Errata

Title & Document Type: **423A and 8470A Crystal Detector Operating and Service Manual**

Manual Part Number: **00423-90001**

Revision Date: **July 1976**

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

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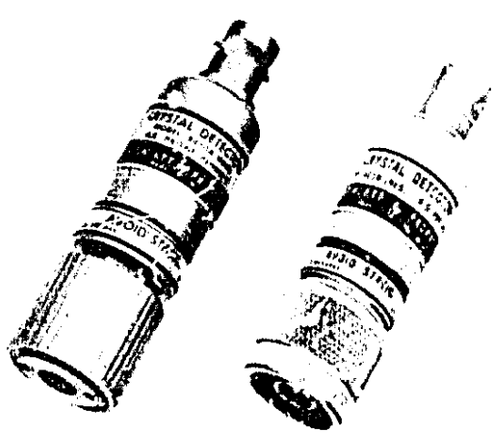
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

HP 423A
HP 8470A

OPERATING AND SERVICE MANUAL

423A
8470A
CRYSTAL DETECTOR



Printed: JULY 1976

HEWLETT hp PACKARD

HP 423A
HP 8470A

1. GENERAL INFORMATION

2. This manual contains operating instructions for the Hewlett-Packard Model 423A and 8470A Crystal Detectors. Included in the manual is the information required to install and test the crystal detectors.

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

4. Specifications

5. Instrument specifications are listed in Table 1. These specifications are the performance standards, or limits against which the instrument may be tested.

6. Description

7. The Hewlett-Packard Model 423A and 8470A Crystal Detectors are 50Ω (nominal) devices designed for measurement use in coaxial systems. The instruments convert RF power levels applied to the 50Ω input connector into proportional values of dc voltage. The instruments measure relative power up to 100 mW and have a BNC female connector for the output jack which allows the detected output to be connected to a SWR meter. The output voltage polarity is negative, unless Option 003 is selected. The frequency range of the 423A is 10 MHz to 12.4 GHz. The 8470A's frequency range extends from 10 MHz to 18 GHz.

8. Options

9. The 423A and 8470A Crystal Detectors are available with the following options (see Table 1 for further descriptions):

Option 001:	Matched pair of detectors
Option 002:	Furnished with matched load resistor (HP 11523A) for optimum square law characteristics
Option 003:	Positive polarity output
Option 012:	Furnished with stainless steel type N male connectors (8470A only).
Option 013:	Furnished with stainless steel type N female connectors (8470A only).

10. INSTALLATION

11. Initial Inspection

12. 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 instrument has been checked mechanically and electrically.

13. The 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 instrument 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 the carrier's inspection. The HP office will arrange for repair or replacement at HP's option without waiting for claim settlement.

14. Mating Connectors

15. The 8470A (standard) RF input connector must be an APC-7 type connector. The mating RF input connectors used with the 423A and 8470A Option 012 must be Type N female connectors which comply with U.S. military standard MIL-C-39012. The mating RF input connector used with the 8470A Option 013 must be Type N male connector which complies with MIL-C-39012.

16. Operating Environment

17. The operating environment of the crystal detectors should be within the following limitations:

a. Temperature: 0° to +55°C
b. Altitude: <4572 metres (15,000 feet)
c. Humidity: <95% relative.

18. STORAGE AND SHIPMENT

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

a. Temperature: −20°C to +55°C
b. Altitude: <7620 metres (25,000 feet)
c. Humidity: <95% relative.

Table 1. Specifications

Frequency Range:
423A: 10 MHz to 12.4 GHz
8470A: 10 MHz to 18 GHz

NOTE

RF may leak through the output connector, especially below 1 GHz. It can be reduced, if objectionable, with a suitable low pass filter.

Frequency Response:[1]
423A: ±0.2 dB over any octave
10 MHz to 8 GHz; ±0.5 dB
10 MHz to 12.4 GHz.
8470A: ±0.2 dB over any octave
10 MHz to 8GHz; ±0.5 dB
10 MHz to 12.4 GHz; ±1.0 dB
10 MHz to 18 GHz.

Maximum Operating Input Power: 100 mW, peak or average.

Maximum Short Term input Power: 100 mW (typical) peak or average for < 1 minute.

Sensitivity at 25°C:
High Level: < 0.35 mW produces 100 mV output.
Low Level: >0.4 mVdc/μW CW.
Output decreases with increasing temperture.
Typically 0.015 dB/°C from 0°C to 55°C.

SWR:
423A and 8470A: 10 MHz to 4.5 GHz, 1.20;
4.5 GHz to 7.0 GHz, 1.35; 7.0 GHz to 12.4 GHz, 1.50.
8470A: 12.4 GHz to 18.0 GHz, 1.70.

Input Impedance: 50Ω (nominal)

Output Impedance: < 15 kΩ shunted by 10 pF.

Output Polarity: Negative (refer to options for positive polarity units).

Detector Element: Supplied (refer to Table 2 for replacement assemblies).

Bias: Not required.

Noise: <200 μV p-p, with CW applied to produce 100 mVdc output.

[1] As read on a meter calibrated for square-law detectors (such as HP 415E SWR Meter).

Options:

423A:

Option 001: Matched pair. Frequency response characteristics (exclusive of basic sensitivity) track within ±0.2 dB over any octave from 10 MHz to 8 GHz, ±0.3 dB from 8 to 12.4 GHz.

Option 002: Furnished with matched load resistor (11523A) for optimum square law characteristics at 24°C (75°F), < ±0.5 dB variation from square law over a range of at least 30 dB up to 50 mV peak output working into an external load > 75 kΩ. Sensitivity typically > 0.1 mV/μW when load resistor is used. Overall length 144 mm (4.5 in.).

Option 003: Positive polarity output.

8470A:

Option 001: Matched pair. Frequency response characteristics (exclusive of basic sensitivity) track within ±0.2 dB over any octave from 10 MHz to 8 GHz, ±0.3 dB from 8 to 12.4 GHz, ±0.6 dB from 12.4 to 18 GHz.

Option 002: Furnished with matched load resistor (11523A) for optimum square law characteristics at 24°C (75°F), < ±0.5 dB variation from square law over a range of at least 30 dB up to 50 mV peak output working into an external load > 75 kΩ. Sensitivity typically > 0.1 mV/μW when load resistor is used. Overall length 144 mm (4.5 in.).

Option 003: Positive polarity output.

Option 012: Furnished with stainless steel type N male connector.

Option 013: Furnished with stainless steel type N female connector.

General:
Weight: Net 114 g (4 oz.) 423A and 8470A
Dimensions:
423A: 63 mm long, 20 mm diameter (2.46 in. long, 0.78 in. diameter).
8470A: 64 mm long, 19 mm diameter (2.50 in. long, 0.75 in. diameter).

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

21. OPERATION

CAUTION

Static discharge can damage the detector element. A 100 pF capacitor (1.2 m[4 ft.] of coax cable) charged to 14 volts stores 0.1 erg, the maximum pulse rating of the detector element. Connect cables to test equipment and discharge the center conductor before connecting to the detector.

DO NOT NEEDLESSLY HANDLE DETECTOR ELEMENT USED IN CRYSTAL DETECTOR. Static electricity which builds up on a person, especially on a cold dry day, must never be allowed to discharge through the crystal detector. Avoid exposed leads to or from the crystal detector, since these are often touched accidentally.

22. Operating Information

23. The crystal detector can be used as a demodulator to obtain a pulse envelope which can then be observed on an oscilloscope. It can also be used as a general purpose detector.

24. When using the crystal detector with an oscilloscope, and the waveshapes to be observed have rise times of less than 5 μs, the coaxial cable connecting oscilloscope and detector should be as short as possible and shunted with a resistor. Ideally, this resistor should be 50Ω to terminate the coaxial cable properly. However, with 50Ω resistance, the output video pulse may be too small to drive some oscilloscopes. Therefore, the cable should be shunted with the smallest value of resistance that will obtain suitable deflection on the oscilloscope; typically the value will lie between 50Ω and 2 kΩ. The larger the resistance the more degradation of rise time.

25. The power applied to the detector can be either modulated or continuous wave (CW). If modulated at a 1090 Hz rate, an SWR meter can be used as an indicator. For CW detection, a dc milliammeter or millivoltmeter can be used as the indicator.

26. Operator's Checks

27. Peak Power Measurement. The arrangement of equipment for peak power measurement is shown in Figure 1. The procedure involves calibration of an oscilloscope which, in turn, is used to calibrate a CW generator. The output of the calibrated CW generator is measure with a power meter; the peak power of a pulse is thereby measured. The procedure is as follows:

a. Connect equipment as shown in Figure 1, step a. Observe pulse on a dc-coupled oscilloscope. Using a marking pencil, mark on the graticule the base-to-peak amplitude of the pulse envelope.

b. Replace the pulse source with a CW generator. While observing the oscilloscope trace, adjust amplitude of CW generator output to make detector's output equal to that of pulse generator, as indicated by markings on graticule (step a).

c. Leave CW generator at setting obtained in step b. Disconnect detector from CW generator.

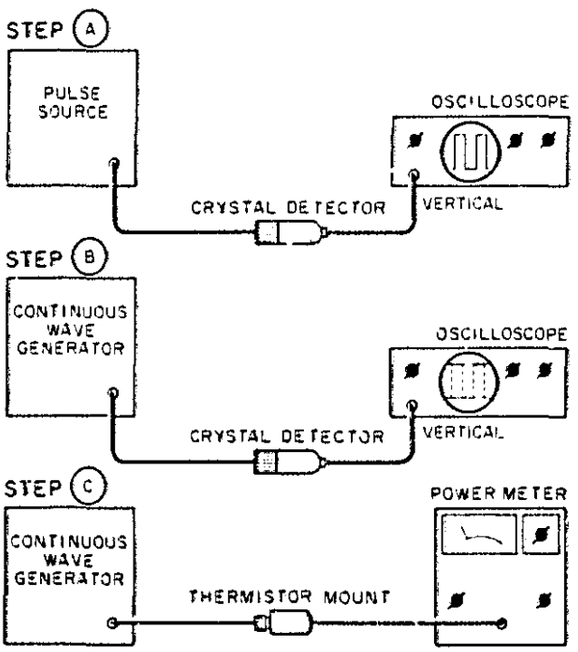


Figure 1. Peak Power Measurement

Connect output of CW generator to power meter. Measure adjusted levels (set in step b) of CW generator output. The peak power of the pulse envelope observed in step a is equal to the output power of the CW generator.

28. Reflectometer Application. For information about reflectometer systems and measurements, see HP Application Note Index, copies of which are available upon request.

29. Harmonic Frequency Comparison Measurement Application. The detector can be used as a mixer in harmonic-frequency comparison measurements (see HP Application Note Index for further information).

30. PERFORMANCE TESTS

31. The following paragraphs suggest methods to use for testing detector specifications. For these tests refer to the manuals of the equipment involved for operating instructions.

32. Frequency Response Test

a. Using signal sources covering 10 MHz to 18 GHz with a 10 dB isolating attenuator and a power meter, connect power sensor to attenuator. Adjust RF power level to −20 dBm input to power sensor.

b. Without changing RF power level of signal source, disconnect power sensor.

c. Connect detector to attenuator. Measure dc voltage output from detector and record measurement.

d. Change frequency of signal source and repeat steps a through c.

e. Since the detector follows a square-law response at this power level, its output is proportional to power ($P_{dB} = 10 \log V_o$). Total variation of detector readings should meet specifications (see Table 1) for all frequencies of interest across the band.

NOTE

Multiple mismatch errors caused by attenuator SWR, power meter SWR, and detector SWR should be taken into account, as well as the accuracy of the indicator used to measure the detector's output.

33. High Level Sensitivity Test

a. Using signal sources covering 10 MHz to 18 GHz and a dc voltmeter or oscilloscope as the indicator, connect detector to signal source. Adjust RF power level for a 100 mV detected output from detector.

b. Disconnect detector from signal source and measure RF output level. The RF output level should be ≤ 0.35 mW.

c. Repeat steps a and b for all frequencies of interest across the band.

34. Low Level Sensitivity Test

a. Using a signal source (covering 100 MHz to 1 GHz), a 10 dB attenuator, and a power meter, connect attenuator to signal source and power sensor to attenuator. Adjust RF power level for −20 dBm output from attenuator. Verify the ambient temperature.

b. Disconnect power sensor from attenuator and connect detector. Measure dc voltage output from detector. The output should be > 4.0 mV at 25°C. The sensitivity slope is typically −0.015 dB/°C from 0°C to +55°C.

NOTE

Multiple mismatch errors caused by attenuator SWR, power meter SWR, and detector SWR should be taken into account, as well as accuracy of indicator used to measure detector's output.

35. Match Test (SWR)

36. To verify the detector's SWR specifications, use any system whose measurement accuracies for SWR (residual SWR) are known.

37. ADJUSTMENTS

38. The detectors have no internal adjustments.

39. REPLACEABLE PARTS

40. The succeeding paragraphs contain information pertaining to replaceable parts (see Table 2) and the ordering of replaceable parts for the Models 423A, 8470A, and 11523A.

41. To order a replacement part, address order or inquiry to the nearest Hewlett-Packard office (see

list in back of manual.) Include the following information for each part: model number, Hewlett-Packard part number, and description.

42. SERVICE

43. The succeeding paragraphs give instructions for repair of the Model 423A and 8470A Crystal Detectors and the Option 002 Load Resistor, Model 11523A. Additional maintenance information can be obtained from the local Hewlett-Packard office. Part numbers for replaceable parts are given in Table 2.

44. Detector Element Replacement

45. The detector element assembly includes only a detector element, unless an Option 002 is ordered, then a replacement load resistor for the 11523A is included. The resistor is to load the diode for square-law operation.

CAUTION

The special detector element (see Figure 4) contained in the detector can be damaged in handling, removal, or installation if certain precautions are not taken. Then handling precautions which follow should be read before performance of any operation with the detector element when it is out of either the housing or the detector element shipping container.

a. Before installing diode into mount, touch exposed metal on mount with your hand to discharge static electricity. Then insert diode into mount.

b. When handing diode to another person, touch hands first to ensure there is no difference in static electricity potential between you.

c. Ohmmeters should not be used to measure forward- and back-resistance since it is easy to damage these diodes. The difficulty arises because of the ohmmeter's open-circuit voltages and short-circuit currents.

46. Replacing Detector Element

47. Parts mentioned in the following procedure are identified in Figure 4.

a. Remove connector cap from body. To remove connector cap, use a pair of gas pliers with plastic teeth or protect body with heavy paper or tape.

b. Remove old detector element, capsule spacer, and capacitive washer, and discard them.

c. Install the new capacitive washer, capsule spacer, and detector element. Install the washer first, the spacer with its polyiron side against the washer. Finally, install the detector element by inserting the resistive end into the center contact inside the detector body.

CAUTION

When inserting the detector element, do not force the tip (resistive end) into the center conductor in the body as the fingers of the center conductor might be damaged, if the detector element is not centered.

d. Replace connector cap and TIGHTEN FIRMLY.

NOTE

The Option 002 Detector Element Assembly includes a detector element and a resistor. The resistor is for use in the Model 11523A and must be installed to match it to the detector.

48. Replacement of Load Resistor (11523A) Parts

49. Parts mentioned in the following procedure are identified in Figures 2 and 3.

50. Replacing Male BNC Connector

a. Remove male BNC connector and lock washer from housing. To remove BNC connector, use a 3/8-inch open-end wrench and hold the housing either in a vise or with pliers. Before using the vise or pliers, protect the housing of the 11523A with material such as heavy paper or tape or use plastic jaws on the vise or pliers.

b. Unsolder resistor.

c. Solder resistor to new BNC connector.

d. Let resistor cool and then check resistance from male BNC pin through resistor; resistance measured should be ±10% that indicated by the color coding.

e. Replace lockwasher and male BNC connector.

51. Replacing Female BNC Connector

a. Remove female BNC connector. To remove or install BNC connector, use a BNC wrench or use a male BNC connector as a wrench to prevent damage to the connector.

b. Unsolder contact spring.

c. Prepare replacement female BNC connector:

(1) Cut center conductor lead to approximately 0.79 mm (1/32 in.)

(2) With flat file, smooth end of lead; remove burr with tweezers or similar metal instrument.

d. Slip contact spring over center conductor lead, and solder.

CAUTION

Use solder sparingly or it will creep back on spring. Solder on spring destroys its usefulness and is difficult to remove.

e. Let contact spring cool and then screw connector into mount.

52. Replacement of APC-7 Connector Center Contact

53. The replacement procedure for the APC-7 connector center contact is covered in Figure 5.

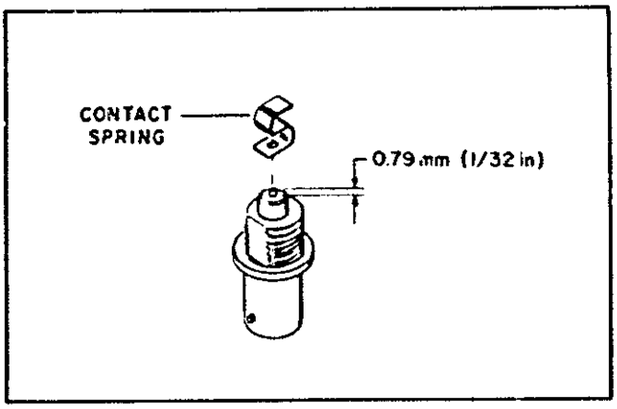


Figure 2. Cutting Center Conductor Lead to Accommodate Contact Spring

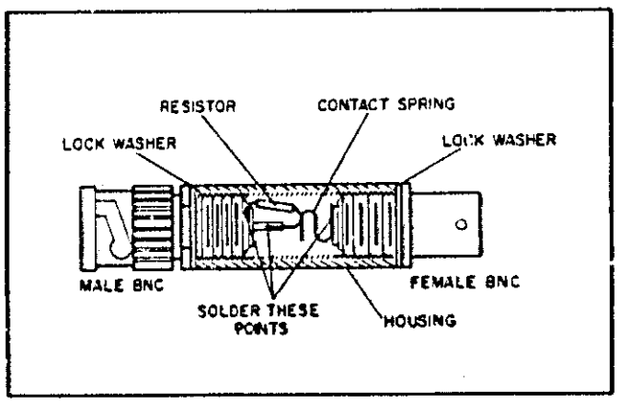


Figure 3. Model 11523A Load Resistor, Cutaway View

The disassembly and assembly instructions for the APC-7 connecotr is covered in Figure 6.

54. Type N Connector Dimensions

55. The critical dimensions for the type N connector are covered in Figure 7.

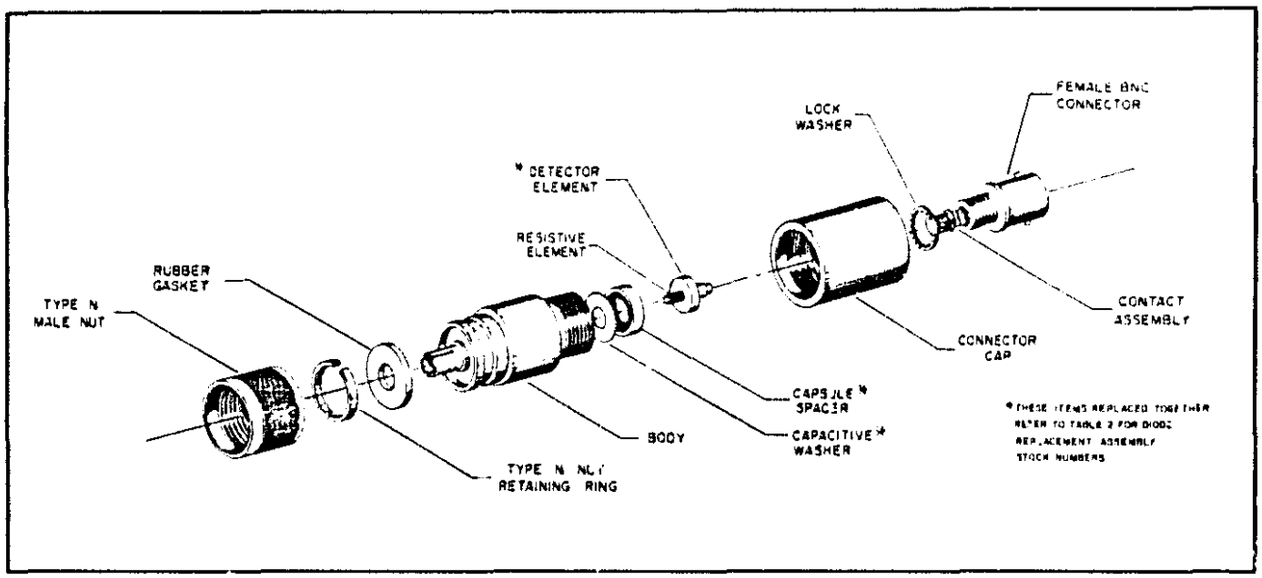


Figure 4. HP Model 423A Crystal Detector Assembly

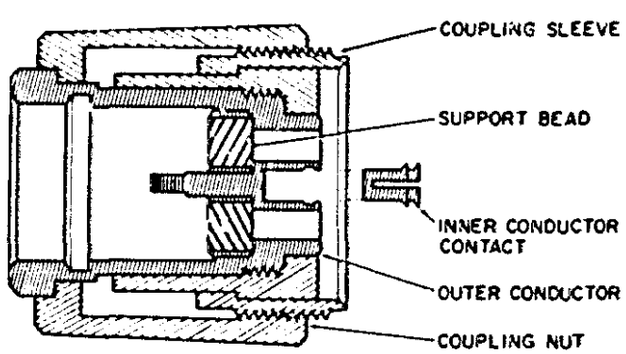
REPLACING AMPHENOL APC-7 CENTER CONTACT

Through wear or damage the contact in the center conductor may need replacing. This contact is a small four-pronged collet which snaps into a recess in the center conductor. This contact is normally held in by the spring-action of the four prongs. With a magnifying glass, examine this contact to determine if it needs replacement. DO NOT REMOVE THIS CONTACT FOR INSPECTION (it may be damaged by removal). The contact should be free of burrs or wear and the prongs should be equally spaced. If the contact is removed, do NOT re-use it (it may be damaged by removal). This contact is Amphenol* part number 131-129 and HP 1250-0907. If this contact needs replacement and a new contact is available, proceed as follows:

1. Place the instrument so the connector faces down, if possible.

2. Tap the connector lightly and the contact should now protrude slightly. Insert the centering pin of the Hewlett-Packard collet remover, Part Number 5060-0236, with the jaws open.

3. Allow the jaws on the tool used to close and pull straight back from the connector without twisting. The contact should come with the tool. If not, repeat the process. Do NOT re-use the contact.



4. Snap in a new contact by pushing a new contact in place. Test the action of the new contact by pushing in on it. It should spring out again when released.

(Amphenol* Part Number 131-129; HP Part Number 1250-0907.

*Amphenol RF Division, Danbury, Conn.

Figure 5. APC-7 Connector

PARTS LIST

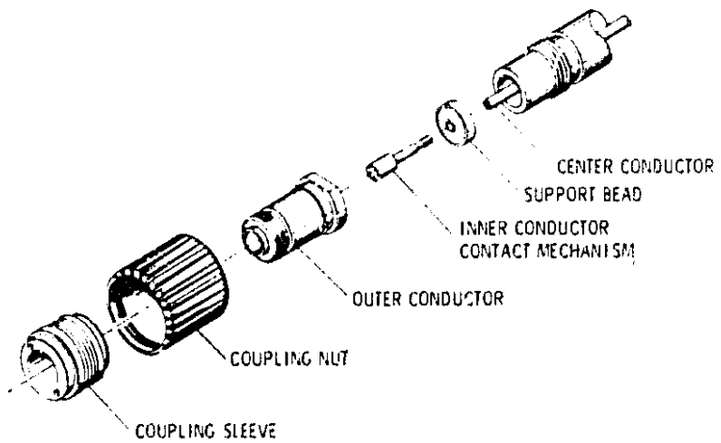
Table 2. Replaceable Parts, Models 423A, 8470A, and 11523A

Description	Stock No.
423A Assembly	
Connector, Female BNC	1250-0251
Connector, Cap	5020-0210
Connector Assembly, Female BNC, including contact assembly	00423-600
Body Assembly, 423A	00423-601
Includes the following:	
Type N Male Connector Outer Conductor	1250-0014
Type N Male Nut Rubber Gasket	1250-0015
Type N Nut Retaining Ring	1250-0016
Type N Male Nut	1250-0918
Type N Male Connector Bead	5020-0207
Type N Male Connector Center Conductor	00423-201
Body, Crystal Mount	00423-202
423A Diode Replacement Assemblies[1]	
Single Diode Negative Polarity	00423-802
Single Diode Positive Polarity (Opt 003)	00423-803
Single Diode Negative Polarity with Matching Load Resistor (Opt 002)	00423-800
Single Diode Positive Polarity with Matching Load Resistor (Opt 002 and 003)	00423-801
Matched Pair Diodes Negative Polarity (Opt 001)	00423-605
Matched Pair Diodes Positive Polarity (Opt 001, 003)	00423-606
Matched Pair Diodes with Load Resistor Negative Polarity (Opt 001, 002)	00423-603
Matched Pair Diode with Load Resistor Positive Polarity (Opt 001, 002, and 003)	00423-604
11523A Load Resistor Assembly[1]	
Connector, Male BNC	1250-0045
Connector, Female BNC	1250-0251
Spring, Contact	5000-0234
Housing	5020-3215
8470A APC-7 Connector Assembly	
Inner Conductor Contact Mechanism (assemblied contact and outer body)	1250-0816
Coupling Sleeve	1250-0820
Inner Conductor Contact	1250-0907
Outer Conductor	1250-1183
Coupling Nut	1250-1465
Support Bead	5040-0306

Description	Stock No.
8470A APC-7 Connector Assembly (Cont'd)	
Tools:[2]	
APC-7 Contact Extractor	5060-0236
APC-7 Spanner Wrench	5060-0237
Open-end Wrench	8710-0877
8470A Assembly	
Resistor, Tubular	0727-1033
Ring, RF Connector (Opt 012)	1250-0016
Connector, Female BNC	1250-0251
Connector, RF APC-N Female (Opt 013)	1250-0914
Contact, RF Connector Female (Opt. 013)	1250-0915
Connector, RF APC-N Male (Opt 012)	1250-0916
Contact, RF Connector Male (Opt 012)	1250-0917
Nut, RF Connector (Opt 012)	1250-0918
Washer, Lock, Internal	2190-0016
Contact, Spring	5000-0234
Cap, Connector	5020-0210
Insulator	5040-0306
Washer, Compression	08470-0001
Washer, Fiber	08470-0002
Body, Crystal Mount	08470-2000
Conductor, Center	08470-2001
8470A Diode Replacement Assemblies[1]	
Single Diode Negative Polarity	08470-6001
Single Diode Positive Polarity (Opt 003)	08470-6002
Single Diode Negative Polarity with Matching Load Resistor (Opt 002)	08470-6003
Single Diode Positive Polarity with Matching Load Resistor (Opt 002,003)	08470-6004
Matched Pair Diodes Negative Polarity (Opt 001)	08470-6005
Matched Pair Diodes Positive Polarity (Opt 001, 003)	08470-6006
Matched Pair Diodes with Load Resistor Negative Polarity (Opt 001, 002)	08470-6007
Matched Pair Diode with Load Resistor Positive Polarity (Opt 001, 002, and 003)	08470-6008

[1] Refer to Table 1 for description of options.

[2] Part of HP Model 11591A, APC-7 Connector Tool Kit.



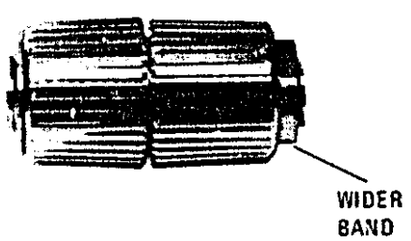
USE

To Connect:

1. On one connector, retract the coupling sleeve by turning the coupling nut counterclockwise until the sleeve and nut disengage.
2. On the other connector, fully extend the coupling sleeve by turning the coupling nut clockwise. To engage coupling sleeve and coupling nut when the sleeve is fully retracted, press back lightly on the nut while turning it clockwise.
3. Push the connectors firmly together, and thread the coupling nut of the connector with retracted sleeve over the extended sleeve.
4. Close the gap between coupling nuts with the nut on the extended-sleeve connector.

To Disconnect:

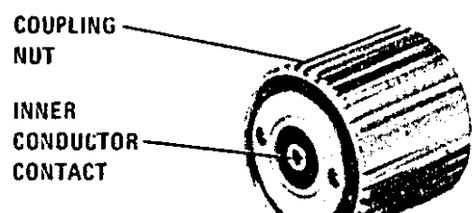
1. Loosen the coupling nut of the connector showing the wider gold band.



2. IMPORTANT: Part the connectors carefully to prevent striking the inner conductor contact.

CARE

1. Keep contacting surfaces smooth and clean. Irregularities and foreign particles can degrade electrical performance.



2. Protect the contacting surfaces when the connector is not in use by leaving the coupling sleeve extended.
3. Use lintless material and/or firm-bristled brush such as a tooth brush for cleaning. If a cleaning fluid is needed use isopropyl alcohol. IMPORTANT: Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, dioxane, gasoline, cellosolve acetate, or carbon tetrachloride. Keep exposure of the connector parts to both the cleaning fluid and its vapors as brief as possible.

Figure 6. APC-7 Connectors

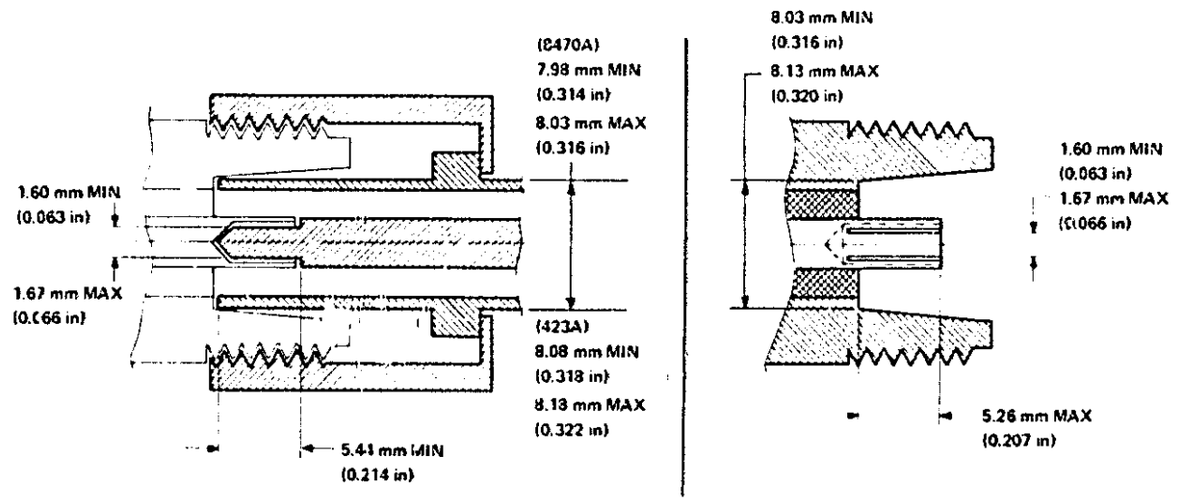


Figure 7. Type N Connector Dimensions

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company 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 AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the preventive maintenance procedures in the manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

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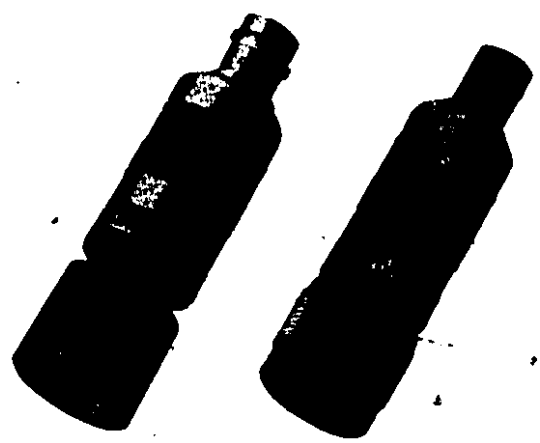
CRYSTAL DETECTOR

423A

8470A



JULY 1972

HEWLETT hp PACKARD

HP 423A
HP 8470A

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.

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For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

Figure 1. Models 423A and 8470A Crystal Detectors and Model 11523 Load Resistor

INTRODUCTION

The 423A and 8470A Crystal Detectors are 50-ohm (nominal) devices designed for measurement use in coaxial systems. They measure relative power up to 100 mW, and have a BNC output jack to connect the detected output to a meter, such as the 415E. Frequency range of the 423A is 10 MHz to 12.4 GHz. The 8470A has additional range up to 18 GHz.

Output polarity of the Detectors is negative unless the Option 003 version is purchased. Specifications and Options are listed in Table 1.

The optional Load Resistor, Model 11523A, is mounted in a separate housing to permit easy conversion from optimum square law to maximum output. Each load is identified by the serial number of the Detector to which it is matched. If you have more than one Model 11523A, always be sure that the proper one is in use for the Detector you are using.

PRECAUTIONS

Electrical Shock

DISCHARGE OF STORED ELECTRICAL ENERGY CAN EASILY DAMAGE THE CRYSTAL DETECTOR. A 100-pF capacitor, the equivalent of four feet of coaxial cable, charged to 14 volts stores 0.1 erg of energy which is the maximum safe pulse rating of the detector. Be certain that a cable is connected to associated equipment and discharged before connecting it to crystal detector.

Handling Detector Element

DO NOT HANDLE DETECTOR ELEMENT USED IN CRYSTAL DETECTOR NEEDLESSLY. Static electricity which builds up on a person, especially on cold, dry day, must never be allowed to discharge through the Crystal Detector. Avoid exposed leads to or from the Crystal Detector, since these are often touched accidentally. Refer to Detector Element Replacement for proper precautions.

GENERAL

The crystal Detector can be used as a demodulator to obtain a pulse envelope which can then be observed on an oscilloscope. It can also be used as a general purpose detector.

When using the Crystal Detector with an oscilloscope and the waveshapes to be observed have rise times of less than 5 μsec, the coaxial cable connecting oscilloscope and detector should be as short as possible and shunted with a resistor. Ideally, this resistor should be 50 ohms to terminate the coaxial

Table 1 Specifications

Frequency Range:

423A: 10 MHz to 12.4 GHz

8470A: 10 MHz to 18 GHz (Below 1 GHz, RF may leak through the video output connector. It can be eliminated, if objectionable, with suitable low pass filter.)

Frequency Response:*

423A: ± 0.2 dB/octave 10 MHz to 8 GHz, ± 0.5 dB overall.

8470A: ± 0.2 dB/octave 10 MHz to 8 GHz, ± 0.5 dB to 12.4 GHz, ± 1.0 dB overall.

Maximum Power: 100 mW, peak or average.

Sensitivity at 25°C:

High Level: < 0.35 mW produces 100 mV output.
Low Level: > 0.4 mVdc/μW CW.
Output decreases with increasing temperature.
Typically 0.015 dB/°C from 0 °C to 55 °C.

Impedance: 50 ohms.

Reflection Coefficient:

423A and 8470A: 10 MHz to 4.5 GHz, 0.091 (1.2 SWR); 4.5 GHz to 7.0 GHz, 0.15 (1.35 SWR); 7.0 GHz to 12.4 GHz, 0.2 (1.5 SWR).

8470A: 12.4 GHz to 18.0 GHz, 0.26 (1.7 SWR).

Output Impedance: < 15kΩ shunted by 10 pF.

Detector Element: Supplied. (Refer to Table 2 for replacement assemblies.)

Output Polarity: Negative. (Refer to options for positive polarity units.)

Noise: <200 μV p-p, with CW applied to produce 100 mVdc output.

Connectors:

423A:

Option 001: Matched pair. Frequency response characteristics (exclusive of basic sensitivity) track within ± 0.2 dB per octave from 10 MHz to 8 GHz, ± 0.3 dB from 8 to 12.4 GHz.

Option 002: Furnished with matched load resistor (11523A) for optimum square law characteristics at 24°C (75°F),* < ± 0.5 dB variation from square law over a range of at least 30 dB up to 50 mV peak output working into an external load > 75k ohms. Sensitivity typically < 0.1 mV/μW when load resistor is used. Overall length 4-1/2 in. (144 mm).

Option 003: Positive polarity output.

8470A:

Option 001: Matched pair. Frequency response characteristics (exclusive of basic sensitivity) track within ± 0.2 dB per octave from 10 MHz to 8 GHz, ± 0.3 dB from 8 to 12.4 GHz, ± 0.6 dB from 12.4 to 18 GHz.

Option 002: Furnished with matched load resistor (11523A) for optimum square law characteristics at 24°C (75°F),* < ± 0.5 dB variation from square law over a range of at least 30 dB up to 50 mV peak output working into an external load <75kΩ. Sensitivity typically > 0.1 mV/μW when load resistor is used. Overall length 4-1/2 in. (144 mm).

Option 003: Positive polarity output.

Option 012: Furnished with stainless steel type N male connector.

Option 013: Furnished with stainless steel type N female connector.

* As read on a meter calibrated for square-law detectors (such as HP 415E SWR Meter).

cable properly. However, with 50 ohms resistance, possibly the output video pulse may be too small to drive some oscilloscopes. Therefore, the cable should be shunted with the smallest value of resistance that will obtain suitable deflection on the oscilloscope; typically the value will lie between 50 and 2k ohms. The larger the resistance the more degradation of rise time.

The power applied to the Detector can be either modulated or continuous wave (CW). If modulated at a 1000-cps rate, the sensitive HP Model 415B/E can be used as the indicator. For CW detection, a dc milliammeter or millivoltmeter such as the HP Model 425A Microvolt-Ammeter can be used as the indicator.

Peak Power Measurement

The arrangement of equipment for peak power measurement is shown in Figure 2. The procedure involves calibration of an oscilloscope which in turn is used to calibrate a CW generator. The output of the calibrated CW generator is measured with a power meter; the peak power of a pulse is thereby measured. The procedure is as follows:

a. Connect equipment as shown in Figure 2, step 1.

b. Observe pulse on a dc-coupled oscilloscope. Using a marking pencil, mark on the graticule the base-to-peak amplitude of the pulse envelope.

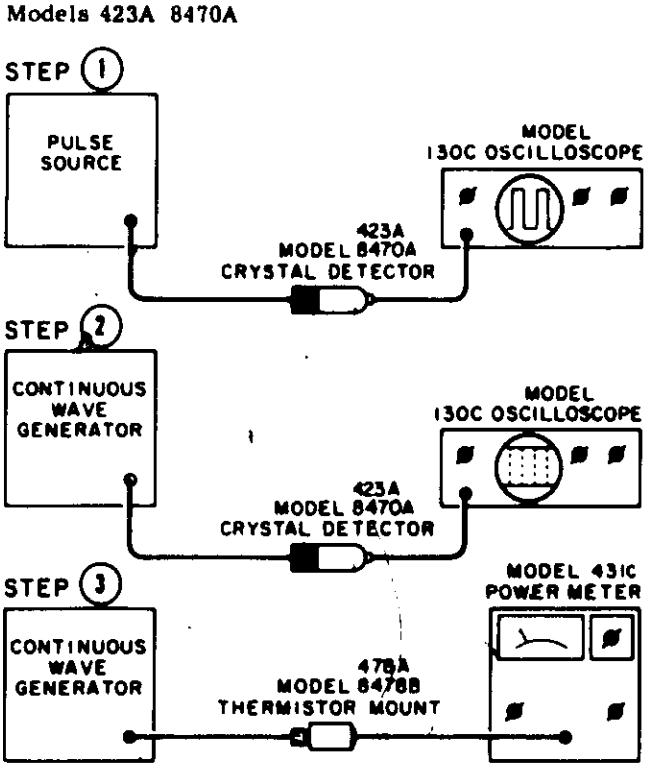


Figure 2. Peak Power Measurement

c. Replace the pulse source with a CW generator (step 2). While observing the oscilloscope trace, adjust amplitude of CW generator output to make crystal output equal to that of pulse generator as indicated by markings on graticule (step b).

d. While performing the next step, leave CW generator at setting obtained in step c. Disconnect Detector from CW generator. Connect output of CW generator to a thermistor and power meter. Measure adjusted level (step c) of CW generator output.

e. The peak power of the pulse envelope observed in step b is equal to the output power of the CW generator.

Reflectometer Application

For information about reflectometer systems and measurements, see HP Application Notes 54 and 61 and Hewlett-Packard Journal Vol. 12, No. 4, December 1960, copies of which are available upon request.

HARMONIC FREQUENCY-COMPARISON MEASUREMENTS

The Detector can be used as a mixer in harmonic-frequency comparison measurements.

REPLACEMENT OF PARTS

Succeeding paragraphs give instructions for repair of the Detector, and the Option 002 Load Resistor, Model 11523A. Additional maintenance information can be obtained from your local Hewlett-Packard field office. Stock numbers for replaceable parts are given in Table 2.

The detector element assembly includes a detector element, an Option 002 load resistor for the 11523A, capacitive washer and a capsule spacer. The resistor is to load the diode for square-law operation, the capacitive washer is to match the diode for VSWR, while the capsule spacer is mainly for flatness of sensitivity. All should be replaced as a unit when the diode is replaced.

Detector Element Replacement

WARNING

The special detector element (See Figure 3) contained in the Detector can be damaged in handling, removal, or installation if certain precautions are not taken. The handling precautions which follow should be read before performance of any operation with the detector element when it is out of either the housing or the detector element shipping container.

Detector Element Handling Precautions

a. Before installing detector into mount, touch exposed metal on mount with your hand to discharge static electricity. Then insert detector into mount.

b. When handing crystal to another person, touch hands first to ensure there is no difference in static electricity potential between you.

c. Ohmmeters should NOT be used to measure forward- and back-resistance since it is rather easy to damage these diodes. (The difficulty arises because of the ohmmeter open-circuit voltages and short-circuit currents. It is easy for these currents or voltages to damage the diode.)

Replacing Detector Element

Parts mentioned in the following procedure are identified in Figure 3.

a. Remove connector cap from body. To remove connector cap, use a pair of gas pliers with plastic teeth or protect body with heavy paper or tape.

b. Remove old detector element, capsule spacer, and capacitive washer, and discard them.

c. Install the new capacitive washer, capsule spacer, and detector element. Install the washer first, the spacer with its polyiron side against the washer. Finally, install the detector element by inserting the resistive end into the center contact inside the Detector body.

CAUTION

When inserting the detector element, do not force the tip (resistive end) into the center conductor in the body as the fingers of the center conductor might be damaged. If the detector element is not centered

d. Replace connector cap and TIGHTEN FIRMLY.

NOTE

The Option 002 Detector Element Assembly includes a detector element and a resistor. The resistor is for use in the Model 11523A and must be installed to match it to the Detector.

Replacing Output BNC Connector

Tools Required.

a. Needle-point soldering iron
b. Wire cutters
c. Flat file, #4
d. Tweezers

Procedure. Parts mentioned in the following procedure are identified in Figures 3 and 4.

a. Remove BNC connector and lockwasher.

b. Unsolder contact spring soldered to center conductor lead

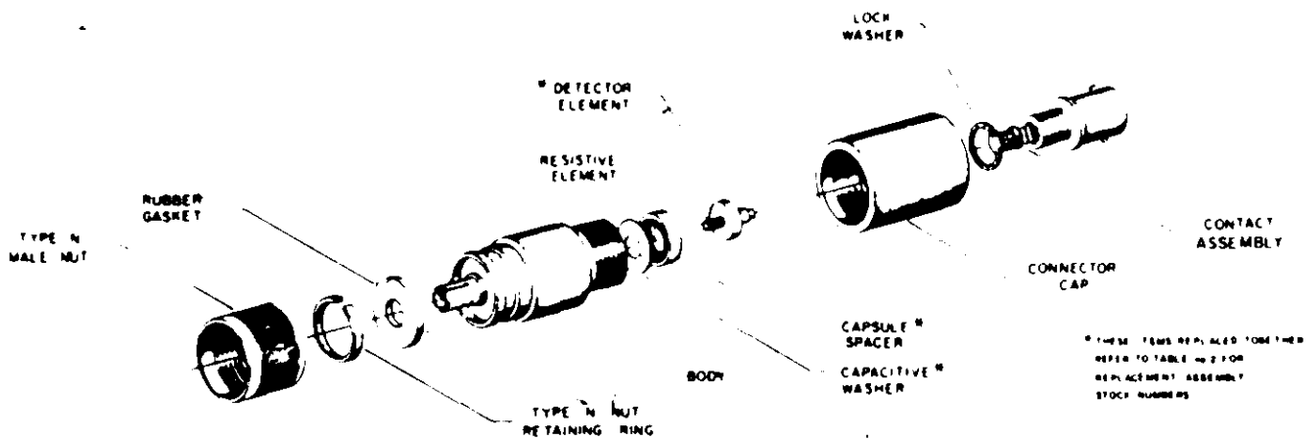


Figure 3. Model 423A Assembly

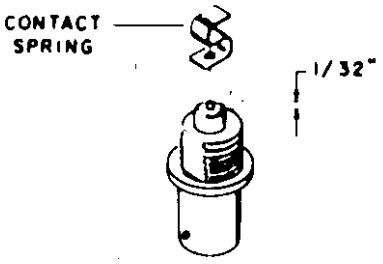


Figure 4. Cutting Center Conductor Lead to Accommodate Contact Spring

(1) Cut center conductor lead to approximately 1/32 inch (see Figure 4).

(2) With flat file, smooth end of lead; wipe off burr with tweezers or similar metal instrument.

c. Slip contact spring over center conductor lead, and solder.

CAUTION

Use solder sparingly or it will creep back on spring. Solder on spring destroys its usefulness, and solder is difficult to remove from spring.

d. Let spring cool, and then replace lockwasher and connector in connector cap.

Replacement of 11523A Parts

Parts mentioned in the following procedure are identified in Figures 4 and 5. Tools required are listed in Replacing Output BNC Connector, Tools Required.

Replacing Male BNC Connector.

a. Remove male BNC connector and lock washer from housing. To remove BNC, use a 3/8-inch openend wrench and hold the housing either in a vise or with gas pliers. Before putting pliers on, protect the housing of the 11523A with material such as heavy paper.

b. Unsolder resistor.

c. Solder resistor to new BNC.

d. Let resistor cool and then check resistance from male BNC pin through resistor; resistance measured should be ± 10% that indicated by the coding.

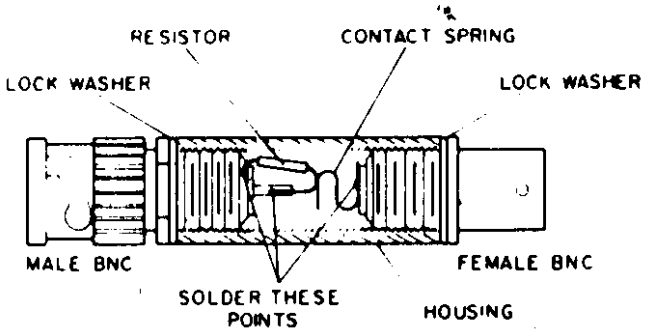


Figure 5 Model 11523A Load Resistor, Cutaway View

e. Replace lockwasher and male BNC.

Replacing Female Connector

a. Remove BNC connector. To remove or install BNC, use a BNC wrench or use a male BNC connector as a wrench.

b. Unsolder contact spring.

c. Prepare replacement BNC connector:

(1) Cut center conductor lead to approximately 1/32 inch.

(2) With flat file, smooth end of lead; wipe off burr with tweezers or similar metal instrument.

d. Slip contact spring over center conductor lead, and solder.

CAUTION

Use solder sparingly or it will creep back on spring. Solder on spring destroys its usefulness and is difficult to remove.

e. Let contact spring cool and then screw connector into mount.

REPLACEABLE PARTS

This section contains information pertaining to replaceable parts (see Table 2) and the ordering of these parts for the Models 423A, 8470A, and 11523A.

To order a replacement part, address order or inquiry to your local Hewlett-Packard field office (see list at rear of this Note).

Specify the following information for each part.

a. Model number
b. Hewlett-Packard stock number
c. Description of part.

PARTS

LIST

Table 2. Replaceable Parts, Models 423A, 8470A, and 11523A

Description	Stock No.
Connector, male BNC for 11523A	1250-0045
Connector, female BNC	1250-0251
Connector Assembly, female BNC, including contact assembly	00423-600
Connector, Cap	5020-0210
Housing for 11523A	5020-3215
11523A without resistor, includes serial plate to be attached to 423A	11523-600
Body Assembly, 423A or 8470A Includes the following:	00423-601
Type N Male Nut	1250-0918
Type N Nut Retaining Ring	1250-0016
Type N Male Nut Rubber Gasket	1250-0015
Body, Crystal Mount	00423-202
Type N Male Connector Center Conductor	00423-201
Type N Male Connector Outer Conductor	1250-0014
Type N Male Connector Bead	5020-0207
423A Diode Replacement Assemblies[1]	
Single detector assembly:	
Negative polarity	00423-802
Positive polarity (Option 003)	00423-803
Single detector assembly with matching load resistor (Option 002):	
Negative polarity	00423-800
Positive polarity (Option 003)	00423-801
Matched pairs of assembly (Option 001):	
Negative polarity	00423-605
Positive polarity (Option 003)	00423-606
Matched pairs of elements with matching load resistor (Option 002):	
Negative polarity	00423-603
Positive polarity (Option 003)	00423-604
8470A Diode Replacement Assemblies	
Single Detector Assembly:	
Negative Polarity	08470-6001
Positive Polarity (Option 003)	08470-6002
Single Detector Assembly with matching load resistor (Option 002):	
Negative Polarity	08470-6003
Positive Polarity (Option 003)	08470-6004
Matched Pairs of assemblies (Option 001):	
Negative Polarity	08470-6005
Positive Polarity (Option 003)	08470-6006
Matched pairs of assemblies with load resistors (Option 002):	
Negative Polarity	08470-6007
Positive Polarity (Option 003)	08470-6008
APC-7 Connector Assembly	1250-0909
Inner conductor contact	1250-0907
Inner conductor contact mechanism (contact plus outer body; assembled)	1250-0816
Support bead	5040-0273
Coupling nut	1250-0819
Outer Conductor	1250-1183
Coupling Sleeve	1250-0820
Tools:[2]	
APC-7 contact extractor	5060-0236
APC-7 Spanner wrench	5060-0237
Open-end wrench	8710-0877

[1] Refer to Table 1 for description of options.

[2] Part of HP Model 11591A APC-7 Connector Tool Kit.

PERFORMANCE CHECKS

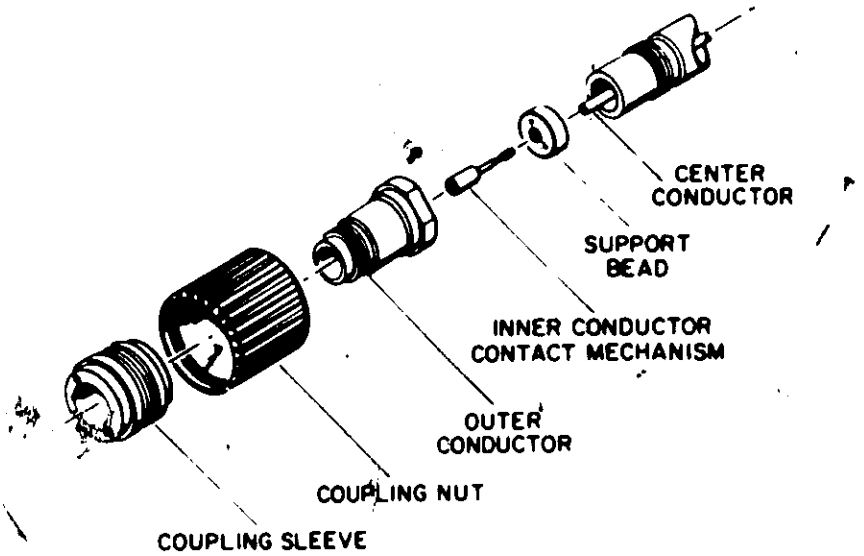
The following paragraphs suggest methods to use for checking detector specifications. For these checks the instrument operator should refer to the manuals of the equipment involved for operating instructions.

Frequency Response Check

a. Using a 10 MHz to 18 GHz signal source with a 10 dB isolating attenuator, and an SWR Meter as the indicator, connect the detector to the signal source and adjust the RF power level for any convenient upper scale reference on the SWR meter.

b. Without changing the RF output level, disconnect the detector from the signal source.

c. Using a power meter/thermistor mount combination, measure the signal source RF output level and record it.



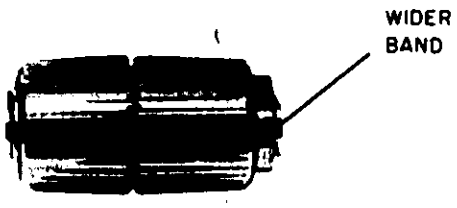
USE

To Connect:

1. On one connector, retract the coupling sleeve by turning the coupling nut counterclockwise until the sleeve and nut disengage.
2. On the other connector, fully extend the coupling sleeve by turning the coupling nut clockwise. To engage coupling sleeve and coupling nut when the sleeve is fully retracted, press back lightly on the nut while turning it clockwise.
3. Push the connectors firmly together, and thread the coupling nut of the connector with retracted sleeve over the extended sleeve.
4. Close the gap between coupling nuts with the nut on the extended-sleeve connector.

To Disconnect:

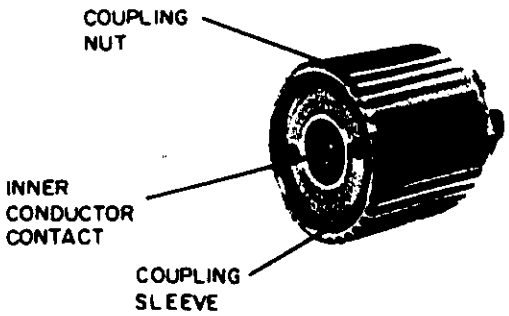
1. Loosen the coupling nut of the connector showing the wider gold band.



2. IMPORTANT: Part the connectors carefully to prevent striking the inner conductor contact.

CARE

1. Keep contacting surfaces smooth and clean. Irregularities and foreign particles can degrade electrical performance.



2. Protect the contacting surfaces when the connector is not in use by leaving the coupling sleeve extended.
3. Use lintless material and/or firm-bristled brush such as a tooth brush for cleaning. If a cleaning fluid is needed use isopropyl alcohol. IMPORTANT: Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, dioxane, gasoline, cellosolve acetate, or carbon tetrachloride. Keep exposure of the connector parts to both the cleaning fluid and its vapors as brief as possible.

Figure 6. APC-7 Connectors

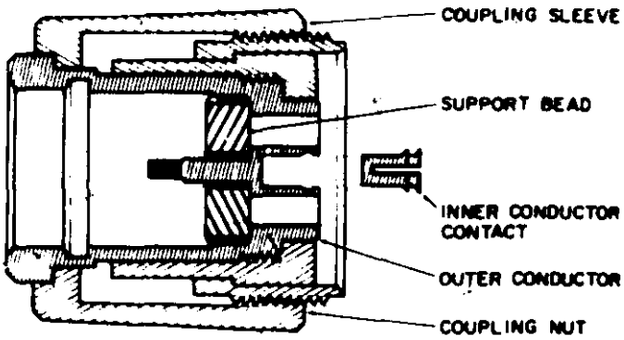
REPLACING AMPHENOL APC-7 CENTER CONTACT

Through wear or damage the contact in the center conductor may need replacing. This contact is a small four-pronged collet which snaps into a recess in the center conductor. This contact is normally held in by the spring-action of the four prongs. With a magnifying glass examine this contact to determine if it needs replacement. DO NOT REMOVE THIS CONTACT FOR INSPECTION (it may be damaged by removing). The contact should be free of burrs or wear and the prongs should be equally spaced. If the contact is removed do NOT re-use it (it may be damaged by removal). This contact is Amphenol* part number 131-129 and HP 1250-0907. If this contact needs replacement and a new contact is available proceed as follows:

1. Place the instrument so the connector faces down, if possible.

2. Tap the connector lightly and the contact should now protrude slightly. Insert the centering pin of the Hewlett-Packard collet remover, Stock Number 5060-0236, with the jaws open. If this tool is not available, an ordinary draftsman's mechanical pencil may be used (the end of the jaws may have to be filed to get a good grasp at the very end).

3. Allow the jaws on the tool used to close and pull straight away from the connector without twisting. The contact should come with the tool. If not, repeat the process. Do NOT re-use the contact.



4. Snap in a new contact by pushing a new contact in place.

(Amphenol* Part number 131-129; HP Part number 1250-0907)

*Amphenol RF Division, Danbury, Conn.

Figure 7 APC-7 Connector

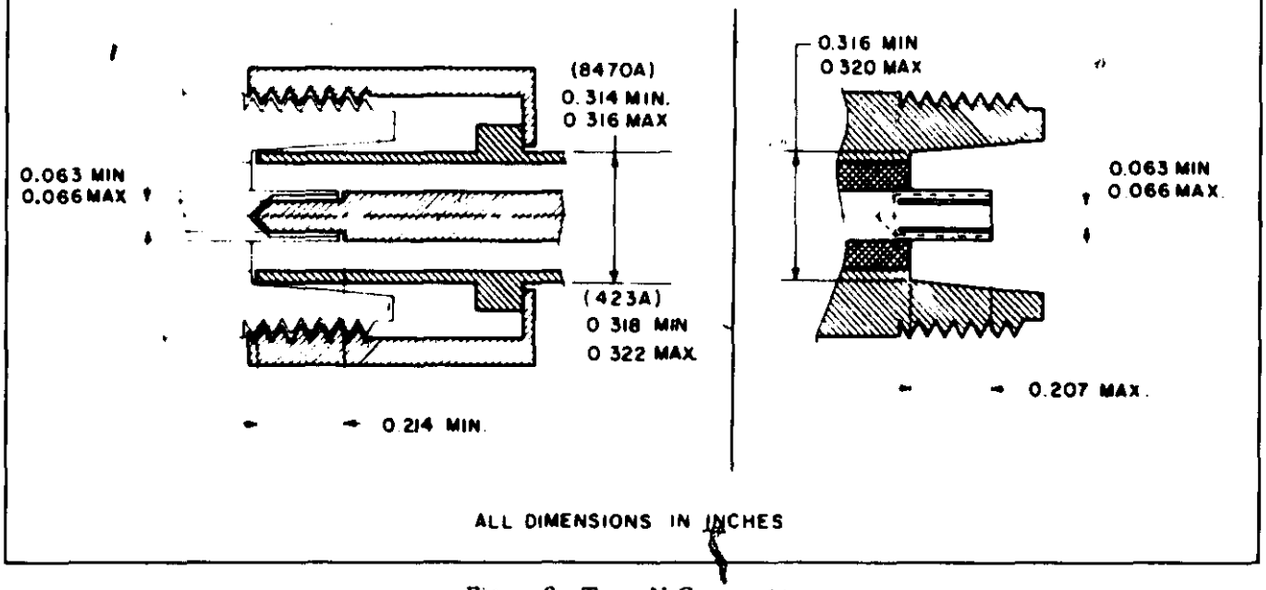


Figure 8. Type N Connector

d. Change the frequency and reset the RF output level to that measured in step c.

e. Disconnect the power meter/thermistor mount from the signal source and reconnect the detector. Total variation should be ≤1 dB to 12.4 GHz; ≤ dB to 18 GHz.

f. Repeat steps b, c, d, and e at all points of interest across the frequency band.

Sensitivity Check

a. Using a 10 MHz to 18.0 GHz signal source and a dc voltmeter as the indicator, connect the detector to the signal source and adjust the RF power level for a 100 mV detected output from the detector.

b. Disconnect the detector from the signal source and measure the RF output level. Specifications: less than 0.35 mW should produce 100 mV detected output.

PERFORMANCE CHECK

PERFORMANCE TESTS

SWR Check

SPECIFICATIONS:

10 MHz to 4.5 GHz: 1.2 SWR
4.5 to 7 GHz: 1.35 SWR
7 to 12.4 GHz: 1.5 SWR
12.4 to 18 GHz: 1.7 SWR

DESCRIPTION: The 8470A is connected to a Coaxial Swept Slotted-Line System.[1] The SWR of the 8470A is measured on a swept-frequency basis. At any frequency where the 8470A appears to be out of specifications, an SWR Meter is connected and the SWR is measured at that frequency on a single-frequency basis. If the SWR is within specifications at higher frequencies, the Detector will be within specifications at lower frequencies also.

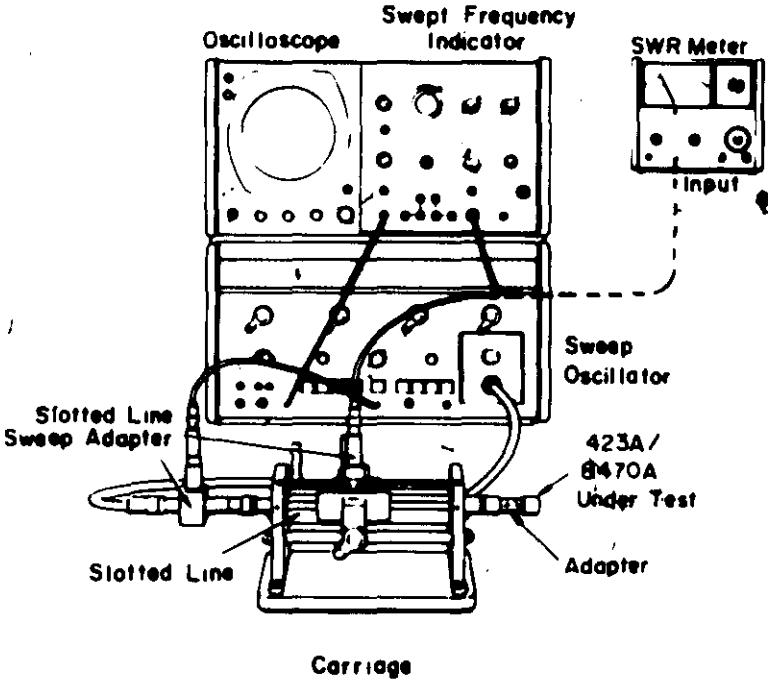


Figure 9. SWR Test Setup

EQUIPMENT:

Slotted-Line Carriage	HP 809C
Slotted-Line	HP 816A
Slotted-Line Sweep Adapter	HP 448A
The above instruments form the	HP 817A Coaxial Swept Slotted-Line System
Sweep Oscillator	HP 8690 mainframe with 8699 (110 MHz to 4 GHz)
	HP 8690 mainframe with 8693 (4 to 8 GHz)
	HP 8690 mainframe with 8694 (8 to 12.4 GHz)
	HP 8690 mainframe with 8695 (12.4 to 18 GHz)
Swept-Frequency Indicator	HP 1416A
Oscilloscope	HP 141A
SWR Meter	HP 415E
Adapter	HP 11534A

[1] For details, see Operating Note for Model 817A Coaxial Swept Slotted-Line System.

PERFORMANCE TESTS

PROCEDURE:

1. Connect the equipment as shown in Figure 9.
2. Set the Sweep Oscillator to sweep the band of interest.
3. Level the sweep oscillator as follows:
   a. Manually sweep the band and adjust Sweep Oscillator output and Slotted Line Sweep Adapter probe penetration for a leveled ALC signal with a DC output of 25 mV. Use a BNC Tee and momentarily connect the Vertical Input of the scope to view the ALC loop.
   b. Switch Sweep Oscillator to AUTO sweep and check leveling of ALC loop.
   c. Check output of 8472A with Oscilloscope. Maximum output should be 100 mV. If too high, turn Sweep Oscillator output down or insert attenuator between Slotted-Line Sweep Adapter and the Carriage.
4. Set Swept Frequency Indicator to LOG MODE with 2 dB/cm sensitivity.
5. Adjust Slotted Line probe and Swept-Frequency Indicator LOG BALANCE for a noise-free display. Use minimum possible probe penetration.
6. Set Oscilloscope PRESENTATION to WRITE.
7. Move the carriage at least one-half wavelength while sweeping the band of interest.
8. Measure the width of the trace in a vertical direction at the thickest point.
9. Compare this with specifications using the formula:

$$SWR = \log^{-1}(dB/20)$$

or

1.2 SWR = 1.58 dB
1.35 SWR = 2.61 dB
1.5 SWR = 3.52 dB
1.7 SWR = 4.61 dB

The SWR should be less than specifications. If not, measure the width of the trace without sweeping. Subtract this reading from the measured value. If the resultant is not less than specification, proceed to the following single-frequency test.

10. Set the Sweep Oscillator to MANUAL sweep. Set Sweep Oscillator to the frequency in question.
11. Connect the output of the Carriage Probe to the input of the SWR Meter. Set the SWR Meter RANGE switch to 30 dB.
12. Set the Sweep Oscillator for internal squarewave modulation and peak indication on SWR Meter.
13. Move the Carriage Probe for a maximum indication.
14. Adjust the SWR Meter GAIN control for a full-scale indication on the SWR Meter.
15. Move the Carriage Probe for a minimum indication.
16. Read the SWR from the indication.

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