby objects and corona can occur even outside of the insulation. This is made worse by sharp corners on grounded objects or the wiring. In severe cases this can reduce the capabilities of the wiring insulation over time, eventually resulting in insulation failure.

WARNING - SOME 964i CONFIGURATIONS USE CURRENTS OF UP TO 40Arms. THE USER MUST ENSURE THAT CONNECTIONS TO THESE TERMINALS HAVE A SUFFICIENT CURRENT CARRYING RATING.

The current rating of all wiring must be sufficient for at least the highest current expected from that terminal.

SECTION 5 –INSTALLATION

GENERAL SPECIFICATIONS

Nominal Dimensions	89mmH x 432mmW x 457mmD (3.5" x 17" x 18")
Nominal Weight	Depends on relay bank content. Without relay banks: 3.5Kg (8lb) net, 7Kg (16lb) shipping Relay banks: <0.75Kg (1.5lb) each
Storage Environment	-20 to 75C (non-condensing)
Operating Environment	0 to 50C, <85% RH (non-condensing), Pollution Degree 2
Operating Altitude	0 to 10000ft ASL
Line Power	Installation Category II using provided external bench power module 105-265Vrms, 45 to 450Hz

THE 964i MUST NOT BE USED IN AN ENVIRONMENT WHERE CONDUCTIVE POLLUTION CAN OCCUR, E.G. IN AN OUTDOOR ENVIRONMENT.

IF FLUIDS OR OTHER CONDUCTIVE MATERIALS ARE ALLOWED TO ENTER THE UNIT ENCLOSURE, EVEN IF NOT POWERED, THEN THE UNIT SHOULD BE IMMEDIATELY TAKEN OUT OF OPERATION AND SERVICED AS SAFETY MAY HAVE BEEN COMPROMISED.

IF THE UNIT IS TRANSPORTED BETWEEN DIFFERING ENVIRONMENTS AND CONDENSATION IS SUSPECTED, THE UNIT SHOULD REMAIN UNPOWERED FOR SUFFICIENT TIME FOR CONDENSATION TO HAVE DISSIPATED.

INITIAL INSPECTION

After the 964i has been shipped or otherwise handled in an unknown manner, the user should visually inspect the 964i for damage before attempting to operate it. Particular attention should be taken to ensure that there are no significant dents or cracks in any outer surfaces and that all terminals are securely mounted to the unit. If any significant dents or cracks, or any loosely mounted terminals, are noted then it is recommended that the 964i be serviced prior to being placed into use, as safety may have been compromised.

MOUNTING POSITION AND ORIENTATION

The 964i may be installed as either a bench top instrument or installed into a standard 19" rack.

The 964i is primarily intended to be used in a horizontal, or close to horizontal position, oriented with the top cover uppermost. There are no known issues with mounting the 964i at any angle or orientation, as long as it is mounted in a secure and stable fashion taking into consideration its' weight and weight distribution.

INSTALLING IN A 19" RACK ENCLOSURE

Often when installing the 964i into a rack enclosure it is desired to remove the feet from the bottom of the 964i. This is easily achieved by simply removing the screws mounting the feet to the bottom of the unit. The user should place the removed feet and mounting hardware into a bag for safe keeping should they be needed at a later date

for bench top usage. DO NOT INSERT THE MOUNTING HARDWARE BACK INTO THE BOTTOM OF THE 964i WITHOUT THE FEET INSTALLED, THIS MAY DAMAGE THE UNIT.

Option RM-1 provides the rack mount ears required for mounting in a standard 19" rack enclosure.

When installing the 964i into a rack enclosure it is recommended that the unit be supported through its' depth. The use of a tray or angle brackets supporting the bottom edges of the unit is recommended.

COOLING

Depending on how many relays are to be continuously closed the 964i can consume anything between 3W (no relays closed) to 25W (worst case, continuously closed relays) or 47W (worst case, highest speed closing and opening of all relays). Refer to SECTION 3 – RELAY CARDS regarding the specifications of the relay cards installed.

The user is recommended to have at least 1.75" (or 1U in rack-based applications) of well ventilated air space above, below and behind the 964i. When mounting in a restricted enclosure with poor ventilation, the user should consider providing forced air cooling.

CONNECTING TO A VITREK 95X OR V SERIES TESTER

The user should consult the relay and terminal configuration document supplied with the specific 964i for details regarding making the analog connections between the 964i and the 95x, V7X, or V series tester unit. Typically, the front panel terminals are connected directly to the similar terminals of the tester.

If the 964i is to be controlled by a ViTREK 95x then either the user should connect the RS232 port of the 964i to the RS232 port of the 95x, or connect the VICL-IN port of the 964i to the VICL-OUT port of the 95x, as required for the control method to be used. If the 964i is to be controlled by a V7X only the VICL connections are applicable.

If multiple 964i units are to be controlled by a 95x or V7X using the VICL interface then connect the VICL-OUT port of each 964i to the VICL-IN port of the next 964i.

SECTION 6 – FRONT PANEL OPERATION

The front panel consists of the following -

- The display. This shows the selected relay switches states and all menus during interactive data entries.

- The **POWER** switch. This turns on/off the power to the 964i.

- The indicators.

  - **ACTIVE**. This is illuminated when any relay in the 964i is closed.

  - **FAULT**. This is illuminated when an internal fault is detected.

  - **LOW POWER**. This is illuminated when the power to the 964i is too low to guarantee proper operation of the relays.

  - **MAINT REQD**. This is illuminated if any relay is over 50% of its expected operational life, it is flashed on and off if any relay is beyond its expected operational life

  - **ERROR**. This is illuminated when the last received interface command contained an error.

  - **REMOTE**. This is illuminated when the 964i is under the control of an interface.

- The **SWITCH STATE** keys. This changes the displayed information as follows –

  - **ALL**. Shows the state of all relays in the 964i as eight pairs of hexadecimal codes, one pair for each relay bank. Relay banks which are not fitted are shown as dashes. An example display showing that bank #7 is not fitted and relays 4 through 1 are closed, is –

    ```
    7:-- 6:00 5:00 4:00
    3:00 2:00 1:00 0:0F
    ```

  - **BANK**. Shows the states of all relays in a specific relay bank as 8 binary digits (1 = closed, 0 = open). Relays which are not fitted are shown as dashes. The user may repeatedly press the **BANK** or the **SELECT** key to select each relay bank in turn. An example display showing that bank #0 relays 4 through 1 are closed, is –

    ```
    BANK 0 (RLY 08-01)
       00001111  (0F)
    ```

  - **SET**. Allows the user to manually select the open or closed state for each relay. The actual relay state(s) are changed to those set by the user when the user presses the **SET** key again to exit the edit mode.

    - If pressed while displaying the ALL data, then all relays can be edited using the hexadecimal codes using the **SELECT** key to move the flashing selection point and the **EDIT** key to alter the hexadecimal code at the selection point.

    - If pressed while displaying the BANK data, then all relays in the displayed relay bank can be edited using the binary codes using the **SELECT** key to move the flashing selection point and the **EDIT** key to toggle the state (1 = closed, 0 = open) at the selection point.

  - **MAINT**. This changes the display to show the maintenance condition of each relay bank. The maintenance condition is shown as the percentage of the expected life which has been used. This is shown for one relay bank; the user may alter which bank is displayed by pressing the **SELECT** key. An example display showing that bank #0 is at 12.10% of the expected life is –

    ```
    WEAR LEVEL OK
    BANK 0 WEAR:  12.10%
    ```

- The **CONFIG** keys. These allow the user to view (and alter for the **IFACE** key) the configuration of the 964i.

  - **IFACE**. The presently selected interface and the configuration for that interface is displayed. The user may alter the selected interface between RS232, VICL and GPIB by pressing the **EDIT** key, or may select the configuration for the selected interface by pressing the **SELECT** key and then changing it by using the **EDIT** key. Any changes made are saved and the display is returned to the ALL state by pressing the **IFACE** key again or by pressing one of the SWITCH STATE keys. An example display is –

    ```
    CONFIGURE INTERFACE
    RS232    115200baud
    ```

  - **SWITCH**. This allows the user to view the configured relay banks. The type of relay bank and the fitted relays for that bank are shown. The user may change which relay bank is being displayed by pressing the **SELECT** key. An example display, showing that an HV type relay card is installed in bank #0 and it has all relays populated, is –

    ```
    SWITCH BANKS
    BANK 0 HV  11111111
    ```

- **SELECT** and **EDIT** keys. The use of these keys depends on the selected display information –

  - When displaying the ALL data. These keys allow the user to change the display contrast.

  - When displaying the BANK data. The SELECT key changes the displayed relay bank.

  - When manually setting relay banks. See SET above.

  - When configuring the interface. See IFACE above.

SECTION 7 – COMPENSATING FOR LEAKAGE CURRENTS AND CONTACT RESISTANCES

The user can measure and correct for any contact resistances in the 964i and the wiring using either the ViTREK 95x, V7X, or V series units. Similarly, leakage currents in the 964i and wiring can also be compensated for in the ViTREK 95x series.

NOTE – the user should ensure that all contact resistances in the terminals is minimized. If contacts remain attached to the terminals for long periods of time then the user should occasionally detach them for cleaning and then reattach them. This will help ensure that any contact resistance in the terminals is consistent over time.

CONTACT RESISTANCE

When using the 964i with a ViTREK 95x, V7X, or V series the 964i contact resistance and the resistance of the wiring and connections between the 964i and the 95x, V7X, or V series unit can be corrected for by using the 95x, V7X, or V series ability to correct their resistance measurement zero.

With the 95x series

This should only be performed for LowΩ type test steps using 2-wire measurements at the DUT. It is not required when performing fully 4-wire LowΩ or Ground Bond measurements.

A test sequence in the 95x can be run in the Lead Compensation mode (consult the 95x series manual for details regarding this) to provide an offset for all future runs of the test sequence. The user must short together all DUT terminals, using the actual cables to the DUT if possible, when running the sequence in Lead Compensation mode. This will provide individual offsets for each measurement being performed, so the differences in relay contact resistances do not affect the future measurements.

With the V7X series

This may be performed for the continuity or GB measurements for the applicable V7X models.

The V7X series unit can store an example contact resistance and use this as an offset to all future measurements or can have a manual input entered on a per test step basis. To perform the universal offset for the V7X series, the user should command the 964i to provide an example zero ohm to the V7X series unit and then run the V7X series offset function (consult the relevant V7X series manual for details regarding this). Since this only corrects for an example contact resistance, the difference between relay contact resistances in the 964i will still affect the measurement results. The manual input will require an offset input (in ohms) per step.

With the V series

This may be performed for the V4 GB measurements or for V6x series Continuity measurements.

The V series unit can measure and store an example contact resistance and use this as an offset to all future measurements. To perform this, the user should command the 964i to provide an example zero ohm to the V series unit and then run the V series offset function (consult the relevant V series manual for details regarding this). Since this only corrects for an example contact resistance, the difference between relay contact resistances in the 964i will still affect the measurement results.

LEAKAGE CURRENTS

When using the 964i with a ViTREK 95x series the 964i and wiring AC or DC leakage current can be corrected for by using the 95x ability to correct its' leakage measurement zero.

A test sequence in the 95x can be run in the Lead Compensation mode (consult the 95x series manual for details regarding this) to provide an offset for all future runs of the test sequence. The user must ensure that there are no connections to the terminals of the 964i to a DUT when running the sequence in Lead Compensation mode. This will provide individual offsets for each leakage measurement being performed.

SECTION 8 – CONNECTING AND CONFIGURING INTERFACES

The 964i contains several interfaces, some of which are options. This section describes how to configure and connect a computer to each interface. For details regarding connecting a 964i to a 95x or V7X, see Connecting to a ViTREK 95x or V series Tester.

For programming information using an interface to control the 964i see SECTION 10 – PROGRAMMING VIA AN INTERFACE.

CONTROLLING THE 964i USING THE RS232 INTERFACE

SPECIFICATIONS

Baud Rate	9600, 19200, 57600 or 115200
Handshake	Bi-directional, hardware (RTS/CTS)
Data Bits	8
Parity	None
Start/Stop Bits	1
Connector	9-pin Male Dsub
Interface Pinout Type	DTE (same as PC computer)
Cable required	9-wire female-female null modem cable, fully wired
Cable Length	<50ft (per standard)

CONFIGURATION

- Press the **IFACE** key. The display shows the present interface configuration, an example is –

  ```
  CONFIGURE INTERFACE
  RS232    115200baud
  ```

- The display shows the presently selected interface in the left side of the lower line. If this is not showing RS232 –

    - If needed, make this the selected data (flashing between the data and blocks) by pressing the **SELECT** key.

    - Press the **EDIT** key as needed to change this to show RS232.

- The display shows the RS232 baud rate for the connection in the right side of the lower line. If this is not showing the desired baud rate –

    - If needed, make the baud rate the selected data (flashing between the data and blocks) by pressing the **SELECT** key.

    - Press the **EDIT** key as needed to change this to the required baud rate.

- Press the **IFACE** key to exit the menu. The RS232 interface will now be active at the set baud rate.

CONNECTION

Using a RS232 cable supplied by ViTREK, connect the RS232 port on the 964i rear panel to the RS232 (Serial) port of a computer. The user may supply their own cable, in which case it should be a 9-wire female-female null modem cable capable of full handshake 115200baud operation.

CONTROLLING THE 964i BY THE GPIB INTERFACE

CONFIGURATION

- Press the **IFACE** key. The display shows the present interface configuration, an example is –

  ```
  CONFIGURE INTERFACE
  RS232    115200baud
  ```

- The display shows the presently selected interface in the left side of the lower line. If this is not showing GPIB –

  - If needed, make this the selected data (flashing between the data and blocks) by pressing the **SELECT** key.

  - Press the **EDIT** key as needed to change this to show GPIB. If the GPIB interface is not fitted then the GPIB selection is not available.

- The display shows the GPIB address of the 964i in the right side of the lower line. If this is not showing the desired address –

  - If needed, make the address the selected data (flashing between the data and blocks) by pressing the **SELECT** key.

  - Press the **EDIT** key as needed to change this to the required address (the allowable range of values is between 1 and 29 inclusive).

- Press the **IFACE** key to exit the menu. The GPIB interface will now be active at the set address.

CONNECTION

Using a standard GPIB cable connect the GPIB port on the 964i rear panel to the GPIB port of a computer. It is recommended to use a high quality, shielded GPIB cable. Cables may be purchased from ViTREK.

SECTION 9 – PERIODIC MAINTENANCE

THE 964i CONTAINS NO INTERNAL USER SERVICABLE PARTS AND REQUIRES NO INTERNAL PERIODIC MAINTENANCE. THE COVERS OF THE 964i SHOULD ONLY BE REMOVED BY ViTREK OR ITS SERVICE CENTERS – REMOVAL OF THE COVERS MAY AFFECT WARRANTY.

RELAY LIFE

The user should periodically check the **MAINT** indicator on the 964i front panel. If the indicator is illuminated, then at least one relay is beyond 50% of its' expected life. If flashing, then it is over 100% of its' expected life. The 964i should be serviced and the relay(s) replaced as needed.

CLEANING AND INSPECTION

Cable Inspection

Carefully inspect all high voltage cabling, for breaks, abrasions or cracks in the outer insulation. Replace any cable found to be damaged.

If a high voltage cable has become excessively dirty then the user should clean it by wiping it with a wetted cloth, with a cleaning agent if needed. If a high voltage cable is wetted ensure it is fully dried before returning it to use.

Display Filter Cleaning

Visually inspect the cleanliness of the front panel display filter. If it is excessively dirty then it should be carefully wiped with a soft, lint free cloth wetted with a weak solution of dish soap. Commercially available pre-wetted wipes may also be used, however under no circumstances should alcohol based cleaners be used on the front panel screen as it may damage the surface.

Terminal Inspection

Visually inspect the terminals and the area immediately around them and clean them if required. IF THE INTERNAL SURFACES OF TERMINALS ARE WETTED DURING CLEANING THEN ENSURE THAT THEY ARE FULLY DRIED BEFORE OPERATING THE 964i AT HIGH VOLTAGES, OTHERWISE SAFETY MAY BE COMPROMISED.

Carefully visually inspect the high voltage terminal shrouds for mechanical damage. If there is any cracking in the shroud then safety may be compromised and the terminal should be replaced. Replacement of high voltage terminals should only be carried out at ViTREK or one of its certified repair establishments.

CALIBRATION

The 964i contains no internal adjustments and requires no periodic calibration.

SECTION 10 – PROGRAMMING VIA AN INTERFACE

The 964i may be programmed via the RS232 or GPIB interface. Both use the same general format for commands and query responses. All data uses the standard 7-bit ASCII character set.

There are two types of command –

- Commands which do not have a response. These always cause the 964i to take an action.

- Commands which have a response (these are named Query commands in this document). These generally do not cause the 964i to take an action other than sending back the response. These all have a keyword which ends with the "?" character.

Throughout this section reference is made to several special ASCII characters –

<CR> the carriage return character

<LF> the line feed character

<SPACE> the space character

GENERAL COMMAND SYNTAX

NOTE – the command syntax described in this manual is the recommended syntax. For compatibility with earlier ViTREK products alternative syntax is allowed in some commands. In general the documented syntax for each command which is in both the 964i and the earlier 948i are compatible.

Every command takes the form of a set of one or more fields; each field is separated from the next by a field separator. The first field is always the command keyword, the remaining fields and their syntax depends on the command keyword and in some cases the content of a preceding field in the command.

Multiple commands can be transferred as a single set of commands; each command is separated from the next by a command separator. If there are multiple query commands in a single set then each response is given as separate fields in the overall response, which is not transmitted until all commands in the set have been successfully actioned. The maximum overall length of a response set is 99 characters. Commands are always actioned in the same order as they are received.

The end of a set of commands is denoted by the inclusion of a command terminator. Sets of commands are always actioned in the same order as they are received.

Received characters on each interface are buffered from the actual communications stream, the contents of the buffer being decoded and actioned when a command terminator is found in the stream. The maximum length of a set of commands is 99 characters.

The 964i does not raise an error if an empty set of commands is received, i.e. if there are two or more consecutive command terminators. This is effectively a "do nothing" set of commands.

The 964i does not raise an error if an empty command is received in a set of commands, i.e. there are two or more consecutive command separators, or a command separator is immediately followed by a command terminator. This is effectively a "do nothing" command.

If an error is found in a set of commands, then processing of the set of commands is terminated and the remainder of the set of commands is not decoded or actioned. There is never any response from a set of commands which contains an error, even if the erroneous command was after a query command in the set.

FIELD SYNTAX

Any field may optionally start and/or end with one or more **<SPACE>** characters.

Fields within a command are position dependent, i.e. the exact order is defined for each command. There are two types of fields in a command -

1. COMMAND KEYWORD. Although all command keywords are shown using uppercase characters in this document, lowercase characters may also be used if desired. Command keywords must exactly match the defined set for the 964i. The first field in a command is always the command keyword.
2. DATA. There are several types of data, the type used is dependent on the field -
   a. **<BOOL>**. This can be the single character "Y" or '1' denoting a true state, or the single character 'N' or '0' denoting the false state (the Y or N may be upper- or lower-case).
   b. **<STATE>**. This is either the characters ON (may be upper- or lower-case) indicating the closed state, or OFF (may be upper- or lower-case) indicating the open relay state.
   c. **<NR1>**. Any of the following methods may be used to define a **<NR1>** field-
      i. Decimal value. A string of numeric (0 through 9) characters defining a decimal number without polarity or decimal point (e.g. "123" defines the decimal number one hundred and twenty three). A value greater than 4294967295 is a syntax error.
      ii. Hexadecimal value. The user can optionally start this field with the characters "0X" or the single character "X" (in both cases the "X" character can also be lowercase) or "#h" (the h must be lower-case), in which case the following data defines the number in hexadecimal format using the numeric characters and the upper-case letters A through F, as an example 0x12 defines the decimal numeric value 18. A value greater than 0xFFFFFFFF is a syntax error.

FIELD SEPARATOR

Fields are separated by the comma character.

COMMAND SEPARATOR

Commands are separated by the semi-colon character.

COMMAND TERMINATOR

A command (or set of commands) is terminated by any of the following-

- A line-feed character (shown in this document as <LF>).
- A carriage return character (shown in this document as <CR>).
- (GPIB only) Any data byte with EOI asserted.
- (GPIB only) Reception of the GET bus command.

GENERAL RESPONSE SYNTAX

Multiple query commands may be included in the same set of commands, in which case the overall response will include each requested response, separated by the comma character, in the order defined in the set of commands. A response is always terminated with a <CR> character followed by a <LF> character (with EOI asserted for the GPIB interface). If the response is over 99 characters in total length then an error is raised and no response is

given. For the GPIB interface only, a <SPACE> character is appended to the start of each set of responses (including a blank response).

On the RS232 interface any response is transmitted as soon as the set of commands containing one or more query commands is completely decoded.

On the GPIB interface the user must take some action to receive the response from the 964i (i.e. a READ bus operation). If a read operation is performed when there is no data to be transmitted then a blank data is transmitted (i.e. a single <SPACE> character followed by <CR><LF>).

If another set of commands is decoded containing a query command prior to the 964i fully transmitting a prior response then the new response is not provided and an error is raised.

The following types of responses are given-

- **<BOOL>.** This is a single character '0' indicating the false condition or '1' indicating the true condition. This is always 1 character in length.
- **<STATE>**. This is either the characters ON indicating the closed state, or OFF indicating the open relay state.
- **<STRING>**. This is one or more printable ASCII characters. This has a variable number of characters in length, and may be of no length.
- **<HEX>**. This defines a hexadecimal quantity. It always starts with the characters #h followed by two hexadecimal characters (0 through 9 and upper-case A through F).
- **<NR1>.** This is one or more decimal characters defining a decimal numeric value. This has a variable number of characters in length.

DELAYS AND TIMEOUTS

The user does not need to perform any delays between sets of commands, or between a set of commands containing query commands and reading the response. The 964i automatically handshakes the commands as needed. The only exception to this is following application of power to the 964i in which case a minimum delay of 3 seconds is required prior to operation of the interfaces.

The maximum length of time for which the 964i will "hold-off" a set of commands (e.g. waiting for a previous set of commands to be decoded) is 100ms.

For all interfaces, responses to query commands are generally transmitted within a very short period of time, however in some circumstances there may be some delay enforced by the 964i. The user should use a timeout of no less than 100ms for responses.

GPIB BUS COMMANDS

Most standard GPIB bus commands are implemented in the normal fashion; however some cause a special activity in the 964i -

Device Clear (SDC and DCL) - Either of these causes the 964i to clear all interface buffers and put all relays into the open state.

Interface Clear (IFC) - This causes the 964i to clear all interface buffers. It does NOT affect any relay states.

Group Execute Trigger (GET) - This can be used as a GPIB interface command terminator.

COMMANDS

Table 4- Interface Commands

Command	Description
?	Responds with the character "1"
~	Resets all interfaces Puts all relays into the open state
*IDN?	Responds with a set of fields describing the product The response fields are – 1) A <STRING> set to "VITREK" 2) A <STRING> set to "964I" 3) A <STRING> indicating the serial number of the 964i 4) A <STRING> indicating the firmware version of the 964i
*RST	Resets all interfaces Puts all relays into the open state
BANK,<NR1>,<NR1>	Causes the relay bank defined by the first <NR1> value (in the range 0 through 7 inclusive) to be set to the states defined by the second <NR1> (in the range 0 through 255) As an example, BANK,4,0xB9 causes the 964i to set relay numbers 39, 37, 36, 35 and 32 to the ON state, and all others in bank #4 to the OFF state
BANK?,<NR1>	Responds with the <HEX> code indicating the states of the relays in the bank number given by the <NR1> value (in the range 1 through 64 inclusive) As an example, BANK?,0 causes the 964i to respond with the present relay states in bank #0 (an example response is "#h0F")
CARD?,<NR1>	Responds with a pair of <HEX> values describing the relay bank fitted in the bank # defined by the <NR1> value (in the range 0 through 7 inclusive). The first response <HEX> is either #h00 (no bank fitted), #h01 (a HV type card is fitted), #h02 (an HC type card is fitted) or #h03 (an LV type card is fitted). The second response <HEX> is the code indicating which relays are fitted in the bank (each bit is a '1' if fitted)
COUNT?,<NR1>	Responds with the <NR1> count value of the number of operations performed by the relay number defined by the <NR1> value in the command (in the range 1 through 64 inclusive).
LOCAL	(RS232 interface only) Releases the effect of the LOCKOUT command (see below)
LOCKOUT	(RS232 interface only) Prevents the user from making relay state or interface configuration changes from the front panel
RELAY,<NR1>,<STATE>	Causes the relay number defined by the <NR1> value (in the range 1 through 64 inclusive) to be set as indicated by <STATE> As an example, RELAY,21,ON causes relay #21 to be placed into the ON (closed) state.
RELAY?,<NR1>	Responds with the <STATE> of the relay number defined by the <NR1> value (in the range 1 through 64 inclusive) As an example, RELAY?,21 causes the 964i to respond with the present state (ON or OFF) of relay #21
SYST,<NR1>…	Causes the relay states in banks 0 upwards to be set to each consecutive <NR1> or <HEX> value. Between one and eight values may be specified. As an example: Using HEX coding send SYST,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00 to set all relays in all eight relay banks to the OFF (open) states.
SYST?	Responds with eight <HEX> codes indicating the present relay states in banks 0 through 7 inclusive.

COMMANDING RELAYS WHICH ARE NOT INSTALLED

If the user attempts to set a relay to the ON (closed) state but it is not installed then an error is raised, but the remainder of the command is still actioned normally.

TIMING OF RELAY CHANGES

The 964i will neither decode any received commands nor respond to previous query command while changing relays. In this manner the user need not implement any delays for relay timing; it is automatically performed by the 964i.

If the user commands several relay changes in the same set of commands then the 964i enforces a "break-before-make" action when performing the changes, otherwise all changes are performed at the same time.

If the user makes several relay changes in different sets of commands, then the changes are made in the order received.

The "?" query command (which always responds with a "1") is useful in this regard, as it allows the user to synchronize external events with the switching of relays in the 964i As an example –

> Sending the command **BANK,1,#h00;?** causes the 964i to set all relays in bank #1 to the OFF (open) state and then respond with a "1" after the relays have settled.

MIGRATING FROM THE ViTREK 948i

The command set, field and command separators and command terminators of the 964i has been designed to be largely compatible with that of the 948i.

If the user previously used a 948i controlled by a 944i then the 964i can be used in place of the 948i. The user should take into account that the 944i could only control relay banks 0 through 5 however, so if the 964i contains relay banks 6 or 7 then they will be unaffected by the 944i.

When using user written software, the following should be observed when migrating from the 948i to the 964i –

- The 948i typically powered up with certain relays closed in bank #6. The 964i always powers up with all relays in the OFF (open) state. If the user relied upon the 948i power on state then they should change their software to not rely upon those relays being closed.

- The 948i allowed undocumented command and field separators in some circumstances. The 964i does not allow anything other than those documented in this manual; except that some commands allow a <SPACE> character to be used as a field separator for 948i compatibility. This may be depreciated in the future; the use should consider fully migrating to the documented 964i command set if possible.

- There a few 948i commands which are not present in the 964i.

    o The 964i does not implement the *OPT command.

    o The 964i does not implement the POLAR command of the 948i. The user should change to using the BANK command which can be programmed to perform the same function as the 948i POLAR command but is compatible with both products.

- The 948i allowed the user to set ON (closed) a relay which was not actually fitted; the query commands would reflect that the relay was ON or OFF (as commanded previously). In the 964i this is not the case, attempts to turn ON a non-fitted relay are ignored and query commands always show the state of a non-

fitted relay as being OFF. The user should remove all attempts to turn ON a relay which is not fitted in the 948i or 964i.

- The SYST command can usually be used unchanged between the products. The 964i allows for up to eight banks to be controlled by this command, whereas the 948i only allowed banks 0 through 5 to be controlled. If the user changes to using the fuller capability of the 964i then this will not be backwards compatible with the 948i.

- The SYST? response format is different for the 964i. The 948i responded with the states of banks 0 through 5 only, whereas the 964i responds with the states of all 8 banks. The user should either switch to using the 964i response format, or write the software to accommodate either response format if needed.

- The response to the *IDN? command is different between the 948i and the 964i. The user should change their software to accommodate either format if needed.

- The 948i required a delay between consecutive commands, the 964i does not. If the user retains the delay this will not affect the 964i but the user will not achieve the full performance potential of the 964i.

- When using the serial RS232 interface, the 948i did not use the hardware handshaking capability of the interface, whereas the 964i does. If the user configures the computer RS232 port in their software then this difference will need to be accommodated. Similarly, the 948i used a fixed baud rate of 9600 baud, whereas the 964i allows for other baud rates. The 964i can be used at 9600 baud (if set accordingly) but the full potential of the 964i will not be achieved, 115200 baud is typically recommended.

- When using the GPIB interface, there are some differences in the response syntax between the 948i and the 964i.

    o The 964i always appends a <SPACE> character to the beginning of all GPIB responses, the 948i did not. The user should strip off any leading <SPACE> characters in all responses in order to be compatible with both the 964i and the 948i.

    o The 964i always responds to a GPIB READ bus command, sending a <SPACE><CR><LF> string if no response is available. The 948i would not respond is there was no response available, causing the GPIB to lockup. This only occurs when there is a programming error in the computer, e.g. when the software reads the 964i but has not previously sent a query command.