HEWLETT PACKARD

TEMPERATURE PROBE

Model 10023A

OPERATING NOTE/JUNE 1980

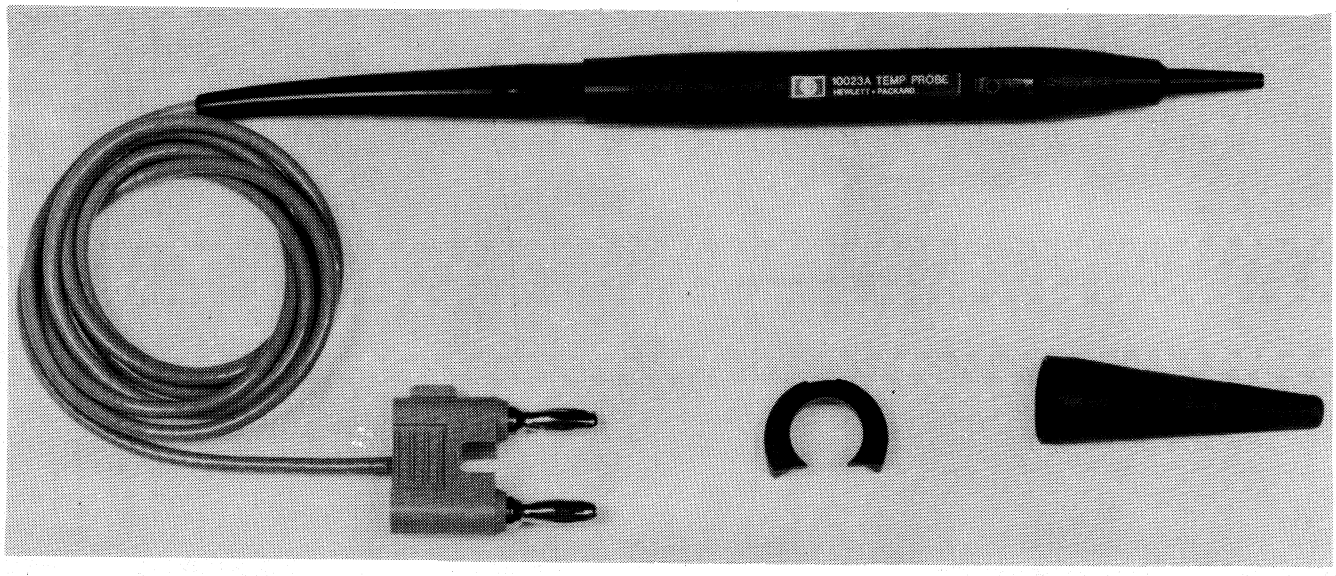

Figure 1. Model 10023A Temperature Probe

1. INTRODUCTION.

2. This operating note provides operating information for the Hewlett-Packard Model 10023A Temperature Probe (figure 1). Probe characteristics are listed in table 1.

3. DESCRIPTION.

4. The 10023A is designed as a diagnostic tool for measurements in circuit design and troubleshooting, estimation of junction temperature and power input in small transistors, and other general purpose surface temperature measurements. The 10023A can be used with any voltmeter having an input impedance of 10MΩ or greater, such as the 1700 series oscilloscope option 034/035 Digital Multimeter. The 10023A thermal characteristics include low thermal loading, high thermal isolation, and a fast response time. This combination provides stable measurements on small electronic components with minimal temperature change of the component being measured and minimal sensitivity to ambient temperatures.

5. The probe tip contains a forward biased diode mounted on a substrate assembly. The probe output voltage (Vo) is 1 mV/°C within the temperature range of —55°C to +150°C. Calibration of each probe is accomplished at the factory by means of a laser trim operation to match each tip diode to its electronic compensating circuit. In case of damage, the probe is easily repaired with a new, precalibrated tip and matching compensating network.

CAUTION

The Model 10023A Temperature Probe is not intended for use as a temperature monitor in environmental test chambers. Using as such may cause degradation of the probe characteristics and performance.

6. The 10023A Temperature Probe is powered by a self-contained, customer replaceable battery that provides 50 hours of continuous probe operation.

7. Accessories supplied with the 10023A are:

a. One replacement battery (HP Part No. 1420-0256).

NOTE

Replacement batteries may be purchased locally using the following part numbers: RAY-O-VAC ®1 No. RS-312-G or T-312-G; DURACELL ®2 No. 10L125;or batteries with similar specifications.

®1 RAY-O-VAC is a registered trademark of ESB, Inc.
®2 DURACELL is a registered trademark of P.R. MALLORY & CO., Inc.

Operating Note Part No. 10023-90901
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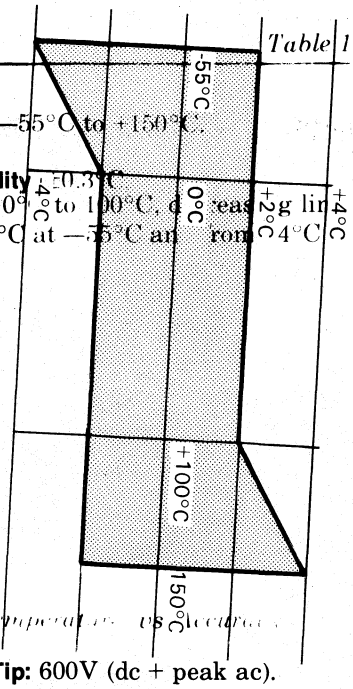
Table 1. Specifications

ELECTRICAL

Measurement Range: —55°C to +150°C.
Output: 1mV/°C.
Short Term Repeatability: ±0.3°C
Accuracy: ±2°C from 0°C to 100°C, decreasing linearly from +2°C to —4°C at —55°C and from +2°C to —4°C at 150°C.



Measured Temperature vs Accuracy

Maximum Voltage at Tip: 600V (dc + peak ac).
Tip Capacitance to Ground: approx 0.5pF.
Thermal Response: <3 sec to settle within 2°C of final reading (liquid measurement) for a 100°C temperature change.
DMM Minimum Input Z: ≥10 megohm

GENERAL

Operating Environment (probe tip to approx 13mm (0.5 in) from probe tip): temperature, —55°C to +150°C; altitude, to 4600 m (15 000 ft); vibration, vibrated in three planes for 15 min. each with 0.38 mm (0.015 in.) excursion, 10 to 55 Hz.
Operating Environment (probe body): temperature, 0°C to 60°C (battery limitation); humidity (non-condensing), to 95% relative humidity at +40°C; altitude, and vibration same as those for probe tip.
Overall Length: approx 1.4 m (53 in.).
Weight: net, 85 g (3 oz); shipping, 312 g (11 oz).
Battery Life: approx 50 hr (varies with ambient temperature).
Low Battery Indication; Probe output indicates approximately —70°C (First indication of a low battery condition is a decreasing probe output of 1 to 2°C/minute with the probe tip subjected to a constant temperature.)

b. One sliding lock collar (HP Part No. 10023-23201) to ensure that the microswitch pushbutton is not depressed during storage or shipment, or to continuously engage the microswitch pushbutton.

c. One probe tip cover (HP Part No. 00547-40005) to protect the probe tip when the probe is not in use.

8. THEORY OF OPERATION.

9. The 10023A temperature sensor is a forward biased diode. The diode is part of a bridge circuit with the balance point set at 0°C. The output voltage (V_0) is 1mV/°C within the temperature range of —55°C to +150°C.

10. The voltage reference (VR1) forms a constant voltage source (see figure 2). All resistors shown in figure 2 are part of the alumina substrate microcircuit with values trimmed by laser operation at the factory. **Therefore, there are no calibration adjustments to be made.** Resistor R4 controls the zero point of the sensing diode and resistor R3 controls the slope. Capacitors C1, C2, and C3 protect VR1 and VR2 against static charges.

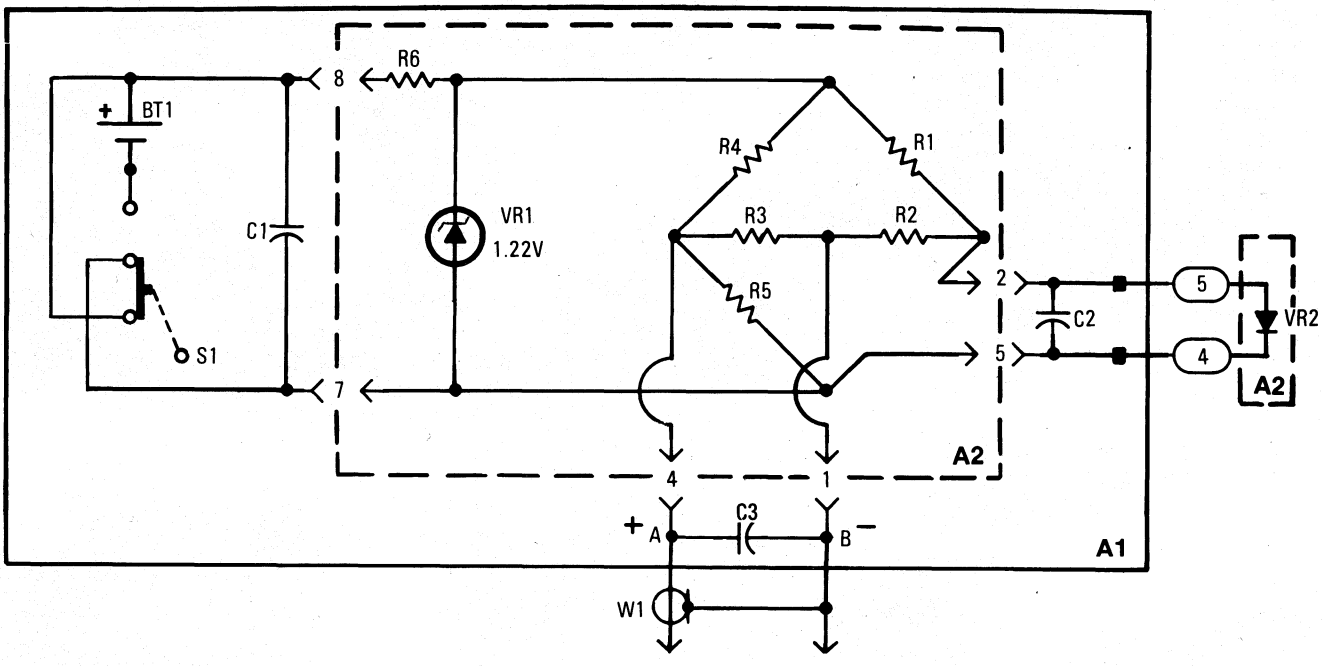


Figure 2. Constant Voltage Source - Probe Tip

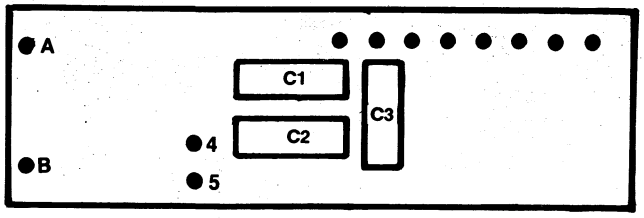


Figure 3. Component Locator

11. OPERATION.

CAUTION

Whenever the temperature probe is not in use, cover the tip with MP1 (PROBE TIP COVER HP Part Number 00574-40005). The temperature probe sensing diode could be damaged by dropping the probe, jarring the probe tip, or from static electricity.

WARNING

Possible SHOCK HAZARD. If the probe tip is damaged, the voltage at the measurement node could be present at the output terminals. Replace the probe tip assembly (A2), if it has been damaged.

12. To operate the 10023A, connect it to the input of a voltmeter having an impedance of 10 megohms or greater. Output from the 10023A will be 1 mV/°C. Select a voltmeter range that keeps the reading on-scale.

13. After connecting the temperature probe to the voltmeter, place probe tip on the surface to be measured. Press the microswitch button on the temperature probe body and read the temperature, (1 mV/°C), from voltmeter indicator. Allow the voltmeter to settle before taking final reading. The highest stabilized reading will be the most accurate.

14. To improve the quality of the measurement, vary the probe angle slightly, from perpendicular, to obtain the best contact with the measurement point. Measurement quality can be further improved by applying a small amount of silicone thermal joint compound applied between the probe tip and the point to be measured.

CAUTION

The 10023A is not intended for liquid temperature measurements except for water or alcohol thermal references. Do not immerse in any liquid past the sealed portion of the probe tip (see figure 4). Avoid contact with plastic solvents, acids and strong salt solutions. Avoid prolonged immersion in any liquid or high heat and humidity environment.

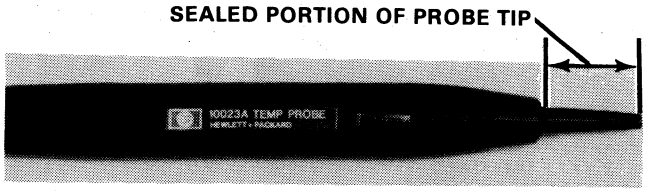


Figure 4. Maximum Liquid Immersion

15. PERFORMANCE CHECK.

16. The accuracy check may be used as a routine maintenance procedure, or as an incoming inspection to verify the performance of the instrument. The accuracy check uses an ice bath and is the same procedure used to calibrate the Quartz Probe used in the performance test. Recommended equipment is listed in Table 2.

Table 2. Recommended Equipment for Performance Check

1 Quart Dewar Flask
Deionized or Distilled Water and Ice
Digital Voltmeter

17. A high quality ice bath prepared with care and using deionized or distilled water and ice will yield an accuracy of ±5m°C. Accuracy is dependent upon water and ice purity and on the technique used in preparation. The ice bath will provide a practical 0°C reference.

18. The ice-bath is prepared as follows:

a. Wash hands thoroughly to remove any salts, then wash Dewar flask if it is dirty.

b. Rinse Dewar flask in deionized or distilled water.

c. Crush as much deionized or distilled ice as needed to pack the Dewar flask full.

d. In a separate container that has been rinsed in deionized or distilled water, mix deionized or distilled water and ice until mixture is precooled to the freezing point.

e. Pour this water into the Dewar flask, filled in step c, until the water level is just below the top of the flask. (Ice should not be floating.)

20. To check temperature probe proceed as follows:

a. Connect 10023A to DVM.

b. Immerse approximately 1/2″ of probe tip into ice bath and stir.

c. DMM reading should stabilize in about 60 seconds.

d. Final reading should be 0°C±2°C.

20. If significant melting has occurred, the bath may be refreshed as follows:

a. Siphon water from the bottom of the Dewar flask.

b. Repack the flask with more crushed deionized or distilled ice.

c. If needed, add more water (as prepared in paragraph 19, step d).

21. PERFORMANCE TEST.

22. For a more accurate and precise method to test the accuracy of the Model 10023A Temperature probe, the following performance test may be used. Required equipment is listed in table 3.

a. Check calibration of Quartz Probe with the ice bath method using deionized or distilled water and ice, as in given procedures in the Model 2804A Operating and Service Manual.

b. Mix bath fluid of 50/50 mixture by volume of ethylene glycol and tap water, and fill bath circulator within 3/4″ from top of circulator. (Extra fluid will be required to keep bath at this level when fluid is circulated through the bath cooler.)

c. Set circulator dial to 0°C and turn power on.

d. Adjust flow to 45 gallons/hour.

e. Set cooling rate switch to maximum.

f. Turn cooler power on.

g. Put Quartz Probe through insulating cover and immerse approximately 1″ of probe tip in bath. (Rubber stopper may be used to hold probe at correct depth.)

h. Set Quartz Thermometer line switch on and resolution to medium.

i. Wait until temperature reaches .05°C, set cooling rate switch to minimum and reduce flow to 15 gallons/hour.

j. Use fine temperature control on bath circulator to stabilize bath temperature at 0°C± .05°C.

k. Connect the 10023A Temperature Probe to DVM. (Set microswitch collar for continuous operation of probe during temperature bath measurements.) See figure 5.

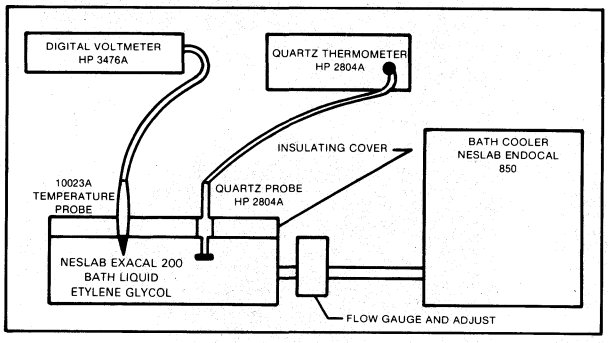


Figure 5. Performance Test Equipment Set-up

l. Put temperature probe through insulating cover and immerse approximately 1/2″ of probe tip into bath.

m. Allow about 60 seconds for DVM reading to stabilize.

Table 3. Required Equipment for Performance Test

Equipment Type	Required Characteristics	Recommended Instrument
Quartz Thermometer	Accuracy ±0.040°C from -50° to +150°	HP 2804A
Quartz Probe		HP 18111A
Bath Circulator	-30°C to +150°C ±0.01°C	Neslab Exacal 200[1]
Bath Cooler	3410 BTU's/hour	Neslab Endocal 850
Insulating Cover	To cover bath and provide holders for the quartz and temperature probes	Styrofoam
Digital Multimeter	input Z ⩽10MΩ	HP 3476A (1700 Series Option 034, 035)
Ethylene Glycol	Antifreeze	
Flow Adjusting Valve and Gauge	0 to 50 gallons/hour water	Brooks-Mite (Brooks Instrument Division)[2]

[1]Neslab Instruments, Inc.; Portsmouth, NH 03801
[2]Brooks Instrument Division Emerson Electric, Hatfield, PA 19440

n. Indicated temperature should be Quartz Thermometer ±2°C. Record reading in table 4.

Table 4. Test Record

Bath Temperature T_B	$T_B \pm 2°C$	DMM Readout
0°	$-2°C \leq T_B \leq +2°C$	
85°C	$83°C \leq T_B \leq 87°C$	

o. Remove 10023A Temperature Probe.

p. Turn bath cooler off and set flow adjustment to zero for a five minute waiting period.

q. Set temperature dial to 85°C.

r. When bath reaches and stabilizes 85°C ± .05°C, repeat steps l through o.

NOTE

Bath fluid at temperatures above 40°C must not be circulated through cooler.

23. BATTERY REPLACEMENT.

24. To replace the 10023A battery, proceed as follows:

a. Remove probe tip cover (MP1) and microswitch collar (MP2).

b. Unscrew plastic nut (MP4) from probe tip.

c. Remove top (MP7) and bottom (MP6) housings by sliding out from hold down collar (MP5).

d. Slide battery insulator (MP3) out from under spring-wire terminal. Battery (BT1) will slide out with insulator.

e. Replace battery.

f. Reassemble by reversing removal procedure.

25. PROBE TIP REPLACEMENT.

26. To replace the probe tip, proceed as follows:

a. Accomplish steps a. through c. in paragraph 24.

b. Gently slide probe tip square pin connectors off pin connectors on P.C. assembly (A1).

c. Remove substrate assembly located on bottom of the P.C. assembly.

d. Replace substrate assembly and probe tip. (Probe tip lead wires are color-coded).

e. Reassemble probe.

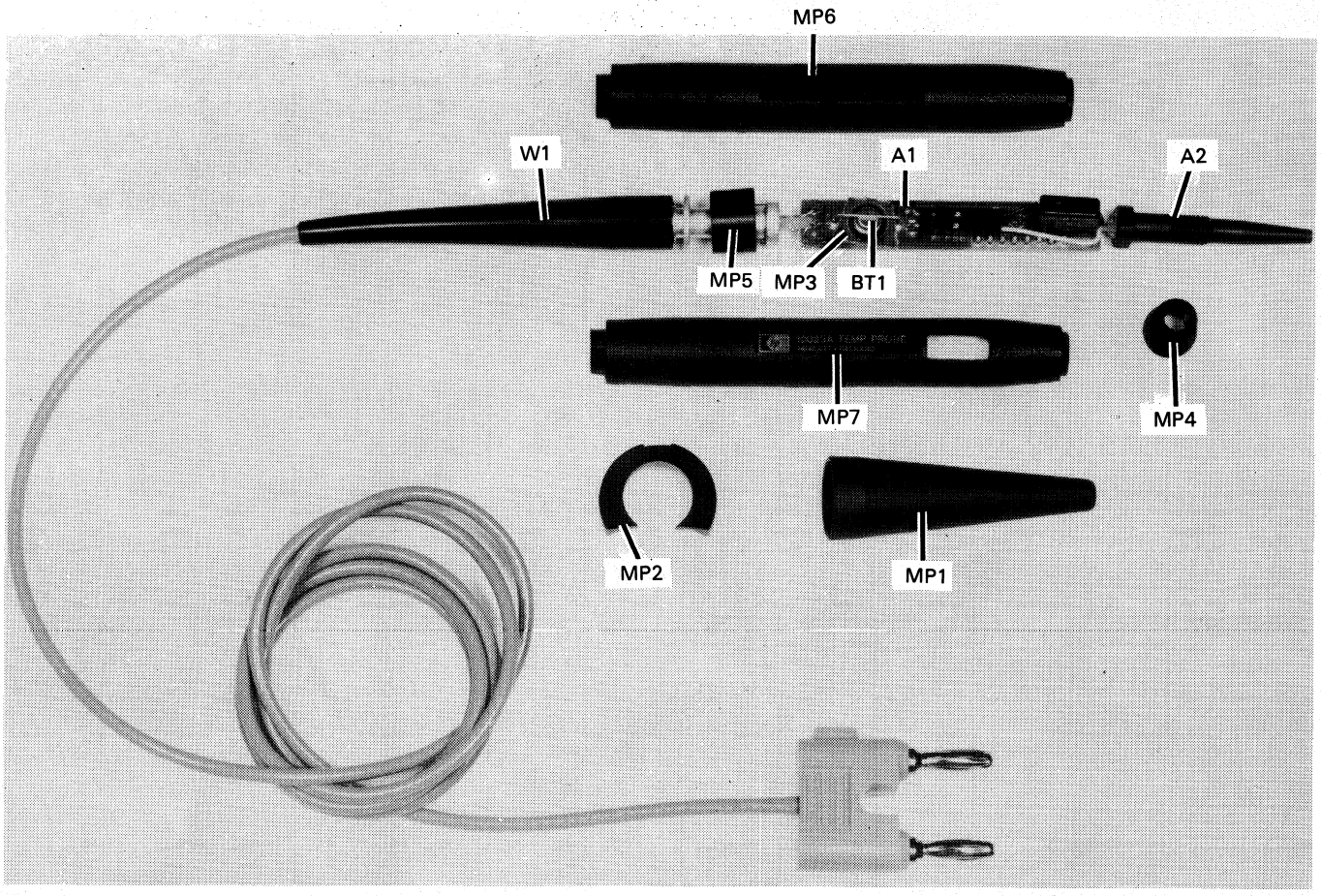


Figure 6. Model 10023A Temperature Probe, Exploded View

Table 5. Replaceable Parts

Reference Designation	HP Part No. and Check Digit		Qty	Description
A1	10023-66502	9	1	ASSEMBLY, PC
A1C1	0180-0472	2	2	C:FXD 1UF +20% 20VDC
A1C2	0180-0472	2		C: FXD 1UF +20% 20VDC
A1C3	0160-3558	9	1	C:FXD .1UF +20% 50VDC
A1S1	3101-1757	5	1	MICROSWITCH
A2	10023-60001	1	1	ASSEMBLY, TIP W/MATCHED RESISTOR SUBSTATE
BT1	1420-0256	1	1	BATTERY
MP1	00574-40005	8	1	COVER, PROBE TIP
MP2	10023-23201	5	1	COLLAR, MICROSWITCH
MP3	10023-25401	1	1	INSULATOR, BATTERY
MP4	10023-25702	5	1	NUT, PLASTIC
MP5	10525-23202	3	1	COLLAR, HOLD DOWN
MP6	10525-40003	8	1	HOUSING, BOTTOM
MP7	10023-42101	7	1	HOUSING, TOP
W1	10023-61601	9	1	CABLE ASSEMBLY, INCLUDES DUAL BANANA PLUG

SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I and the Safety Summary for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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