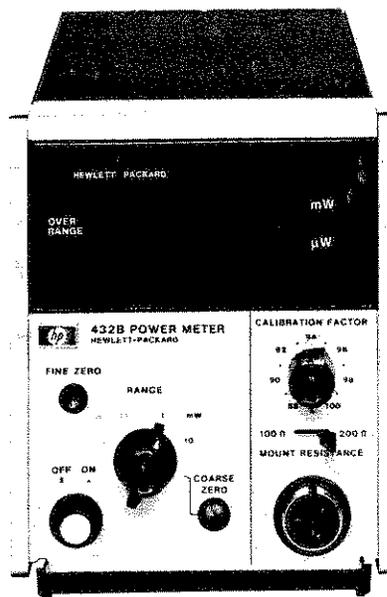


MANUAL SUPPLEMENT

# 432B POWER METER



USE THIS SUPPLEMENT WITH  
MANUAL PART NO. 00432-90009  
PRINTED JUNE 1972



**HEWLETT  
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# 432B POWER METER

## SERIAL NUMBERS

This supplement applies directly to instruments with serial numbers prefixed 2130A.

With changes described after the Replaceable Parts table, this supplement also applies to instruments with serial numbers prefixed 0933A, 1140A, 1141A, 1206A, 1512A, 1528A, 1541A, 1714A, 1736A, 1830A, 1913A and 1930A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY SUPPLEMENT in paragraph 4 of this manual.



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SUPPLEMENT PART NUMBER. 00432-90053  
Microfiche Part No. 00432-90054

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## 1. GENERAL INFORMATION

### 2. Description

3. The Hewlett-Packard Model 432B Power Meter is a digital readout version of the HP Model 432A; the only electrical and mechanical differences between the two instruments are changes that were made to accommodate the Digital Panel Meter Assembly M1.

4. This supplement is intended to be used with the 432A Operating and Service Manual and covers changes necessary to document the 432B. This supplement applies to instruments with the serial number prefix listed on the title page. When the instrument serial number prefix is higher than the prefix listed on the title page, a yellow "Manual Changes" sheet is provided to update the supplement. With the backdating changes described after the Replaceable Parts table, this supplement also applies to instruments with serial number prefixed lower than the prefix listed on the title page.

### 5. Accessories

6. Accessories supplied with, and available for, the 432B Power Meter are the same as those for the 432A.

### 7. Options

8. Options for the 432B are the same as those for the 432A except that Option 001, rechargeable battery, is not available.

## 9. INSTALLATION

10. Installation procedures for the 432B are the same as those for the 432A except for those that deal with internal battery operation.

### NOTE

*The rear panel fuse, F1, is labeled with the international designation mA.T. It means milliamp, slo-blow. A 125 mA.T fuse is the same as an 1/8 A slo-blow.*

## 11. OPERATING INFORMATION

### 12. Introduction

13. The 432B operates the same as the 432A with the following exceptions:

1. No battery operation.
2. Ranges are 10 and 100  $\mu$ W, 1 and 10 mW.
3. Greater meter accuracy (see Table 1).
4. BCD output at rear panel.

### 14. BCD Output

15. J6, on the rear panel, provides a Binary Coded Decimal output that duplicates the reading of the digital panel meter. The information is in an 8421 BCD code (1 = high) and is TTL compatible. "Print" and "Hold" lines are available (see Table 9 and Service Sheet 4). The output is directly com-

Table 1. HP Model 432B Specifications

|  |   |
|--|---|
| <p><b>Instrument Type:</b> Automatic self-balancing power meter for use with temperature-compensated thermistor mounts.</p> <p><b>Power Range:</b> 40 dB with full-scale ranges of 10 and 100 <math>\mu</math>W, 1 and 10 mW.</p> <p><b>Accuracy:</b></p> <p><b>Instrument Uncertainty:</b> <math>\pm 0.5\%</math> on 100 <math>\mu</math>W and 1 and 10 mW ranges, <math>\pm 1.0\%</math> on 10 <math>\mu</math>W range (20° — 30°C).</p> <p><math>\pm 1.5\%</math> max. on all ranges (0 — 55°C) <math>\pm 1.0\%</math> typical.</p> <p><b>Zero Uncertainty:</b> <math>\pm</math> one count on all ranges.</p> <p><b>Noise:</b> Less than 0.25% of full scale peak.</p> <p><b>Response Time:</b> 35 ms time constant at recorder output (typical).</p> | <p><b>Fine Zero:</b> Automatic, operated by front panel switch.</p> <p><b>Zero Carryover:</b> Less than 0.5% of full scale when zeroed on most sensitive range.</p> <p><b>Calibration Factor Control:</b> 13-position switch normalizes meter reading to account for thermistor mount Calibration Factor. Range 100% to 88% in 1% steps.</p> <p><b>Meter:</b> 3 digits with 1 digit overrange. 20% overrange capability on all ranges.</p> <p><b>Power:</b> 115 or 230 Vac <math>\pm 10\%</math>, 50 to 400 Hz, 8W.</p> <p><b>Weight:</b> 3.12 kg (6 lb, 14 oz).</p> <p><b>Dimensions:</b> 295 mm (11-5/8 in.) by 130 mm (5-1/8 in.) by 165 mm (6-1/2 in.).</p> |
|--|---|

patible with an HP 5150A Thermal Printer using an HP 562A-16C interface cable. The "Print" output signifies that data is ready by a transition from a logical 1 (high) to a 0 (low) at J6 pin 48. A logical 0 at J6 pin 47 (the "Hold" input) holds the data from the last full conversion in the output register, while a logical 1 or open circuit allows the register to be updated.

#### NOTE

*The HP 1251-0086 plug (Amphenol and Cinch part number 57-30500-375) mate with the BCD output connector, J6.*

### 16. DIGITAL PANEL METER

17. The Digital Panel Meter Assembly M1, consisting of three separate circuit boards, contains an analog-to-digital converter and a solid state display. Digital panel meters in instruments with serial numbers prefixed below 1930A are self-contained units and are not field repairable. A Digital Panel Meter kit (HP part number 00432-60116) is available for use as a replacement if the self-contained panel meter is found to be defective.

### 18. PRINCIPLES OF OPERATION

19. The 432B is the same as the 432A except that the Digital Panel Meter Assembly M1 accepts the analog information from the Meter Logic Assembly A2. The operation of the Thermistor Bridge Assembly A1 and the Meter Logic Assembly A2 is the same in both instruments. The power supply transformer T1, in the 432B, has additional windings to provide power to the digital panel meter.

20. The Digital Panel Meter Assembly M1 consists of three circuit boards: The Display Assembly (M1A1), the A/D Converter Assembly (M1A2), and the Demultiplexer Assembly (M1A3). The A/D Converter Assembly accepts analog data from the Meter Logic Assembly A2 and converts it to BCD. The Display Assembly provides a visual representation of the BCD digits. The purpose of the Demultiplexer Assembly is to latch the BCD data in a parallel format. This permits the Power Meter to be used with a 5150A Thermal Printer or a computer interface.

21. A/D Converter M1A2U1 samples the analog output from the Meter Logic Assembly A2 and converts it to digital data in a Binary Coded Decimal (BCD) format. BCD data bits from the A/D Converter are applied to the 7-Segment De-

coder M1A2U2. U2 decodes the BCD data to a 7-segment code. The 7-segment code lights the correct LED of the display for decimal digits 0 through 9. The Decoder will not decode binary values greater than 9.

22. Digit Select lines DS1 to 4 from the A/D Converter enable the appropriate display to accept the 7-segment code, lighting the correct LEDs to display the digit. The Digit Select lines also go to the four Demultiplexer Latches M1A3U1 through U4 to clock the BCD bits into the correct D flip-flop for the units, tens, hundreds, and thousands digit. The BCD data then goes through CMOS-TTL buffers to Output Registers M1A3U8 and U9. The digital data from Output Registers is available at rear panel connector J6.

23. A/D Converter M1A2U1 compares the unknown analog voltage  $V_x$  to the reference voltage  $V_{REF}$ . The meter reads full scale when the two voltages are equal. When the analog voltage is less than the voltage reference the meter reads less than full scale.

24. Clock M1A2U3 enables the A/D Converter. The Clock functions as a free running, astable multivibrator. The frequency, which is approximately 80 kHz, is set by R1 and C1.

25. An A/D conversion is completed in approximately 250 ms. An End of Conversion (EOC) pulse is generated at the completion of each conversion and applied to M1A2U7D and M1A2U1 pin 9. The EOC output of the A/D Converter (pin 14) is gated with the output of M1A2U4B at NAND gate M1A2U7D. In local and remote operation, the External Trigger and Hold inputs to the Power Meter are both high. Therefore, the Set input to M1A2U4B (pin 7) is high and the pin 1 output is also high. When a high EOC pulse is combined with the high output of pin 1, the output of NAND gate M1A2U7D is pulsed low for the time the EOC pulse is high. This pulse is inverted by M1A2U7C and applied to CMOS-TTL Buffer M1A2U10. The output of the buffer is a TTL positive pulse that clocks the new power level reading into Output Registers M1A3U8 and U9. The high output of Inverter M1A2U7C is also connected to the Reset of the J/K Flip Flop but has no effect since the Set input remains high, until set low by an external input to pin 47 of J6. When the EOC pulse to the NAND gate goes low, the output of the NAND gate goes high. This output is inverted to low by M1A2U7C until the next A/D conversion is com-

pleted. Therefore, each time the A/D Converter generates an EOC pulse, the power measurement data is clocked into the Output Registers on the low-to-high transition of the pulse. The high-to-low transition of the EOC pulse indicates that data is ready on the "Print" output line, J6 pin 48.

26. The A/D Converter continues to make analog to digital conversions every 250 ms, and to update the display when the Hold input (J6 pin 47) is low. However, when the Hold input is low the power measurement data displayed at the end of each conversion is not clocked into the Output Registers. The data information available at connector J6 is the data clocked into the Output Registers on the first conversion after the Hold input was set low.

27. A low Hold input pulls the Set input to M1A2U4B low. When both the Set and Reset inputs are low the output on pin 1 remains high. When a high EOC pulse is gated with pin 1, the output of NAND gate M1A2U7D is low. M1A2U7C inverts the low level to a high level. The Reset input to the J/K Flip Flop is then high. With the Set input low, the output on pin 1 is switched low. Also, the Reset input is switched back to low. With both the Set and Reset inputs low, the output on pin 1 remains low until the input to the NAND gate changes from a low level to a high level. This transition is accomplished when a high-to-low pulse is applied to the External Trigger (J6 pin 49). The External Trigger pulse pulls the input to Inverter M1A2U7B low; the output of the inverter then goes high. This low-to-high transition gates J/K Flip Flop pin 1 high, enabling the NAND gate on the next EOC pulse from the A/D Converter. At this time, the NAND gate output goes low and is inverted by M1A2U7C. The high output of M1A2U7C resets the output of the J/K Flip Flop until the next pulse on the External Trigger. Data is clocked into the Output Registers on the low-to-high transition of the pulse. The truth table for M1A2U4B is shown below.

| J | K | S | R | Clock(G) | Pin 1         |
|---|---|---|---|----------|---------------|
| x | x | 1 | 0 | x        | 1             |
| x | x | 0 | 1 | x        | 0             |
| 1 | x | 0 | 0 | ↑        | 1             |
| x | 0 | 0 | 0 | ↑        | 1             |
| x | x | 1 | 1 | x        | Indeterminate |

28. The Overrange Logic M1A3U10 decodes the thousands data bit (10<sup>3</sup>) and three of the hundreds data bits (10<sup>2</sup>B, 10<sup>2</sup>C, and 10<sup>2</sup>D). These data bits are the thousand bit 1 and the hundred bits 2, 4, and 8 from Output Register M1A3U8. The thousands bit is ANDed with each of the three hundreds bits to provide a low output on M1A3U10 pin 8. This low output blanks the units, tens and hundreds digits in the overrange condition. The meter overranges when the value in the Output Registers is 1200 or greater. The meter remains in the overrange condition until the reading is less than 1200. The low output of M1A3U10 pin 8 is inverted by M1A2U5D to illuminate Overrange Light DS5. The low output on M1A3U10 pin 8 is gated with the DS1 output from the A/D Converter at NOR gate M1A2U5C. The DS1 output of the A/D Converter clocks the thousand digit into display DS1 and Demultiplexer Latch M1A3U1. When both the overrange bit and the DS1 input to the Blanking Logic NOR gate M1A2U5C are low, the output of the NOR gate is high. The high output is inverted by M1A2U5B for a low G3 input to the 7-Segment Decoder M1A2U2, thus disabling the decoder. The decoder will remain disabled while DS1 is low and blank the display because the units, tens, and hundreds digits will not be decoded. When DS1 goes high for the thousands digit, the 7-Segment Decoder is enabled and the digit is decoded and displayed.

29. The minus sign, located on DS1 of the Display Assembly, lights only when both:

- a. M1A2U1 pin 19 (DS1) is high.
- b. M1A2U1 pin 22 (Q2) is low.

The DS1 line from the A/D Converter must be high to enable display DS1. The logic level on the Q2 line from the A/D Converter determines the polarity of the digits in the display. A low Q2 input to M1A1DS1 pin 4 illuminates the minus sign. A high Q2 input to M1A1DS1 pin 4 indicates positive polarity, but the plus sign does not illuminate.

30. Recorder Output Buffer M1A2U6 prevents a load on Recorder rear panel connector J4 from interfering with the operation of the Meter Assembly.

31. The power supply for M1, located on the M1A3 circuit board, consists of a full-wave bridge rectifier (CR1—4). The +5V supply is filtered by capacitors 2 through 7 and regulated by series regulator U1. The -5V supply is filtered by C1 and regulated by CR5. The power supply is used throughout the meter assembly.

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**PERFORMANCE TESTS**


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**32. PERFORMANCE TESTS**

33. The performance tests are suitable for incoming inspection, periodic evaluation, and troubleshooting. Use the recommended test equipment listed in Table 5-1 of the 432A manual with the following exceptions:

- a. Change the Filter Network (see Figure 1 in this supplement).
- b. Add a Digital Printer with TTL logic levels, +8421 BCD code 4 lines minimum — HP 5150A Thermal Printer with HP 562A-16C interface cable.

34. To test the rear panel BCD output at J6, connect the digital printer to J6 and check that it prints the same digits that appear on the digital panel meter. Before performing the following tests, remove the 432B top cover.

**WARNING**

*Voltages potentially dangerous to life are present at the power supply transformer pins.*

**35. Meter Accuracy Test****SPECIFICATION:****Accuracy:**

**Instrument Uncertainty:**  $\pm 0.5\%$  on 100  $\mu\text{W}$  and 1 and 10 mW ranges,  $\pm 1.0\%$  on 10  $\mu\text{W}$  range ( $20^\circ - 30^\circ\text{C}$ )  
 $\pm 1.5\%$  max. on all ranges ( $0 - 55^\circ\text{C}$ )  $\pm 1.0\%$  typical

**Zero Uncertainty:**  $\pm$  one count on all ranges.

**DESCRIPTION:** Meter accuracy is checked with an 8477A Calibrator. At the same time, RECORDER output is checked with a digital voltmeter.

**EQUIPMENT:**

|                              |           |
|------------------------------|-----------|
| Calibrator . . . . .         | HP 8477A  |
| Digital Voltmeter . . . . .  | HP 3435A  |
| Cable Assembly (2) . . . . . | HP 10503A |
| Cable Assembly . . . . .     | HP 11000A |

**PROCEDURE:**

a. Connect the digital voltmeter and the calibrator to the 432B (see Figure 5-1 in the 432A manual). Set the 8477A Calibrator controls as follows:

|                      |              |
|----------------------|--------------|
| POWER (MW) . . . . . | 0.01 mW      |
| FUNCTION . . . . .   | 200 $\Omega$ |
| ZERO/TEST . . . . .  | ZERO         |

b. Set the 432B controls as follows:

|                              |                  |
|------------------------------|------------------|
| MOUNT RESISTANCE . . . . .   | 200 $\Omega$     |
| RANGE . . . . .              | 10 $\mu\text{W}$ |
| POWER . . . . .              | ON               |
| CALIBRATION FACTOR . . . . . | 100%             |
| A2S1 . . . . .               | CALIBRATE        |

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