

# Keysight Technologies

## Why Migrate from HP/Keysight 432A/B to Keysight N432A Thermistor Power Meter?

### Migration Guide



### Seven Key Reasons

- Thermistor power sensor backward compatibility
- Built-in 6.5 digit digital multimeter (DMM)
- User selectable operating resistance
- IO connectivity remote interface
- Power sensor calibration factor storage in power meter
- Built-in range calibrator
- Enhanced user interface with numeric keypad and high resolution
- LCD display

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## Sustain Your Past Achievement and Enhance Your Measurement Performance by Migrating to the New N432A Thermistor Power Meter

In the 1960s, HP/Keysight Technologies, Inc. introduced the 432A/B digital/analog thermistor power meter, which has been on the market since. The 432A/B thermistor power meters are mainly used for instrumentation and system calibration, as well as characterization via metrology and standard lab, calibration lab, or power meter calibration “self-maintenance”.

However, some new applications and technologies require better capability and performance in areas such as auto zeroing, built-in range calibrator, and digital multimeter. Besides, many users prefer instrument connectivity interfaces such as USB 2.0 or Gigabit LAN, often coupled with a need for faster measurement throughput to handle more demanding test methodology.

Therefore, the transition from 432A/B digital/analog thermistor power meter to a new high-performance thermistor power meter requires careful consideration. This document provides an overview and comparison of the new Keysight N432A thermistor power meter with existing 432A/B thermistor power meters. It also provides seven reasons to migrate from the HP/Keysight 432A/B to Keysight N432A thermistor power meter.

## Introduction

Keysight Technologies is introducing the N432A thermistor power meter, a replacement for the legacy 432A/B thermistor power meters. The new N432A thermistor power meter, when used with temperature-compensated thermistor mount sensors, has a power range of  $-30$  dBm to  $+10$  dBm and a frequency range of 100 kHz to 18 MHz.



## N432A Enhanced Features

- Frequency range: 100 kHz to 18 MHz
- Power range:  $-30$  dBm to  $+10$  dBm (10 mW to  $1 \mu\text{W}$ )
- Selectable operating resistance:  $100 \Omega$ ,  $200 \Omega$ ,  $300 \Omega$  or  $400 \Omega$
- Keysight thermistor mount sensor compatibility: 8478B, 478A and K/P/R/X486A
- Built-in 6.5 digit DMM
- External  $V_{\text{ref}}$  &  $V_{\text{comp}}$  output (through BNC port at rear panel) for higher accuracy measurement
- Easy-to-use front panel interface
- Built-in test system (BIST) for ADC calibration without the need of a range calibrator
- Digital display output of power measurement (in mW or dBm unit)
- Recorder output
- Calibration factor table for manual inputs of the thermistor mount calibration factor

## Key Specifications and Features

Specification	N432A	432A/B
Frequency range		100 kHz to 18 MHz (Sensor dependent)
Power range		-30 dBm to +10 dBm (1 $\mu$ W to 10 mW)
Bridge resistance	100 $\Omega$ , 200 $\Omega$ , 300 $\Omega$ or 400 $\Omega$ (User Selectable)	100 $\Omega$ or 200 $\Omega$ (User Selectable)
Power sensor compatibility	478A, 8478B, S486A*, G486A*, J486A*, H486A*, X486A*, M486A*, P486A*, K486A* and R486A* (Thermistor power sensor)	
Measurement speed (reading/second)	2.5 readings/sec	Not applicable
1 mW reference accuracy	$\pm 0.4\%$ (Typical)	Not applicable
Power meter accuracy	0.2% $\pm 0.5 \mu$ W	0.2% $\pm 0.5 \mu$ W
Cal factor	Manually enter power sensor calibration factors into power meter	Calibration factor selector on power meter
Cal factor resolution	4 digits	2 digits
Display	Color LCD	Analog with gauge
IO connectivity	GPIB, USB, and LAN (LXI-C)	None
Measurement display	Digital	Analog
$V_{rf}$ & $V_{comp}$ output	Yes (Rear panel BNC port)	
Recorder output	Yes (Rear panel BNC port)	
Software driver	IVI-COM & IVI-C	None
Physical dimension (Width x Height x Depth)	212.6 mm x 88.5 mm x 348.3 mm (8.5 in x 3.5 in x 13.7 in)	130 mm x 155 mm x 279 mm (5.2 in x 6.1 in x 11 in)
Weight	3.6 kg (8.0 lb)	3 kg (6.4 lb)

\* S486A\*, G486A\*, J486A\*, H486A\*, X486A\*, M486A\*, P486A\*, K486A\*, and R486A\* are obsolete products and are no longer supported by Keysight Technologies.

Table 1. Comparison of the new N432A and 432A/B thermistor power meter

### Power Meter Dimensions

The new N432A thermistor power meter has the same form factor as the existing Keysight power meters (such as the E4416/7/8/9 A/B, N1913/14A, and N1911/2A). It measures 212.6 mm x 88.5 mm x 348.3 mm (excluding front panel and rear panel protrusions). This size is well suited for system integration because it is half of the standard rack width.

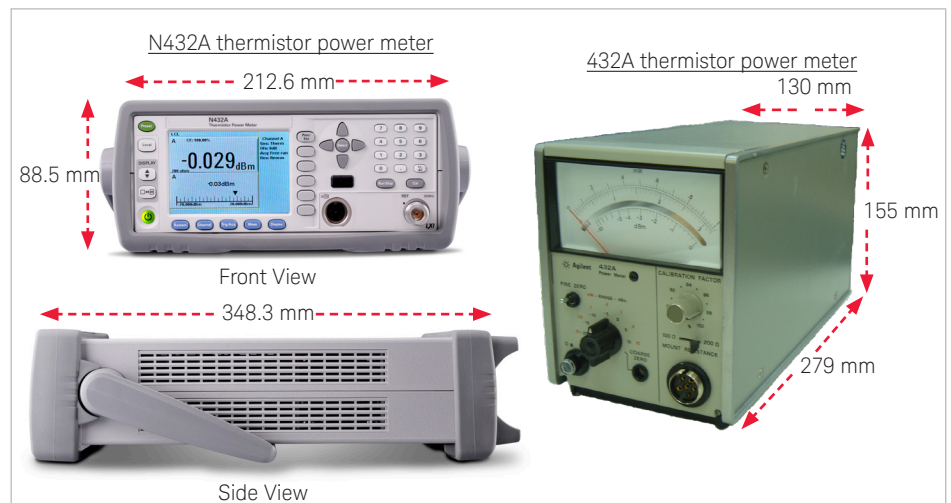


Figure 1. The front view and side view dimension of N432A and 432A/B



## Seven Reasons to Migrate from 432A/B to N432A Thermistor Power Meter

### Reason 1

#### Thermistor Power Sensor Backward Compatibility

The new N432A thermistor power meter is designed to be fully compatible with the Keysight thermistor mount sensors. This compatibility protects your investment capital and makes the migration to the new thermistor power meter much easier. The existing thermistor mount contains data showing the calibration factor (CF) at multiple frequencies, which are traceable to the U.S. National Institute of Standards and Technology (NIST) at the frequencies where NIST provides calibration service. This sensor compatibility accounts for the thermistor power meter being widely used in metrology and calibration lab for instrumentation and system calibration, as well as characterization.



Figure 2. Keysight N432A thermistor power meter supports 478A, 8487B, and X/P/K/R486A thermistor power sensors



## Built-in 6.5 Digit Digital Multimeter

## Reason 2

The legacy 432A thermistor power meters require an external DMM to measure the  $V_{ref}$  and  $V_{comp}$  voltage via the rear panel BNC output of 432A meter. However, this external DMM is only available at an additional cost.

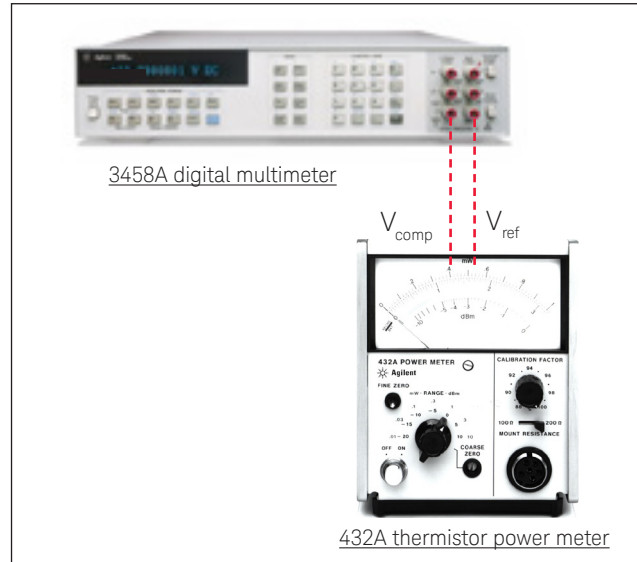


Figure 3. External DMM is required for measuring  $V_{comp}$  and  $V_{ref}$  voltage in 432A meter

The new N432A thermistor power meter is designed with an internal ADC, which is equivalent to a 6.5 DMM. This built-in DMM can measure the  $V_{comp}$  and  $V_{ref}$  internally, without the need for an external DMM. The voltage measurement can display up to six digits. External  $V_{ref}$  &  $V_{comp}$  output (via BNC at rear panel) for higher accuracy measurement can be done via external DMM and is an optional setup.

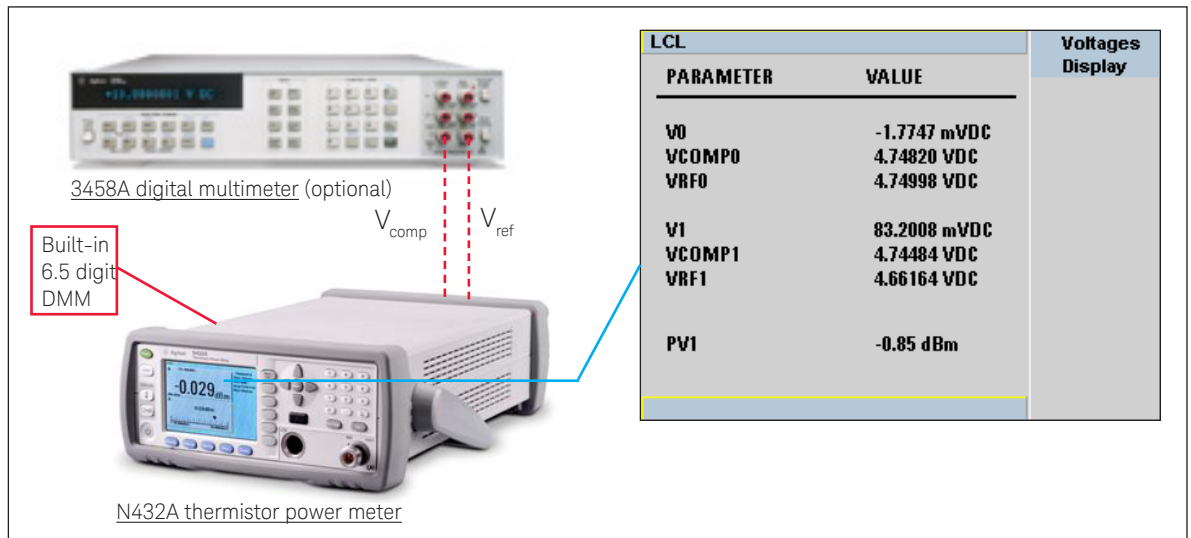


Figure 4. New N432A thermistor power meter provides  $V_{ref}$  and  $V_{comp}$  voltage measurement internally and externally



## User Selectable Operating Resistance Reason 3

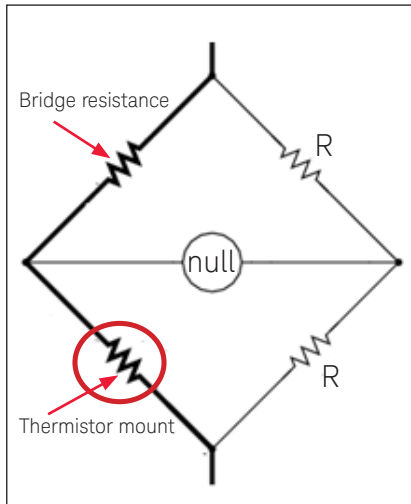


Figure 5. Legacy 432A performance tests with 8477A range calibrator

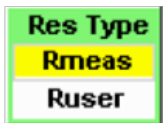


Figure 6. Resistance type pop-up list

### Setting the bridge resistance

A bridge resistance can be set for the thermistor sensor to balance the bridges. There are four selectable bridge resistance values consisting of 100  $\Omega$ , 200  $\Omega$ , 300  $\Omega$ , and 400  $\Omega$ , with 200  $\Omega$  as the default value.

In some applications, such as the Voltage Standing Wave Reflection (VSWR) measurement of a power source/reference, the bridge resistance is switched to have both balanced and unbalanced conditions, so that the VSWR can be measured and calculated. The unbalanced condition occurs when the bridge resistance selected is not the same as the operating thermistor resistance.

The N432A has more flexibility than its predecessor, the 432A, because it has more selections (100  $\Omega$ /200  $\Omega$ /300  $\Omega$ /400  $\Omega$ ) compare to the old model.

### Setting the resistance type

You can select two resistance types (Rmeas or Ruser) where Rmeas is set as default. When you select Rmeas as the resistance type, an externally measured (in factory) bridge resistance value stored in EEPROM will be used. This value corresponds to the current bridge resistance setting, and is not editable via the front panel.

However, you can also measure and input the measured bridge resistance value into the power meter. When the Ruser is selected, you can enter a resistance value to be used in power measurement. The value of Ruser corresponds to the current bridge resistance setting, with a  $\pm 10\%$  tolerance. If a value entered for Ruser exceeds the  $\pm 10\%$  tolerance level of the bridge resistance, the value will be clipped to the upper/lower limit within tolerance.

This flexibility allows you to choose between the default bridge resistance value (stored in EEPROM) and the new bridge resistance value.





## IO Connectivity Remote Interface

### Reason 4

Previously, the legacy 432A/B thermistor power meters were designed without input/output (IO) connectivity or an interface. You could not perform automated testing for any application and thus it is less frequently used in slow performance test. Manual setting via front panel of the 432A/B thermistor power meters required you to understand well the test methodology and procedure to perform the testing and produce the result from time-to-time without any human error.

To sustain the high performance and reproducible measurement outcome, the new N432A introduces USB, LAN, and GPIB IO interface. This allows you to program and configure the measurement setting via SCPI commands using programming language. IVI-COM and IVI-C driver will be provided to function with the N432A thermistor power meter. IVI-COM driver works in any development environment which supports COM programming including Microsoft® Visual Basic, Microsoft Visual C++, Microsoft .NET, Keysight VEE Pro, National Instruments LabView® whereas IVI-C driver will support National Instruments LabWindows/CVI, and any others.

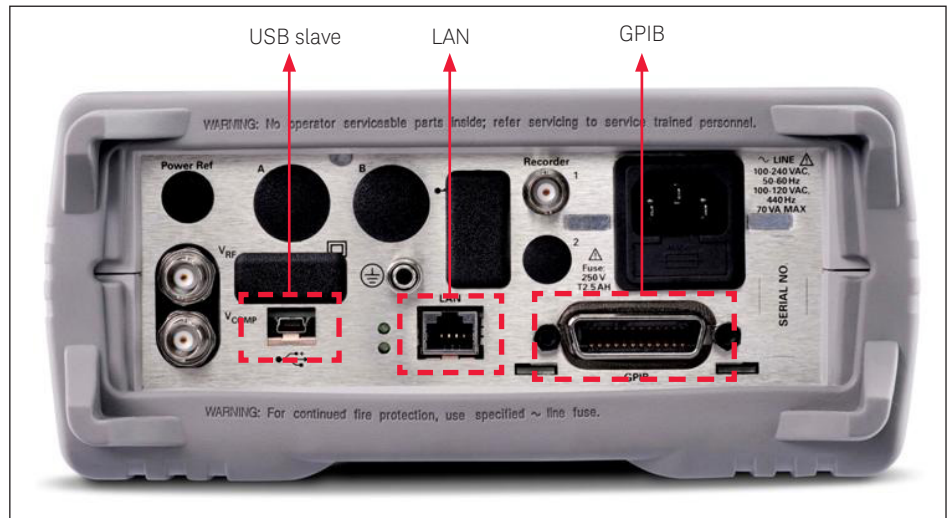


Figure 7. N432A IO connectivity with USB slave, LAN, and GPIB

The USB and LAN interface are growing in popularity as PC interfaces and their use is in line with the direction of other Keysight instruments. The USB 2.0 host interface provides PC connectivity via USB cable. The LAN interface can be configured by users and provides enhanced LXI-Class C compliance. The unrivalled connectivity of USB and LAN enables users to cope with the majority of PC control applications, and allows the test system to be easily integrated into the modern test environment.

The new N432A is a LXI-Class C compliance instrument that combines the advantages of Ethernet with simplicity and familiarity of GPIB. Having a web browser over the LAN connection allows you to view and control the N432A setting remotely (see Figures 3, 4, and 5). The web browser contains key information such as the manufacturer, model number, serial number, description, hostname, MAC address, and IP address.



## IO Connectivity Remote Interface (continued)

## Reason 4 (continued)

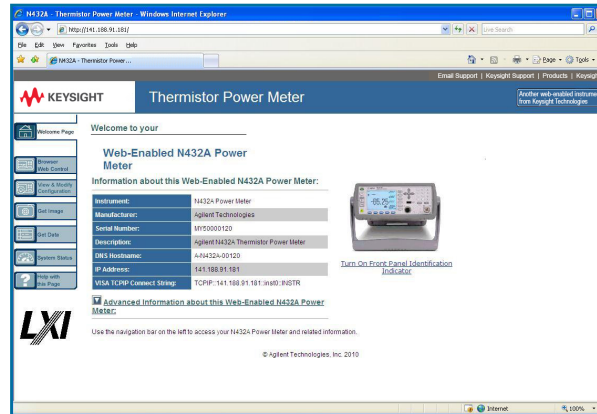


Figure 8. Instrument web browser shows instrument settings at a glance and enables remote access/control

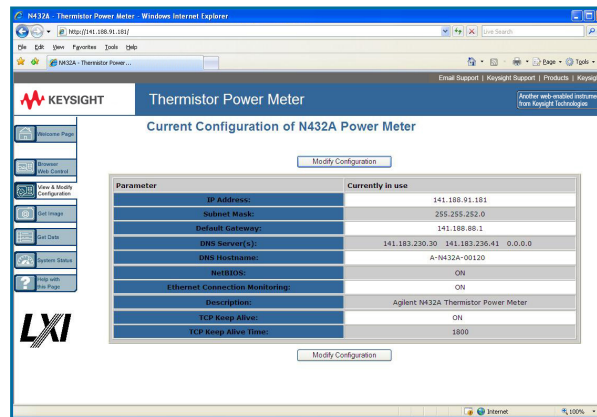


Figure 9. The web browser allows you to view and modify the LAN configuration

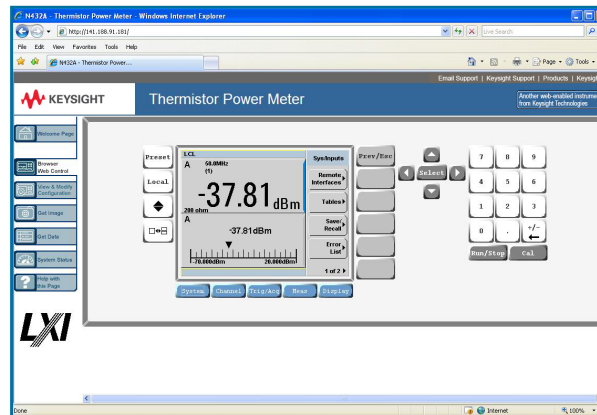


Figure 10. The web browser allows you to access/control the instrument settings remotely before performing any measurements





## Power Sensor Calibration Factor Storage in Power Meter

### Reason 5

The calibration factor is a correction factor that is used to improve the accuracy of power measurements. This factor appears on the thermistor power sensor mount. The calibration factor compensates for thermistor mount VSWR and RF losses whenever the thermistor mount is connected to RF source. With the legacy 432A/B thermistor power meters, you were required to manually set the “Calibration Factors Selector” to the appropriate factor indicated on the thermistor mount before making any measurement. The instrument normalizes the power meter reading to compensate for the calibration factor of a thermistor mount used for a given measurement.

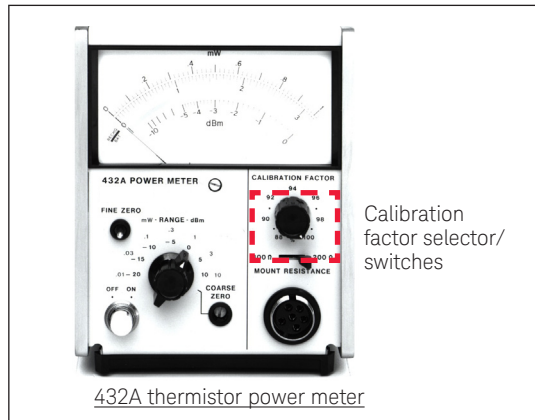


Figure 11. Legacy thermistor power meter with manually calibration factor selector or switches

The new N432A thermistor power meter has a sensor calibration table, which stores the measurement calibration factors for a thermistor mount power sensor. This feature allows you to manually key in the calibration factor into power meter and use the sensor calibration table when making power measurements over a range of frequencies. During the measurement, specify the frequency of signal you want to measure. The calibration factor will be automatically set by the power meter from the sensor calibration table.

You can also create your own custom table for each sensor that you want to use for optimal accuracy.

LCL				Sensor Tbls
Tbl Name	State	Pts		
0	DEFAULT	off	2	Edit Table Table Off On Done 1 of 1
1	478A	on	14	
2	8478B	off	16	
3	CUSTOM_0	off	0	
4	CUSTOM_1	off	0	
5	CUSTOM_2	off	0	
6	CUSTOM_3	off	0	
7	CUSTOM_4	off	0	
8	CUSTOM_5	off	0	
9	CUSTOM_6	off	0	

Figure 12. Calibration factor sensor table selected



## Built-in Range Calibrator Reason 6

The HP/Keysight model 8477A calibrator is a precision instrument designed to calibrate the legacy 432A/B thermistor power meters, and provides verification of full scale meter readings on all range as well as meter tracking. It supplies the two voltages:  $V_{ref}$  and  $V_{comp}$  to verify the operation of the 432A using the internal power bridge circuit with either 100 ohms to 200 ohms thermistor mount resistances. You need to connect the cable between the power meter and calibrator. The CAL ADJ control on the power meter is used to set the meter to full scale on the 1 mW range.

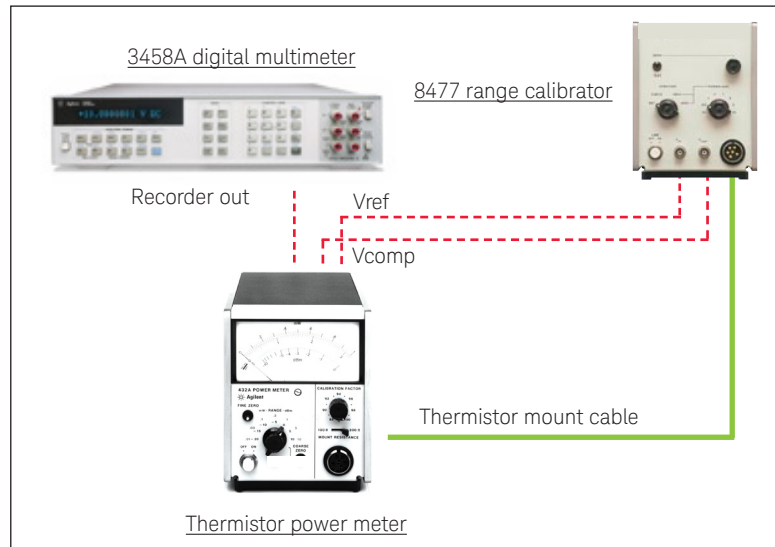


Figure 13. Legacy 432A performance tests with 8477A range calibrator

The new N432A thermistor power meter has a built-in range calibrator DAC source that allows the average paths to be verified with an external DMM. The DAC source balances the DC bridge and uses the external DMM to measure the voltages:  $V_{ref}$  and  $V_{comp}$ . As seen in Figure 14, you can verify the power meter uncertainty with SCPI commands without using the 8477A range calibrator.

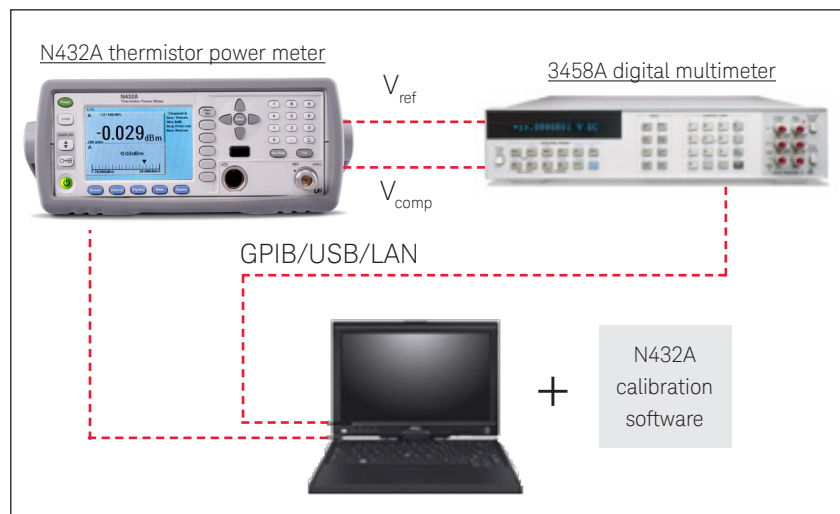


Figure 14. New N432A thermistor power meter with built-in range calibrator inside the meter



## Enhanced User Interface with Numeric Keypad and High Resolution LCD Display

### Reason 7

Changing and controlling the settings via the front panel of the power meter are the most common steps before making a measurement. The new N432A thermistor power meter offers arrow keys and numeric keypad, and allows positioning of the cursor for character selection and editing. The arrow keys are used to navigate around the parameter entry. While the legacy 432A/B thermistor power meters' measurement settings were done via front panel "Selector" or "Switches".

The new N432A thermistor power meter front panel is designed to enhance the view of measurement data and comes with a high-resolution color LCD display. You can view the measurement data in digital numeric and analog format concurrently. Whereas the legacy 432A measurement display is only available in analog, the 432B is in digital format.

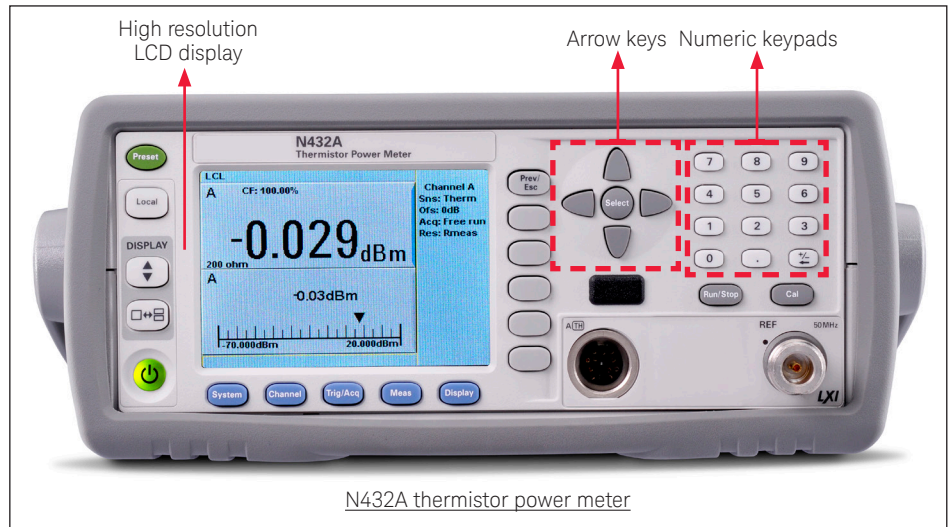


Figure 15. Enhanced user interface with LCD display, arrow keys, and numeric keypad

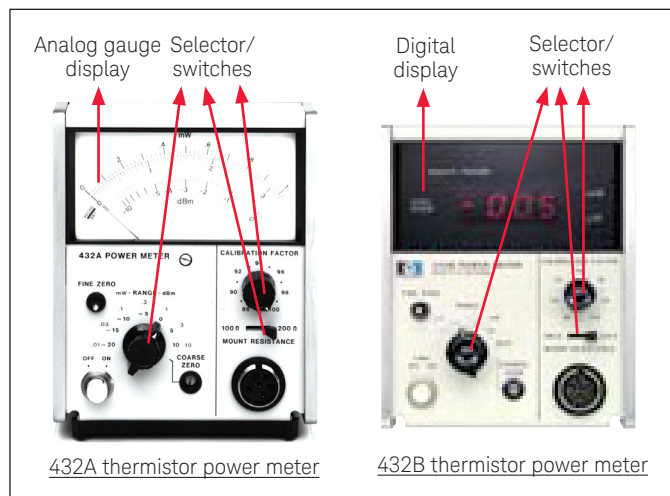


Figure 16. Legacy 432A/B front panel interface with analog/digital display and selector or switches



## Conclusion

Migrating the legacy 432A to the new N432A thermistor power meter is a simple process that has been outlined in this document. Customers will be benefited from the following features added to the new N432A:

- Keysight thermistor mount sensor compatibility with 8478B, 478A, and K/P/R/X486A
- IO connectivity: GPIB, LAN (LXI-C compliance), and USB
- Selectable operating resistance: 100  $\Omega$ , 200  $\Omega$ , 300  $\Omega$  or 400  $\Omega$
- Built-in high accuracy 6.5 digit DMM
- $V_{rf}$  &  $V_{comp}$  internal measurement or external output (through BNC port at rear panel)
- Built-in Test system (BIST) for ADC calibration without external range calibrator
- Enhanced user interface with numeric keypad and high resolution LCD display
- Calibration factor table provided for manual inputs of the thermistor mount calibration factor

## Related Literatures

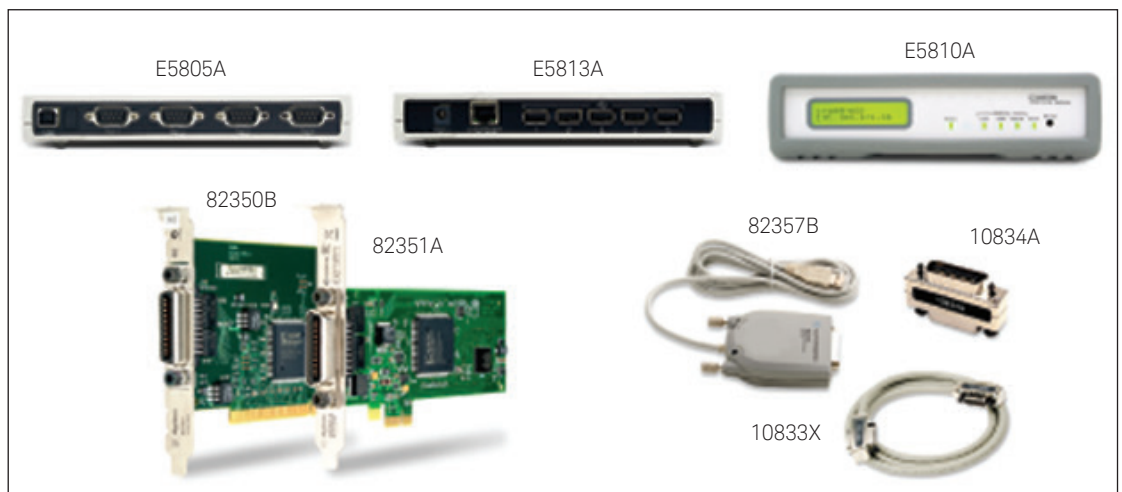
Keysight N432A Thermistor Power Meter, Data Sheet – 5990-5740EN

## Related Link

<http://www.keysight.com/find/powermeters>



## Linking up your instruments to the PC



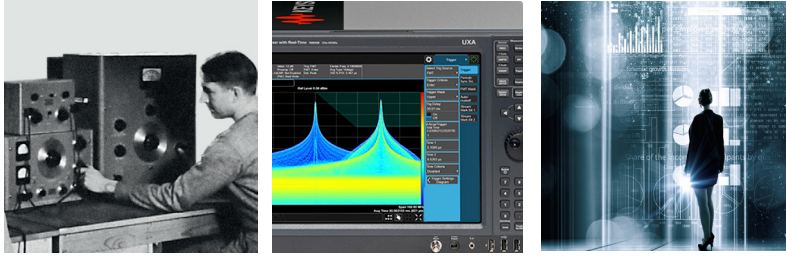
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