950 Series Operating Manual

950 SERIES FRONT PANEL OPERATION

Throughout this document the instrument is referred to as the 950, this applies to all instruments in the 950 series.

SAFETY

WARNING IF THE 950 IS USED IN A MANNER NOT SPECIFIED BY VITREK, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED AND SAFETY MAY BE COMPROMISED.

WARNING THE 950 PRODUCES VOLTAGES AND CURRENTS WHICH MAY BE LETHAL, UNSAFE OPERATION MAY RESULT IN SEVERE INJURY OR DEATH

WARNING HIGH VOLTAGES AND CURRENTS MAY BE PRESENT ON THE TERMINALS OF THE 950. ENSURE NO VOLTAGE OR CURRENT IS PRESENT ON THE TERMINALS WHEN CONNECTING TO OR DISCONNECTING FROM THE TERMINALS

WARNING THE 950 IS INTENDED TO BE POWERED FROM A POWER CORD HAVING A PROTECTIVE GROUND WIRE WHICH MUST BE INSERTED INTO A POWER OUTLET HAVING A PROTECTIVE GROUND TERMINAL. IF THE 950 IS NOT POWERED FROM A SUITABLE POWER SOURCE THEN THE CHASSIS GROUND TERMINAL LOCATED NEAR THE POWER ENTRY CONNECTOR ON THE REAR PANEL MUST BE PROTECTIVE GROUNDED

GENERAL FRONT PANEL CHARACTERISTICS

The front panel of the 950 is divided into the following operational areas –

1. The display. This shows all menus during interactive data entries, all measurements during a test, and the present date/time when not performing any other duties.

2. The POWER switch. This turns on/off the power to the 950.

3. The START and STOP buttons.

    a. The START button allows the user to start performing a previous selected sequence of tests, or (while running a test sequence) select to continue a test when it is waiting for the user to do so.

    b. The STOP button aborts any testing in progress (if running a test), aborts the menu activity in progress discarding any changes made (if performing a menu), or makes no test sequence selected (otherwise).

4. The menu selection buttons. These are the Left Arrow, Right Arrow, EXIT and ENTER keys. During all menus, the selected element of the menu is highlighted by flashing between the data and blocks. These keys allow the user to move the selection point within a menu.

    a. The Left and Right Arrow keys are used to move the selection point within a menu.

    b. The ENTER key is used to finish entry of a menu data and automatically move to the next menu item.

    c. The EXIT key is used to save all changes made within a menu and return to the previous menu (if any) or to the inactive display.

5. The edit buttons. These are the Down Arrow and Up Arrow keys. These allow the user to decrement or increment (respectively) a selected menu item. During numeric entry these initiate "edit" mode of data entry, rather than "direct" mode of data entry (i.e. allow the user to adjust the existing entry using the Up/Down Arrow keys, rather than overwriting the existing value with a new value using the numeric keys).

    a. The Down Arrow and Up Arrow keys are used to edit a displayed menu data.

    b. The Left and Right Arrow keys are used to move the selection point within a menu.

    c. The ENTER key is used to finish entry of a menu data and automatically move to the next menu item.

    d. The EXIT key is used to save all changes made within a menu and return to the previous menu (if any) or to the inactive display.

6. The indicators. These area as follows –

    a. HIGH VOLTAGE or HIGH CURRENT PRESENT. This is illuminated whenever the 950 has a high voltage (>30V) or a high current (>5A) present on its' terminals.

    b. PASS. This is illuminated whenever a test is passing (during testing) or the previously run test has passed all tests (following completion of testing).

c. FAIL. This is illuminated whenever a test is failing (during testing) or the previously run test has failed any test (following completion of testing).

d. TESTING. This is illuminated when the 950 is performing tests.

e. READY. This is illuminated after the user has selected a test sequence to run and the 950 is ready to perform that sequence of tests.

f. ARC. This is illuminated whenever the 950 is detecting an ARC current.

g. C/V LIMITED. This is illuminated when the 950 output is either current or voltage limited by the load. This is only used in certain types of tests.

h. REMOTE. This is illuminated when the 950 is under the control of an interface (e.g. RS232, Ethernet or GPIB). If the user wishes to return to front panel control of the 950 the CNFG key should be pressed to achieve this.

7. The menu keys. These initiate a menu allowing the user to perform certain activities via the front panel of the 950. Many of these can be disabled by the user by requiring a password in order to utilize them. These are –

a. SELECT. Initiates a menu allowing the user to select a test sequence which has already been defined in the 950. This never requires a password.

b. EDIT. Initiates a menu allowing the user to select and existing test sequence and then edit it. After editing it is automatically made ready to run. This optionally requires a password.

c. NEW. Initiates a menu allowing the user to select a presently undefined test sequence number and name, and then to create the sequence of tests to be performed. This optionally requires a password.

d. DEL. Initiates a menu allowing the user to select an existing test sequence and delete it from the 950. This optionally requires a password.

e. PRINT. Initiates a menu allowing the user to select an available printout to perform using the optional USB interface. This never requires a password.

f. VIEW. Initiates a menu allowing the user to either –

    i. If no test sequence is ready to run. View the pass and fail counts for any defined test sequence, and optionally to clear them.   This never requires a password except (optionally) to clear the counts.

    ii. If a test sequence has been defined and has been run. View the test results of each step within the previously run test sequence. This is automatically performed after a test sequence has been run. This never requires a password.

g. LEADS. Allows the user to run the selected test sequence in Lead Compensation mode. This allows the 950 to store any load offsets for each step in the test sequence and to correct all future tests using that test sequence for these load offsets. This optionally requires a password.

h. EXT. Allows the user to perform a calibration of the 950 against external standards. This optionally requires a password (this is separate to the other menu activity password).

i. CNFG. Initiates a menu allowing the user to configure the 950. This uses a series of sub-menus. This optionally requires a password.

j. TEST. Shows the present operational status of the 950 and allows the user to perform internal operation verification (This optionally requires a password).

8. The data entry keys. These are –

a. The numeric keys (0 through 9), decimal point and change sign keys. These are used during front panel entry of numeric data into menus.

b. The UNIT key. This is used to change the units during front panel entry of numeric data into menus, and is also used while running a test or while review test results to change the displayed test result measurement.

c. The LIMIT key.   This is used during front panel entry of numeric data into menus to set a value to the largest possible. When setting test dwell times this sets that the dwell should be user terminated rather than automatically terminated after the entered time. When setting a resistance type upper limit, this allows the user to set that there is no upper limit.

d. CLEAR key. This is used to clear an entry during front panel entry of data into menus.

ADJUSTING THE DISPLAY CONTRAST

The user can adjust the display contrast while the 950 is not performing other tasks (i.e. the display shows the model number and the time/date). An example display when the user can adjust the display contrast is –

ViTREK 951i
9-Feb-10   9:08:51am

Using the Up and Down Arrows keys select the display contrast which best suits the users normal viewing position. NOTE – it may be best to select the contrast which shows the least "blurring" when the seconds digit in the displayed time changes. This has been found to produce the best adjustment for viewing angle as well as contrast.

CONFIGURING THE 950

When the CNFG key is pressed the display shows the main configuration menu (assuming the unit is in local control and the optional password protection has not been enabled). This initial menu allows the user which area of the 950 is to be configured. The user can select any of the available areas by using the Left and Right Arrow keys and the press the ENTER key to select that specific area.

If a menu line allows the user to edit the associated data, then the left side of the line shows descriptive text for the item followed by a colon character with the editable item at the right end of the line. The editable item is selectable.

Start

If a menu line is an entry into a sub-menu, then the left side of the line shows descriptive text for the item followed by an ellipsis character (…). The descriptive text is selectable.

If a menu line is for informative purposes only, then the left side of the line shows descriptive text for the item followed by a colon character with the informative data at the right end of the line. The descriptive text is selectable.

NOTE – not all menus and not all menu lines may be available in a specific 950, items which are not pertinent to the specific build of the 950 are not shown on the product.

The main configuration menu is as follows –

```
TEST...
SYSTEM..
INTERFACES...
DIGITAL I/O...
BUILD...
SET TO DEFAULTS...
LOCK PASSWORD: 000000
RELOCK...
```

TEST CONFIGURATION SUB-MENU

This sub-menu allows the user to set general testing parameters which will apply to all test sequences run.

The test configuration menu is as follows –

```
START BEEP:         MED
PASS BEEP:          MED
FAIL BEEPS:        LOUD
ARC:   FAIL ON DETECT
CONTINUITY SENSE: OFF
FAST RERUN:      ENABLE
USER MAX DCV:   10.0KV
USER MAX ACV:   10.0KV
HI SAFETY:      ENABLED
```

- START BEEP. This allows the user to set the volume of the beep sound emitted by the 950 when a test sequence is started.

- PASS BEEP. This allows the user to set the volume of the beep sound emitted by the 950 when a test sequence is completed with a PASS status.

- FAIL BEEP. This allows the user to set the volume of the beep sounds emitted by the 950 when a test sequence is completed with a FAIL status.

- ARC. This allows the user to select whether all tests configured for ARC detection will either fail the test if an ARC is detected (FAIL ON DETECT) or not (DETECT ONLY).

- CONTINUITY SENSE. This allows the user to turn on/off the Continuity Sense feature in certain types of tests (see the specific test type sections of this manual for details).

- FAST RERUN. This allows the 950 to always allow the user to rerun a test without having to review the results (ENABLE), or only allow it if all tests passed (IF PASS), or never allow it (DISABLE).

- USER MAX DCV. This allows the user to set a maximum DC Voltage which the 950 will produce. This limits all test defined and will not allow any existing test sequence containing a step level outside of this limit to run.

- USER MAX ACV. This allows the user to set a maximum AC Voltage which the 950 will produce. This limits all test defined and will not allow any existing test sequence containing a step level outside of this limit to run.

- HI SAFETY. This turns on/off the ability of the 950 to detect excessive HV terminal current in high voltage test step types.

SYSTEM CONFIGURATION SUB-MENU

This sub-menu allows the user to set general operational characteristics.

The system configuration menu is as follows –

```
KEY  BEEPS:        SOFT
LINE  FREQ:        60Hz
TIME  FORMAT:      12hr
SET  TIME:    9:18:06am
SET  DATE:     9-Feb-10
```

- KEY BEEPS. This allows the user to set the volume of the beep sounds made by the 950 whenever a key is pressed.

- LINE FREQ. This allows the user to select whether the 950 is being powered from 50/400Hz line or 60Hz line frequency. This information is used by the 950 when making very low level current measurements.

- TIME FORMAT. This allows the user to select whether the 950 displays time in 12hour or 24hour format.

- SET TIME. This allows the user to adjust the presently displayed time. The hour, minute and second are separately adjusted using the Up and Down Arrow keys.

- SET DATE. This allows the user to adjust the presently displayed date. The day, month and year are separately adjusted using the Up and Down Arrow keys.

INTERFACES CONFIGURATION SUB-MENU

This sub-menu allows the user to configure the interfaces which are fitted in this specific 950.

The interfaces configuration menu is as follows –

```
RS232 BAUD:      115200
SWITCH:            NONE
ETHERNET…
GPIB ADDR:           2
```

The ethernet configuration sub-menu is as follows –

```
USE DHCP:          YES
IP:   192.168.001.111
SNET: 255.255.255.000
GTWY: 192.168.001.001
MAC:      0123456789AB
```

- RS232 BAUD. This allows the user from the available baud rates for the RS232 interface.

- SWITCH. This allows the user to configure what (if any) type of external switch matrix is being controlled by the 950. Note, if 948 (SERIAL) is selected then the RS232 BAUD setting (above) is ignored.

- ETHERNET. This allows the user to configure the optional Ethernet interface by a sub-menu.

  o USE DHCP. Allows the user to select whether the 950 will use DHCP or not to obtain its' IP address and related information.

  o IP. If using DHCP then this shows the IP address obtained by the 950, if DHCP is not enabled then this allows the user to enter a specific IP address for the 950.

  o SNET. If using DHCP then this shows the IP subnet mask obtained by the 950, if DHCP is not enabled then this allows the user to enter a specific IP subnet mask for the 950.

  o GTWY. If using DHCP then this shows the IP address of the local gateway obtained by the 950, if DHCP is not enabled then this allows the user to enter a specific IP address of the local gateway for the 950.

  o MAC. This shows the MAC address of the Ethernet port in the 950. This is not editable.

- GPIB ADDR. This allows the user to select a GPIB address for the 950 GPIB interface option.

DIGITAL I/O CONFIGURATION SUB-MENU

This allows the user to configure the various digital inputs and outputs available at the 950 rear panel.

The digital I/O configuration menu is as follows –

```
START:          IGNORE
ABORT:          IGNORE
INTERLOCK:      IGNORE
SEQUENCE:       IGNORE
PASS:        ACTIVE LO
FAIL:        ACTIVE LO
TESTING:     ACTIVE HI
```

```
DWELL:          ACTIVE HI
HV:             ACTIVE HI
```

- START, ABORT, INTERLOCK and SEQUENCE. These allow the user to select whether the respective digital inputs are to be ignored, active low or active high.

- PASS, FAIL, TESTING, DWELL and HV. These allow the user to select whether the respective digital output is to be active low or active high.

BUILD CONFIGURATION SUB-MENU

This allows the user to inspect the serial number, firmware versions, and option build status in this specific 950.

An example build configuration menu is as follows –

```
SERIAL#          123456
FIRMWARE:         v1.12
   FP:            v1.10
   MEAS:          v1.10
   DRIVE:         v1.10
BASE UNIT:         951i
CAP OPTION:         YES
AC2 OPTION:          NO
PULSE OPTION:       YES
INTERFACE:         IF-4G
MAC:        0123456789AB
```

SET TO DEFAULTS CONFIGURATION SELECTION

This allows the user to set all settings to their default (factory set) values.

LOCK PASSWORD CONFIGURATION SELECTION

This enables the user to set a password which will be needed to perform most menu activities in the future. A password of all zeroes disables the front panel lock.

RELOCK CONFIGURATION SELECTION

This is only available when a password has already been enabled locking most menu activities and allows the user to relock those menus after unlocking them.

WORKING WITH TEST SEQUENCES

There are two types of test sequences which may be defined –

- A MANUAL sequence. This contains a single test step. During testing the user is allowed to change the applied voltage, current and/or frequency as applicable for the specific test type being performed.

- A standard sequence. These sequences are numbered 1 through 99 inclusive, may optionally have a name associated with each, and each may contain up to 99 test steps. During testing the user may not alter the voltages, currents or frequencies being applied by the 950. Certain test types allow for the user to use the START button to continue the sequence (see the specific test types later in this document).

CREATING A NEW TEST SEQUENCE

A new sequence can be created by –

- Press the NEW key. The display gives the lowest available sequence number and a blank name field. An example is -

  ```
  NEW TEST SEQUENCE
  # 2
  ```

- Either change the sequence number or press the ENTER key. The display now selects the name field. The user can enter a name by pressing the Up Arrow key followed using the Up, Down, Left and Right keys to change/select each character, and the user may use the numeric keys to directly enter numeric characters..

- Press the ENTER key. The display now shows the first test step (step #1) with no test type selected (NEW is displayed).. An example is -

  ```
  Seq 2 Step 1        NEW
  ```

- Using the Up or Down Arrow keys select the desired first step type.

- Using the information for each test step type later in this document, program the requirements for this step.

- If no more steps are required, press the EXIT key. The 950 stores the sequence and makes it ready to be run.

- If further steps are required, then press the Up arrow key once when the previously entered step # is selected, the next step # will be displayed with a NEW test type. Repeat from 4 as required.

EDITING AN EXISTING TEST SEQUENCE

An existing sequence can be edited by –

- Press the EDIT key. The display shows the last used sequence number and the name associated with that sequence.. An example is -

```
  EDIT TEST SEQUENCE
# 2 950 LINE HYPOT
```

- Either change the sequence number or press the ENTER key. The display now selects the name field. The user can enter a name or alter the existing name by pressing the Up Arrow key followed using the Up, Down, Left and Right keys to change/select each character, and the user may use the numeric keys to directly enter numeric characters..

- Press the ENTER key. The display now shows the first test step (step #1) of the existing sequence.. An example is -

```
Seq 2 Step 1      ACW
LEVEL: 1500.0V 60.0Hz
```

- If needed, using the information for each test step type later in this document, program the requirements for this step.

- To select a different step # in the existing sequence press the Up Arrow (or Down Arrow) key until the desired step # is shown. To add a step to the end of the sequence press the Up Arrow key until a NEW step is shown. If the user accidently creates a NEW step after the end of the existing sequence, press the DEL key to delete it while it is being displayed.

- The delete any step, press the DEL key while the desired step is selected.

- The insert a new step into the sequence, select the step before which the new step is to be inserted then press the NEW key. A NEW step is inserted before the selected step.

- When no more changes are required, press the EXIT key. The 950 stores the sequence and makes it ready to be run.

DELETING AN EXISTING TEST SEQUENCE

An existing sequence can be deleted from memory by –

- Press the DEL key. The display shows the last used sequence number and the name associated with that sequence. An example is -

```
DELETE TEST SEQUENCE
# 2 950 LINE HYPOT
```

- Either change the sequence number to select the desired sequence or press the ENTER key. The selected sequence is now deleted.

SELECTING AND RUNNING AN EXISTING TEST SEQUENCE

An existing sequence can be selected to be run by-

- Press the SELECT key. The display shows the last used sequence number and the name associated with that sequence. An example is -

   EDIT TEST SEQUENCE
   # 2 950 LINE HYPOT

- Either change the sequence number to select the desired sequence or press the ENTER key. The selected sequence is now made ready to be run.

After an existing sequence is selected (either by using the SELECT or EDIT menus) the test may be run by –

- Press the START button.

- During the test sequence the display shows the progress. An example is -

   1.01-   1500V 60.0Hz
   22s PASS   5.5nArms

  o The selected sequence number and the present step # are shown in the upper left display. Following this, the / character is shown during the ramp period or – during the dwell period of the test step being performed. During the discharge period the character is blank and an informative message is displayed in the lower line of the display.

  o The present output level and frequency are shown in the reminder of the upper display line. If the MANUAL sequence is being run (the upper left shows MAN) then either the level or the frequency can be selected and either edited using the arrow keys (start by pressing the Up Arrow key while selected) or directly overwritten (enter a new value using the numeric keys while it is selected).

  o The time since the start of the present step # and step period is shown in the lower left display. If this is flashing between the value and blocks then the unit is waiting for the user to press the START button to continue.

  o The remainder of the lower display shows a measurement result. Initially this is the first checked measurement, but may be changed during the step by pressing the UNIT key which toggles between all available measurement results for that specific test type.

  o The entire sequence may be aborted by pressing the STOP button.

- When the sequence has been completed, the overall pass or failure status is temporarily displayed for approx. 2 seconds and then the measured results are reviewed. If the sequence failed, then the review is initiated at the first failed step, otherwise it is initiated at the first step. An example is -

   SEQUENCE 1 PASSED
       ALL TESTS

- While reviewing results, the step number and the time can be selected using the Left or Right Arrow keys. With the step # selected the Up and Down Arrow keys can be used to sequentially scan through the results for each step. With the time selected the user can select to view the

last measurement made (at the time shown), or the MAX, MIN or AVG measurement. The user can use the UNIT key to change which measurement result is being viewed for that step. The level and frequency shown in the upper line of the display are those measured at the termination of the step. An example is -

```
1.01-   1500V 60.0Hz
30s PASS    5.5nArms
```

- Use the EXIT key or STOP key to return to the date/time display, or use the START button (if FAST RERUN is enabled) to start another run of the sequence.

- When a sequence is ready to run, the last measurement results for that sequence can be review by pressing the VIEW key.

TEST STEP TYPES

There are several types of steps available. A brief summary of each type is given below, not all types may be available in a specific 950 as some depend on certain option content being present. A full description of each test step type is given later in this document.

- ezAC or ACW types. These test dielectric performance using an applied AC test voltage. ARC Current detection, breakdown detection, and either AC Leakage current or AC Impedance range checking may be performed. Independent range checking can be performed on any two of the RMS, in-phase or quadrature measurements simultaneously. The ezAC test type is a reduced complexity variant of the standard ACW test. Multiple steps of these types can optionally be concatenated together without the output going to zero between them.

- ezDC, DCW or DCIR types. These test for dielectric performance using an applied DC test voltage. ARC Current detection, breakdown detection, and either DC Leakage current or DC Insulation Resistance range checking may be performed. The ezDC test type is a reduced complexity variant of the DCW test. The DCIR test type is an enhanced variant of the DCW test. Multiple steps of these types can optionally be concatenated together without the output going to zero between them.

- ezGB or GB types. Typically used for chassis ground-bond measurements, this tests for low impedance performance using an applied AC test current and a 4-wire "Kelvin" measurement. Either AC voltage drop or AC impedance range checking may be performed. Range checking is performed on the RMS, in-phase or quadrature measurements. The ezGB test type is a reduced complexity variant of the standard GB test. Multiple steps of these types can optionally be concatenated together without the output going to zero between them.

- Low Ohms type. This programs the 950 to perform low voltage DC, low to medium resistance measurements using either 2- or 4-wire techniques. Range checking is performed on the measured resistance value.

- ACIR type. This is similar to the ACW type but the measured in phase load resistance measurement value is range checked.

- ACCAP type. This is similar to the ACW type but the load capacitance and dissipation factor measurements are range checked. Multiple steps of these types can optionally be concatenated together without the output going to zero between them.

- ACI type. This programs the 950 to measure an applied AC ground leakage current and (optionally) an applied ground referenced AC voltage. Range checking may be performed on the measured ground leakage current using the RMS. ARC testing may also optionally be performed.

- DCCAP or IRCAP types. These are similar to the DCW type above, but are optimized for operation with capacitive loads. The user can program the 950 to control the maximum ramp voltage rate and charging current during the initial and final ramps.

- DCI type. This programs the 950 to measure an applied DC ground leakage current and (optionally) an applied ground referenced DC voltage. Range checking may be performed on the measured ground leakage current. ARC testing may also optionally be performed.

- PULSE type. This programs the 950 to check for breakdown current and (optionally) ARC detection during a very fast applied pulse (down to 1.5ms). A single pulse of either polarity or a pair of opposite polarity pulses may be applied.

- SWITCH type. This programs the 950 to control an external switch matrix. This allows the user to program the required switch matrix settings prior to subsequent test steps. The user can specify any timing requirements in this step also.

- PAUSE type. This programs the 950 to pause for a programmed amount of time before continuing the test sequence.

- HOLD type. This programs the 950 to hold the test sequence at this step waiting for the user to press the START button.

EZAC OR ACW TEST STEP TYPES

These test types have a ramp, dwell, and (optionally) a discharge period.

- During ramp, the test voltage is slewed to the programmed voltage level at the programmed frequency from the starting level in the time specified, or at the rate specified. Breakdown and optionally ARC current are monitored and checked against the programmed limits for this step. Breakdown or ARC detection will abort the entire step and cause the test step to fail.

- During dwell, the test voltage is held at the programmed test level and frequency for the time specified (which can be programmed as user terminated). Breakdown, ARC (Optionally), and load current or impedance can be range checked. Any out of range measurement will abort the entire step and cause the test step to fail. When used in the MANUAL sequence the user can modify the voltage level and frequency while this period is being run.

- During discharge the test voltage is ramped down to a zero level. If any breakdown occurs during this phase (or a safety event occurs) the output reduced as fast as possible but this does not cause the step to fail.

An example ACW menu is as follows –

```
Seq 1 Step 1        ACW
LEVEL: 1500.0V 60.0Hz
BREAKDOWN:  49.50mApk
RAMP:          1.00sec
DWELL:        30.0sec
 Check1:          RMS
   Lim:     On-35.00mA
 Check2:        INPHS
   Lim:     On-5.000mA
ARC DETECT:4us   10mA
DISCHARGE:    AS RAMP
ON FAIL:    ABORT SEQ
```

An example ezAC menu is as follows –

```
Seq 1 Step 1      ezAC
LEVEL: 1500.0V  60.0Hz
RAMP:           1.00sec
DWELL:          30.0sec
 Lim:       On-35.00mA
ON FAIL:    ABORT SEQ
```

- LEVEL. Allows the test voltage level (in Vrms) and the frequency (in Hz) to be programmed.

- (ACW only) BREAKDOWN. Allows breakdown detection to be programmed as a maximum peak current level.

- RAMP. Allows the ramp time period to be specified either as a time (in seconds) or as a rate (in Volts per second). The UNIT key toggles the selection between these two methods.

- DWELL. Allows the dwell time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- (ACW only) Check1. Allows the user to define a measurement to be checked against range limits.

- Lim (#1). Allows the user to define the range within which the selected Check1 measurement is considered a PASS during the dwell period (RMS for the ezAC type). The peak equivalent of the upper current limit is also used as the overall breakdown limit for the ezAC type. The range can be entered in units of RMS current or Impedance, the UNIT key toggles the selection. For the impedance selection the user may optionally disable the upper limit by pressing the LIMIT key while the upper limit is selected.

- (ACW only) Check2. Allows the user to define a measurement to be checked against range limits. The NONE selection is also available to disable this 2nd range check.

- (ACW only) Lim (#2). Allows the user to define the range within which the selected Check2 measurement is considered a PASS during the dwell period. The range can be entered in units of RMS current or Impedance, the UNIT key toggles the selection. For the impedance selection the user may optionally disable the upper limit by pressing the LIMIT key while the upper limit is selected.

- (ACW only) ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled. For the ezAC type ARC detection is always disabled.

- (ACW only) DISCHARGE. Allows the user to program whether the discharge period should use the same timing as the ramp period (AS RAMP), be as fast as possible (FAST) or if possible should be skipped if the next step is also ezAC or ACW (NONE). If NONE is selected but the next step is not ezAC or ACW then the FAST selection is used by default. The FAST setting is always used for the ezAC type.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

EZDC, DCW OR DCIR TEST STEP TYPES

These test types have a ramp, dwell, and (optionally) a discharge period.

- During ramp, the test voltage is slewed to the programmed voltage level from the starting level in the time specified, or at the rate specified. Breakdown and optionally ARC current are monitored and checked against the programmed limits for this step. Breakdown or ARC detection will abort the entire step and cause the test step to fail.

- During dwell, the test voltage is held at the programmed test level for the time specified (which can be programmed as user terminated). Breakdown, ARC (Optionally), and, after a programmable delay, the load current or impedance can be range checked. For ezDC or DCW types, any out of range measurement will abort the entire step and cause the test step to fail. For the DCIR test types the user can program the dwell period to be terminated when the current or load measurement is inside the range, outside the range, or always terminates at the end of the specified dwell time. When used in the MANUAL sequence the user can modify the voltage level while this period is being run.

- During discharge the test voltage is ramped down to a zero level. If any breakdown occurs during this phase (or a safety event occurs) the output reduced as fast as possible but this does not cause the step to fail.

An example DCW menu is as follows –

```
Seq 1 Step 1       DCW
LEVEL:          1500.0V
BREAKDOWN:  30.00mApk
RAMP:           1.00sec
DWELL:          30.0sec
 Delay:         0.25sec
 Lim:       On-15.00mA
ARC DETECT:4us   10mA
DISCHARGE:     AS RAMP
ON FAIL:      ABORT SEQ
```

An example ezDC menu is as follows –

```
Seq 1 Step 1      ezDC
LEVEL:          1500.0V
RAMP:           1.00sec
DWELL:          30.0sec
 Lim:       On-15.00mA
DISCHARGE:     AS RAMP
ON FAIL:      ABORT SEQ
```

An example DCIR menu is as follows –

```
Seq 1 Step 1      DCIR
LEVEL:          1500.0V
```

```
BREAKDOWN:   30.00mApk
RAMP:         1.00sec
DWELL:       30.0sec
 Delay:       0.25sec
 End On:         PASS
 Lim:  100.0K-no maxΩ
ARC DETECT:4us   10mA
DISCHARGE:    AS RAMP
ON FAIL:    ABORT SEQ
```

- LEVEL. Allows the test voltage level (in V) to be programmed.

- (DCW or DCIR only) BREAKDOWN. Allows breakdown detection to be programmed as a maximum peak current level.

- RAMP. Allows the ramp time period to be specified either as a time (in seconds) or as a rate (in Volts per second). The UNIT key toggles the selection between these two methods.

- DWELL. Allows the dwell time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- (DCW or DCIR only) Delay. Allows the user to program a delay in the dwell period before the selected measurement range check is performed.

- (DCIR only) End On. Allows the user to select whether the dwell period should be automatically ended when the range check passes (PASS), fails (FAIL) or should always be the entire dwell period (TIME).

- Lim. Allows the user to define the range within which the load current or impedance measurement is considered a PASS during the dwell period. The upper current limit is also used as the overall breakdown limit for the ezDC type. The range can be entered in units of current or resistance, the UNIT key toggles the selection. For the impedance selection the user may optionally disable the upper limit by pressing the LIMIT key while the upper limit is selected.

- (DCW or DCIR only) ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled. For the ezDC type ARC detection is always disabled.

- (DCW or DCIR only) DISCHARGE. Allows the user to program whether the discharge period should use the same timing as the ramp period (AS RAMP), be as fast as possible (FAST) or if possible should be skipped if the next step is also ezDC, DCW or DCIR (NONE). If NONE is selected but the next step is not ezDC, DCW or DCIR then the FAST selection is used by default. The FAST setting is always used for the ezDC type.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

EZGB OR GB TEST STEP TYPES

These test types have a ramp, dwell, and (optionally) a discharge period.

- During ramp, the test current is slewed to the programmed current level at the programmed frequency from the starting level in the time specified, or at the rate specified.

- During dwell, the test current is held at the programmed test level and frequency for the time specified (which can be programmed as user terminated). The load voltage or impedance can be range checked. Any out of range measurement will abort the entire step and cause the test step to fail. When used in the MANUAL sequence the user can modify the current level and frequency while this period is being run.

- During discharge the test current is ramped down to a zero level.

An example GB menu is as follows –

```
Seq 1 Step 1         GB
LEVEL: 25.000A 60.0Hz
V CLAMP:          8.0V
RAMP:          0.00sec
DWELL:         30.0sec
  Check:           RMS
   Lim:     0u-250.0mV
DISCHARGE:    AS RAMP
ON FAIL:    ABORT SEQ
```

An example ezGB menu is as follows –

```
Seq 1 Step 1       ezGB
LEVEL: 25.000A 60.0Hz
DWELL:         30.0sec
   Lim:     0u-250.0mV
ON FAIL:    ABORT SEQ
```

- LEVEL. Allows the test current level (in Arms) and the frequency (in Hz) to be programmed.

- (GB only) V CLAMP. Allows the voltage clamp level of the current source to be programmed as a maximum Vrms level. This is fixed at the highest allowed for the ezGB type.

- (GB only) RAMP. Allows the ramp time period to be specified either as a time (in seconds) or as a rate (in Amps per second). The UNIT key toggles the selection between these two methods. This is fixed at zero time for the ezGB type.

- DWELL. Allows the dwell time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- (GB only) Check. Allows the user to define a measurement to be checked against range limits.

- Lim. Allows the user to define the range within which the selected Check measurement is considered a PASS during the dwell period (RMS for the ezGB type). The range can be entered in units of voltage or Impedance, the UNIT key toggles the selection.

- (GB only) DISCHARGE. Allows the user to program whether the discharge period should use the same timing as the ramp period (AS RAMP), be as fast as possible (FAST) or if possible should be skipped if the next step is also ezGB or GB (NONE). If NONE is selected but the next step is not ezGB or GB then the FAST selection is used by default. The FAST setting is always used for the ezGB type.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

LOW OHMS TEST STEP TYPE

This test type has a single time period during which the measured resistance is checked against the user programmed range. The user can program a delay before the range checking is performed during the test.

An example Low Ohm menu is as follows –

```
Seq 1 Step 1     LOW Ω
2/4-WIRE:        4-WIRE
TIME:            1.00sec
 Delay:          0.05sec
 Lim:     0.0m-150.0KΩ
ON FAIL:      ABORT SEQ
```

- 2/4-WIRE. Allows the user to select whether the 2-wire or 4-wire measurement technique is to be employed.

- TIME. Allows the test time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- Delay. Allows the user to program a delay in the test period before the selected measurement range check is performed.

- Lim. Allows the user to define the range within which the resistance measurement is considered a PASS during the dwell period.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

ACIR TEST STEP TYPE

This test type has a ramp, dwell, and (optionally) a discharge period.

- During ramp, the test voltage is slewed to the programmed voltage level at the programmed frequency from the starting level in the time specified, or at the rate specified. Breakdown and optionally ARC current are monitored and checked against the programmed limits for this step. Breakdown or ARC detection will abort the entire step and cause the test step to fail.

- During dwell, the test voltage is held at the programmed test level and frequency for the time specified (which can be programmed as user terminated). Breakdown, ARC (Optionally), and load resistance can be range checked. Any out of range measurement will abort the entire step and cause the test step to fail. When used in the MANUAL sequence the user can modify the voltage level and frequency while this period is being run.

- During discharge the test voltage is ramped down to a zero level. If any breakdown occurs during this phase (or a safety event occurs) the output reduced as fast as possible but this does not cause the step to fail.

An example ACIR menu is as follows –

```
Seq 1 Step 1     ACIR
LEVEL: 1500.0V 60.0Hz
BREAKDOWN:  49.50mApk
RAMP:         1.00sec
DWELL:        30.0sec
 Lim:  45.26K-201.5KΩ
ARC DETECT:4us   10mA
DISCHARGE:    AS RAMP
ON FAIL:    ABORT SEQ
```

- LEVEL. Allows the test voltage level (in Vrms) and the frequency (in Hz) to be programmed.

- BREAKDOWN. Allows breakdown detection to be programmed as a maximum peak current level.

- RAMP. Allows the ramp time period to be specified either as a time (in seconds) or as a rate (in Volts per second). The UNIT key toggles the selection between these two methods.

- DWELL. Allows the dwell time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- Lim. Allows the user to define the range within which the in-phase resistance measurement is considered a PASS during the dwell period. The user may optionally disable the upper limit by pressing the LIMIT key while the upper limit is selected.

- ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled.

- DISCHARGE. Allows the user to program whether the discharge period should use the same timing as the ramp period (AS RAMP), be as fast as possible (FAST) or if possible should be skipped if the next step is also ACIR (NONE). If NONE is selected but the next step is not ACIR then the FAST selection is used by default.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

ACCAP TEST STEP TYPE

This test type has a ramp, dwell, and (optionally) a discharge period.

- During ramp, the test voltage is slewed to the programmed voltage level at the programmed frequency from the starting level in the time specified, or at the rate specified. Breakdown and optionally ARC current are monitored and checked against the programmed limits for this step. Breakdown or ARC detection will abort the entire step and cause the test step to fail.

- During dwell, the test voltage is held at the programmed test level and frequency for the time specified (which can be programmed as user terminated). Breakdown, ARC (Optionally), and load capacitance and dissipation factor can be range checked. Any out of range measurement will abort the entire step and cause the test step to fail. When used in the MANUAL sequence the user can modify the voltage level and frequency while this period is being run.

- During discharge the test voltage is ramped down to a zero level. If any breakdown occurs during this phase (or a safety event occurs) the output reduced as fast as possible but this does not cause the step to fail.

An example ACCAP menu is as follows –

```
Seq 1 Step 1    ACCAP
LEVEL: 1500.0V  60.0Hz
BREAKDOWN:  49.50mApk
RAMP:          1.00sec
DWELL:         30.0sec
 C:     0.488p-1.512pF
 DF:    0.0000-0.0005
ARC DETECT:4us   10mA
DISCHARGE:     AS RAMP
ON FAIL:     ABORT SEQ
```

- LEVEL. Allows the test voltage level (in Vrms) and the frequency (in Hz) to be programmed.

- BREAKDOWN. Allows breakdown detection to be programmed as a maximum peak current level.

- RAMP. Allows the ramp time period to be specified either as a time (in seconds) or as a rate (in Volts per second). The UNIT key toggles the selection between these two methods.

- DWELL. Allows the dwell time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- C. Allows the user to define the range within which the load capacitance measurement is considered a PASS during the dwell period.

- DF. Allows the user to define the range within which the load dissipation measurement is considered a PASS during the dwell period. Note that the range check ignores the polarity of DF measured when range checking.

- ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled.

- DISCHARGE. Allows the user to program whether the discharge period should use the same timing as the ramp period (AS RAMP), be as fast as possible (FAST) or if possible should be skipped if the next step is also ACCAP (NONE). If NONE is selected but the next step is not ACCAP then the FAST selection is used by default.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

ACI TEST STEP TYPE

This test type has a single time period during which the measured ground leakage current is checked against the user programmed range and optionally ARC current may be detected. The user can program a delay before the range checking is performed during the test.

An example ACI menu is as follows –

```
Seq 1 Step 1      ACI
TIME:         25.0sec
 Delay:        0.05sec
 Lim:      On-35.00mA
ARC DETECT:4us   10mA
ON FAIL:     ABORT SEQ
```

- TIME. Allows the test time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the test period.

- Delay. Allows the user to program a delay in the test period before the selected measurement range check is performed.

- Lim. Allows the user to define the range within which the RMS current measurement is considered a PASS.

- ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

DCCAP OR IRCAP TEST STEP TYPES

These test types have a ramp, dwell, and (optionally) a discharge period.

- During ramp, the test voltage is slewed to the programmed voltage level from the starting level at less than the maximum ramp rate limit and charging current limit programmed for the step. If this takes longer than the programmed timeout value then the entire step is aborted with a fail status. Breakdown and optionally ARC current are monitored and checked against the programmed limits for this step. Breakdown or ARC detection will abort the entire step and cause the test step to fail.

- During dwell, the test voltage is held at the programmed test level for the time specified (which can be programmed as user terminated). Breakdown, ARC (Optionally), and, after a programmable delay, the load current or impedance can be range checked. For the DCCAP type, any out of range measurement will abort the entire step and cause the test step to fail. For the IRCAP test type the user can program the dwell period to be terminated when the current or load measurement is inside the range, outside the range, or always terminates at the end of the specified dwell time.

- During discharge the test voltage is ramped down to a zero level, again using the programmed ramp rate and current limits. If any breakdown occurs during this phase (or a safety event occurs) the output reduced as fast as possible but this does not cause the step to fail.

An example DCCAP menu is as follows –

```
Seq 1 Step 1    DCCAP
LEVEL:         1500.0V
RAMP:          100.0V/s
 Limit:          1.00mA
 Timeout:      30.0sec
DWELL:         60sec
 Delay:          5.0sec
 Lim:        On-500.0uA
ARC DETECT:4us   10mA
DISCHARGE:     AS RAMP
ON FAIL:     ABORT SEQ
```

An example IRCAP menu is as follows –

```
Seq 1 Step 1    IRCAP
LEVEL:         1500.0V
RAMP:          100.0V/s
 Limit:          1.00mA
 Timeout:      30.0sec
DWELL:         60sec
 Delay:          5.0sec
 End On:          PASS
 Lim:        On-500.0uA
```

```
ARC DETECT: 4us   10mA
DISCHARGE:    AS RAMP
ON FAIL:     ABORT SEQ
```

- LEVEL. Allows the test voltage level (in V) to be programmed.

- RAMP. Allows the maximum ramp rate to be specified (in Volts per second).

- Limit. Allows the maximum charging current to be specified (in amps).

- Timeout. Allows the ramp timeout to be specified (in seconds).

- DWELL. Allows the dwell time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the dwell period.

- Delay. Allows the user to program a delay in the dwell period before the selected measurement range check is performed.

- (IRCAP only) End On. Allows the user to select whether the dwell period should be automatically ended when the range check passes (PASS), fails (FAIL) or should always be the entire dwell period (TIME).

- Lim. Allows the user to define the range within which the load current or impedance measurement is considered a PASS during the dwell period. The range can be entered in units of current or resistance, the UNIT key toggles the selection. For the impedance selection the user may optionally disable the upper limit by pressing the LIMIT key while the upper limit is selected.

- ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled.

- DISCHARGE. Allows the user to program whether the discharge period should use the same limits as the ramp period (AS RAMP), or be as fast as possible (FAST).

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

DCI TEST STEP TYPE

This test type has a single time period during which the measured ground leakage current is checked against the user programmed range and optionally ARC current may be detected. The user can program a delay before the range checking is performed during the test.

An example DCI menu is as follows –

```
Seq 1 Step 1      DCI
TIME:         25.0sec
 Delay:        0.05sec
  Lim:     On-35.00mA
```

```
ARC DETECT: 4us   10mA
ON FAIL:    ABORT SEQ
```

- TIME. Allows the test time period to be specified (in seconds) or set to be user terminated with the START button. The LIMIT key toggles between the two methods of terminating the test period.

- Delay. Allows the user to program a delay in the test period before the selected measurement range check is performed.

- Lim. Allows the user to define the range within which the ground current measurement is considered a PASS.

- ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

PULSE TEST STEP TYPE

This test type has a single time period during which the load is checked for breakdown and optionally ARC current may be detected.

An example PULSE menu is as follows –

```
Seq 1 Step 1    PULSE
LEVEL:          200.0V
POLARITY:    UNIPOLAR+
BREAKDOWN:  150.0mApk
RAMP:          1.0msec
HOLD:          1.5msec
ARC DETECT: 4us   10mA
ON FAIL:    ABORT SEQ
```

- LEVEL. Allows the user to specify the target peak voltage level of the pulse.

- POLARITY. Allows the user to program whether the pulse is to be positive only (UNIPOLAR+), negative only (UNIPOLAR-), or bi-polar (BIPOLAR).

- BREAKDOWN. Allows breakdown detection to be programmed as a maximum peak current level.

- RAMP. Sets the time for the initial ramp from zero and the final ramp to zero. The ramp between polarities if BIPOLAR is selected is twice this period.

- HOLD. Sets the time for which the target voltage is held.

- ARC DETECT. Allows the user to program the 950 for ARC current detection during this step. Both the time and current level can be independently programmed. ARC detection can also be disabled.

- ON FAIL. This allows the user to program the 950 to abort the entire sequence (ABORT SEQ) or only this step (CONT SEQ) if this step fails any of its checks. A safety related failure or a user abort (STOP button) always aborts the entire sequence.

SWITCH TEST STEP TYPE

This test type has a three time periods –

- A pre-switch delay period.

- A switch period during which the selected switch pattern is programmed into the switch matrix.

- A post-switch delay period.

An example SWITCH menu is as follows –

```
Seq 1 Step 1   SWITCH
PRE-DELAY:      0.10sec
POST-DELAY:     0.15sec
#1: 0123456789ABCDEF
```

- PRE-DELAY. Allows the user to program the time delay of the pre-switch period.

- POST-DELAY. Allows the user to program the time delay of the post-switch period.

- SWITCH #1 thru' #4. Allows the user to specify the state for up to four external switch matrices.

PAUSE TEST STEP TYPE

An example PAUSE menu is as follows –

```
Seq 1 Step 1    PAUSE
TIME:           1.25sec
```

- TIME. Allows the user to program the required pause time (in seconds).

HOLD TEST STEP TYPE

An example HOLD menu is as follows –

```
Seq 1 Step 1    PAUSE
TIMEOUT:        120sec
```

- TIMEOUT. Allows the user to program the required hold timeout (in seconds).

CONNECTING TO THE OBJECT BEING TESTED

This section is for directly connecting the object under test to the 950. If using an external switch matrix then consult the manual for the matrix regarding connections.

ALL TESTS EXCEPT EZGB, GB AND LOW OHMS

For most applications connect one side of the object being tested to the HV terminal using high voltage wire and the other side to the RETURN terminal using suitable wire.

If the object has an accessible side (e.g. if the object is a device and one side is chassis) then for safety the 950 should be configured for Continuity Sense (see the CNFG->TEST menu) and the RETURN and SENSE+ terminals should be separately wired to the chassis, with the HV terminal wired to the other side of the object. In this manner if the protective RETURN wire is disconnected the chassis of the object will not become live during the test.

For best low level (high impedance load) performance the wiring should have low leakage, in extreme circumstances the RETURN wire should be the inner wire of a coaxial cable, with the shield wired to the GUARD terminal of the 950. This will significantly reduce the DC and AC leakage between the HV and RETURN wires during the test. This coaxial cable does not need to be high voltage rated as the RETURN terminal is protected to the 950 chassis ground, a cable such as RG174 is a suitable choice.

EZGB AND GB TESTS

Use a 4-wire connection to the object using the schematic shown between the SENSE and SOURCE terminals on the front panel as a reference. Ensure that the wire gauge used for the SOURCE connections are suitable for the current used in the test. For best performance at high frequencies and/or high currents the two SOURCE wires should be a twisted pair, and the two SENSE wires should be twisted pair (or a coaxial cable such as RG174).

LOW OHMS TESTS (4-WIRE)

Use a 4-wire connection to the object using the schematic shown between the SENSE and SOURCE terminals on the front panel as a reference.

LOW OHMS TESTS (2-WIRE)

Connect the object between the SENSE terminals using two suitable wires (the use of coaxial cable is not recommended for this situation).

SPECIFICATIONS

ENVIRONMENTAL

Temperature	0 to 50C operating (<85% RH, non-condensing)
	-20 to 75C storage (non-condensing)
Altitude	0 to 7000ft ASL (10000ft with reduced output drive capability)
Line	105-265Vrms, 45 to 450Hz (operates with reduced drive below 110V)
	Opt. LOLINE: 85 to 130Vrms, 45 to 450Hz (full specifications)
Specifications	Valid for 1 year over operating temperature range if calibrated at 23C
	Relative to calibration standards used

EZDC, DCW, DCIR TESTS (951-955 ONLY)

Test Voltage	951,952: 2V to 6500V
	953,954,955: 2V to 11000V
	All Models: 0.1V resolution (1V above 999.9V)
	All Models: <(0.25% + 0.5V) accuracy
	All Models: <(0.01% + 0.05V)/mA static loading effect
Loading	951,952: 50mA max (25mA above 6000V)
	953,954,955: 30mA max (20mA above 6000V, 10mA above 7500V, 5mA above 9000V)
	All Models: 10Kohm min load resistance (>175V), 15mA max (<175V)
	951,952: 0.15uF max capacitive load
	953,954,955: 0.1uF max capacitive load
Ramp	0.01 to 9999sec, 0.01sec resolution
	or 0.1 to 50000V/sec, 0.1V/sec resolution
	50KV/sec max slew rate, 0.01sec min ramp time
	<(15% + 0.3sec) accuracy
	<(5% + 5V) uniformity during ramp
	<20% overshoot (<250ms ramp time)
	<10% overshoot (<1s ramp time)
	< 5% overshoot (>1s ramp time)
Dwell	0.02 to 9999sec or user terminated, 0.01sec resolution
	<(0.05% + 20ms) accuracy
Discharge	<325V : 25mA max (controlled constant current)
	<4500V (2500V with AC2) : 45Kohm
	>4500V (953,954,955, (2500V with AC2)) : 245Kohm
	>4500V (951,952, (2500V with AC2)) : 7Mohm
	Optionally limited to user set breakdown current limit if not a safety related

discharge event

Optionally limited to same slew rate as ramp if not a safety related discharge event

Optionally skipped if next test step is ezDC, DCW or DCIR, and is not a safety related discharge event

Automatically terminated 20ms after voltage < 30V, discharge maintained until user terminated if last step in sequence

Breakdown Limit	Active throughout test
	User set breakdown current, 1uA to 50mApk (limited to max load current for the test voltage level)
	<3msec response time (typically <500usec)
	Breakdown limit same as test limit for ezDC test
ARC Current	Optionally active throughout test
	1mA to 30mArms (50KHz to 5MHz bandwidth)
	1mA resolution on limit, 0.1mA resolution on displayed readings
	<(10% + 0.5mA) accuracy at 1MHz
	4us, 10us, 15us, 20us, 30us or 40us measurement period
RETURN Current	0 to +/-200mA
	4 digit (0.1nA min) resolution
	<(0.25% + 1nA + ½ digit) accuracy (add 1nA/nF capacitive load)
	1 line cycle (50/60Hz) measurement period
	Displayed results filtered with period of 1% of dwell time (250ms max)
Insulation Resistance	Add Test Voltage and RETURN Current Accuracies as percentages
	Display resolution automatically adjusted
Cable Compensation	Leakage Resistance Compensation to <(1% of error) for each individual test step
Test Limit	Applied during dwell, after user set delay (10ms resolution)
	User set RETURN Current or Insulation Resistance Limit Range
	DCIR: Selectable stop on inside limits, outside limits, or at end of dwell
	ezDC, DCW: Stop on outside limits or at end of dwell
Test Results	Last, minimum, average & maximum test limit measurement.
	Maximum peak RETURN current throughout test.
	Last, minimum, average & maximum ARC Current throughout test.
	Actual applied voltage at the end the test.

DCCAP, IRCAP TESTS (951-955 WITH OPTION CAP ONLY)

Test Voltage	951,952: 50V to 6500V
	953,954,955: 75V to 11000V
	All Models: 0.1V resolution (1V above 999.9V)

	All Models: <(1% + 1V) accuracy
	All Models: <(0.01% + 0.05V)/mA static loading effect
Loading	951,952: 50mA max (25mA above 6000V)
	953,954,955: 30mA max (20mA above 6000V, 10mA above 7500V, 5mA above 9000V)
	All Models: 10Kohm min load resistance
	All Models: Unlimited capacitive load
Ramp	0.1 to 5000V/sec, 0.1V/sec resolution user set max slew rate
	1uA to 50mA charging current limit (within loading limits)
	Voltage automatically ramped to maintain rate and current within limits
	1 to 9999sec, 0.1sec resolution user set timeout
	<5% overshoot
Dwell	5 to 9999sec or user terminated, 1sec resolution
	<(0.05% + 20ms) accuracy
Discharge	<325V : 25mA max (controlled constant current)
	<4500V (2500V with AC2) : 45Kohm
	>4500V (953,954,955, (2500V with AC2)) : 245Kohm
	>4500V (951,952, (2500V with AC2)) : 7Mohm
	Optionally limited to user set charging current limit if not a safety related discharge event (7Mohm min discharge load for 951,952 or 14Mohm for 953,954 & 955)
	Automatically terminated 500ms after voltage < 30V, discharge maintained until user terminated if last step in sequence
ARC Current	Optionally active throughout test
	1mA to 30mArms (50KHz to 5MHz bandwidth)
	1mA resolution on limit, 0.1mA resolution on displayed readings
	<(10% + 0.5mA) accuracy at 1MHz
	4us, 10us, 15us, 20us, 30us or 40us measurement period
RETURN Current	0 to +/-200mA
	4 digit (0.1uA min) resolution
	Load < 30uF : <(0.25% + 0.5uA + 0.1uA/uF + ½ digit) accuracy
	Load > 30uF : <(0.25% + 3uA + ½ digit) accuracy
	1 line cycle (50/60Hz) measurement period
	Displayed results filtered with period of 3% of dwell time (1s max)
Insulation Resistance	Add Test Voltage and RETURN Current Accuracies as percentages
	Display resolution automatically adjusted
Cable Compensation	Leakage Resistance Compensation to <(1% of error) for each individual test step

Test Limit	Applied during dwell, after user set delay (0.1s resolution, 1s min)
	User set RETURN Current or Insulation Resistance Limit Range
	IRCAP: Selectable stop on inside limits, outside limits, or at end of dwell
	DCCAP: Stop on outside limits or at end of dwell
Test Results	Last, minimum, average & maximum test limit measurement.
	Maximum peak RETURN current throughout test.
	Last, minimum, average & maximum ARC Current throughout test.
	Actual applied voltage at the end the test.

EZAC, ACW, ACIR, ACCAP TESTS (951-955 ONLY)

Test Voltage	951-4 (standard build): 20V to 6000Vrms
	951-4 (opt. AC2): 10V to 2000Vrms
	955 (standard build): 50V to 10000Vrms
	All Models : Decrease max test voltage by 0.1%/Hz above 100Hz
	All Models: 0.1V resolution (1V above 999.9V)
	All Models: <(0.25% + 1.5V + 0.01% per Hz) accuracy
	All Models: <(0.01% + 0.2V)/mA static loading effect
Test Frequency	951-4 (standard build or opt. AC2): 20Hz to 500Hz
	955 (standard build): 40Hz to 500Hz
	0.1Hz resolution (1Hz above 99.9Hz)
	<0.1% accuracy
Test Waveform	Sinewave, 1.3 – 1.5 Crest Factor
Loading	951-4 (standard build): 50mArms max, decrease max. test voltage by 12.5V/mA load. 12.5Kohm min load impedance
	951-4 (opt. AC2): 200mArms max, decrease max. test voltage by 1.5V/mA load. 1.5Kohm min load impedance
	955 (standard build): 30mArms max, decrease max. test voltage by 25V/mA load. 25Kohm min load impedance
	All models: decrease max drive by 0.1%/Hz above 100Hz
	All models: increase min. load impedance by 10ohm/Hz above 100Hz
Ramp	0 to 9999sec, 0.01sec resolution
	or 0.1 to 100000V/sec, 0.1V/sec resolution
	<(1% + 0.1sec) accuracy
	<(5% + 20V) uniformity during ramp
	<10% overshoot (<200ms ramp time)
	<5% overshoot (<500ms ramp time)
	< 2% overshoot (>500ms ramp time)
Dwell	0.02 to 9999sec or user terminated, 0.01sec resolution
	<(0.05% + 20ms) accuracy

Discharge	Optionally limited to same slew rate as ramp
	Optionally skipped if next test step is ezAC, ACW or ACIR
	Otherwise: 20ms
Breakdown Limit	Active throughout test
	User set RETURN breakdown current, 1uA to 280mApk (limited to max peak load current for the test voltage level)
	<3msec response time (typically <500usec)
	Breakdown same as peak current test limit for ezAC test
ARC Current	Optionally active throughout test
	1mA to 30mArms (50KHz to 5MHz bandwidth)
	1mA resolution on limit, 0.1mA resolution on displayed readings
	<(10% + 0.5mA) accuracy at 1MHz
	4us, 10us, 15us, 20us, 30us or 40us measurement period
RETURN Current	0 to 200mArms
	4 digit (0.1nA min) resolution
	<(0.25% + 2nA + 0.01% per Hz + 100pA per Hz + ½ digit) accuracy
	(add 10nA for RMS measurements, or all measurements if testing within 20Hz of line frequency)
	(add 100pA per kV*Hz for RMS, Fund and Quad measurements, 10pA per kV*Hz for InPhs measurements)
	1 cycle measurement period
	Selectable RMS, In-phase, Quadrature or Fundamental
	<0.01° per Hz phase relative to test voltage (InPhs, Quad)
	Displayed results filtered with period of 1% of dwell time (250ms max)
Cable Compensation	Resistance (>5Mohm) + Capacitance (<1000pF) Compensation to <(1% of error + 0.01pF) for each individual test step
Insulation Resistance	Computed from test voltage and InPhs RETURN Current
	Add Test Voltage and InPhs RETURN Current Accuracies as percentages
	Display resolution automatically adjusted
Test Limit	Applied during dwell
	ezAC: Single range limit of RETURN(rms) Current
	ACW: Pair of range limits of any RETURN Current
	ACIR: Range limit of insulation resistance
	Stop on outside limits or at end of dwell
Test Results	Last, minimum, average & maximum test limit measurement(s).
	Maximum peak RETURN current throughout test.
	Last, minimum, average & maximum ARC Current throughout test.
	Actual applied voltage at the end the test.

EZGB, GB TESTS (952, 954 AND 959 ONLY)

Test Current	0.1 to 40Arms, 0.001A resolution
	<(0.25% + 0.005A + 0.01% per Hz) accuracy
	<(0.01% + 0.001A)/V loading effect
Test Frequency	40Hz to 500Hz
	0.1Hz resolution (1Hz above 99.9Hz)
	<0.1% accuracy
Test Waveform	Sinewave, 1.3 – 1.5 Crest Factor
Loading	SOURCE terminals: 6.5Vrms – 0.015V/A max (may be user limited below this with 0.01V resolution)
	10ohm max load impedance
	2Vrms max SOURCE- to SENSE- terminals
Ramp (GB only)	0 to 1000sec, 0.01sec resolution
	or 0.0001 to 5000A/sec, 0.0001A/sec resolution
	<(1% + 0.1sec) accuracy
	<(5% + 50mA) uniformity during ramp
	<10% overshoot (<200ms ramp time)
	<5% overshoot (<500ms ramp time)
	< 2% overshoot (>500ms ramp time)
Dwell	0.02 to 9999sec or user terminated, 0.01sec resolution
	<(0.05% + 20ms) accuracy
Discharge	Optionally limited to same slew rate as ramp (GB only)
	Optionally skipped if next test step is ezGB or GB
	Otherwise: 35ms
SENSE Voltage	0 to 8Vrms
	4 digit (10uV min) resolution
	<(0.25% + 30uV + 0.01% per Hz + 0.5uV/A + ½ digit) accuracy
	Add 200uV for RMS measurements
	<0.01° per Hz phase relative to test current
	Displayed results filtered with period of 1% of dwell time (250ms max)
Cable Compensation	Resistance + Inductance Compensation to <(1% of error) for each individual test step
Load Impedance	Add Test Current and SENSE Voltage Accuracies as percentages
	Display resolution automatically adjusted
Test Limit	Applied during dwell
	ezGB: Range limits for SENSE(rms) Voltage or Load Impedance
	GB: Range limits for SENSE(rms) Voltage or Load Impedance, RMS, Fund, InPhs

or Quad component.
Stop on outside limits or at end of dwell

| Test Results | Last, minimum, average & maximum test limit measurement. |
| | Actual applied current at the end the test. |

LOW Ω TEST (ALL BUILDS)

Open Circuit Voltage	Nominally 5Vdc
Test Current	55mAdc max
Range	0 to 150Kohm
Accuracy (4-wire)	<30Kohm : 0.8% + 0.002ohm + ½ digit
	>30Kohm : 1.5% + ½ digit
	>100Kohm : 5% + 1 digit
Accuracy (2-wire)	<30Kohm : 0.8% + 0.02ohm + ½ digit
	>30Kohm : 1.5% + ½ digit
	>100Kohm : 5% + 1 digit
Resolution	5 digits (0.1milliohm min)
Lead Compensation	Resistance Compensation to <(1% of error + 0.0005ohm) for each individual test step
4-wire Compensation	SOURCE <(1% total lead impedance)
	SENSE <(0.1% total lead impedance)
Test Time	0.02 to 9999sec or user terminated, 0.01sec resolution
	<(0.05% + 20ms) accuracy
	1 line cycle (50/60Hz) measurement period
	User settable delay (0 min, 0.01s resolution) before test limits are applied
	Displayed results filtered with period of 1% of test time (250ms max)
Test Results	Last, minimum, average & maximum test limit measurement.

DCI TEST (951-955 ONLY)

HV-GND Voltage	(951,952) 0 to +/-8000V
	(953,954) 0 to +/-11000V
	0.1V resolution (1V above 999.9V)
	<(0.25% + 0.5V) accuracy
	100Mohm nominal input impedance
ARC Current	Optionally active throughout test
	1mA to 30mArms (50KHz to 5MHz bandwidth)
	1mA resolution on limit, 0.1mA resolution on displayed readings

<(10% + 0.5mA) accuracy at 1MHz

4us, 10us, 15us, 20us, 30us or 40us measurement period

RETURN Current	0 to +/-200mA 4 digit (0.1nA min) resolution <(0.25% + 1nA + ½ digit) accuracy 1 line cycle (50/60Hz) measurement period <50ohm impedance (6Kohm below 100uA) Protected to 5V at 1A
Lead Compensation	Current Compensation to <(1% of error) for each individual test step
Test Time	0.02 to 1000sec (or infinite), 0.01sec resolution User settable delay (0 min, 0.01sec resolution) before test limits are applied Displayed results filtered with period of 1% of test time (250ms max)
Test Results	Last, minimum, average & maximum test limit measurement. Last, minimum, average & maximum ARC Current throughout test. HV-GND voltage at the end of the test.

ACI TEST (951-955 ONLY)

HV-GND Voltage	(951,952) 0 to 6000Vrms (953,954) 0 to 10000Vrms 0.1V resolution (1V above 999.9V) <(0.25% + 0.5V) accuracy 100Mohm nominal input impedance
HV-GND Frequency	Measured in range 20 to 1000Hz for voltages >50Vpk 0.1Hz resolution (1Hz above 99.9Hz) <0.1% accuracy
ARC Current	Optionally active throughout test 1mA to 30mArms (50KHz to 5MHz bandwidth) 1mA resolution on limit, 0.1mA resolution on displayed readings <(10% + 0.5mA) accuracy at 1MHz 4us, 10us, 15us, 20us, 30us or 40us measurement period
RETURN Current	0 to +/-200mArms 4 digit (0.1nA min) resolution <(0.25% + 12nA + 0.01% per Hz + 100pA per Hz + ½ digit) accuracy 1 cycle measurement period <50ohm impedance (6Kohm below 100uA) Protected to 5V at 1A
Test Time	0.02 to 1000sec (or infinite), 0.01sec resolution User settable delay (0 min, 0.01sec resolution) before test limits are applied Displayed results filtered with period of 1% of test time (250ms max)

Test Results	Last, minimum, average & maximum test limit measurement.
	Last, minimum, average & maximum ARC Current throughout test.
	HV-GND voltage at the end of the test

PULSE TESTS (951-955 WITH OPTION PULSE ONLY)

Test Waveform	Half cycle (unipolar) or full cycle (bipolar) trapezoidal
	Unipolar: User defined ramp time to a user defined level, which is maintained for a user defined period and then ramped back to zero at the same rate as the starting ramp. User selected positive or negative polarity.
	Bipolar: User defined ramp time to a user defined positive level, which is maintained for a user defined period and then ramped to the negative polarity at the same rate as the starting ramp which is then held for the same period as the positive polarity, then ramped back to zero at the same rate as the starting ramp.
Test Voltage	951-4 (standard build): 50V to 8000V
	951-4 (opt. AC2): 20V to 2750V
	955: 100V to 10000V
	All Models: 0.1V resolution (1V above 999.9V)
	All Models: <(0.25% + 1.5V) accuracy
	951-4 (standard build): 12Kohm + 0.5H nominal output impedance
	951-4 (opt. AC2): 1.4Kohm + 0.2H nominal output impedance
	955: 25Kohm + 1.0H nominal output impedance
1st Ramp Time	1ms (0.5ms for option AC2) to 30ms ramping time with 0.1ms resolution
Level Hold Time	1ms (0.5ms for option AC2) to 30ms hold time with 0.1ms resolution
Breakdown Limit	Active throughout test
	User set RETURN breakdown current, 1uA to 280mApk (limited to max peak load current for the test voltage level)
	<3msec response time (typically <500usec)
ARC Current	Optionally active throughout test
	1mA to 30mArms (50KHz to 5MHz bandwidth)
	1mA resolution on limit, 0.1mA resolution on displayed readings
	<(10% + 0.5mA) accuracy at 1MHz
	4us, 10us, 15us, 20us, 30us or 40us measurement period
Lead Compensation	Load Resistance Compensation to <(1% of error) for each individual test step. Corrects for output impedance into known load.
Test Results	Maximum peak RETURN current throughout test.
	Last, minimum, average & maximum ARC Current throughout test.
	Maximum peak applied voltage during the test.

MISCELLANEOUS

REAL TIME CLOCK (STANDARD)

Accuracy   better than 10 seconds per day

Battery Backup   longer than 30 days

NON-VOLATILE INTERNAL STORAGE (STANDARD)

All test sequences, user settings and calibration data are stored in internal non-volatile memory which is specified for over 20 years data retention without power and for over 1000000 write cycles.

VICL INTERFACE (2 PROVIDED AS STANDARD)

These are for control of any mixture of 964 switches and 950 series instruments.

RS232 INTERFACE (STANDARD)

Baud Rate   User selectable: 9600, 19200, 38400, 57600 or 115200

Format   8 data bits
                            No parity
                            1 stop bit
                            1 start bit

Handshake   RTS/CTS and DSR/DTR

DIO (STANDARD)

This provides 8 digital inputs and 5 digital outputs.

Each digital input can be independently configured via the front panel or interface as active high or active low or to be ignored. The instrument responds to changes in digital inputs within 2ms (typically within 500us). Each input has an internal pull-up resistor of nominally 1.8Kohms to 4V and uses standard 3.3V CMOS logic levels. Each input is protected to 5V levels.

The digital inputs are –

START   Starts a test sequence when transitions inactive to active

ABORT   Aborts a test sequence when active

INTERLOCK   Aborts a test sequence (high voltage steps only) when inactive

SEQUENCE 1, 2, 4, 8, and 16 Selects the sequence to be started with the START signal

Each digital output can be independently configured via the front panel or interface as active high or active low output. Each output has an open-drain drive with 12V withstand and 200mA sink capability with a pull-up resistor of nominally 2.2Kohm to 5V. Each output is internally clamped to nominally 15V so may be used to directly drive a relay.

An internal +12V DC power source is included which is internally fused at 100mA (self resetting).

The digital outputs are –

PASS	Active at the end of a sequence if passed
FAIL	Active at the end of a sequence if failed
IN PROGRESS	Active while running a sequence
DWELL	Active during the dwell period of a measurement type of test
HIGH VOLTAGE	Active whenever an unsafe voltage or current is detected

ETHERNET (OPT. IF-3 OR OPT. IF-4G)

10/100Base-T. Half-duplex or full-duplex at 10 or 100Mbit speeds.

Static or dynamic IP (via DHCP) is supported.

IPv4 is supported (IPv6 is not supported).

Unit responds to all standard ARP and ICMP requests.

Uses the standard ASCII based command set protocol running as a stream using TCP port 10733. Unit limits a single user to be active at any time via the Ethernet port.

950 SERIES INTERFACE COMMANDS

Throughout this document the instrument is referred to as the 950, this applies to all instruments in the 950 series.

USING THE RS232 INTERFACE

The RS232 interface can operate at baud rates of 9600, 19200, 57600 or 115200. The user must ensure that both the 950 and the computer are set for the same baud rate. The 950 baud rate can be set via the SYSTEM->CNFG->INTERFACES menu on the front panel. The 950 uses the standard 7-bit ASCII character set, with no parity, 1 stop bit and 1 start bit. The 950 has a 9-pin male D-sub connector identical to that used on PC computers, so a null modem cable should be used to connect between them. The 950 uses standard hardware handshaking (RTS/CTS) and uses the DTR and DSR lines to signal the presence of the devices. The computer should also be configured to use RTS/CTS hardware handshake.

It is not recommended to connect the cable while the 950 is powered as an invalid character can be created during the insertion of the cable which will cause the first message transmitted to the 950 to have an error.

Typically there are no special cabling considerations to using the RS232 interface of the 950, however if the user is using a long cable (over 100ft typically) then the use of lower baud rates (57600 and less) or shielded cables may be beneficial. In severe interference conditions the user may need to provide a low impedance direct ground path between the chassis of the 950 and that of the computer.

USING A TERMINAL PROGRAMME

The 950 does not echo received characters. If the user is using a terminal programme to communicate with the 950 then it should be set to echo typed characters locally in order that the user can see the typed characters. The 950 does not respond to backspace or delete characters, so the user may not be able to edit typed characters. The 950 terminates commands when a <CR> or <LF> is received and terminates all transmitted messages with both a <CR> and a <LF> character, no special programming of the computer is usually needed to accommodate this.

USING USER WRITTEN SOFTWARE

If the user is writing software to be run on a computer then no special considerations are needed to communicate with the 950 other than ensuring that the communications port on the computer has been correctly configured for baud rate, character format and handshaking.

USING THE GPIB INTERFACE

The GPIB interface on the 950 uses a standard IEEE488.1 connector and generally needs no special considerations regarding its' use. The user can set the GPIB address of the 950 via the SYSTEM-CNFG-

INTERFACES menu on the front panel. Addresses in the range 0 through 29 are valid for the 950, however the user must ensure that no other device exists on the bus with the same address (especially note that many controller PCBs in a computer have an address, typically this is 0 or 21).

It is strongly discouraged to connect the IEEE488.1 cable to the 950 while the 950 is powered as invalid bus conditions can occur during the cable insertion which may cause the 950 to be unable to communicate. If an Interface Bus Clear (IFC) is used then this will clear this condition and is highly recommended to be normally performed when the user starts attempting to communicate with any GPIB device.

The 950 is typically used in high interference environments thus the user is encouraged to use fully shielded IEEE488.1 compliant cabling and to ensure that the maximum length specification of the IEEE488.1 standard is strictly adhered to. In high noise environments the user will often need to provide a low impedance ground path between the chassis of the 950 and that of the controller.

USING THE ETHERNET INTERFACE

The 950 usually needs no special considerations regarding Ethernet operation on IPv4 networks. The 950 operates using auto-negotiation of bus speed and is compatible with either 10Mbit or 100Mbit Ethernet networks using half- or full-duplex (100Mbit full-duplex is recommended). The 950 can normally be used in a 1Gbit network also, since most of these allow for 100Mbit full-duplex devices. The 950 can operate using DHCP (highly recommended) to dynamically obtain its' IP address, subnet mask and gateway address, or it can be manually configured with a fixed IP address, subnet mask and gateway address using the SYSTEM-CNFG-INTERFACES menu on the front panel.

To use the 950 on an IPv6 only network the user may need to isolate it using a suitably configured router as the 950 is only IPv4 capable.

The 950 generally uses a MTU setting of 1518 bytes, but can use a lower figure if using DHCP and a lower setting is part of the DHCP data sent by the DHCP server. If using a fixed IP on a network strictly using a lower MTU then the 950 must be isolated from the network using a correctly configured router so that the router can fragment any packets over the local MTU.

The 950 uses standard RFC894 packets for transmission and will receive either RFC894 or standard IEEE802.1 packet formats but does not use VLAN (IEEE802.1q) encoded packets. If the user intends to use the 950 Ethernet interface on strict VLAN networks then a correctly configured router must be used to isolate the 950 from the VLAN network. The 950 does not use the SNMP protocol. The 950 responds normally to ICMP Echo requests (i.e. it can be "pinged").

The MAC address of the 950 can be read from the front panel using the SYSTEM-CNFG-INTERFACES menu. This may be needed in some systems to allow the 950 to communicate on the Ethernet and/or use DHCP to obtain its' IP details.

If the user is communicating with the 950 via a router then it may be necessary to "open" the router to allow communication using the TCP protocol on port 10733 of the 950. No other ports or special protocols are used by the 950.

The Ethernet interface operates using the TCP protocol and is accessible via port 10733. Commands are sent to port 10733 via TCP as a stream and responses are returned as a stream from port 10733 to the same port used by the user to transmit the command. Commands are streaming, so may span several datagrams. Note – a TCP datagram is NOT the same as an Ethernet packet (or frame), the TCP datagram may be fragmented by Ethernet without affecting the 950.

The 950 only allows a single connection via the Ethernet. Using TCP the user can establish or terminate a session using the TCP protocol. A session is established between the 950 and a specific port of a specific IP addressed computer, if the computer has a dynamically allocated IP address and its address changes then the session will not continue.

Note that the TCP protocol includes session management; if the 950 is reset while a session is in progress then the computer must restart the session if it is wishes to continue the session. Other than resetting the 950, only the computer can terminate a TCP session using the normal TCP session management protocol.

See the "Decoding and Execution of Commands" section later in this document for further specific details regarding the use of the Ethernet interface.

The Ethernet interface has excellent interference rejection characteristics and does not rely on a common ground between devices, so no special cabling is recommended beyond that normally used for 10Mbit or 100Mbit Ethernet. The use of shielded Ethernet cables generally offers no difference in performance except in extremely harsh environments.

GENERAL COMMAND SYNTAX

All commands have the same syntax, independent of the interface being used.

Received characters on each interface are buffered, the contents of the buffer being decoded and auctioned when a command terminator is received. Multiple commands can be contained in a single set of commands by separating them by a command separator character with the last one being followed by a command terminator. If a command causes the 950 to respond with a message then all messages from a set of commands are compiled and sent to the corresponding interface after all commands in the command set have been decoded and auctioned successfully. These activities are independent for each interface.

Commands are decoded, and generally executed, in the order in which they were received. Other than query commands, there is no difference visible to the user between issuing commands using one command per terminator, or with multiple commands as a set with a single terminator (assuming the 1023 character buffer limit is not exceeded). An exception to this is if a command within a set of commands is encountered with an error then the remainder of the set of commands may not be decoded.

COMMAND TERMINATOR

The 950 does not perform any action (other than storing them) on received characters until a command terminator is received.

If more than 1023 characters are received without a terminator then this results in an input buffer overflow and the characters will be discarded along with all further characters until a terminator is received. This results in the 950 generating an error.

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

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

If a completely blank command is received (i.e. no characters between consecutive command terminators) then this is ignored by the 950. In this manner the user can terminate a command with multiple terminators (e.g. <CR><LF>).

COMMAND SEPARATOR

Each command within a set of commands must be separated by the semi-colon character. No error is raised if there are no characters between consecutive command separators, i.e. the last command may be optionally terminated by a command separator (but the command terminator must always be present) and/or the first command may be optionally preceded by a command separator.

FIELD SEPARATOR

Many commands have fields of sub-commands and/or data. Each field is separated by the comma character. All fields except for the <STRING> data field type (see below) may optionally have any number of leading and/or trailing whitespace characters (any combination of spaces or tabs).

Fields within a command are position dependent, i.e. the exact order is defined for each command. In some cases fields may be either optional or may not be needed at all, in these cases the user can simply not place any characters (or only place whitespace characters) between successive field separator characters or just terminate the command (with a Command Separator or Command Terminator) if the last field(s) is/are not needed.

FIELD SYNTAX

There are two types of fields in a command -

1. COMMAND WORDS. Although all command words are shown using uppercase characters in this document, lowercase characters may also be used if desired.
2. DATA. There are several types of data, the type used is dependent on the data being defined-
    a. Boolean Data. This is shown in this document as <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. Integer Data. This is shown in this document as <NR1>. One of three methods may be used to define a <NR1> field-

      i. 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. 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), in which case the following data defines the number in hexadecimal format using the numeric characters and the letters A through F (either upper- or lowercase), as an example 0x12 defines the decimal numeric value 18. A value greater than 0xffffffff is a syntax error.

      iii. The user can optionally start this field with the characters "0B" or the single character "B" (in both cases the "B" character can also be lowercase), in which case the following data defines the number in binary format using the "0" and "1" characters only with the most-significant bit being defined first, as an example 0b00010010 defines the decimal numeric value 18 or hexadecimal value 0x12. In all cases, leading digits or bits which are not defined are assumed to be zero (e.g. 0b00010010 is the same as 0b10010). A value greater than 32 bits is a syntax error.

  c. Floating Point Data. This is shown in this document as <NR3>. This is a string of characters defining a floating point numeric value, optionally having a polarity, and/or a decimal point, and/or an exponent. Within the limitations of the 950 command input buffer, there is no limitation on the number of numeric characters before the decimal, after the decimal or in the exponent. There may only be one polarity character (if any) and it must be the first character in the field. If an exponent is required then it may be defined immediately following the mantissa in one of two ways, either a) an upper- or lowercase 'E' character followed by an optional exponent polarity character (+ or -) followed by the integer exponent, or b) a single character (case sensitive) explicitly defining the exponent which may be one of the characters T (+12), G (+9), M (+6), K (+3), k (+3), m (-3), u (-6), n (-9) or p (-12). Examples include –

      i. "12". Defines the floating point value +12.0.

      ii. "-12". Defines the floating point value -12.0.

      iii. "1.2345". Defines the floating point value +1.2345.

      iv. "12.45e+1". Defines the floating point value +124.5.

      v. "12.45e+01". Defines the floating point value +124.5.

      vi. "12.45e1". Defines the floating point value +124.5.

      vii. "12.345K". Defines the floating point value +12345.0.

  d. String Data. This is shown in this document as <STRING>. This can be any combination of printable ASCII characters (including whitespace characters). To include a separator character in a <STRING> the user must immediately precede the character with the / character. Any character immediately following a / character is taken "literally" and included in the <STRING> and the / character is discarded.

GENERAL RETURNED DATA SYNTAX

There are many commands which cause the 950 to return data as a response to the controller, in all cases these commands end with the ? character (as shown in the individual command syntax paragraphs). These commands are generally referred to in this document as "query commands". 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 4094 characters in total length then an error is raised and no response is given. The response is available immediately following decode of the set of commands containing a query command.

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 and Ethernet interfaces 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 950 (i.e. a READ bus operation). If a read operation is performed when there is no data to be transmitted (i.e. there have been no query commands since the last reset of the 950 or interface) 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 950 fully transmitting a prior response then the new response is not provided and an error is raised.

The following types of responses are given-

- Boolean Data. This is shown in this document as <BOOL> and is the single character '0' indicating the false condition or '1' indicating the true condition. This is always 1 character in length.
- String Data.   This is shown in this document as <STRING> and is one or more printable ASCII characters. This has a variable number of characters in length, and may be of no length.
- Integer Data. This is shown in this document as <NR1> and is one or more decimal characters defining a decimal numeric value. If the polarity is positive then no polarity character is included, otherwise the data starts with the minus character. This has a variable number of characters in length.
- Floating Point Data. This is shown in this document as <NR3>, is always 12 characters in length, and is of the following format (in the order shown)-
    - A single polarity character (either + or -).
    - Six decimal characters with a decimal point character contained within them (i.e. a total of seven characters) indicating the mantissa value.
    - The single 'E' (always uppercase) character.
    - A single polarity character (either + or -) indicating the polarity of the exponent.
    - Two decimal digit characters indicating the value of the exponent. For clarity in engineering use the exponent is always divisible by 3.

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 950 automatically handshakes the commands as needed. The only exception to this is following application of power to the 950 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 950 will "hold-off" a set of commands (e.g. waiting for a previous set of commands to be decoded) is 20ms.

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 950. The user should use a timeout of no less than 100ms for responses.

MULTIPLE INTERFACE OPERATION

Generally operation of the 950 via multiple interfaces is not recommended but is possible. The 950 will decode sets of commands in the order in which they were terminated (each interface has separate receive and transmit buffers). Any query responses will only be transmitted via the interface over which the query command originated.

FRONT PANEL OPERATION WHILE USING INTERFACES

It is possible to inter-mix front panel and interface operation of the 950 however the user should be aware of the following-

- The front panel has three states associated with interface operation-
    - LOCAL. The front panel operates normally. When any command from an interface is decoded, the front panel enters either the REMOTE or REMOTE LOCK-OUT state (depending on the interface and the commands executed) and any menu in progress is aborted.
    - REMOTE. The front panel is locked out other than the STOP push button (and the START button in some circumstances) but the user can return to the LOCAL state by pressing the SYSTEM-CNFG button.
    - REMOTE LOCK-OUT. The front panel is completely locked-out except for the STOP push button (and the START button in some circumstances). The user cannot return the front panel to any other state by front panel action.
- The GPIB interface also has a set of remote states associated with it as defined by IEEE488.1 and IEEE488.2. The 950 does NOT decode commands while in the GPIB LOCAL or GPIB LOCAL LOCK-OUT states (as required by IEEE488.2). Transitions between the GPIB interface states are controlled by specific GPIB bus commands as defined by the standards.
- A LOCKOUT command is provided on the RS232 and Ethernet interfaces to allow the user to command the front panel to the REMOTE LOCK-OUT state; this command raises an error if received via the GPIB interface.
- A LOCAL command is provided on the RS232 and Ethernet interfaces to allow the user to remotely return the front panel to the LOCAL state. This command must be the last command in a set of commands.

GPIB BUS COMMANDS

Most standard GPIB bus commands are implemented in the normal fashion, however some cause a special activity in the 950-

DEVICE CLEAR (SDC AND DCL)

Either of these cause the 950 to clear all interface buffers, abort any test sequence in progress, return to the no test sequence selected state and clear all interface status registers.

INTERFACE CLEAR (IFC)

This causes the 950 to clear all interface buffers and clear all interface status registers. It does NOT affect any test sequence in progress or affect the selected test sequence.

GROUP EXECUTE TRIGGER (GET)

This can be used as a GPIB interface command terminator.

COMMANDS

RESET COMMAND

*RST

This causes the 950 to clear all interface buffers and clear all interface status registers.

- If a test sequence is being run when this is decoded then the test sequence is aborted as if the STOP button was pressed on the front panel.
- Otherwise, the 950 is set to the no test sequence selected state.

FRONT PANEL OPERATION CONTROL COMMANDS

These commands are only available via the RS232 or Ethernet interfaces. Executing these commands via the GPIB interface causes an error to be raised.

LOCKOUT

This command forces the front panel into the REMOTE LOCK-OUT state.

LOCAL

This command forces the front panel into the LOCAL state.

UNIT IDENTIFICATION COMMANDS

*IDN?

The 950 responds with fields as follows each separated by comma characters-

1. The manufacturer as a <STRING> (e.g. VITREK).
2. The 950 variant base model number as a <STRING> format (e.g. 951i).
3. The 950 serial number as a <STRING> (e.g. 017252).
4. The 950 main firmware version as a <STRING> (e.g. v1.32)
5. The 950 front panel firmware version as a <STRING> (e.g. v1.02)
6. The 950 measurement DSP firmware version as a <STRING> (e.g. v1.12)
7. The 950 drive DSP firmware version as a <STRING> (e.g. v1.13)

SERNUM?

The 950 responds with the <STRING> serial number of the 950.

*OPT?

The 950 responds with a series of fields (comma separated) each of which has a <STRING> format. Each field describes a fitted option. If no options are fitted then the response is blank (i.e. contains only the terminator), note that this "empty" response is only possible for the RS232 interface since the other interfaces are optional.

STATUS QUERY & CONTROL COMMANDS

*CLS

This command causes all status information and controls to be cleared for this interface only (except the *STB? Response which is common to all interfaces, see below). Note, dynamically set status bits may become immediately set following this command.

*STB?

The 950 responds with a <NR1> response which is the decimal equivalent value of the status byte (as also returned by a GPIB SRQ data request). Note that there is a single status byte which is common to all interfaces. The response is the decimal value of a single 8-bit byte binary value (i.e. in the range 0 to 255) and is the logical OR of the following bit values-

- Bit 0, decimal value 1, binary value 00000001 – set if a high voltage is currently present on the HV terminal while performing a test sequence. The value of this status bit is "dynamic" – i.e. its' value can change without user interaction.
- Bit 1, decimal value 2, binary value 00000010 – set when a test step dwell period is completed, cleared when read, when a test sequence is started, when a different test sequence is selected, or when the 950 is reset.
- Bit 2, decimal value 4, binary value 00000100 – set if a test sequence is currently being performed. The value of this status bit is "dynamic" – i.e. its' value can change without user interaction.

- Bit 3, decimal value 8, binary value 00001000 – set when a test sequence is completed, cleared when read, when a test sequence is started, when a different test sequence is selected, or when the 950 is reset.
- Bit 4, decimal value 16, binary value 00010000 – set when a test failure has been detected, cleared when read, when a test sequence is started, when a different test sequence is selected, or when the 950 is reset.
- Bit 5, decimal value 32, binary value 00100000 – set when an ARC current over limit has been detected, cleared when read, when a test sequence is started, when a different test sequence is selected, or when the 950 is reset.
- Bit 6, decimal value 64, binary value 01000000 – as defined by IEEE488.1, set if the 950 is asserting the SRQ line, otherwise it is cleared.
- Bit 7, decimal value 128, binary value 10000000 – not used, always 0.

*SRE,<NR1>

Although this command can be executed from any interface, it is only useful when used with the GPIB interface and the register only "exists" in the GPIB interface itself. This command defines which bits in the status byte will cause the GPIB SRQ line to be asserted. The bit values are the same as defined above for the *STB? Command, except that the bit 6 value is ignored.

*SRE?

This command responds with the presently set *SRE,<NR1> value as a <NR1> value.

*OPC?

The 950 responds with a <NR1> response which is the decimal equivalent value of the operational command status register. There is a separate register for each interface in the 950. All of the bits in this register are "sticky" – i.e. the 950 can only set bits, the bits are cleared when read by the user. This is the decimal value of a single 8-bit byte binary value (i.e. in the range 0 to 255) and is the logical OR of the following bit values-

- Bit 0, decimal value 1, binary value 00000001 – set when a command set is decoded without error.
- Bit 1, decimal value 2, binary value 00000010 – set when a command is decoded with a field count error.
- Bit 2, decimal value 4, binary value 00000100 – set when a command is decoded with an internal memory error.
- Bit 3, decimal value 8, binary value 00001000 – set when a command is decoded with a field syntax or data range error.
- Bit 4, decimal value 16, binary value 00010000 – set when a command is decoded with a compatibility error (e.g. this 950 variant is incapable of performing the requested operation).
- Bit 5, decimal value 32, binary value 00100000 – set when a query command is decoded but there is insufficient room in the output buffer for the response.
- Bit 6, decimal value 64, binary value 01000000 – set when the command buffer is overflowed.

- Bit 7, decimal value 128, binary value 10000000 – set when a command is received with a command word that is not known to the 950, or the command cannot be processed at this time.

*ESR?

The 950 responds with a <NR1> response which is the decimal equivalent value of the event status byte register. There is a separate register for each interface in the 950. All of the bits in this register are "sticky" – i.e. the 950 can only set bits, the bits are cleared when read by the user. This is the decimal value of a single 8-bit byte binary value (i.e. in the range 0 to 255) and is the logical OR of the following bit values-

- Bit 0, decimal value 1, binary value 00000001 – set when a command is decoded and an error occurred during decode. Note – this is effectively the logical OR of bits 1, 2, 3, 4 and 7 of the *OPC? Response (but the *OPC? Command does NOT affect the contents of the *ESR? Response and vice versa).
- Bit 1, decimal value 2, binary value 00000010 – set when a query command is decoded but the response is too long for the response buffer.
- Bit 2, decimal value 4, binary value 00000100 – set when a test failure has been detected.
- Bit 3, decimal value 8, binary value 00001000 – set when the internal temperature of the 950 is above limits.
- Bit 4, decimal value 16, binary value 00010000 – set when an internal fault is detected.
- Bit 5, decimal value 32, binary value 00100000 – set when an ARC current over limit has been detected.
- Bit 6, decimal value 64, binary value 01000000 – not used, always 0.
- Bit 7, decimal value 128, binary value 10000000 – not used, always 0.

COMMANDS TO SELECT AND RUN A STORED TEST SEQUENCE

These commands are not valid while running a test sequence. An error is raised if they are decoded while running a test sequence.

NOSEQ

Commands that no test sequence is presently selected, i.e. it erases the active test sequence.

RCL,<NR1>

This command causes the previously stored test sequence defined by the value of the <NR1> data to be selected and available to be run (i.e. it is copied into the active test sequence). The value 0 is used to select the MANUAL test sequence. The value must be in the range 0 through 99 and the selected test sequence must be defined. If the selected test sequence is not defined then the active test sequence is erased and an error is raised.

RUN

This command causes the active test sequence to be run. This performs a similar operation as pressing the front panel START button after a test sequence has been selected except that this command does not require that the sequence be made ready beforehand.

READY

This command causes the active test sequence to be made ready to run. This command enables the user to start an interface defined sequence using the front panel START key. This is not required for a sequence loaded by the RCL command or from the front panel, or if the sequence is to be run via an interface using the RUN command. If no sequence is active, or the sequence cannot be run due to errors, an error is raised.

RUN,LEADS

This command causes the active test sequence to be run in leads compensation calibrate mode. This performs a similar operation as pressing the front panel CALIBRATE-LEADS button followed by the START button after a test sequence has been selected.

COMMAND TO REMOVE LEAD COMPENSATION DATA FROM THE ACTIVE SEQUENCE

CLRLEADS

This command is not valid while running a test sequence; an error is raised if it is decoded while running a test sequence. This command causes the active test sequence to have any associated lead compensation data cleared.

COMMAND TO STORE THE ACTIVE SEQUENCE

SAVE,<NR1>

This command causes the active test sequence to overwrite the non-volatile test sequence defined by the <NR1> value. The value 0 defines that the MANUAL test sequence will be overwritten (only the first step is used in this case) while values between 1 and 99 causes the specific test sequence to be overwritten. Values over 99 cause an error to be raised.

Note the following-

- The active test sequence is unchanged by this command.
- If the active test sequence is empty then this erases the requested test sequence. If the MANUAL test sequence was requested with an empty active test sequence then an error is raised.
- This allows the user to make one test sequence active and then "copy" it into another test sequence. This operation is not available from the front panel. For example, **RCL,10;SAVE,11**

copies the non-volatile test sequence #10 into non-volatile test sequence #11 (the active test sequence remains #10).

COMMAND TO NAME THE ACTIVE SEQUENCE

NAME,<STRING>

This command overwrites the name of the active sequence with the value of <STRING>. A maximum of 15 printable characters can be included in <STRING>. If the active sequence is the manual sequence then this command raises an error.

COMMANDS TO DEFINE THE ACTIVE SEQUENCE

The user can define a test sequence and then run it (using the RUN command) and/or save it (using the SAVE command). The user can sequentially create each test step or overwrite a specific test step.

ADD,<STRING>,<FIELDS>
SET,<NR1>,<STRING>,<FIELDS>

These commands either sequentially adds a test step (ADD style) or overwrites the specified step # (SET,<NR1> style, the <NR1> portion is the desired step #).

When sequentially defining a test sequence, the internal test step counter is reset by the NOSEQ, SAVE and RUN commands, and the first ADD command automatically erases the test sequence before adding the step.

When defining a test sequence using specific test step numbers the user should take care that there are no empty test steps created, as the test sequence will automatically terminate on an empty test step (thus any test steps after an empty one will be ignored).

Whether the ADD or SET variant is used, the active test sequence created is initially numbered 100, indicating that it is an interface defined test sequence. If run without saving then the displays shows "IN" in place of the sequence number and the sequence is always run in "automatic" mode. Once the sequence has been saved then it becomes numbered with a normal test sequence number and can be run in "manual" mode if it is stored into sequence 0.

The <STRING> portion defines the desired test step type and the <fields> portion defines the specific information for each type. The available <STRING> type definitions correspond to the descriptions used in the TEST MEMORY-EDIT menu and are-

ADD,EZAC,<FIELDS>
SET,<NR1>,EZAC,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts RMS. This field must be present.
2. A <NR3> value defining the output frequency in Hz. This field must be present.

3. A <NR3> value defining the ramp time in seconds. This field must be present.
4. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
5. A <NR3> value setting the minimum RMS load current in Amps.   This field must be present.
6. A <NR3> value setting the maximum RMS load current in Amps. This field must be present.
7. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,ACW,<FIELDS>
SET,<NR1>,ACW,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts RMS. This field must be present.
2. A <NR3> value defining the output frequency in Hz. This field must be present.
3. A <NR3> value defining the maximum breakdown current in Amps Peak. This field must be present.
4. A <NR3> value defining the ramp time in seconds. This field must be present.
5. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
6. A <STRING> value which selects either-
    a. RMSA or a blank field – selects that the primary checked value is the RMS current load.
    b. INPHSA - selects that the primary checked value is the In-Phase current load.
    c. QUADA - selects that the primary checked value is the Quadrature current load.
    d. RMSO – selects that the primary checked value is the RMS impedance load.
    e. INPHSO - selects that the primary checked value is the In-Phase resistive load.
    f. QUADO - selects that the primary checked value is the Quadrature reactive load.
7. A <NR3> value setting the minimum primary check value in Amps or Ohms. This field must be present.
8. A <NR3> value setting the maximum primary check value in Amps or Ohms. If one of the resistance selections has been made and this value is blank then there is no maximum limit, otherwise this field must be present.
9. A <STRING> value which selects either-
    a. NONE or a blank field – selects that there is no secondary checked value.
    b. RMSA – selects that the primary secondary value is the RMS current load.
    c. INPHSA - selects that the primary secondary value is the In-Phase current load.
    d. QUADA - selects that the primary secondary value is the Quadrature current load.
    e. RMSO – selects that the primary checked value is the RMS impedance load.
    f. INPHSO - selects that the primary checked value is the In-Phase resistive load.
    g. QUADO - selects that the primary checked value is the Quadrature reactive load.
10. A <NR3> value setting the minimum secondary check value in Amps. This field must be present if a secondary check type has been selected.

11. A <NR3> value setting the maximum secondary check value in Amps. If one of the resistance selections has been made and this value is blank then there is no maximum limit, otherwise this field must be present if a secondary check type has been selected.
12. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
13. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank, otherwise it must be present.
14. A <STRING> value which selects either-
    a. NONE or a blank field – selecting that there should not be a discharge phase if the next step is compatible.
    b. FAST – selecting that the discharge should be as fast as possible
    c. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.
15. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,EZDC,<FIELDS>
SET,<NR1>,EZDC,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts. This field must be present.
2. A <NR3> value defining the ramp time in seconds. This field must be present.
3. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
4. A <NR3> value setting the minimum load current in Amps. This field must be present.
5. A <NR3> value setting the maximum load current in Amps. This field must be present.
6. A <STRING> value which selects either-
    a. ABORT or blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,DCW,<FIELDS>
SET,<NR1>,DCW,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts. This field must be present.
2. A <NR3> value defining the maximum breakdown current in Amps Peak. This field must be present.
3. A <NR3> value defining the ramp time in seconds. This field must be present.
4. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
5. A <NR3> value defining the pre-check delay time in seconds. This field must be present.
6. A <STRING> value which selects either-

a. AMPS or a blank field – selects that the checked value is the current load.

b. OHMS – selects that the checked value is the resistance load.

7. A <NR3> value setting the minimum check value in Amps or Ohms. This field must be present.

8. A <NR3> value setting the maximum check value in Amps or Ohms. If the OHMS is selected and this value is blank then there is no maximum limit, otherwise this field must be present.

9. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.

10. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank, otherwise it must be present.

11. A <STRING> value which selects either-

a. NONE or a blank field – selecting that there should be not be a discharge phase (if the next step is compatible).

b. FAST – selecting that the discharge should be as fast as possible

c. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.

12. A <STRING> value which selects either-

a. ABORT or a blank field – selects that the test sequence will be aborted on failure

b. CONT – selects that the test sequence will continue on failure

ADD,DCIR,<FIELDS>

SET,<NR1>,DCIR,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts. This field must be present.

2. A <NR3> value defining the maximum breakdown current in Amps Peak. This field must be present.

3. A <NR3> value defining the ramp time in seconds. This field must be present.

4. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.

5. A <NR3> value defining the pre-check delay time in seconds. This field must be present.

6. A <STRING> value which selects either-

a. FAIL or a blank field – selects that the dwell period will be terminated on the first failure.

b. PASS – selects that the dwell period will be terminated on the first non-failure.

c. TIME – selects that the dwell period will be terminated only when the dwell time expires (thus the pass/fail is determined on the last measurement taken).

7. A <STRING> value which selects either-

a. AMPS or a blank field – selects that the checked value is the current load.

b. OHMS – selects that the checked value is the resistance load.

8. A <NR3> value setting the minimum check value in Amps or Ohms. This field must be present.

9. A <NR3> value setting the maximum check value in Amps or Ohms. If the OHMS is selected and this value is blank then there is no maximum limit, otherwise this field must be present.

10. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
11. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank, otherwise it must be present.
12. A <STRING> value which selects either-
    a. NONE or a blank field – selecting that there should be not be a discharge phase (if the next step is compatible).
    b. FAST – selecting that the discharge should be as fast as possible
    c. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.
13. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,EZGB,<FIELDS>
SET,<NR1>,EZGB,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Amps RMS. This field must be present.
2. A <NR3> value defining the output frequency in Hz. This field must be present.
3. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
4. A <NR3> value setting the minimum RMS load impedance in Volts. This field must be present.
5. A <NR3> value setting the maximum RMS load impedance in Volts. This field must be present.
6. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,GB,<FIELDS>
SET,<NR1>,GB,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Amps RMS. This field must be present.
2. A <NR3> value defining the output frequency in Hz. This field must be present.
3. A <NR3> value defining the maximum open circuit voltage drive in Volts RMS. This field must be present.
4. A <NR3> value defining the ramp time in seconds. This field must be present.
5. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
6. A <STRING> value which selects either-
    a. RMSV or a blank field – selects that the checked value is the RMS voltage load.

      b.   INPHSV - selects that the checked value is the In-Phase voltage load.

      c.   QUADV - selects that the checked value is the Quadrature voltage load.

      d.   RMSO – selects that the checked value is the RMS impedance load.

      e.   INPHSO - selects that the checked value is the In-Phase resistive load.

      f.   QUADO - selects that the checked value is the Quadrature reactive load.

7. A <NR3> value setting the minimum check value in Volts or Ohms. This field must be present.

8. A <NR3> value setting the maximum check value in Volts or Ohms. This field must be present.

9. A <STRING> value which selects either-

      a.   NONE or a blank field – selecting that there should be not be a discharge phase (if the next step is compatible).

      b.   FAST – selecting that the discharge should be as fast as possible

      c.   RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.

10. A <STRING> value which selects either-

      a.   ABORT or a blank field – selects that the test sequence will be aborted on failure

      b.   CONT – selects that the test sequence will continue on failure

ADD,LOWOHM,<FIELDS>
SET,<NR1>,LOWOHM,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <BOOL> value defining if the test is to be performed using 4-wires (false value) or 2-wires (true value). This field must be present.

2. A <NR3> value setting the test time in seconds. A blank field indicates that the test time is to be infinite.

3. A <NR3> value defining the pre-check delay time in seconds. This field must be present.

4. A <NR3> value setting the minimum check value in Ohms. This field must be present.

5. A <NR3> value setting the maximum check value in Ohms. This field must be present.

6. A <STRING> value which selects either-

      a.   ABORT or a blank field – selects that the test sequence will be aborted on failure

      b.   CONT – selects that the test sequence will continue on failure

ADD,ACIR,<FIELDS>
SET,<NR1>,ACIR,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts RMS. This field must be present.

2. A <NR3> value defining the output frequency in Hz. This field must be present.

3. A <NR3> value defining the maximum breakdown current in Amps Peak. This field must be present.

4. A <NR3> value defining the ramp time in seconds. This field must be present.

5. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
6. A <STRING> value which selects either-
   a. AMPS – selects that the checked value is the In-Phase current load.
   b. OHMS or a blank field - selects that the primary checked value is the In-Phase resistive load.
7. A <NR3> value setting the minimum check value in Amps or Ohms. This field must be present.
8. A <NR3> value setting the maximum check value in Amps or Ohms. If the OHMS is selected and this value is blank then there is no maximum limit, otherwise this field must be present.
9. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
10. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
11. A <STRING> value which selects either-
    a. NONE or a blank field – selecting that there should not be a discharge phase (if the next step is compatible).
    b. FAST – selecting that the discharge should be as fast as possible
    c. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.
12. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,ACCAP,<FIELDS>
SET,<NR1>,ACCAP,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts RMS. This field must be present.
2. A <NR3> value defining the output frequency in Hz. This field must be present.
3. A <NR3> value defining the maximum breakdown current in Amps Peak. This field must be present.
4. A <NR3> value defining the ramp time in seconds. This field must be present.
5. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
6. A <NR3> value setting the minimum capacitance check value in Farads. This field must be present.
7. A <NR3> value setting the maximum capacitance check value in Farads. This field must be present.
8. A <NR3> value setting the minimum dissipation factor check value. This field must be present.
9. A <NR3> value setting the maximum dissipation factor check value. This field must be present.

10. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
11. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
12. A <STRING> value which selects either-
    a. NONE or a blank field – selecting that there should be not be a discharge phase (if the next step is compatible).
    b. FAST – selecting that the discharge should be as fast as possible
    c. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.
13. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,ACI,<FIELDS>
SET,<NR1>,ACI,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value setting the test time in seconds. A blank field indicates that the dwell time is to be infinite.
2. A <NR3> value defining the pre-check delay time in seconds. This field must be present.
3. A <NR3> value setting the minimum primary check value in Amps. This field must be present.
4. A <NR3> value setting the maximum primary check value in Amps. This field must be present.
5. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
6. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
7. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,DCCAP,<FIELDS>
SET,<NR1>,DCCAP,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts. This field must be present.
2. A <NR3> value defining the maximum ramp rate in Volts/sec. This field must be present.
3. A <NR3> value defining the maximum ramp current in Amps. This field must be present.
4. A <NR3> value defining the ramp timeout value in seconds. This field must be present.

5. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
6. A <NR3> value defining the pre-check delay time in seconds. This field must be present.
7. A <STRING> value which selects either-
    a. AMPS or a blank field – selects that the checked value is the current load.
    b. OHMS – selects that the checked value is the resistance load.
8. A <NR3> value setting the minimum check value in Amps or Ohms. This field must be present.
9. A <NR3> value setting the maximum check value in Amps or Ohms. If the OHMS is selected and this value is blank then there is no maximum limit, otherwise this field must be present.
10. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
11. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
12. A <STRING> value which selects either-
    a. FAST or a blank field – selecting that the discharge should be as fast as possible
    b. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.
13. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,IRCAP,<FIELDS>
SET,<NR1>,IRCAP,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the final output level in Volts. This field must be present.
2. A <NR3> value defining the maximum ramp rate in Volts/sec. This field must be present.
3. A <NR3> value defining the maximum ramp current in Amps. This field must be present.
4. A <NR3> value defining the ramp timeout value in seconds. This field must be present.
5. A <NR3> value setting the dwell time in seconds. A blank field indicates that the dwell time is to be infinite.
6. A <NR3> value defining the pre-check delay time in seconds. This field must be present.
7. A <STRING> value which selects either-
    a. FAIL or a blank field – selects that the dwell period will be terminated on the first failure.
    b. PASS – selects that the dwell period will be terminated on the first non-failure.
    c. TIME – selects that the dwell period will be terminated only when the dwell time expires (thus the pass/fail is determined on the last measurement taken).
8. A <STRING> value which selects either-
    a. AMPS – selects that the checked value is the current load.
    b. OHMS or a blank field – selects that the checked value is the resistance load.
9. A <NR3> value setting the minimum check value in Amps or Ohms. This field must be present.

10. A <NR3> value setting the maximum check value in Amps or Ohms. If the OHMS is selected and this value is blank then there is no maximum limit, otherwise this field must be present.
11. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
12. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
13. A <STRING> value which selects either-
    a. FAST or a blank field – selecting that the discharge should be as fast as possible
    b. RAMP – selecting that the discharge should use the same rate as used in the starting RAMP phase.
14. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,DCI,<FIELDS>
SET,<NR1>,DCI,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value setting the test time in seconds. A blank field indicates that the dwell time is to be infinite.
2. A <NR3> value defining the pre-check delay time in seconds. This field must be present.
3. A <NR3> value setting the minimum check value in Amps. This field must be present.
4. A <NR3> value setting the maximum check value in Amps. This field must be present.
5. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
6. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
7. A <STRING> value which selects either-
    a. ABORT or a blank field – selects that the test sequence will be aborted on failure
    b. CONT – selects that the test sequence will continue on failure

ADD,PULSE,<FIELDS>
SET,<NR1>,PULSE,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the test output level in Volts. This field must be present.
2. A <BOOL> value defining if the test is to be bipolar (false value) or unipolar (true value). This field must be present.
3. A <NR1> value defining the ramping rate in V/s. This field must be present.
4. A <NR1> value defining the level hold time in seconds. This field must be present.
5. A <NR3> value defining the maximum breakdown current in Amps Peak. This field must be present.

6. A <NR1> value which selects the time period in microseconds for ARC detection. A zero value or a blank field disables ARC detection; the only other valid values are 4, 10, 15, 20, 30, and 40.
7. A <NR1> value which selects the ARC detection limit in milliamps. This field can be blank if the ARC detection time is zero or blank.
8. A <STRING> value which selects either-
   a. ABORT or a blank field – selects that the test sequence will be aborted on failure
   b. CONT – selects that the test sequence will continue on failure

ADD,PAUSE,<FIELDS>
SET,<NR1>,PAUSE,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the pause time in seconds. This field must be present.

ADD,HOLD,<FIELDS>
SET,<NR1>,HOLD,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the timeout in seconds. This field must be present.

ADD,SWITCH,<FIELDS>
SET,<NR1>,SWITCH,<FIELDS>

The <fields> for this test step type are (in order)-

1. A <NR3> value defining the pre-switch delay in seconds. This field must be present.
2. A <NR3> value defining the post-switch delay in seconds. This field must be present.
3. A <NR1> value defining the switch code for switch #1. This field must be present.
4. A <NR1> value defining the switch code for switch #2. This field must be present if a multi-switch system has been configured.
5. A <NR1> value defining the switch code for switch #3. This field must be present if a multi-switch system has been configured.
6. A <NR1> value defining the switch code for switch #4. This field must be present if a multi-switch system has been configured.

COMMANDS TO QUERY THE CONTENTS OF THE ACTIVE SEQUENCE

SEQ?

This command causes the 950 to respond with the active test sequence number in <NR1> format. The returned response is as follows-

- If the active test sequence is empty then -1 is returned.

- If the MANUAL sequence is presently selected then 0 is returned.
- If a valid non-volatile test sequence is selected then its number is returned (i.e. 1 to 99 inclusive).
- If an interface defined the active test sequence contents then 100 is returned.

LEADS?

This command causes the 950 to respond with a <BOOL> value indicating if the active test sequence contains leads compensation data (a TRUE value) or does not (a FALSE value).

STEP?,<NR1>

The 950 responds with the contents of the requested test step in the active sequence. If the requested step is empty then the response is an empty string, otherwise it has exactly the same format as the **SET,<NR1>,<STRING>,<fields>** command described above (including the commands themselves). In this manner the user can copy the response and transmit it unchanged to store the step into another 950 and/or into a different test sequence.

NAME?

This command causes the 950 to respond with the <STRING> name of the presently active sequence.

COMMANDS TO CONTROL A RUNNING TEST SEQUENCE

These commands are only active while running a test sequence; an error is raised if they are decoded when not actively running a test sequence.

CONT

This command causes the presently executing step to be completed and the test sequence to continue with the next test step in the sequence (if any). This does NOT abort the test sequence. The presently executing test step must either be in the DWELL phase and have an infinite dwell period or be of a WAIT type; otherwise this command causes an error and does not affect the running test sequence.

ABORT

This causes the presently running test sequence to be aborted with an error (USER ABORT).

COMMANDS TO ALTER A RUNNING MANUAL TEST SEQUENCE

These commands are only active while running a MANUAL test sequence; an error is raised if they are decoded when not actively running a MANUAL test sequence.

VOLTS,<NR3>

This command causes the voltage output of the 950 to be changed to the <NR3> value expressed in volts (RMS if an AC test). If the unit is not running a manual test sequence which causes a voltage output, or the requested voltage is out of the range available then this raises an error.

AMPS,<NR3>

This command causes the current output of the 950 to be changed to the <NR3> value expressed in amps RMS. If the unit is not running a manual test sequence which causes a current output (i.e. not a Ground Bond type of test step), or the requested current is out of the range available then this raises an error.

FREQ,<NR3>

This command causes the output frequency of the 950 to be changed to the <NR3> value expressed in Hz. If the unit is not running a manual test sequence which causes an AC voltage or current output, or the requested frequency is out of the range available then this raises an error.

COMMANDS TO QUERY THE STATUS OF A RUNNING OR COMPLETED TEST SEQUENCE

READY?

This command causes the 950 to respond whether the active sequence is ready to run or not by means of a <BOOL> format response (true if ready to run).

RUN?

This command causes the 950 to respond with whether a test sequence is presently being run or not in <BOOL> format (true if running a test sequence).

STEP?

This command causes the presently executing step number to be returned in <NR1> format. This returns 0 if there is no step running.

PHASE?

This command causes the presently executing step phase to be returned in <NR1> format as follows-

0. No step is presently running.
1. The step is in the RAMP phase
2. The step is in the PRE-CHECK phase (i.e. in DWELL but during the pre-check delay).
3. The step is in the CHECK phase (i.e. in DWELL after the pre-check delay).
4. The step is in the DISCHARGE phase.

TTRIG?

This command causes the time elapsed in the presently executing step phase to be returned in <NR3> format in seconds. This has 1ms resolution.

TTEST?

This command causes the time elapsed in the presently executing test step to be returned in <NR3> format in seconds. This has 1ms resolution. Note that this is the time since the step was initiated, not the time when the ramp was started. Depending on the step type, the ramp may not be started for 1 to 20ms after the step is initiated.

RSLT?

This command causes the latest pass/fail status to be returned as a <NR1> decimal value representing a 16-bit binary value. The value is the logical OR of the following fault conditions which occurred during the entire test sequence being run, or last run (i.e. the value is 0 if there is no fault).

- Bit 0, decimal value 1 – An internal fault has occurred in the 950
- Bit 1, decimal value 2 – The 950 could not control the output drive level (i.e. the load is unstable)
- Bit 2, decimal value 4 – The breakdown current was exceeded
- Bit 3, decimal value 8 – The ramp timeout was exceeded
- Bit 4, decimal value 16 – The user aborted the sequence
- Bit 5, decimal value 32 – The continuity check failed
- Bit 6, decimal value 64 – A wiring error was detected
- Bit 7, decimal value 128 – An ARC was detected greater than the set limit
- Bit 8, decimal value 256 – The primary check value was below the minimum limit
- Bit 9, decimal value 512 – The primary check value was above the maximum limit
- Bit 10, decimal value 1024 – The secondary check value was below the minimum limit
- Bit 11, decimal value 2048 – The secondary check value was above the maximum limit
- Bit 12, decimal value 4096 – the interlock digital input was opened while the output was at high voltage
- Bit 13, decimal value 8192 – The HV terminal current safety trip was exceeded

STAT?

This command causes the 950 to respond with a <STRING> containing one character for each defined test step in the active test sequence. Each character corresponds to a test step, the first character being for test step #1, the second to test step #2 and so on. The data is maintained during and following running a test sequence. Each character is one of-

- A 'P' character (indicating that the test step passed or is passing)
- A 'F' character (indicating that the test step failed or is failing).
- A '?' character (indicating that the status cannot be determined at this time).
- A '-' character (indicating that the step has not been started at this time).

STEPRSLT?,<NR1>

This command can only be decoded after a test sequence has been run, otherwise an error is generated.

The <NR1> value (1 to 99 inclusive) specifies the test step number for which results are being requested.

The set of response fields is as follows-

1. A <NR1> indicating the last performed phase of the test step (see the PHASE? For details).
2. A <NR3> value indicating the duration of the last performed phase of the test step in seconds.
3. A <NR1> value describing any failure(s) in this step (see the RSLT? for details).
4. A <NR3> value indicating the output level (in Volts or Amps as applicable) at the end of the last performed phase of the test step for applicable test step types, a blank otherwise.
5. A <NR3> value indicating the output frequency (in Hz) at the end of the last performed phase of the test step for applicable test step types, a blank otherwise.
6. A <NR3> value indicating the highest measured breakdown current value (in Amps) for applicable test step types, a blank otherwise.
7. A <NR3> value indicating the highest measured voltage value (in Volts) for the PULSE test step type, a blank otherwise.
8. A <NR3> value indicating the highest measured value for the primary check value for applicable test step types, a blank otherwise.
9. A <NR3> value indicating the lowest measured value for the primary check value for applicable test step types, a blank otherwise.
10. A <NR3> value indicating the average measured value for the primary check value for applicable test step types, a blank otherwise.
11. A <NR3> value indicating the final measured value for the primary check value for applicable test step types, a blank otherwise.
12. A <NR3> value indicating the highest measured value for the secondary check value for applicable test step types, a blank otherwise.
13. A <NR3> value indicating the lowest measured value for the secondary check value for applicable test step types, a blank otherwise.
14. A <NR3> value indicating the average measured value for the secondary check value for applicable test step types, a blank otherwise.
15. A <NR3> value indicating the final measured value for the secondary check value for applicable test step types, a blank otherwise.
16. A <NR3> value indicating the highest ARC current measured value for applicable test step types, a blank otherwise.
17. A <NR3> value indicating the lowest ARC current measured value for applicable test step types, a blank otherwise.
18. A <NR3> value indicating the average ARC current measured value for applicable test step types, a blank otherwise.
19. A <NR3> value indicating the final ARC current measured value for applicable test step types, a blank otherwise.

COMMANDS TO OBTAIN MEASUREMENT RESULTS WHILE RUNNING A TEST SEQUENCE

These commands all query measurement results during certain types of test steps. In all cases they return zero data if no test step is being run or if the measurement result requested is not appropriate for the running test step type.

MEASRSLT?,<STRING>

This query command responds with a latest measurement result. The <STRING> portion should be one of the following-

- FREQ : Selecting that the measured frequency value is returned (in Hz).
- AMPS : Selecting that the DC or RMS Current value is returned (in Amps).
- INPHSA : Selecting that the In-Phase Current value is returned (in Amps).
- QUADA : Selecting that the Quadrature Current value is returned (in Amps).
- VOLTS : Selecting that the DC or RMS Voltage value is returned (in Volts).
- INPHSV : Selecting that the In-Phase Current value is returned (in Volts).
- QUADV : Selecting that the Quadrature Current value is returned (in Volts).
- OHMS : Selecting that the DC or RMS Load Impedance value is returned (in Ohms).
- INPHSO : Selecting that the In-Phase Load Impedance value is returned (in Ohms).
- QUADO : Selecting that the Quadrature Load Impedance value is returned (in Ohms).
- CAP : Selecting that the Load Capacitance value is returned (in Farads, only for ACCAP test steps).
- DF : Selecting that the Load Dissipation Factor value is returned (no units, only for ACCAP test steps).
- ARC : Selecting that the ARC current value is returned (in Amps).
- BRKDN : Selecting that the maximum breakdown current value is returned (in Amps).

COMMANDS TO CONFIGURE THE 950

These commands allow the user to configure the 950 via an interface. All settings are non-volatile.

Each of these commands also have a query form which is the same command word(s) with a ? character appended to the end of the initial command word and no data with the command, e.g. the query variant of the BEEP,PASS,<NR1> command is BEEP?,PASS. The response has the same format as the command itself (i.e. the response can be captured and re-sent unchanged to the same 950 or another 950).

BEEP,START,<NR1>
BEEP,PASS,<NR1>
BEEP,FAIL,<NR1>
BEEP,KEY,<NR1>

These commands set the test start, pass, fail, and key press beep strength respectively. The <NR1> value must be in the range 0 through 4 inclusive, 0 being OFF and 4 being the loudest.

FAILARC,<BOOL>

This command sets whether the 950 will fail on ARC detection (TRUE value) or only detect ARCs but not fail the test (FALSE value). Note, if ARC detection is disabled in a test step then ARC detection is turned off and this setting is ignored for that test step.

CONTSENSE,<BOOL>

This command sets whether the 950 will automatically check chassis continuity during every high voltage test step (TRUE value) or not (FALSE value).

FASTRERUN,<NR1>

This command sets whether the user can immediately restart a just completed test sequence or not from the front panel. This command does not affect interface operation. The <NR1> value must be one of the following-

0. The user may always immediately restart a test sequence
1. The user may only immediately restart a test sequence if the previous one passed.
2. The user cannot immediately restart a test sequence; they must review the results first.

VLIMIT,DC,<NR3>
VLIMIT,AC,<NR3>

These commands set the maximum output voltage which the 950 is allowed to output. Note-

- These values may be set higher than the capabilities of the specific 950 capabilities. The output will always be limited by the 950 capabilities.
- These values may limit an existing test sequence. Attempting to run a test sequence which requires output voltages above these limits will cause the sequence to not run and an error to be generated.

HVDETECT,<BOOL>

This command allows the user to enable (TRUE value) or disable (FALSE value) HV terminal safety current detection. Note, this is automatically turned off for a test step if it has a breakdown current setting above 7.5mA. Setting this to FALSE turns it off for all test steps.

LINE50,<BOOL>

This command sets whether the 950 is being powered by 50/400Hz (TRUE value) or 60Hz (FALSE value) nominal line frequency. Note, this affects the 950's ability to reject line interference when making high sensitivity measurements.

TIME12,<BOOL>

This command sets whether the 950 should display with time in 12 hour (TRUE value) or 24 hour (FALSE value) format. Note, the TIME? Command always responds in 24 hour format.

TIME,<NR1>,<NR1>,<NR1>

This command allows the user to set the time via an interface. The time is set by the NR1 values as follows-

1. The first NR1 value is the hour in 24 hour format (values between 0 and 23 are valid).
2. The second<NR1> value is the minute (values between 0 and 59 are valid).
3. The third <NR1> value is the second (values between 0 and 59 are valid).

DATE,<NR1>,<NR1>,<NR1>

This command allows the user to set the date via an interface. The date is set by the NR1 values as follows-

1. The first <NR1> value is the month (values between 1 and 12 are valid).
2. The second <NR1> value is the day of the month (values between 1 and 31 are valid).
3. The third <NR1> value is the year (values between 0 and 99 are valid).

DIO,START,<STRING>
DIO,ABORT,<STRING>
DIO,INTERLOCK,<STRING>
DIO,SEQUENCE,<STRING>

These commands allow the user to set the configuration for each DIO input line(s). The <STRING> value must be one of the following-

- OFF : Selecting that the respective DIO input should be ignored.
- HI : Selecting that the respective DIO input should be inspected and is active HI.
- LO : Selecting that the respective DIO input should be inspected and is active LO.

DIO,PASS,<STRING>
DIO,FAIL,<STRING>
DIO,TESTING,<STRING>
DIO,DWELL,<STRING>
DIO,HV,<STRING>

These commands allow the user to set the configuration for each DIO output line. The <STRING> value must be one of the following-

- HI : Selecting that the respective DIO output should be active HI.
- LO : Selecting that the respective DIO output should be active LO.

SWITCHES,<STRING>

This command allows the user to select how the 950 interfaces with external switches. The <STRING> value must be one of the following-

- NONE : Selecting that the 950 will not control any external switches.
- 948 : Selecting that the 950 will control an external 948 using the RS232 interface (note that this disables use of the RS232 interface for any other purpose).
- 964SER : Selecting that the 950 will control an external 964 using the RS232 interface (note that this disables use of the RS232 interface for any other purpose).
- VICL1 : Selecting that the 950 will control a single 964 switch via the VICL interface.
- VICL2 : Selecting that the 950 will control two 964 switches via the VICL interface.
- VICL3 : Selecting that the 950 will control three 964 switches via the VICL interface.
- VICL4 : Selecting that the 950 will control four 964 switches via the VICL interface.

RS232,<NR1>

This command sets the RS232 baud rate. The <NR1> value must be either 9600, 19200, 57600 or 115200. Using this command via the RS232 interface itself may cause undesired affects.

Note, this command has no affect if the SWITCHES,948 setting has been selected as the RS232 baud rate is automatically fixed at 9600 in that condition.

GPIB,<NR1>

This command sets the GPIB address to the <NR1> value (in the range 0 to 29 inclusive). Using this command via the GPIB interface itself may cause undesired affects.

DHCP,<BOOL>

This command selects whether the Ethernet interface will use DHCP (TRUE value) or not (FALSE value).

IP,<NR1>,<NR1>,<NR1>,NR1>

This sets the Ethernet IP address of the 950 when not using DHCP. The four <NR1> values set the IP address in the normal manner. Using this command via the Ethernet interface itself may cause undesired affects.

SUBNET,<NR1>,<NR1>,<NR1>,NR1>

This sets the Ethernet Subnet mask of the 950 when not using DHCP. The four <NR1> values set the Subnet mask in the normal manner. Using this command via the Ethernet interface itself may cause undesired affects.

GATEWAY,<NR1>,<NR1>,<NR1>,NR1>

This sets the Ethernet Gateway IP address when not using DHCP. The four <NR1> values set the Gateway IP Address in the normal manner. Using this command via the Ethernet interface itself may cause undesired affects.