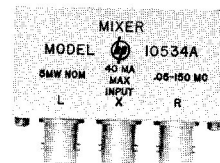


# OPERATING AND SERVICE MANUAL

## MIXERS 10534A/B/C



HEWLETT  PACKARD

## **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**

All Hewlett-Packard products are 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 operating 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. Addresses are provided at the back of this manual.

# MIXERS

## 10534A/B/C

Copyright      HEWLETT-PACKARD COMPANY      1968  
1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

10534-90014

Printed: JAN 1970

HEWLETT  PACKARD

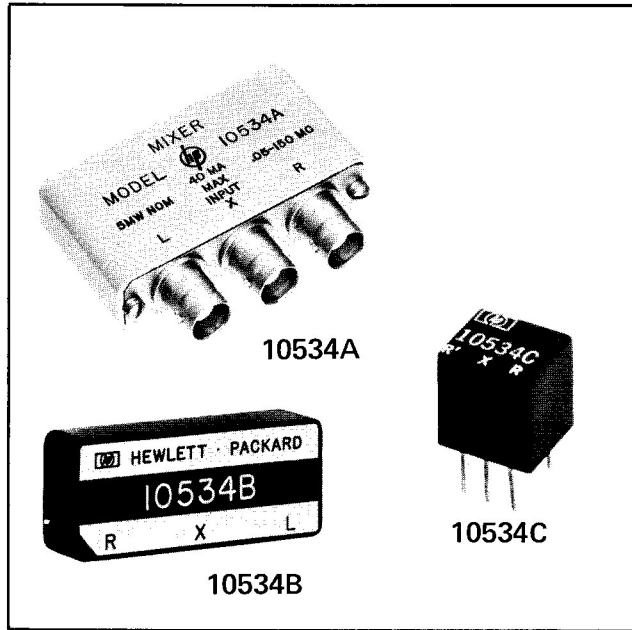


Figure 1. Model 10534A/B/C Mixers

**CAUTION**

Do not apply more than 40 milliamperes peak. Application of more than 40 milliamperes peak or any attempt to open the case and make repairs will void the warranty.

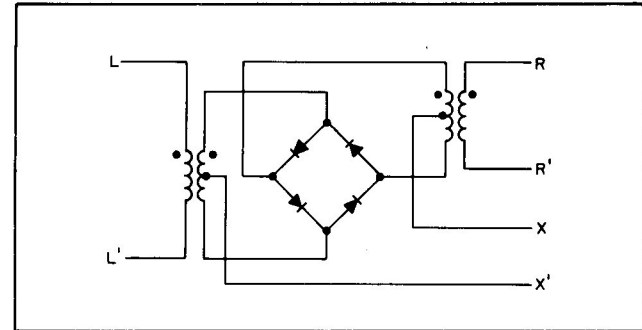


Figure 2. Schematic Diagram

## 1. GENERAL INFORMATION.

2. Hewlett-Packard Model 10534A/B/C Mixers operate between 50 kHz and 150 MHz, with capabilities as a mixer, phase detector, frequency doubler, current-controlled attenuator, balanced modulator, amplitude modulator or pulse modulator. The Mixer is designed for use with 50-ohm systems, but use with a 75-ohm load at the "X" connector should give about the same results. The nominal input level at the "L" connector is 5 mw. Maximum input level at any connector is 40 ma. Mixer operating power is obtained from the input signals. The Mixer is sealed and is not repairable.

## 3. Identification.

4. The three-digit number on each Mixer is a series number, for documentation purposes. The series number identifies a group of instruments and is not unique for any given Mixer within the series.

## 5. Initial Inspection.

6. If shipping package is damaged, ask that carrier's agent be present when package is opened.

Inspect the Mixer for obvious physical damage (dents, scratches, etc.). If the Mixer is damaged or fails to meet specifications, notify carrier and nearest Hewlett-Packard field office immediately. (Field offices are listed at back of this manual.) Retain shipping package and padding material for carrier's inspection. The field office will arrange for replacement of your Mixer without waiting for the claim against the carrier to be settled. The Mixer case is sealed at the factory. Any attempt to open the Mixer case will void the warranty.

## 7. Environment.

8. Mixers type tested to meet specifications as outlined in table of specifications.

9. Temperature during storage and shipment should be limited as follows:

a. Minimum temperature:  $-62^{\circ}\text{C}$  ( $-80^{\circ}\text{F}$ ).

b. Maximum temperature:  $+85^{\circ}\text{C}$  ( $+185^{\circ}\text{F}$ ).

## SPECIFICATIONS

## COMMON SPECIFICATIONS

25°C, 50  $\Omega$  Source and Load Impedances

Input/Output Frequencies: "L" and "R" ports: 50 kHz to 150 MHz; "X" port: dc to 150 MHz.

Maximum Input: 40 mA (damage level).

Impedance: Designed for and specified in a 50  $\Omega$  system.

Mixer Conversion Loss:\*

| Frequency Range       |             | Conversion Loss (dB max.) |
|-----------------------|-------------|---------------------------|
| $f_L$ and $f_R$ (MHz) | $f_X$ (MHz) |                           |
| 0.2 — 35              | dc — 35     | 6.5                       |
| 0.05 — 150            | dc — 150    | 8.0                       |

Noise Performance:\*

| Frequency Range       |             | Noise Figure (dB max.) |
|-----------------------|-------------|------------------------|
| $f_L$ and $f_R$ (MHz) | $f_X$ (MHz) |                        |
| 0.2 — 35              | 0.05 — 35   | 6.5                    |
| 0.1 — 150             | 0.05 — 150  | 8.0                    |

Less than 100 nV per root cycle max. at output for  $f_X$  at 10 Hz.

Typical Conversion Compression: \* By  $f_R$  alone: 0.3 dB for 1 mW level. By  $f_{R2}$  signal presence interfering with  $f_{R1}$  signal: 1 dB for  $f_{R2}$  level of 1 mW, 10 dB for  $f_{R2}$  level of 10 mW ( $f_L$  level at 5 mW).

Internal Interference: \* Typical levels with  $f_L = 5$  mW and  $f_R = 70$  mV.  $f_L = 21$  MHz and  $f_R = 20$  MHz.

| Product                  | Level† | Product       | Level† |
|--------------------------|--------|---------------|--------|
| $2f_L - f_R$             | 40 dB  | $2f_R - f_L$  | 65 dB  |
| $3f_L - 2f_R$            | 65 dB  | $3f_R - 2f_L$ | 65 dB  |
| $4f_L - 3f_R$            | 65 dB  | $4f_R - 3f_L$ | 90 dB  |
| $5f_L - 4f_R$            | 85 dB  | $5f_R - 4f_L$ | 90 dB  |
| $6f_L - 5f_R$            | 90 dB  | $6f_R - 5f_L$ | 95 dB  |
| $7f_L - 6f_R$            | 95 dB  | $7f_R - 6f_L$ | 95 dB  |
| †Referred to $f_X$ level |        |               |        |

Typical Pulse Modulator Performance (pulse input at "X" port, output at "R"):

Rise or Fall Times: A/B 1 ns. C: 2 ns.

\*See Notes/Terminology, page 6

## SPECIFICATIONS (Cont)

Pulse Width: No restriction.

On-Off Ratio: 35 dB.

Saturation Pulse Amplitude: 10 mA with  $f_L = 5$  mW.

Maximum Input: 40 mA damage level.

Modulation Source: Either + or - polarity turns switch on. Amplitude between pulses, within 2 mV of 0V.

Linearity: Output is linear over a 30 dB input current range at 150 MHz; better at lower frequencies.

## INDIVIDUAL SPECIFICATIONS

10534A

Mixer Balance:\*

| Mixer<br>Balance<br>for | In Frequency Ranges (MHz)               |                                            | Refer-<br>enced<br>to |
|-------------------------|-----------------------------------------|--------------------------------------------|-----------------------|
|                         | $f_L, f_R: 0.05 - 35$<br>$f_X: dc - 35$ | $f_L, f_R: 0.035 - 150$<br>$f_X: dc - 150$ |                       |
| $f_L$ at R              | 40 dB                                   | 30 dB                                      | $f_L$                 |
| $f_L$ at X              | 35 dB                                   | 20 dB                                      | $f_L$                 |
| $f_R$ at L              | 40 dB                                   | 30 dB                                      | $f_R$                 |

| Mixer<br>Balance<br>for | In Frequency Ranges (MHz)               |                                            | Refer-<br>enced<br>to |
|-------------------------|-----------------------------------------|--------------------------------------------|-----------------------|
|                         | $f_L, f_R: 0.05 - 35$<br>$f_X: dc - 35$ | $f_L, f_R: 0.035 - 150$<br>$f_X: dc - 150$ |                       |
| $f_R$ at X              | 20 dB                                   | 15 dB                                      | $f_R$                 |
| $f_X$ at L              | 35 dB                                   | 20 dB                                      | $f_X$                 |
| $f_X$ at R              | 20 dB                                   | 12 dB                                      | $f_X$                 |

Connectors: Female BNC.

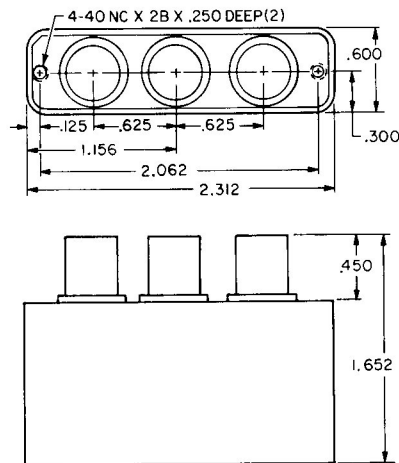
Environmental: Type tested to meet its specifications over  $-28^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$  and through five cycles of  $50^{\circ}\text{C}$  and 95% humidity. Compliance with the rigid MIL-I-6181D RFI specification has been demonstrated. Non-operating tests include  $-54^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$  exposure; vibration to 500 Hz  $\pm 10$  g's; 100 g's in each plane and altitude to 50,000 feet.

Weight: 2.1 ounces (59 grams).

\* See Notes/Terminology, page 6.

## SPECIFICATIONS (Cont)

## Dimensions:



\*See Notes/Terminology, page 6.

## 10534B

## Mixer Balance:\*

| Mixer<br>Balance<br>for | In Frequency Ranges (MHz)                 |                                              | Refer-<br>enced<br>to |
|-------------------------|-------------------------------------------|----------------------------------------------|-----------------------|
|                         | $f_L, f_R$ : 0.05 - 35<br>$f_X$ : dc - 35 | $f_L, f_R$ : 0.035 - 150<br>$f_X$ : dc - 150 |                       |
| $f_L$ at R              | 40 dB                                     | 30 dB                                        | $f_L$                 |
| $f_L$ at X              | 35 dB                                     | 20 dB                                        | $f_L$                 |
| $f_R$ at L              | 40 dB                                     | 30 dB                                        | $f_R$                 |
| $f_R$ at X              | 20 dB                                     | 15 dB                                        | $f_R$                 |
| $f_X$ at L              | 35 dB                                     | 20 dB                                        | $f_X$                 |
| $f_X$ at R              | 20 dB                                     | 12 dB                                        | $f_X$                 |

Connectors: 0.040-inch pins for printed circuit board mounting.

Environmental: Type tested to meet environmental specifications of MIL-E-16400F Class 1; MIL-T-21200 Class 1; and MIL-5400K Class 2. Conditions include: non-operating temp.  $-62^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ; operating temp.  $-54^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ ; humidity 95% at  $+65^{\circ}\text{C}$ ;

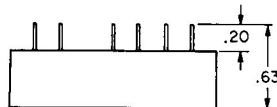
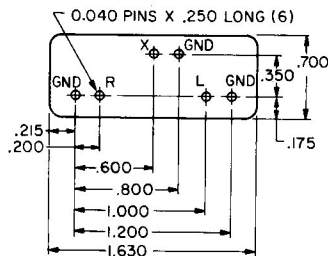
## SPECIFICATIONS (Cont)

vibration to 500 Hz to 10 g's; shock simulated hammer test 1500 g's; operating altitude 50,000 feet. Not designed to meet RFI requirements since it is usually contained in other equipment.

**Lead Temperature (During soldering):** 265°C (509°F) max. at distances greater than 1/32 inch from seating surface for 10 seconds max.

**Weight:** 0.5 oz. (14 grams).

**Dimensions:**



\*See Notes/Terminology, page 6.

## 10534C Mixer Balance:\*

| Mixer<br>Balance<br>for | In Frequency Ranges (MHz)                 |                                              | Refer-<br>enced<br>to |
|-------------------------|-------------------------------------------|----------------------------------------------|-----------------------|
|                         | $f_L, f_R$ : 0.05 - 35<br>$f_X$ : dc - 35 | $f_L, f_R$ : 0.035 - 150<br>$f_X$ : dc - 150 |                       |
| $f_L$ at R              | 35 dB                                     | 25 dB                                        | $f_L$                 |
| $f_L$ at X              | 35 dB                                     | 25 dB                                        | $f_L$                 |
| $f_R$ at L              | 35 dB                                     | 25 dB                                        | $f_R$                 |
| $f_R$ at X              | 20 dB                                     | 15 dB                                        | $f_R$                 |
| $f_X$ at L              | 35 dB                                     | 25 dB                                        | $f_X$                 |
| $f_X$ at R              | 20 dB                                     | 12 dB                                        | $f_X$                 |

**Connectors:** 0.009 x 0.020-inch leads for printed circuit board mounting.

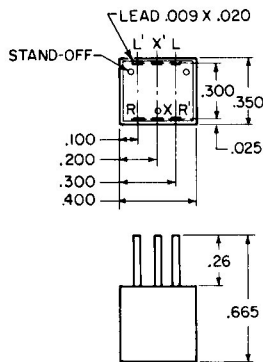
**Environmental:** Type tested to meet environmental specifications of MIL-E-16400F Class 1; MIL-T-21200 Class 1; and MIL-5400K Class 2. Conditions include: non-operating temp. -62°C to +85°C; operating temp. -54°C to +75°C; humidity 95% at +65°C;

## SPECIFICATIONS (Cont)

vibration to 500 Hz to 10 g's; shock simulated hammer test 1500 g's; operating altitude 50,000 feet.  
**Lead Temperature (During soldering):** 265°C (509°F)  
 max. at distances greater than 1/32 inch from seating surface for 10 seconds max.

**Weight:** 0.053 oz (1.5 grams).

**Dimensions:**



## NOTES/TERMINOLOGY:

**Impedance:** The performance of the 10534 is specified for 50  $\Omega$  source and load impedances. The mixers also work well at other impedance levels, including both 75  $\Omega$  and 93  $\Omega$ .

**Conversion Loss:** Conversion loss is the power ratio between the available input power at the "R" port and the power delivered in one of the output sidebands ("L" input = +7 dBm). Conversion loss is not strongly dependent on the available power at the "L" port when this is above 0 dBm.

**Noise Performance:** For difference frequencies above 50 kHz, noise performance is specified in terms of the relative signal-to-noise ratios at the "R" and "X" ports (i.e., noise figure). The low frequency (1/f) noise contributed by the mixer is specified by the rms noise voltage at the "X" port in a 1 Hz bandwidth centered at 10 Hz.

**Conversion Compression:** Conversion compression describes the increase in conversion loss that occurs as the input to the "R" port is increased in level. "Com-

## SPECIFICATIONS (Cont)

pression by  $f_R$  alone" implies that  $f_R$  is a single frequency input. "Compression by  $f_{R2}$  interfering with  $f_{R1}$ " describes the decrease in  $f_L \pm f_{R1}$  as  $f_{R2}$  is increased in level.

**Internal Interference:** Ideally a mixer produces only sum and difference frequencies of the local oscillator and receive frequencies. Internal interference refers to the higher order mixing products generated when single frequency inputs are impressed in "R" and "L" ports.

**Balance:** A double balanced mixer suppresses the "R" port signal appearing at both "L" and "X" ports. Similarly the "L" port signal is suppressed at both "R" and "X" ports. In addition, when used as a modulator, the "X" port signal is suppressed at both "L" and "R" ports. The balance specification describes how effective this suppression actually is.

### 10. Permanent Mounting.

11. The 10534A Mixer may be mounted on a panel as part of a permanent system as follows:

- a. Cut opening in panel for connectors.
- b. Drill two #33 holes (or notch opening to 2.062 inches apart for mounting screws.
- c. Remove two allen-drive screws on connector side of Mixer case. (Removing these screws does not allow the Mixer case to be opened.)
- d. Mount Mixer on panel. Use two 4-40 screws, 1/4-inch longer than the panel thickness.

## 12. OPERATION.

13. The Mixers are designed for use in 50-ohm systems; but use with a 75-ohm load at the "X" connector should give about the same results. Connections for various applications are given in Paragraphs 14 through 26.

### 14. Mixer.

- a. Connect one input signal, 50 kHz to 150 MHz, 5 mw (0.5 Vrms into 50 ohms) to L.

b. Connect second input signal, 50 kHz to 105 MHz, 1 mw or less (0.22 Vrms into 50 ohms) to R.

c. Output (sum and difference frequencies of L and R inputs, dc to 150 MHz) is available at X.

d. The load at X should present an impedance of 50 ohms at  $f_X$ .

e. Conversion efficiency is the ratio of power in one output sideband to the power available at R. Figure 3 represents the conversion efficiency as a function of the available power at L, of a typical Model 10534A/B/C Mixer used as a mixer (Paragraph 14) or phase detector (Paragraph 15). Input signals at L and R are 1 MHz, with the signal level at R maintained at 10 mv. Note that the conversion efficiency decreases sharply as power available at L is reduced below 0 dBm.

f. Figure 4 represents the conversion loss of a typical Model 10534A/B/C Mixer used as a mixer

(Paragraph 14) or phase detector (Paragraph 15). The lower frequency input is +7 dBm at L and the higher frequency input is -3 dBm at R. Response

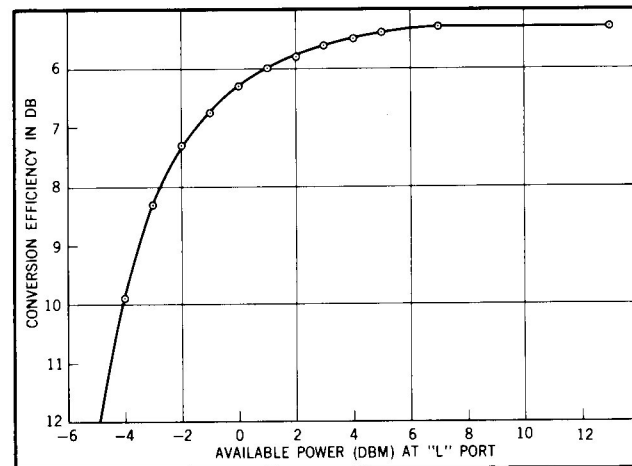


Figure 3. Conversion Efficiency

near the -3 dB points can be improved about 0.5 dB by increasing the signal at L a few dB (20 mw maximum input signal).

### 15. Phase Detector.

a. Connect as for mixer (Paragraph 14). Input signals must be same frequency.

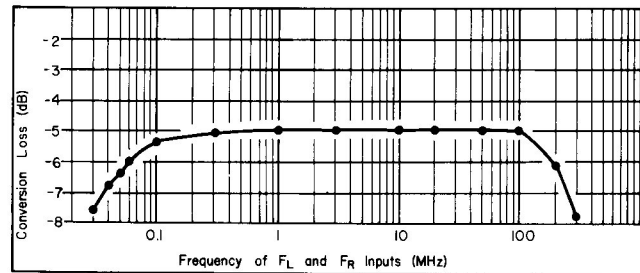


Figure 4. Frequency Response of Conversion Loss

b. Measure dc output from X. Output will be near zero when signals are 90 degrees out of phase; maximum when signals are in phase or 180 degrees out of phase.

c. The dc load on X may be a high impedance, but the ac load at X should be 50 ohms or less for the input frequency at L and R.

### 16. Frequency Doubler.

a. Connect same signal to L and R inputs with equal length lines from a Tee connection.

b. Take rf output from X, terminated with a 50-ohm resistive load.

### 17. Current-Controlled Attenuator.

a. Connect series current limiting resistor at X. In calculating the value of this resistor, assume that the resistance at X is zero and the resistor must limit current to 40 mA at maximum possible

supply voltage. (The discharge of a power supply output filter capacitor, or the capacitance of a length of coaxial cable can cause a 40 mA peak current through the diodes, if the resistor is not in place.) Table 1 lists the appropriate minimum resistance values for power supply voltages from 1 volt to 500 volts. Current limiting resistors are needed for any source voltage above 0.5-volt peak.

b. Connect dc control source through current limiting resistor to X.

c. Connect rf input signal, 50 kHz to 150 MHz, 5 mw (0.5 Vrms into 50 ohms) to L.

d. Take rf signal output from R.

18. Figure 5 shows attenuation and relative harmonic levels characteristic of a typical Model 10534A Mixer when used as a current-controlled attenuator. In this example input signals are 30 MHz at +0 dBm at L and 0 to 40 ma dc control current at X.

Table 1. Current Limiting Resistors

| Voltage   | Minimum Resistance |
|-----------|--------------------|
| 1 volt    | 27 ohms            |
| 5 volts   | 150 ohms           |
| 10 volts  | 270 ohms           |
| 50 volts  | 1500 ohms          |
| 100 volts | 2700 ohms          |
| 500 volts | 15K ohms           |

## 19. Balanced Modulator.

a. Connect rf input signal, 50 kHz to 150 MHz, 5 mw (0.5 Vrms into 50 ohms) to L.

b. Connect modulating signal (dc to 150 MHz) through current limiting resistor (described in Paragraph 17a) to X.

c. Output modulation product of L and X inputs (above 50 kHz) is available at R. This out-

put consists of sidebands displaced plus and minus the modulation frequency away from the carrier (rf input) frequency. The carrier (rf input) is suppressed.

20. Figure 6 shows the output of a typical HP Model 10534A Mixer when used as a balanced modulator, displayed on a HP Model 851/8552

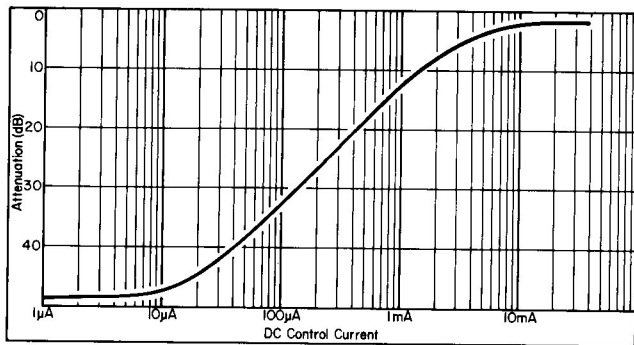


Figure 5. Typical Attenuation

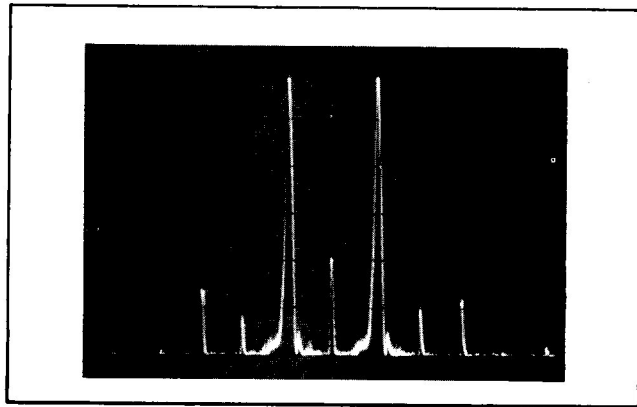


Figure 6. Balanced Modulator Output

Spectrum Analyzer. A 30 MHz signal is being modulated by a 1 MHz signal. Vertical scale is 10 dB/cm. Horizontal scale is 1 MHz/cm. The 30 MHz signal is centered on the display and is shown to be about 40 dB down from the sideband output.

## 21. Amplitude Modulator.

- a. Connect rf input signal, 50 kHz to 150 MHz, 5 mw (0.5 Vrms into 50 ohms) to L.
- b. Connect modulating signal (dc to 150 MHz) to X.
- c. Connect dc control current through current limiting resistor (described in Paragraph 17a) to X.
- d. For 100% modulation, modulating signal should be approximately 150 mVrms and dc control current should be approximately 4 ma. (These are typical values.)
- e. Take modulated signal output (above 50 kHz) from R.

22. Figure 7 is the presentation on a dual-trace oscilloscope of the output of a typical Model 10534A Mixer used as an amplitude modulator. Upper trace is modulating waveform. Lower trace is output of Mixer. In this case, the carrier was

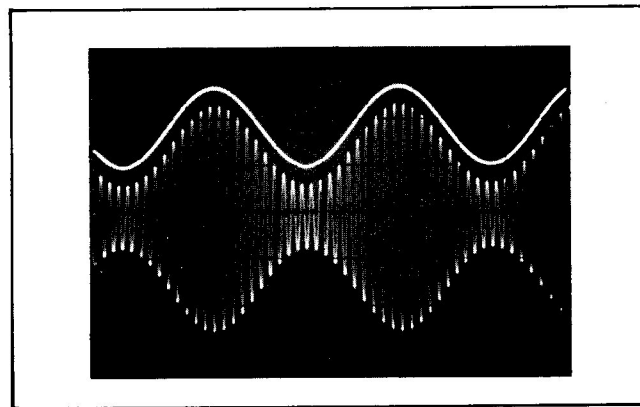


Figure 7. Amplitude Modulator Output

reinserted at the balanced modulation output to obtain ordinary amplitude modulation. However, ordinary modulation could also be obtained by applying a dc current with the modulating signal, as described in Paragraph 21c.

### 23. Pulse Modulation.

a. Connect rf input signal, 50 kHz to 150 MHz, 5 mw (0.5 Vrms into 50 ohms) to L.

b. Connect modulating signal through current limiting resistor if necessary (described in Paragraph 17a) (pulse, 0 ma = off, 10 ma = saturated on) to X.

c. Take modulated signal output (above 50 kHz) from R.

24. Figure 8 shows the output of a typical Model 10534A Mixer used as a pulse modulator. Input signals to the Mixer are 30 MHz, 5 mw at L and pulses 0.165  $\mu$ sec wide, 300 mv high, repetition rate 1 MHz at X. The oscilloscope presentation, Figure 8a, is made with a sweep speed of 0.02  $\mu$ sec/cm and shows the clean rf pulses obtainable. The spectrum analyzer display, Figure 8b, presents the pulse modulator output on a log vertical scale

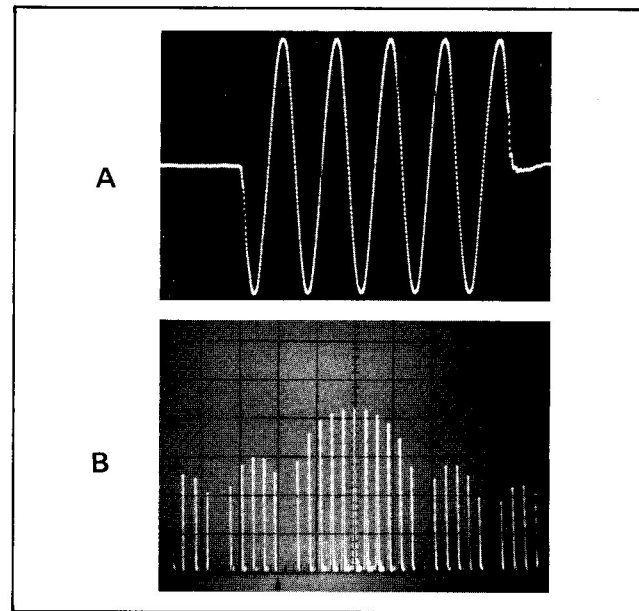


Figure 8. Pulse Modulator Output

as a function of frequency, with a horizontal scale of 3.5 MHz/cm, showing dispersion and envelope of the output. Figure 8b shows that when connected as a pulse modulator, the Mixer may be used as a spectrum or "comb" generator.

## 25. THEORY OF OPERATION.

26. The circuit of the Model 10534A Mixer (Figure 9) is commonly known as a double-balanced, or ring modulator. Note that the diodes are all connected with the cathode of one connected to the anode of the next, "short-circuiting" the transformer secondaries; this is not the same circuit as a rectifier bridge.

### 27. Mixer, Phase Detector, Frequency Doubler.

28. The voltage at the left transformer secondary winding causes current to flow through diode pair ABD or ACD, depending on polarity. The dc voltage of B or C is held at ground potential by voltage divider action of the conducting diode pair. The

diode pairs (ABD and ACD) alternate conduction, causing the ends of the right transformer secondary winding (B and C) to be alternately at ground potential, switching at a rate equal to the frequency of the input signal at L. The instantaneous voltage at X is determined by: (1) the level and polarity of the instantaneous voltage at the right transformer secondary winding, and (2) which terminal of the

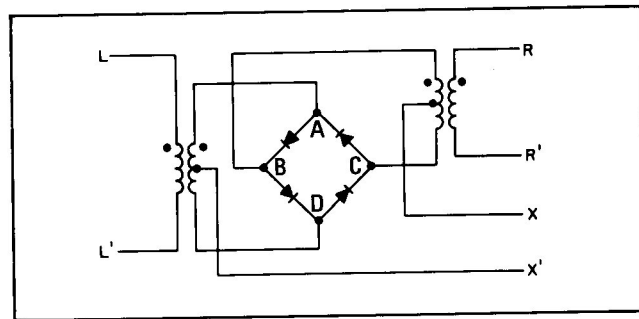


Figure 9. Schematic Diagram

secondary is at ground potential at that instant. With rf input signals at L and R, the output at X contains the sum and difference frequencies of the input signals. For phase detection and frequency doubling, the rf input signals at L and R are the same frequency. Their sum is twice either input frequency and their difference is zero Hz, or dc. A high-pass, low-pass or bandpass filter may be used at the Mixer output (X) to select the desired signal.

**29. Current Controlled Attenuator, Balanced Modulator, Amplitude Modulator or Pulse Modulator.**

30. To use the Mixer as a current controlled attenuator, balanced modulator, amplitude modulator or pulse modulator the rf input signal is connected at L, the control or modulating signal at X and the output taken from R.

31. With no input at X, an input signal at L appears greatly attenuated at R. Applying a dc control current at X causes conduction of a pair of

diodes, which then act like resistors in series in a link-coupling circuit. When sufficient dc current is applied at X to cause a pair of diodes to act like small resistors, the secondary windings of the left and right transformers (refer to schematic diagram, Figure 9) are connected together and the input at L will be available at the output R. Attenuation is inversely proportional to the dc current applied at X.

32. With an rf signal applied at L and a modulating signal at X, the output at R is the rf frequency plus and minus the modulating frequency; the carrier is suppressed. The modulating signal appears at terminals B and C of the rectifier (ring). B and C are alternately switched toward ground potential at the frequency of the rf input signal at L. The small voltage at the X input is not sufficient to cause the diodes to conduct heavily. Switching the signal at L, however, switches current paths toward ground potential through the right transformer secondary. This causes the signal at X to be sampled at the rate of the signal at L. The sampled signal is

induced into the right transformer primary winding, and may be coupled out through R.

33. By combining the action of the Mixer as a voltage controlled attenuator and a balanced modulator, an amplitude modulator is obtained. For this application, a signal containing both ac and dc components is applied at X. The ac components produce sidebands as described in Paragraph 32. The dc acts as a modulating signal of zero cycles, and its amplitude controls the amplitude of the carrier that will appear at R, as in the current controlled attenuator described in Paragraph 31. This combination provides the desired amplitude modulation output.

34. The steep sides and sharp corners of a good pulse indicate high frequency components (harmonics) while the pulse duration reflects low frequency components. When the Model 10534 is modulated by a pulse, the output represents the sum and difference of the rf signal and the modulating signal, including the harmonics. A square

pulse, to have a good shape, requires components at least to the 10th harmonic. In the example given in Figure 8 the 1 MHz repetition rate causes harmonics of 1 MHz and up; the rectangular pulse  $10^{-7}$  second wide causes the signal to have components of 10 MHz at least through 100 MHz. The spectrum presented in Figure 8b shows the relative levels of the carrier and signals to  $\pm 17.5$  MHz away from carrier frequency.

### 35. PERFORMANCE TESTS.

#### 36. Conversion Loss.

a. Set output levels of Signal Generator before connecting them to the Mixer. use the following procedure for each generator:

1. Set Signal Generator to desired frequency.
2. Set output level to be as shown in Figure 10 using RF Millivoltmeter (HP Model 411A or equivalent) terminated with 50-ohm resistive load.

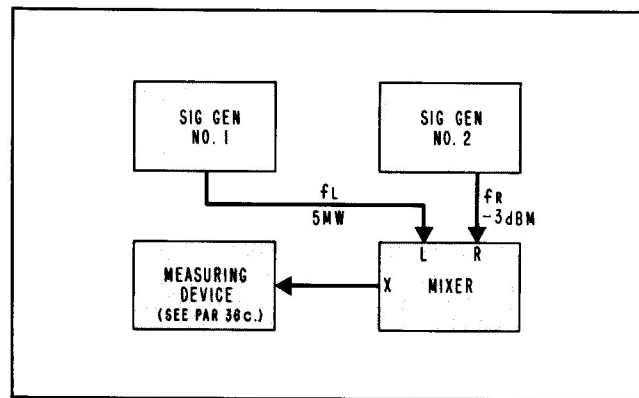


Figure 10. Test Setup — Conversion Loss

## Note

5 mw = 0.5 Vrms into 50 ohms

1 mw = 0.22 Vrms into 50 ohms

- b. Make connections as shown in Figure 10.

c. Measuring device used at X must present 50-ohm resistive load at X. The measuring device should be a tuned voltmeter, spectrum analyzer, wave analyzer or other type of receiver capable of providing a calibrated indication of signal level of one of the sidebands (only) at X.

d. Measure power in one of the sidebands,  $f_L + f_R$  or  $f_L - f_R$  at X.

e. Conversion loss is the difference in level, in dB, between the input signal at R (-3 dBm, set in step a. 2) and one of the sideband signals output at X. Refer to specification table to determine whether Mixer is within specification for the frequencies of  $f_L$  and  $f_R$  used. If the conversion loss is within specifications, this is an indication that the noise figure is satisfactory.

## 37. Mixer Balance.

- a.  $f_L$  or  $f_R$  at X.

1. Set Signal Generator #1 to  $f_L$ .

2. Using RF Millivoltmeter terminated with 50-ohm resistive load, measure Signal Generator output level. Set  $f_L$  level to 5 mw (0.5 Vrms into 50 ohms).
3. Connect Signal Generator #1 to L.
4. Set Signal Generator #2 to  $f_R$ .
5. Using RF Millivoltmeter terminated with 50-ohm resistive load, measure Signal Generator output level. Set  $f_R$  level to 1 mw or less (0.22 Vrms or less into 50 ohms).
6. Connect Signal Generator #2 to R.
7. Connect Measuring Device to X. Measuring Device should be a tuned voltmeter, spectrum analyzer, wave analyzer or other type of receiver capable of providing a calibrated indication of signal level at the desired frequency. The

Measuring Device should present a 50-ohm load to its signal source.

8. Tune the Measuring Device to the frequencies of  $f_L$  and  $f_R$ . These levels, measured at X, referred to their input levels, should be within the appropriate specification.
- b.  $f_R$  or  $f_X$  at L.
1. Set Signal Generator #1 to  $f_L$ .
  2. Connect Signal Generator #1 to Power Splitter shown in Figure 11. The values for the Power Splitter resistors are chosen so a 50-ohm load is presented at any terminal when the other two terminals are terminated with 50-ohm loads.
  3. Terminate one Power Splitter output with 50-ohm resistive load.

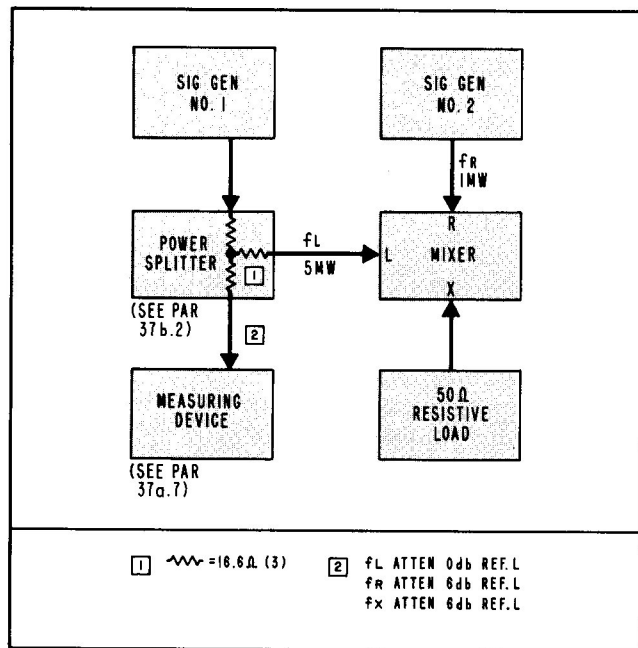


Figure 11. Test Setup — Mixer Balance

4. Using R F Millivoltmeter terminated with 50-ohm resistive load, measure signal level at remaining Power Splitter output terminal. Set this  $f_L$  level to be 5 mw (0.5 Vrms into 50 ohms).
5. Disconnect 50-ohm termination and R F Millivoltmeter from Power Splitter outputs and connect output terminal to L.
6. Using R F Millivoltmeter terminated with 50-ohm resistive load, measure Signal Generator #2 output level. Set  $f_R$  level to 1 mw or less (0.22 Vrms or less into 50 ohms).
7. Connect Signal Generator #2 to R.
8. Terminate X with a 50-ohm resistive load. A Measuring Device such as the one described in Paragraph 37, step a 7, may be used when  $f_X$  is being measured. The signal  $f_X$  is either one of the sidebands ( $f_L + f_R$  or  $f_L - f_R$ ) obtainable at X.

9. Connect a Measuring Device such as the one described in Paragraph 37 step a 7, to the Power Splitter output as shown in Figure 11.
  10. Tune the Measuring Device to the frequencies of  $f_R$  and  $f_X$ . These levels measured at the Power Splitter output, increased 6 dB to compensate for Power Splitter attenuation and then referred to their input levels, should be within the appropriate specification.
- c.  $f_L$  or  $f_X$  at R.
1. Using RF Millivoltmeter terminated with 50-ohm resistive load, measure Signal Generator output level. Set  $f_L$  level to 5 mw (0.5 Vrms into 50 ohms).
  2. Connect Signal Generator #1 to L.
  3. Connect Signal Generator #2 to Power Splitter.
  4. Terminate one Power Splitter output with 50-ohm resistive load.
  5. Using RF Millivoltmeter terminated with 50-ohm resistive load, measure level at remaining Power Splitter output terminals. Set this  $f_R$  level to be 1 mw or less (0.22 Vrms or less into 50 ohms).
  6. Disconnect 50-ohm termination and RF Millivoltmeter from Power Splitter outputs and connect one Power Splitter output terminal to R.
  7. Terminate X with a 50-ohm resistive load. A Measuring Device, such as the one described in Paragraph 37, step a 7, may be used when  $f_X$  is being measured. The signal  $f_X$  is either one of the side-

bands ( $f_L + f_R$  or  $f_L - f_R$ ) obtainable at X.

8. Connect a Measuring Device such as the one described in Paragraph 37, step a 7, to the Power Splitter output.
9. Tune the Measuring Device to the frequencies of  $f_L$  and  $f_X$ . These levels measured at the Power Splitter output, increased 6 dB to compensate for Power

Splitter attenuation and then referred to their input levels, should be within the appropriate specification.

### 38. MAINTENANCE.

39. Model 10534 Mixer is sealed at the factory. Any attempt to open the case or make repairs voids the warranty. For assistance of any kind, contact the nearest HP field office (see list inside back cover).

# 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

HEWPAK, S.A.  
1217 Meyrin  
Geneva

## IN AFRICA, ASIA, AND AUSTRALIA:

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

## IN CENTRAL AND SOUTH AMERICA:

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