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# N432A Thermistor Power Meter

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### CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

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A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

## Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment. Keysight further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization calibration facility, and to the calibration facilities of other International Standards Organization members.

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# Equipment Operation

## Warnings and Cautions

This guide uses warnings and cautions to denote hazards.

### **WARNING**

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or loss of life. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

---

### **CAUTION**

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

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## Personal safety considerations

This is a Safety Class I instrument (provided with a protective earthing ground, incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to damage the instrument. Intentional interruption is prohibited. If the instrument is not used as specified, the protection provided by the instrument could be impaired. The instrument must be used in a normal condition (in which all means of protection are intact) only. No operator serviceable parts inside. Only refer servicing to qualified personnel. To prevent electric shock, do not remove covers. For continued protection against fire, replace the line fuse(s) only with fuses of the same type and rating (for example, normal blow, time delay, and so on). The use of other fuses or material is prohibited.

## Safety Symbols

The following symbols on the instrument and in the documentation indicate precautions which must be taken to maintain safe operation of the instrument.

|   |  |
|---|--|
|  <p>Caution, risk of danger (refer to this manual for specific Warning or Caution information)<br/>The instrument is marked with this symbol when it is necessary for the user to refer to the instructions in the supplied documentation.</p> |  <p>This symbol indicates the operating switch for 'Stand-by' mode.<br/>Note, this instrument is NOT isolated from the mains when the switch is pressed. To isolate the instrument, the mains coupler (mains input cord) should be removed from the power supply.</p> |
|  <p>Direct current (DC)</p>  |  <p>Alternating current (AC)</p>  |
|  <p>Both direct and alternating current</p>  |  <p>Three-phase alternating current</p>   |
|  <p>Off (mains supply)</p>   |  <p>On (mains supply)</p>   |
|  <p>Caution, risk of electric shock</p>   |  <p>Caution, hot surface</p>   |
|  <p>Earth (ground) terminal</p>  |  <p>Equipment protected throughout by double insulation or reinforced insulation</p>  |
|  <p>Protective earth (ground) terminal</p>   |  <p>Frame or chassis (ground) terminal</p>  |
|  <p>In position of a bi-stable push control</p>  |  <p>Out position of a bi-stable push control</p>  |
|  <p>Equipotentiality</p>   |  |

## Safety Considerations

Read the information below before using this instrument.

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

### **WARNING**

Before the instrument is switched on, make sure that it has been properly grounded through the protective conductor of the AC power cable to a socket outlet provided with protective earth contact. Any interruption of the protective (grounding) conductor inside or outside of the instrument, or disconnection of the protective earth terminal can result in personal injury.

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### **CAUTION**

Any adjustments or service procedures that require operation of the instrument with protective covers removed should be performed only by trained service personnel.

---

## Environmental Conditions

The N432A is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

| Environmental condition | Requirement  |
|-------------------------|--|
| Temperature             | Operating condition<br>- 0 °C to 45 °C                           |
|                         | Storage condition<br>- -40 °C to 70 °C                           |
| Humidity                | Operating condition<br>- 15% to 95% RH at 40 °C (non-condensing) |
|                         | Storage condition<br>- Up to 90% RH at 65 °C (non-condensing)    |
| Altitude                | Up to 4,600 m (15,000 ft.)                                       |

## Regulatory Information

The N432A complies with the requirements of the EMC Directive 89/336/EEC. The N432A also complies with the following safety and Electromagnetic Compatibility (EMC) compliances:

### Safety compliance

- IEC 61010- 1:2001/EN 61010- 1:2001
- CAN/CSA- C22.2 No.61010- 1- 04
- ANSI/UL61010- 1:2004

### EMC compliance

The N432A complies with the essential requirements of the following applicable European (EC) Directives, and carries the CE marking accordingly to the Low Voltage Directive (2006/95/EC) and EMC Directive (2004/108/EC).

EMC tests conform to the IEC 61326- 2- 1:2005/EN 61326- 2- 1:2006 and CISPR 11:2003/EN 55011:2007 (Group 1, Class A). In order to preserve the EMC performance of the N432A, any cable which becomes worn or damaged must be replaced with the same type and specification.

The N432A also meets the following EMC standards:

- Canada: ICES- 001:2004
- Australia/New Zealand: AS/NZS CISPR11:2004

Degradation of some instrument specifications can occur in the presence of ambient EM fields and noise that are coupled to the power line or I/O cables of the N432A. The N432A will self- recover and operate to all specifications when the source of ambient EM fields and noise are removed or when the N432A is protected from the ambient EM fields or when the N432A cabling is shielded from the ambient EM noise.

## Regulatory Markings

|   |   |   |  |
|---|---|---|--|
|  | <p>The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.</p> |  <p>This is the symbol of an Industrial Scientific and Medical Group 1 Class A product</p> |  <p>The CSA mark is a registered trademark of the Canadian Standards Association.</p><br> <p>External Protective Earth Terminal. While this is a Class I product, provided with a protective earthing conductor in a power cord, an external protective earthing terminal has also been provided. This terminal is for use where the earthing cannot be assured. At least an 18 AWG earthing conductor should be used in such an instance, to ground the instrument to an assured earth.</p> |
|---|---|---|--|

### IEC 1010-1 compliance

This instrument has been designed and tested in accordance with IEC Publication 1010-1+A1:1992 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

## Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

### Product category

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit <http://about.keysight.com/en/companyinfo/environment/takeback.shtml> for more information.

## Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

- [www.keysight.com/support/N432A](http://www.keysight.com/support/N432A)  
(product-specific information and support, software and documentation updates)
- [www.keysight.com/find/assist](http://www.keysight.com/find/assist)  
(worldwide contact information for repair and service)

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# 1 N432A at a Glance

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This chapter provides an overview of the N432A front and rear panel outlook as well as its display layout.

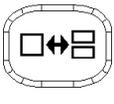
## Front Panel Outlook

This section briefly describes the functions of the front panel keys and connectors.



These keys are located to the left of the display.

| Key | Function  |
|-----|---|
|     | Press this key to preset the N432A to its default state.  |
|     | Press this key to control the N432A from the front panel when it is operating via the remote interfaces (when Local Lock Out is disabled).  |
|     | Press this key to select the upper or lower measurement window. The selected window is highlighted by a blue line on the right of the window. Any measurement setup you create is performed in the selected window. |

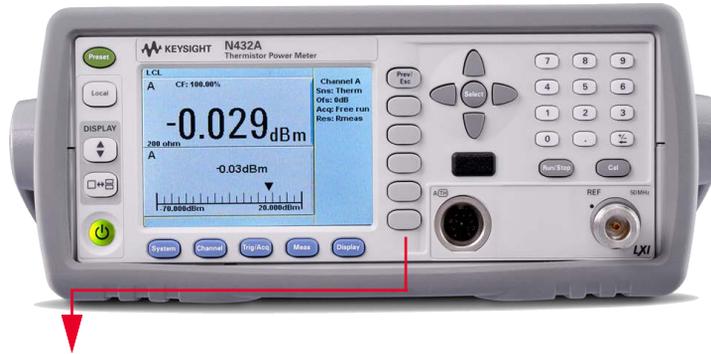
| Key   | Function   |
|---|--|
|  | Press this key to select a windowed, expanded, or full-screen display of a numeric measurement.  |
|  | Press this key to switch the N432A between on and standby. When power is supplied, the background LED turns red. Pressing the key switches on the N432A and the background LED turns yellow. When the N432A is powered on, the startup will take approximately 25 seconds. |

# 1 N432A at a Glance



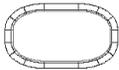
These keys are located along the lower edge of the display.

| Key   | Function   |
|---|--|
|    | Press this key to access general configuration menus, such as the remote interface configuration. You can also access some measurement configuration menus. The measurement screen remains visible.  |
|    | Press this key to access the channel configuration menu. Channel parameters such as voltage averaging and offsets are configured from this menu.   |
|  | Press this key to access the triggering menu.  |
|  | Press this key to configure measurements for the selected measurement window, such as display offsets and relative measurements.   |
|  | Press this key to access the measurement display menu. You can select the displayed measurement resolution, unit, and display format.<br>Use this key together with  to configure measurement displays. |



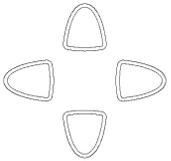
These keys are associated with the menu labels and data entry. They are located to the right of the display.

| Key   | Function   |
|---|--|
|  | Press this key to return to the previous screen. This key also cancels pop-up entries. |

| Key   | Function  |
|---|---|
|  |   |
|  | <p>These unmarked keys are called 'softkeys' and are referred to by the text on the display next to them.</p>   |
|  | <p>For example, during a preset, you are given an option to confirm the command.</p>  |
|  | <p>Press <b>Confirm</b> to continue, that is, press the softkey beside the displayed word <b>Confirm</b>.</p>   |
|  |   |
|  | <p>The lowest of the unmarked softkeys is used when there is a two-page menu to be displayed. For example, a <b>1 of 2</b> is displayed beside the key indicating the first page of a two-page menu. Press the key to access the next page or the second page (a <b>2 of 2</b> is displayed).</p> |



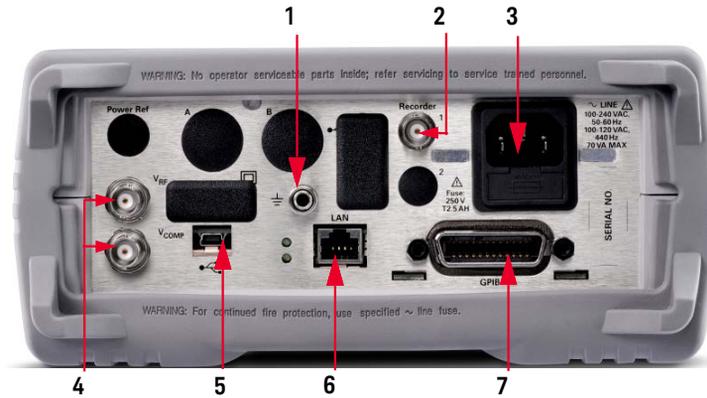
These keys and connectors are associated with the measurement channel and are located on the right of the front panel.

| Key   | Function  |
|---|---|
|   | The arrow keys are used for navigation around the parameter entry screens. The up and down arrows are used for selecting values from a pop-up list. They are also used to enter text such as table names. |
|  | Press this key to select a highlighted field to allow data entry, select a check box, or confirm the entry of a pop-up list.  |
|  | Press this key to access the zeroing menu.  |

| Key  | Function   |
|--|--|
|   | Press this key to reset the MAX HOLD and MIN HOLD measurements.  |
| <br><br><br> | Press these keys to enter numeric values in the pop-up fields, for example, the offset values. To complete the entry, use the softkey. |

| Connector  | Function  |
|--|---|
|   | The power reference is a 1 mW (0 dBm), 50 MHz signal available from a 50 $\Omega$ type-N connector. It is used for calibrating a 478A or 8478B thermistor sensor and meter system. The yellow LED beside the connector is lit when turned on. |
|  | Thermistor mount input connector for 1.5 m, 3 m, and 6.1 m cables that connect to the 478A or 8478B thermistor sensors.   |

## Rear Panel Connections

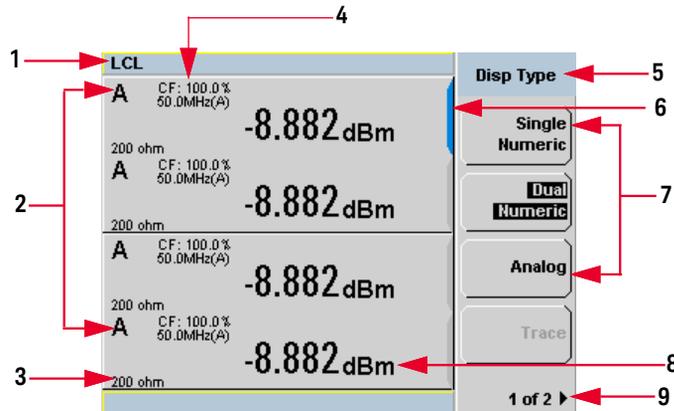


| No. | Connection  |
|-----|---|
| 1   | Ground connector  |
| 2   | Recorder output terminal 1<br>Recorder output connection is made via a BNC connector. This output produces a DC voltage that corresponds to the power level of the channel input.   |
| 3   | AC inlet<br>The N432A has an auto-configuring power supply. This allows it to operate over a range of voltages without manually being set to a certain voltage.   |
| 4   | $V_{RF}$ and $V_{COMP}$ output terminals<br>The $V_{RF}$ BNC terminal outputs the RF bridge voltage, while the $V_{COMP}$ BNC terminal outputs the compensation bridge voltage. Both the $V_{RF}$ and $V_{COMP}$ outputs are used for calibrating the N432A and for precision power measurements. |
| 5   | USB Mini-B port<br>Allows the N432A to be controlled remotely over the USB interface.   |
| 6   | LAN interface<br>Allows the N432A to be controlled remotely over the LAN interface.   |
| 7   | GPIB interface<br>Allows the N432A to be controlled remotely over the General Purpose Interface Bus (IEEE-488) standard interface.  |

## Display Layout

The following figure shows the display when two windows are configured in the dual numeric mode.

Other display formats are available by pressing  > **Disp Type**.



**Figure 1-1** Dual numeric display

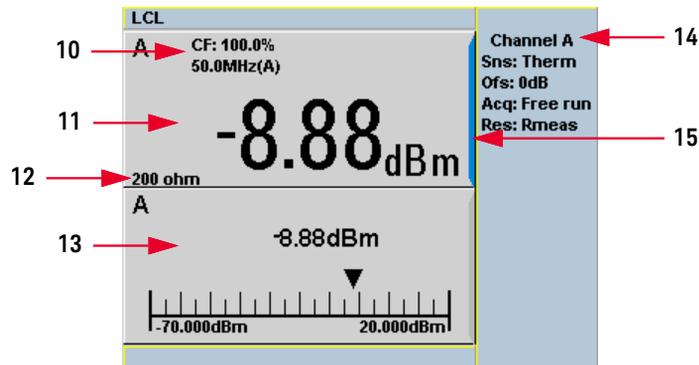
- 1 The status reporting line displays messages and the control status of the N432A.

For example, the status can be either **RMT** (remote, GPIB, USB, or LAN operation) or **LCL** (local, front panel operation). The message field will indicate **ERR** for any error conditions that occur.

- 2 The measured channel is shown with a thermistor sensor connected.
- 3 This field displays the current bridge resistance value as an indicator with or without the thermistor sensor connected.
- 4 The information in this field is displayed in two lines and depends on the sensor calibration factor, sensor calibration and frequency-dependent offset tables currently selected, and the measurement frequency.
- 5 This field displays the menu title.

For example, **Channel Setup**, or press  and the **Zero/Cal** menu is displayed.

- 6 The blue highlight on the right of the window indicates the currently selected measurement display line. This measurement line refers to the upper window/ upper measurement.
- 7 The available softkey labels are displayed in these fields. Additionally, settings associated with the labeled function are displayed under the label. Softkey labels that are grayed out cannot be selected.
- 8 This displays the measurement unit.
- 9 This displays the number of pages in the current menu. For example, **1 of 2** indicates that there are two pages in the menu and the first page is currently displayed. Pressing the softkey displays the next page, indicated by **2 of 2** (press the softkey again to display the previous menu page).



**Figure 1-2** Single numeric and analog display

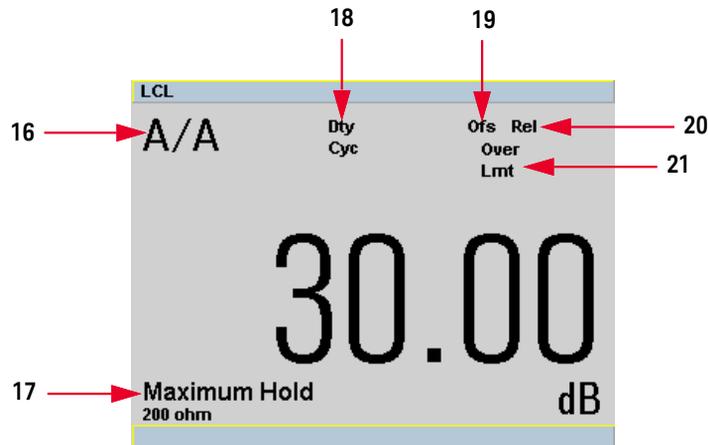
Figure 1-2 shows the default display format of two measurement windows in the single numeric and analog mode.

- 10 The information in this field is displayed in two lines and depends on the sensor calibration factor, sensor calibration and frequency-dependent offset tables currently selected, and the measurement frequency.
- 11 The upper window is configured to show a single numeric display.
- 12 This field displays the current bridge resistance value as an indicator with or without the thermistor sensor connected.
- 13 The lower window is configured to show an analog meter which displays the measurement result and the meter scaling.

- 14 This displays the connected sensor, offset value, acquisition mode, and bridge resistance type for the channel.
- 15 The blue highlight on the right of the window indicates the currently selected measurement display line.

Using the up/down arrow key or , you can change the measurement window selection.

Using  on a numeric measurement result window allows you to select either a single enlarged window or a full screen display. The display style is applied to the currently selected window or measurement line.



**Figure 1-3** Full screen numeric display

Figure 1-3 shows a single numeric full screen displaying a relative result.

- 16 This field displays either a ratio or difference measurement indicator when the Combined measurement function is enabled.
- 17 This field displays either **Minimum Hold** or **Maximum Hold** if the range hold is set to minimum or maximum respectively.
- 18 This field displays **Dty Cyc** if a duty cycle is set.
- 19 This field displays **Ofs** if an offset is set.

- 20** This field displays **Rel** if relative mode is enabled.
- 21** This field indicates that the measurement result is beyond the configured upper or lower limit. If the measurement result is within the limits, this field is empty. If the measurement result is less than the minimum limit set, **Undr Lmt** is displayed. If the measurement result is more than the maximum limit set, **Over Lmt** is displayed.

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## 2 Calibration Procedures

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This chapter provides the information on calibration and self-test of the N432A.

## Introduction

This section provides the guidelines for verifying the performance of the N432A as well as carrying out the necessary adjustments. Performance verification tests allow you to verify that the N432A is operating within its published specifications. Adjustments are not usually required on any regular basis. They are normally performed only after a performance test has indicated that some parameters are out of specifications, or after repair.

## Keysight Technologies Calibration Services

When your N432A is due for calibration, contact your local Keysight Service Center for a low-cost recalibration. The N432A is supported on an automated calibration and adjustment systems, which allow Keysight to provide this service at competitive prices.

To obtain warranty, service, or technical support information, refer to the Web links listed in “Sales and Technical Support” on page 10. You can also use the following Web link for information on contacting Keysight worldwide:

[www.keysight.com/find/assist](http://www.keysight.com/find/assist)

or contact your Keysight representative.

Before shipping your N432A, request the Keysight Service Center to provide shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for use in such shipments.

## Calibration Interval

A one-year interval is adequate for most applications. Accuracy specifications are warranted only if calibration is made at regular calibration intervals. Accuracy specifications are not warranted beyond the one-year calibration interval. Keysight does not recommend extending calibration interval beyond the recommended calibration interval for any application.

## Self-Test

### NOTE

- Always ensure that the self-test passes before proceeding with any performance verification test or adjustment.
- If all tests pass, you have a high confidence (~90%) that the N432A is operational.

The N432A troubleshooting mode self-test can be accessed via the front panel or remotely. The front panel softkey menu allows you to run individual tests, whereas the remote command runs a full instrument self-test as listed in “Remote testing” on page 36.

### Front panel selection of self-tests

Press  > **1 of 2** > **Service** > **Self Test** to access the **Self Test** menu that consists of the following tests:

- Instrument Self-Test
- Keyboard
- Bitmap Displays
- RTC Battery

### Instrument self-test

When **Instrument Self Test** is selected, the following tests will be run: (These are the same tests run using the `*TST?` command.)

- Test Point Voltages
- Calibrator
- Fan
- RTC Battery
- $V_{RF}$  Path

- $V_{COMP}$  Path
- $V_0$  Path

When **Run Self Test** is pressed, the N432A will check if the thermistor sensor is connected. If connected, you will be prompted to disconnect the sensor.

Once **Confirm** is pressed, the N432A will check if the sensor is disconnected. If disconnected, self-test will initiate and display the test results accordingly.

As each test takes place, the name of the test is listed on the screen. While a test is running, the message **Testing...** appears beside the name of the test. As each stage of the test completes, the **Testing...** message is replaced by either **Passed** or **Failed**.

| LCL                        |               | Self Test   |
|----------------------------|---------------|-------------|
| TEST                       | RESULT        |             |
| <b>Test Point Voltages</b> | <b>Passed</b> | <b>Done</b> |
| <b>Calibrator</b>          | <b>Passed</b> |             |
| <b>Fan</b>                 | <b>Passed</b> |             |
| <b>RTC Battery</b>         | <b>Passed</b> |             |
| <b>Vrf Path</b>            | <b>Passed</b> |             |
| <b>Vcomp Path</b>          | <b>Passed</b> |             |
| <b>V0 Path</b>             | <b>Passed</b> |             |

**Figure 2-1** Self-test completed

When the self-test has completed, press **Done** to return to the **Self Test** menu.

If the self-test failed, information about the failure will be displayed on the screen.

For any currently selected bridge resistance value of either 100  $\Omega$ , 200  $\Omega$ , 300  $\Omega$ , or 400  $\Omega$ , the internal self-test resistance value of 200  $\Omega$  will be used to perform the self-test.

When you press **Run Self Test** followed by **Confirm** even if the sensor is still connected, you will be prompted again to disconnect the sensor. If you cancel the sensor disconnect confirmation with the sensor still connected, tests for  $V_{RF}$ ,  $V_{COMP}$ , and  $V_0$  will be skipped and displayed as shown in [Figure 2-2](#).

| LCL <span style="color: red;">ERR</span>     |         | Self Test |
|--|---------|-----------|
| TEST   | RESULT  |           |
| Test Point Voltages                          | Passed  | Done      |
| Calibrator                                   | Passed  |           |
| Fan  | Passed  |           |
| RTC Battery                                  | Passed  |           |
| V <sub>rf</sub> Path<br>(Sensor connected)   | Skipped |           |
| V <sub>comp</sub> Path<br>(Sensor connected) | Skipped |           |
| V <sub>0</sub> Path<br>(Sensor connected)    | Skipped |           |
|  |         |           |

**Figure 2-2**  $V_{RF}$ ,  $V_{COMP}$ , and  $V_0$  tests skipped

## Test descriptions

This section specifies what is actually checked by each test in the instrument self-test. Some of the tests may only be applicable to one method of invocation (for example, from the front panel). If this is the case, it is specified in the test description. Most of the tests have an associated error message which is added to the error queue if the test fails. The exception to this is the bitmap display test. For more information on the error messages, refer to the *N432A Thermistor Power Meter User's Guide*.

### Test point voltages

An array of tests on various DC voltages inside the N432A.

### Calibrator

The reference calibrator is turned on (indicated by the POWER REF LED) and measured internally. A pass or fail result is returned.

### Fan

This test confirms that the internal cooling fan is running.

### Real time clock (RTC) battery

The RTC battery provides power for the real-time clock circuitry on the motherboard when the N432A is powered off.

During the RTC battery test, the RTC battery power level is determined by converting the ADC value of the RTC battery power level read from the FPGA, to voltage level. If the battery power level is less than a pre specified threshold (threshold to be defined later), the test will fail. An error will be logged in the error list if the test fails.

### $V_{RF}$ , $V_{COMP}$ , $V_0$ paths

An array of tests on the voltage metering for  $V_{RF}$ ,  $V_{COMP}$ , and  $V_0$ . The built-in self-test circuit will output a set of known DC voltages to the bridge which are then compared to those measured by the N432A metering. This is a user-invoked self-test.

## Remote testing

To perform a remote instrument self-test, the IEEE-488.2 common command **\*TST?** is used. This command runs a full self-test and returns one of the following codes:

- 0 – no tests failed
- 1 – one or more tests failed

The communications assembly is tested implicitly, in that the command will not be accepted or return a result unless the remote interface is functioning correctly.

When the **\*TST?** command is executed, the screen is cleared. As each test takes place, the name of the test is listed on the screen. While a test is running, the message **Testing...** appears beside the name of the test. As each stage of the test completes, the message **Testing...** is replaced by either **Passed** or **Failed**.

# 3 Performance Tests

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| 1 mW Power Reference Level Test       | 39 |
| Output Standing Wave Ratio (SWR) Test | 42 |
| Instrument Accuracy Test              | 48 |

This chapter provides the information on performance verification tests of the N432A which ensure that it is operating within its published specifications.

## Introduction

The performance tests described in this section test the power meter's electrical performance against the specifications detailed in Chapter 7. They are used for incoming inspection, the calibration cycle (also called periodic maintenance), or after repairs have been made.

# 1 mW Power Reference Level Test

## Description

This test uses an 8482A power sensor to transfer the power measured on an accurately calibrated power meter to the DUT as reference.

## Required test equipment

- 1 unit of reference power meter (E4416A, E4417A, N1911A, N1912A, or equivalent)
- 1 unit of power sensor (8482A or equivalent)

## Test method

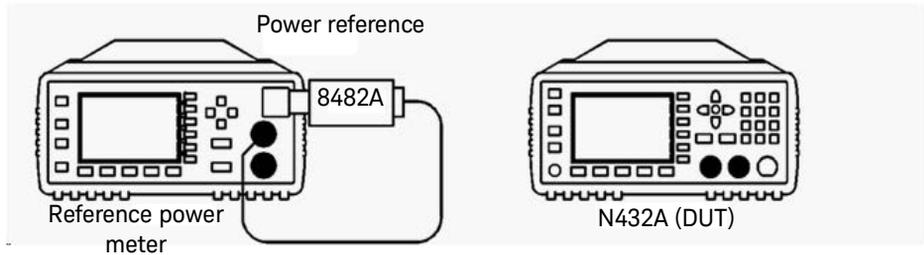
- 1 Obtain the 1 mW power level of the reference power meter from the calibration certificate. Calculate the **STD Error** using the following formula:

$$\text{STD Error (mW)} = 1 \text{ mW} - \text{Power level on the certificate}$$

### NOTE

The 1 mW reference of the power meter used must be precisely calibrated at a standard accredited lab.

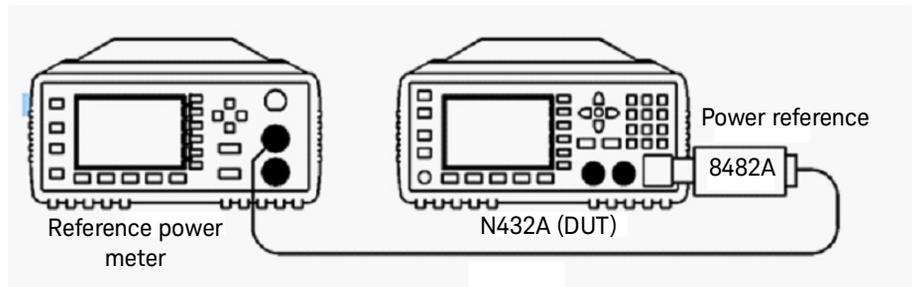
- 2 Connect the 8482A sensor to Channel A and the power reference connector on the reference power meter as shown in [Figure 3-1](#).



**Figure 3-1** Connecting 8482A to Channel A for 1 mW power reference level test

- 3 Preset the reference power meter.
- 4 Perform a zeroing and calibration operation.
- 5 Turn on the 1 mW power reference on the reference power meter.
- 6 Take the measurement from Channel A of the reference power meter. Calculate the **Cal Error** using the following formula:  

$$\text{Cal Error (mW)} = 1 \text{ mW} - \text{Reference power meter Channel A measurement}$$
- 7 Turn off the 1 mW power reference on the reference power meter.
- 8 Disconnect the 8482A sensor from the reference power meter and connect it to the N432A (referred to as the DUT) as shown in [Figure 3-2](#).



**Figure 3-2** Connecting 8482A to N432A for 1 mW power reference level test

- 9 Preset the DUT.

- 10** Turn on the 1 mW power reference on the DUT.
- 11** Take the measurement from the DUT and compare it to the following value:  
Target (mW) = 1 mW - (STD Error + Cal Error)

**NOTE**

An adjustment is available for this test if it fails.

---

## Output Standing Wave Ratio (SWR) Test

### Description

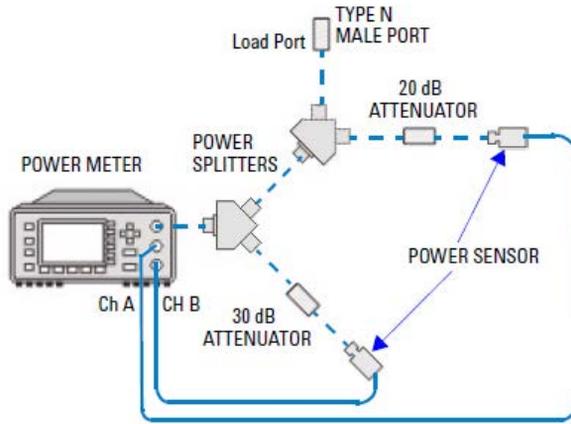
Connector mismatch is the largest single contributor to measurement uncertainty, so this specification must be warranted to provide assurance of instrument accuracy. The 1 mW power reference level test must be carried out prior to this test, as the voltage standing wave ratio VSWR specification is only valid at 1 mW. This test measures VSWR by equating relative powers (measured by the test system power meter and its sensors) when the power reference is exercised under different load conditions.

### Required test equipment

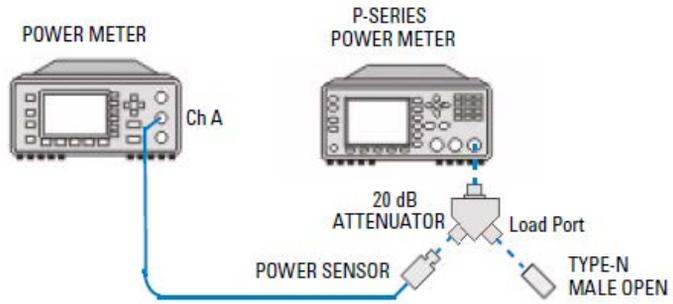
- 1 unit of network analyzer (8753ES/ET or equivalent, as long as it can measure S11 in the 45 - 55 MHz range)
- 1 unit of calibration kit (85032B or equivalent that fits the network analyzer connector type)
- 1 unit of dual-channel power meter (E4419B or E4417A or equivalent)
- 2 units of 8481D power sensor
- 2 units of 11667A option 001 power splitter
- 1 unit of 20 dB attenuator (8491A or equivalent)
- 1 unit of 30 dB attenuator (11708A or equivalent)

#### NOTE

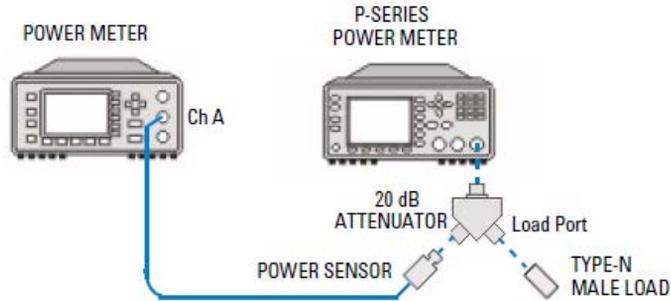
- The above specified power sensors and power splitters models must be used.
- Any type of attenuator can be used (as long as there are no additional mating connections, or differing attenuator values).
- 1 unit of 11667A, 1 unit of 8481D, and the 30 dB attenuator combine to create the "Calibration System".
- 1 unit of 11667A, 1 unit of 8481D, and the 20 dB attenuator combine to create the "Measurement System".



**Figure 3-3** System calibration connection diagram



**Figure 3-4** Output SWR test setup - Open connection diagram



**Figure 3-5** Output SWR test setup - Load connection diagram

### Test method

- 1 Obtain the S11 parameter of the Measurement System at 50 MHz. More specifically, obtain the mean scalar values for the Voltage Reflection Coefficient (VRC) under open and load conditions. These parameters will be referred to hereafter as:

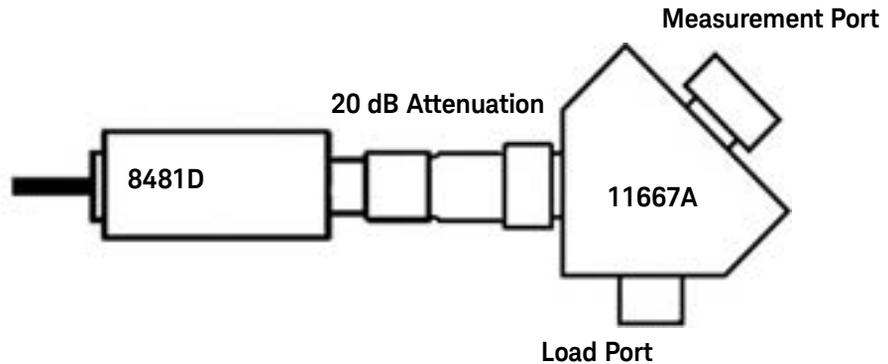
Meas Port VRC (Open) and Meas Port VRC (Load).

#### NOTE

If this system was constructed and measured at an earlier date, then the parameters are only valid if the connections have not been disturbed since. The VRC values must be re-measured if any of the system components have since been loosened or tightened.

- a Set the frequency of the network analyzer to 50 MHz, set the format to LIN MAG and calibrate the network analyzer.

- b** Connect the Measurement System (as shown in the figure below) to a power meter.



- c** Switch on the power meter.
- d** Connect the measurement port of the 11667A to Port 1 of the network analyzer.
- e** Connect the 50 Ohm load to the load port of the 11667A (refer to figure shown in [step b](#)).
- f** Record the MEAN value; this will be referred to as Meas Port VRC (Load).
- g** Disconnect the 50 Ohm load from the load port of the 11667A.
- h** Connect the open to the load port of the 11667A.
- i** Record the MEAN value; this will be referred to as Meas Port VRC (Open).
- j** Disconnect the open from the load port of the 11667A.
- k** Disconnect the Measurement System from the network analyzer, taking care not to loosen or tighten any of the connections between each of the component parts.
- 2** Connect the Measurement System and the Calibration System to the power meter. Refer to [Figure 3-3](#).
- 3** Zero the Measurement System and Calibration System.

**NOTE**

These systems do not need to be calibrated with respect to the 1 mW power reference; the measurement being taken are relative to one another, and not absolute.

- 4 Turn on the 1 mW power reference on the power meter.
- 5 Connect a 50 Ohm load to the Measurement System load port. Take note of the readings on both Channel A and Channel B of the power meter. Calculate the **Meas System S21 (Load)** parameter using the following formula:  
$$\text{Meas System S21 (Load)} = \text{Channel A} / \text{Channel B}$$
- 6 Disconnect the 50 Ohm load from the Measurement System load port. Take note of the readings on both Channel A and Channel B of the power meter. Calculate the **Meas System S21 (Open)** parameter using the following formula:  
$$\text{Meas System S21 (Open)} = \text{Channel A} / \text{Channel B}$$

**Note:** There is no need to connect an “Open” to the Measurement System at a frequency as low as 50 MHz, a free-air measurement is sufficient.
- 7 Turn off the 1 mW power reference on the power meter.
- 8 Calculate the **Meas System S21 Multiplier** parameter using the following formula:  
$$\text{Meas System S21 Multiplier} = \text{Meas System S21 (Open)} / \text{Meas System S21 (Load)}$$
- 9 Completely disconnect the Calibration System from the power meter, taking care not to disturb any of the interconnections.
- 10 Connect the Measurement System to the Power Reference connector on the N432A (referred to as the DUT). Refer to [Figure 3-4](#).
- 11 Zero the Channel A of the power meter.
- 12 Set the measurement resolution of Channel A on the power meter to four digits.
- 13 Connect a 50 Ohm load to the Measurement System load port.
- 14 Turn on the 1 mW power reference on the DUT.
- 15 Allow two seconds for the power level to settle, and then take a measurement from Channel A of the power meter. This reading shall be referred to as DUT Power (Load).
- 16 Disconnect the 50 Ohm load from the Measurement System load port.
- 17 Allow two seconds for the power level to settle, and then take a measurement from Channel A of the power meter. This reading shall be referred to as DUT Power (Open).

**18** Turn off the 1 mW power reference on the DUT.

**19** Calculate the **M Factor** using the following formula:

$$\text{M Factor} = [\text{DUT Power (Load)} / \text{DUT Power (Open)}] \times \text{Meas System S21 Multiplier}$$

**20** Calculate the VRC of the DUT using the following formula:

$$\text{VRC} = \frac{-b \pm (\sqrt{b^2 - 4ac})}{2a}$$

$$a = \text{VRC1}^2 \times M - \text{VRC2}^2$$

$$b = 2 \times \text{VRC1} \times M - 2 \times \text{VRC2}$$

$$c = M - 1$$

Refer to the following for M, VRC1, and VRC2:

M = load power / open power × S21 multiplier (from steps 5, 6, 8 and 19)

VRC1 = input VRC open (from step 1i)

VRC2 = input VRC load (from step 1f)

#### NOTE

This equation will yield two results. One of these results will be a real number, whilst the other will be an imaginary number. The imaginary number should be discarded, as the real number represents the resulting VRC.

**21** Calculate the VSWR of the DUT using the following formula:

$$\text{VSWR} = \frac{(1 + |\text{VRC}|)}{(1 - |\text{VRC}|)}$$

**22** Compare the VSWR of the DUT to the value stated in the datasheet.

## Instrument Accuracy Test

As mentioned in “Self-Test” on page 33 pass means this instrument have high confidence (~90%) that N432A is operational.

To have more confidence level, we can perform the test as below:

### Description

This test uses an 478A Option H75 (Thermistor) power sensor to measure on an accurately calibrated EXG/MXG Vector Signal Generator ( or equilibrium).

### Required test equipment

- 1 unit of reference Signal Generator (N5172B, N5183B or equivalent)
- 1 unit of power sensor (478A Option H75) or equivalent)

### Test Method

- 1 Power up all instruments > 45 mins in a stable temperature environment.

#### NOTE

For the instrument to meet performance specifications and for accurate self test results, allow a warm up period of 45 minutes within an operational temperature range of 0 to 55 °C. For more information, refer to the X-Series signal generator Data Sheets.

- 2 Ensure the setting frequency on the N432A power meter under test is at default (50.00MHz) and it has been powered on for at least 30 minutes before continuing. (This is the recommended warm up time).
- 3 Connect the RF Output 50  $\Omega$  port at signal generator to the 478A Option H75 power sensor and connect it to N432A power meter under test. Connect all the instrument as shown as figure below.

## 4 Connection as below:



## 5 Set the Signal Generator with below setup:

- a Frequency to 50Mhz.
  - i Press FREQ button.
  - ii Press Numeric Keypad 50.
  - iii Press select 'MHz' and press the button beside screen.
- b Amplitude setting: -10, 0, 10 dBm.
  - i Press AMPTD button.
  - ii Press Numeric Keypad -10. (change the amplitude for 0 and 10dBm)
  - iii Press select 'dBm' and press the button beside screen.

## 6 N432A measurement:

- a Set the Resistance to 200 ohm. 478A Option H75 will auto detect the level. Press '200 ohm', then 'Confirm' button.
- b Press 'Cal' button.
- c Press 'Zero' button, then 'Confirm'.
- d Set the unit in Watt. Press 'Display', select 'Units' then select watt 'W'. (If the setting is 'W' then can skip this step).
- e Set the Signal Generator to -10 dBm @ 50 Mhz.
- f Press button 'RF ON/OFF' button to turn on the RF [sig gen] and read the measurement [N432A].

### 3 Performance Tests

- g** Then, press again 'RF ON/OFF' button to turn off the RF.
- h** Repeat **step b** until **step g** for 0 dBm @ 50 MHz and 10 dBm @ 50 MHz.
- i** Once all 3 readings have been obtained, use a power absolute accuracy specification of (0.1% of reading + 0.5  $\mu$ W) to determine the specification.

| Signal Generator setting/dBm | W      | Lower Limit/W | Upper limit/W |
|------------------------------|--------|---------------|---------------|
| -10 dBm @ 50 Mhz             | 0.0001 | 0.0000994     | 0.0001006     |
| 0 dBm @ 50 Mhz               | 0.001  | 0.0009985     | 0.0010015     |
| 10 dBm @ 50 Mhz              | 0.01   | 0.0099895     | 0.0100105     |

# 4 Service and Maintenance

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This chapter contains general service and maintenance information for the N432A.

## Introduction

This chapter provides the information on how to access service-related features on the N432A, as well as guidelines on how to clean the N432A and check the power line fuses.

## Service-Related Features

**NOTE**

For more information on the following service-related features, refer to the *N432A Thermistor Power Meter User's Guide*.

---

To access the Service menu on the N432A, press  > **1 of 2** and select **Service**:

- Press **Self Test** to access the self-test menu which enables you to run individual test as described in “Self-Test” on page 33.
- Press **Version** to view the current firmware revision.
- Press **Secure Erase** to securely erase the N432A user-accessible memory.
- Press **Warm Start** to toggle On/Off the warm start feature. This feature allows you to retain the N432A current states and settings upon power cycle or in the event of interrupted power.
- Press **1 of 2** > **Display** to access the blank screen and secure blank features which enable you to secure data confidentiality.
- Press **Backlight** to access the backlight intensity control menu which allows you to increase or decrease the backlight brightness.

To view the error list on the N432A, press  and select **Error List**. Press **Next** to view the next error message and **Clear Errors** to clear the error list.

## Cleaning

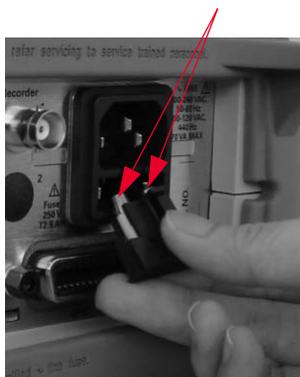
Power off the N432A and wipe its outer panels with a soft, lint-free, slightly dampened cloth. Do not use detergent. Disassembly is not required or recommended for cleaning.

## Checking the Power Line Fuses

The power line fuses are located within the N432A fuse holder assembly on the rear panel. For all voltages, the N432A uses 250 V, T2.5 H, 20 mm slow blow fuses with high breaking capacity.

Use the following procedure to check the power line fuses:

- 1 Slide the fuse holder assembly from the rear panel as shown in the figure below.
- 2 The fuses should be positioned “in line” as shown below. Ensure that both fuses are operational.
- 3 Slide the fuse holder assembly back into the rear panel.



**Figure 4-1** Checking the fuses

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# 5 Specifications and Characteristics

For the characteristics and specifications of the N432A Thermistor Power Meter, refer to the datasheet at

<http://literature.cdn.keysight.com/litweb/pdf/5990-5740EN.pdf>

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This information is subject to change without notice. Always refer to the Keysight website for the latest revision.

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