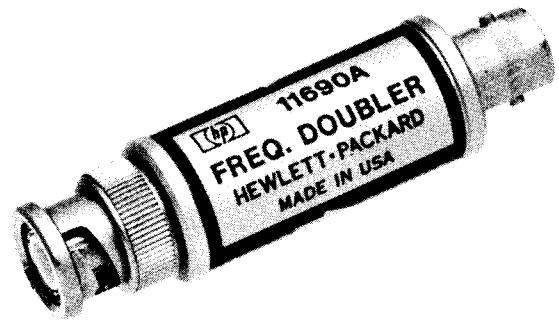


# FREQUENCY DOUBLER

**11690A**



JUNE 1973

HEWLETT  PACKARD

## 1. GENERAL INFORMATION

2. The Hewlett-Packard Model 11690A Frequency Doubler is an accessory for the HP Model 8640A/B Signal Generator. This manual explains how to use the doubler, briefly describes tests that can be used to verify the doubler's specifications, and explains how to repair the doubler.

3. On the rear of this manual, below the manual part number, is a "Microfiche" part number. This number may be used to order a 4-inch by 6-inch microfilm transparency of the manual.

## 4. Specifications

5. The doubler's specifications are listed in Table 1. These specifications are the performance standards, or limits against which the doubler may be tested.

## 6. Description

7. The doubler utilizes a balanced, diode quad to double the frequency of input signals that range from 200 to 550 MHz. The diode quad is a full-wave rectifier that generates a high-amplitude second harmonic while suppressing the fundamental signal.

8. The AM distortion, frequency response, and spurious signals in the doubler's output signal all depend upon the quality of the input signal. For example if the input signal's second harmonic is high, the output signal's fundamental feedthrough (see Figure 2) will be high. Therefore, to fully realize the doubler's specifications, the signal generator used with the doubler must have specifications for AM distortion, harmonic level, and output flatness that are as good as, or better than, the Model 8640A/B.

9. Since the doubler is passive, it needs an input signal level of +10 to +19 dBm. Figure 1 shows typical conversion loss versus input signal level.

10. Amplitude modulation will appear on the output signal with little or no distortion added by the doubler. Frequency modulation, while not distorted, will be changed by the doubler in that the peak deviation of the output signal will be double that of the input signal.

## NOTE

When using the doubler with a Model 8640A/B Signal Generator, set the generator's RANGE control to 512-1024 MHz. The generator's frequency readout and FM deviation readout will then be correctly calibrated for the signal at the doubler's output.

Table 1. Specifications

### SPECIFICATIONS

(All specifications are tested using an 8640A/B Signal Generator. Critical signal generator specifications are harmonics >30 dB down and VSWR <2:1.)

#### Frequency Characteristics:

**Range:** 200 to 550 MHz INPUT  
400 to 1100 MHz OUTPUT

#### Harmonic Suppression: (below level of desired output signal - $f_2$ )

$f_1$  (fundamental input frequency) > 20 dB  
 $f_3$  (3rd harmonic of input) > 25 dB  
 $f_4$  (4th harmonic of input) > 12 dB

#### Level Characteristics:

**Input Power Range:** +10 to +19 dBm  
**Input Power Limit:** +22.5 dBm (180 mW)

**Conversion Loss:** <13 dB

**Flatness:** (with constant input level)  
at +10 dBm input, <4 dB total variation  
at > +13 dBm input, typically <2.5 dB total variation

**VSWR:** input and output typically less than 2:1 in a 50 $\Omega$  system

#### General:

**Temperature Range:** Operating, 0° to 55°C  
Non-operating, -40° to +75°C

**EMI:** meets MIL-I-6181D for interference specification

**Size:** 2½ in.L by 21/32 in. Dia (64 mm x 17 mm)

**Weight:** 2 ounces (56 grams)

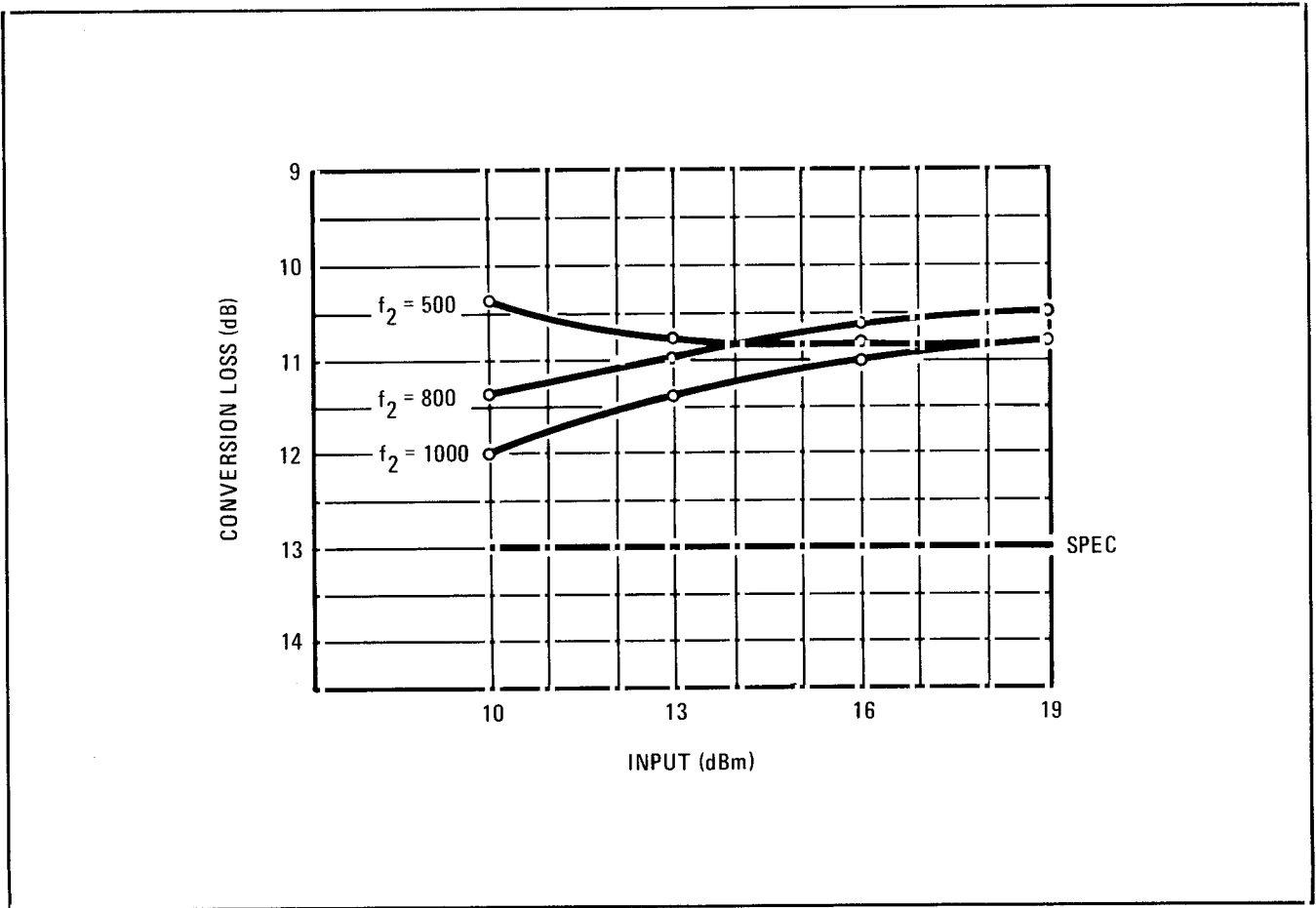


Figure 1. Typical Conversion Loss

## 11. INSTALLATION

### 12. Initial Inspection

13. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged it should be kept until the contents of the shipment have been checked for completeness and the doubler has been checked mechanically and electrically. The contents of the shipment should be as shown on the front cover of this manual, and procedures for checking electrical performance are given under PERFORMANCE TESTS. If the contents are incomplete, if there is mechanical damage or defect, or if the doubler does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for carrier's inspection. The HP office will arrange for repair or replacement without waiting for claim settlement.

## 14. Storage and Shipment

15. **Environment.** The doubler should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

- a. Temperature:  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$
- b. Humidity: <95% relative
- c. Altitude: <25,000 feet

16. **Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the doubler is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the doubler by model number and full serial number.

## 17. Mating Connectors

18. Mating connectors used with the doubler should be 50-ohm BNC connectors.

## 19. OPERATION

### 20. Environment

21. The operating environment should be within the following limitations:

- a. Temperature: 0°C to +55°C
- b. Humidity: <95% relative
- c. Altitude: <15,000 feet

### 22. Operating Instructions

23. Since the doubler is a uni-directional device, the input signal should be applied to the male BNC connector. The input signal should be from +10 to +19 dBm, 200 to 550 MHz.

24. Attenuation pads or a variable attenuator can be used between the doubler and its load to improve the source match and to enable the operator to vary the signal level from the doubler.

### CAUTION

Do not apply more than +22.5 dBm (180 mW) to the doubler.

25. Fundamental feedthrough (see Figure 2) can be reduced if the second harmonic is removed from the doubler's input signal. Use a lowpass filter (between the doubler and the signal source) that attenuates the fundamental signal's second harmonic.

## 26. PERFORMANCE TESTS

27. The specifications in Table 1 can be checked using the signal generator and spectrum analyzer listed in Table 2. Substitute test equipment can be used if its specifications meet or exceed those listed in the table.

28. To check the doubler, set the signal generator for a +10 dBm signal at some frequency ( $f_1$ ) between 200 and 550 MHz. Set the spectrum

analyzer's amplitude controls to measure  $f_1$  at +10 dBm, and set the analyzer's frequency controls to span from  $f_1$  to the fourth harmonic ( $f_4$ ) of  $f_1$ . (40 to 50 dB of input attenuation will be required with most spectrum analyzers.) Connect the signal generator's output to the spectrum analyzer's input and note the level of  $f_1$  on the analyzer's display. Then connect the doubler between the generator and the analyzer.

29. To check conversion loss, compare the level of  $f_2$  now visible on the analyzer's display to the level of  $f_1$  noted above; the difference should be <13 dB. To check harmonic suppression, compare the levels of  $f_1$ ,  $f_3$ , and  $f_4$  now visible on the analyzer's display to the level of  $f_2$  now visible;  $f_1$  should be >20 dB below  $f_2$ ,  $f_3$  should be >25 dB below  $f_2$ , and  $f_4$  should be >12 dB below  $f_2$ .

## 30. ADJUSTMENTS

31. The doubler requires no mechanical or electrical adjustments.

## 32. REPLACEABLE PARTS

33. To order any of the parts listed in Table 3, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

Table 2. Recommended Test Equipment

Instrument	Critical Specifications	Suggested Model
Spectrum Analyzer	Range: 200 to 2200 MHz Amplitude Display Accuracy: $\pm 0.25$ dB/dB but not more than $\pm 1.5$ dB over 70 dB dynamic range Resolution BW: 300 kHz Span Width: 200 MHz/div	HP 141T/8553B/8555A
Signal Generator	Frequency Range: 200 to 550 MHz Harmonics: >30 dB down VSWR: <2:1 Output Level: +10 dBm Output Level Accuracy: $\pm 1.5$ dB	HP 8640A/B

Table 3. Replaceable Parts

Reference Designation	HP Part No.	Qty	Description	Mfr. Code**	Mfr. Part No.
A1	11690-60002	1	FREQUENCY DOUBLER BD ASSY	28480	11690-60002
A1C1	0160-3877	1	C: FXD CER 100 PF 20% 200 VDCW	72982	8121-B227-X7R-101M
A1CR1-4	5080-0271	1	DIODE: SILICON MATCHED QUAD, NSR*	28480	5080-0271
A1L1	9100-2247	1	COIL: FXD RF 0.10 UH 10%	28480	9100-2247
A1R1	0698-7195	1	R: FXD MET FLM 19.6 OHM 2% 1/8W	28480	0698-7195
A1T1	11690-80001	1	TRANSFORMER	28480	11690-80001
A1MP1	3050-0254	1	FIBER WASHER		
A1MP2	10534-4001	1	RUBBER TACK	28480	10534-4001
J1	—	1	PART OF MP1, NSR*		
J2	—	1	PART OF MP1, NSR*		
MP1	10515-2002	1	DOUBLER BODY	28480	10515-2002
MP2	11690-20001	1	DOUBLER HOUSING	28480	11690-20001
MP3	3030-0007	2	SETSCREW, 4 x 40 x 1/8 inch		
MP4	7120-0655	1	LABEL	28480	7120-0655

\* NSR = Not separately replaceable.  
 \*\*Mfr Code: 28480 = Hewlett-Packard Company, Mountain View, California, 94040.  
 72982 = Erie Technical Products, Erie, Pennsylvania, 16512.

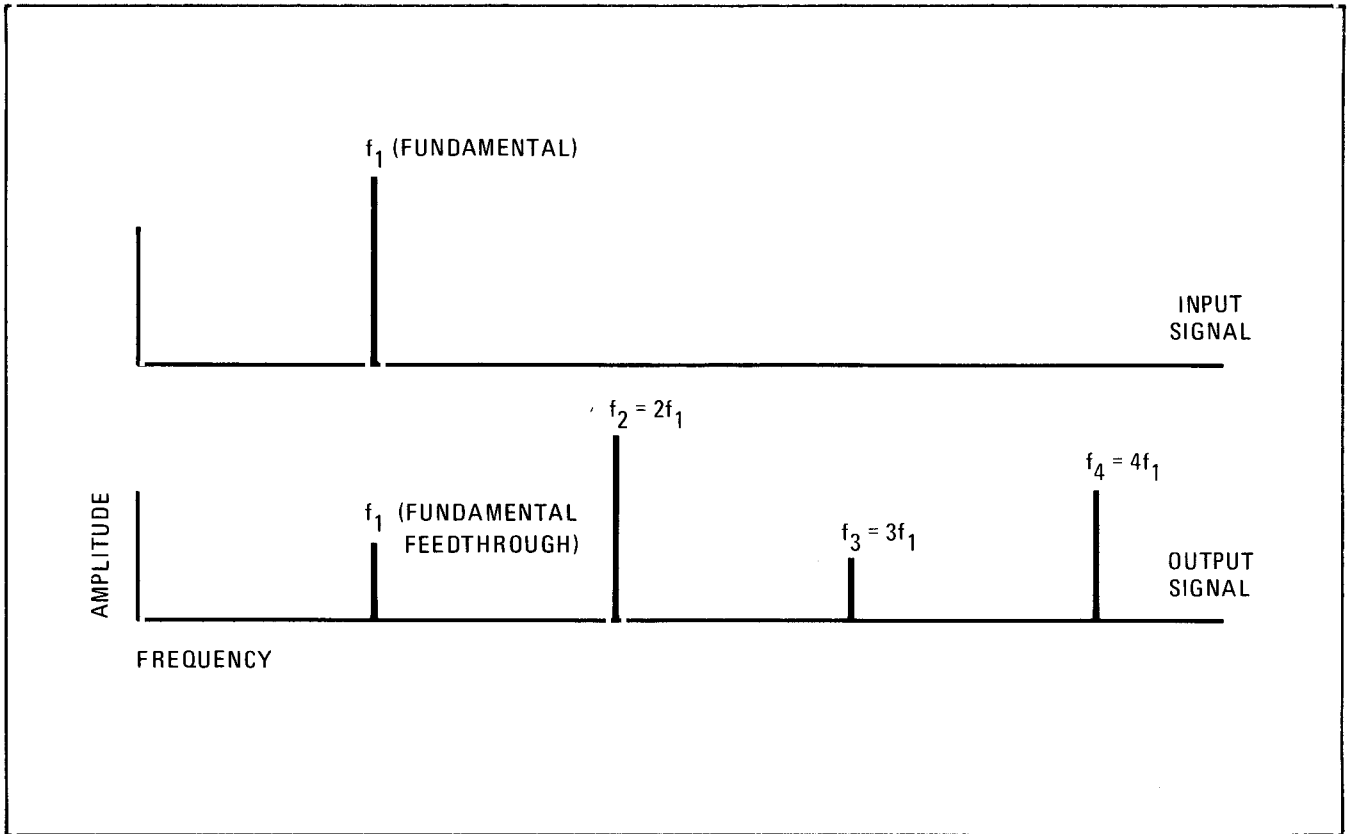


Figure 2. Signals Associated With Doubler

### 34. SERVICE

35. If the doubler's connectors have been damaged or have become worn, or if the doubler won't meet its specifications because one or more of its electrical components have failed, the doubler can be disassembled, the defective part can be replaced, and the doubler can then be reassembled.

### 36. Disassembly

37. Gently peel the label from the doubler housing, taking care not to damage it. Loosen the two setscrews that secure the housing to the doubler body, and remove the housing.

### 38. Troubleshooting

39. Use an ohmmeter to check continuity through the transformer windings (A1T1) and the inductor (A1L1); both should be approximately 0.5 ohms. Also check resistor A1R1. Because of the circuit configuration, A1CR1-4 cannot be checked with an ohmmeter without removing them from the circuit.

### 40. Repair

41. The components on the circuit board can be removed and replaced without removing the board from the body. Use a pencil-type soldering iron rated at 20 watts or less.

#### NOTE

Use silver solder (HP Part Number 8090-0022) on all soldered connections in the doubler.

42. If the circuit board must be removed from the doubler body, heat the soldered connections very slowly to avoid damage to the board. As the solder melts, remove it with a wire brush or some other device.

### 43. Assembly

44. To assemble the doubler, reverse the procedures outlined above. If the circuit board has been removed from the doubler body, be sure to orient it as indicated in the illustrated parts breakdown before soldering it into place. Orient the label so that it indicates that the input port is the male connector.

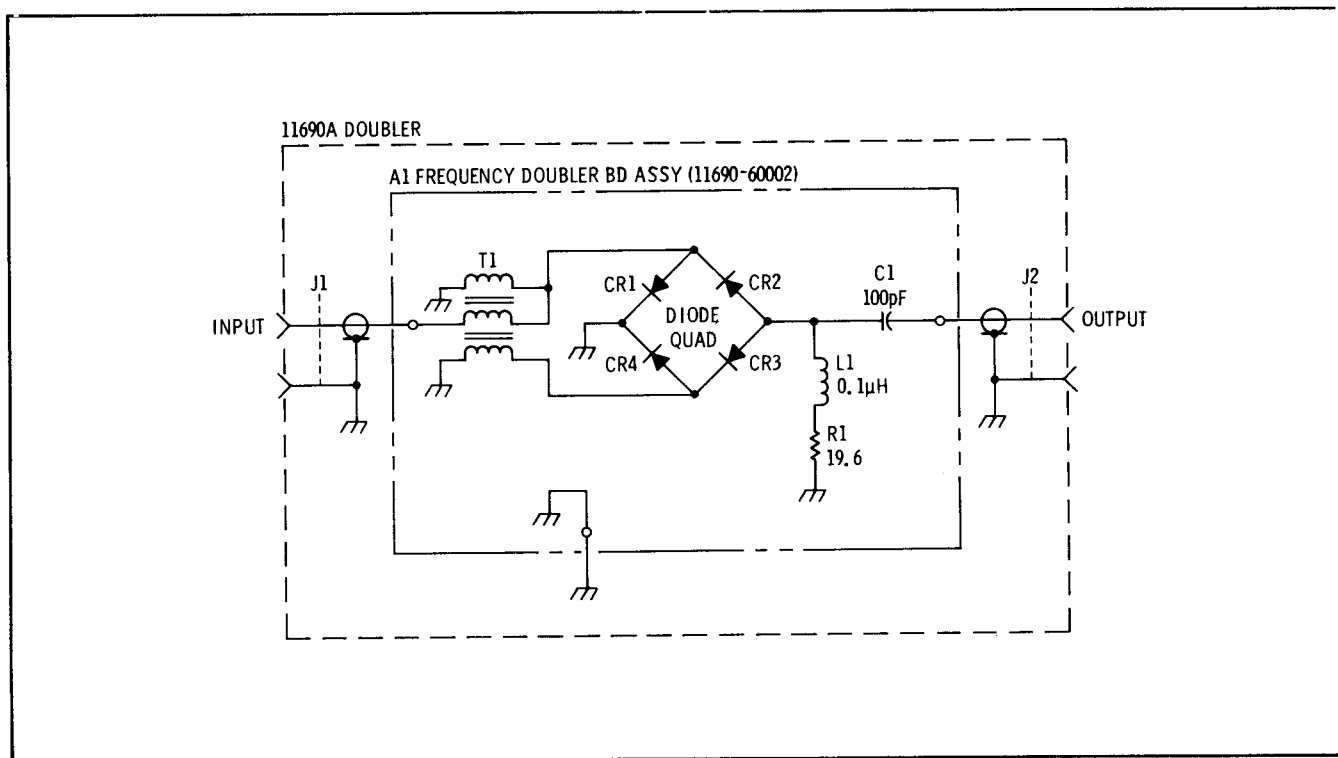


Figure 3. Schematic Diagram

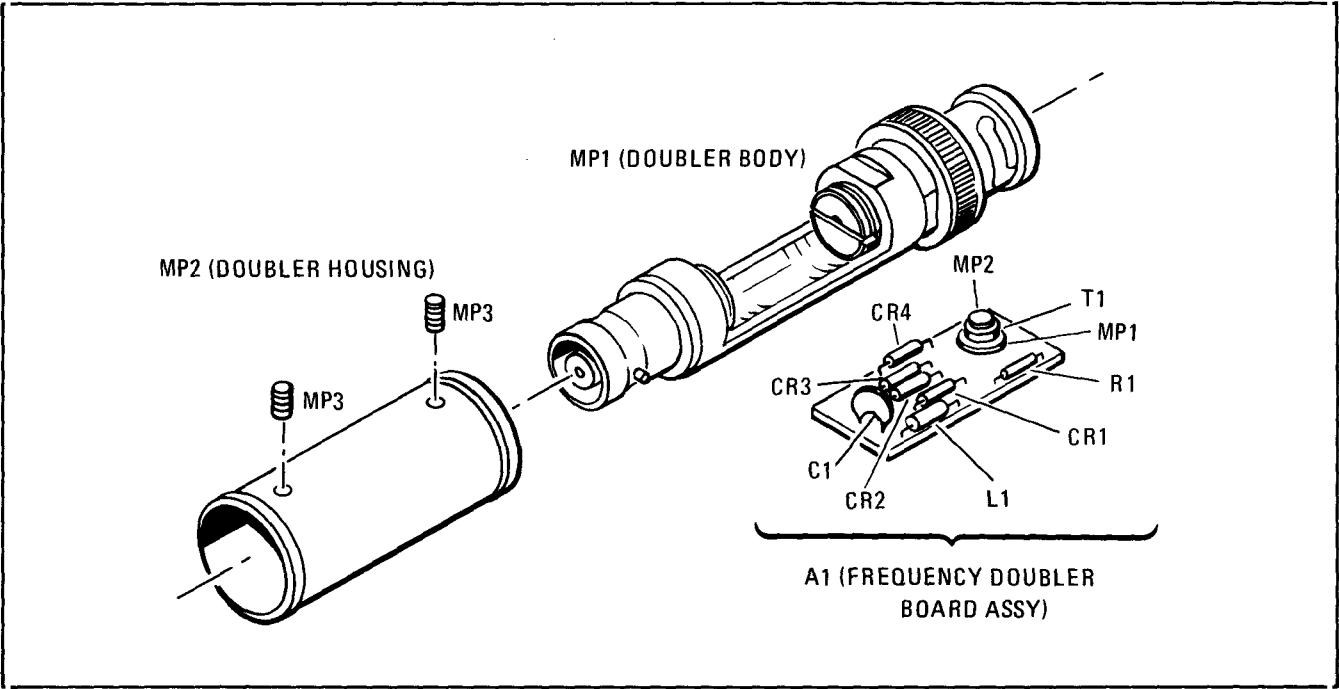


Figure 4. Illustrated Parts Breakdown

## CERTIFICATION

*The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.*

## WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.

## HEWLETT-PACKARD SALES AND SERVICE OFFICES

To obtain servicing information and order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office in HP Catalog, or contact the nearest regional office.

### IN THE UNITED STATES:

#### CALIFORNIA

3939 Lankershim Blvd.  
North Hollywood 91604

#### GEORGIA

P.O. Box 28234  
450 Interstate North  
Atlanta 30328

#### ILLINOIS

5500 Howard Street  
Skokie 60076

#### NEW JERSEY

W. 120 Century Road  
Paramus 07652

### IN CANADA:

#### QUEBEC

Hewlett-Packard (Canada) Ltd.  
275 Hymus Blvd.  
Pointe Claire

### IN EUROPE:

#### SWITZERLAND

Hewlett-Packard (Schweiz) AG  
Rue du Bois-du-Lan 7  
P.O. Box 85  
CH-1217 Meyrin 2 Geneva

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Hewlett-Packard Intercontinental  
3200 Hillview Ave.  
Palo Alto, California 94304

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