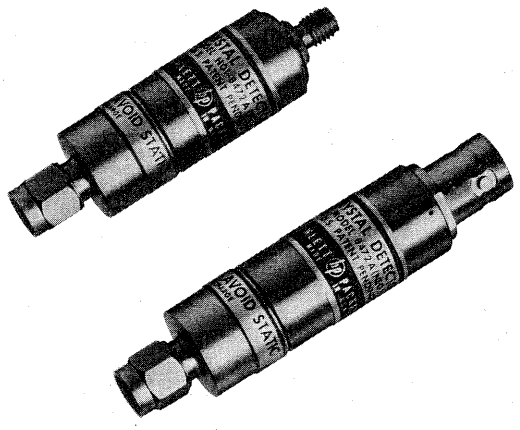
OPERATING NOTE

CRYSTAL DETECTOR

8472A

H01 8472A



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INTRODUCTION

The 8472A Crystal Detector is a 50-ohm (nominal) device designed for measurement use in coaxial systems. It measures relative power up to 100 mW, and has a BNC output jack to connect the detected output to a meter, such as the 415E. Frequency range is 10 MHz to 18.0 GHz. The H01-8472A uses an OSSM subminiature output connector.

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

PRECAUTIONS

Electrical Shock

Static discharge can damage the detector element. A 100 pF capacitor (4 feet of coax cable) charged to 14 volts stores 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.

Handling Detector Element

Do not handle detector element used in crystal detector needlessly. Static electricity which builds

Table 1. Specifications

Frequency Range: 10 MHz to 18 GHz. (Below 1 GHz, RF may leak through the video output connector. Should the leakage be objectionable, it can be eliminated with a suitable low pass filter.)

Frequency Response:* ±0.2 dB per octave, 10 MHz to 8 GHz; ±0.5 dB to 12.4 GHz, ±1 dB over-all.

Impedance: 50 ohm.

Reflection Coefficient:

10 MHz to 4.5 GHz: <0.091 (1.2 SWR, 20.8 dB return loss).

4.5 to 7 GHz: <0.15 (1.35 SWR, 16.5 dB return loss).

7 to 12.4 GHz: <0.2 (1.5 SWR, 14 dB return loss).

12.4 to 18 GHz: <0.26 (1.7 SWR, 11.7 dB return loss).

Sensitivity:

High level: <0.35 mW produces 100 mV output.

Low level: >0.4 mV dc/μW CW.

Output Impedance: 15KΩ maximum, shunted by 10 pF.

Detector Element: Supplied

Maximum Input: 100 mW, peak or average.

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

Output Polarity: Negative.

Input Connector: Male OSM-type.

Output Connector:

8472A: Female BNC.

H01-8472A: Female OSSM-type.

Dimensions:

8472A: 9/16 in. (14 mm) diameter; 2-1/2 in. (64 mm) long.

H01-8472A: 9/16 in. (14 mm) diameter; 2-1/16 in. (52 mm) long.

Weight:

8472A: Net, 1-1/2 oz (42g).

H01-8472A: Net, 1-1/4 oz (35 g).

Modifications Available on Special Order:

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.

Positive polarity output.

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

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.

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 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-Hz 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 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 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 1, 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.

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, copies of which are available upon request.

HARMONIC FREQUENCY-COMPARISON MEASUREMENTS

The detector can be used as a mixer in harmonic-frequency comparison measurements. See HP Application Note 2.

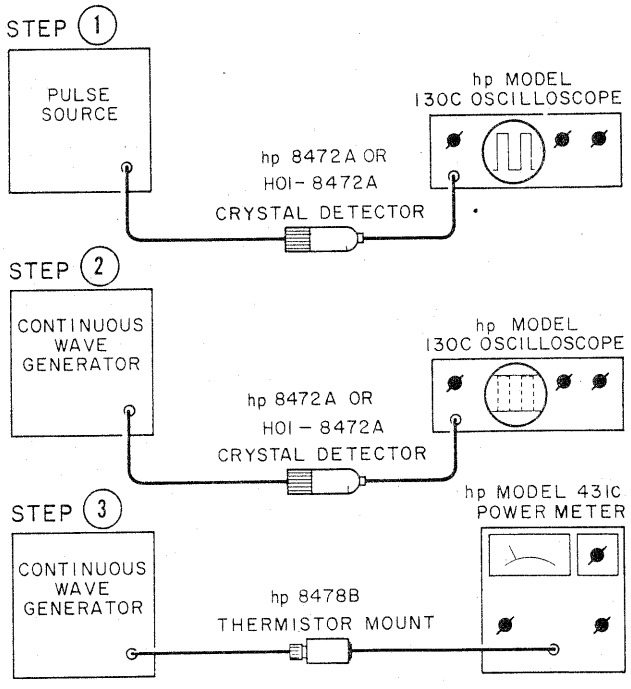

Figure 1. Peak Power Measurement

REPLACEMENT OF PARTS

Succeeding paragraphs give instructions for repair of the detector. Additional maintenance information can be obtained from your local Hewlett-Packard field office. Part numbers for replaceable parts are given in Table 2.

The detector element assembly includes a detector element, a capacitive washer and a capsule spacer. 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 2) 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 2.

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.

Table 2. Replaceable Parts, Models 8472A and H01-8472A

Description	Part No.
8472A Output Connector Assembly	08472-60003
1 Connector, BNC Female	1250-0251
2 Washer	
4 Contact Spring	
5 Tubular Resistor 40-70Ω	
8472A and H01-8472A	
3 Cap	08472-2007
6 Retainer	08472-2003
9 Capsule Spacer	5020-0208
10 Polyiron Spacer	5020-0209
11 Capacitive Washer	2190-0377
12 Body	08472-2001
13 Diode Contact	08472-2000
14 Locator	08472-2002
15 Connector, OSM Male	1250-0923
H01-8472A Output Connector Assembly	08472-60004
16 Connector, OSSM, Female	
17 Plug, Sleeve } Sleeve Assy	
18 Contact Spring	
19 Tubular Resistor 40-70Ω	
Replacement Diode Assemblies	
8 Negative Crystal Diode (standard)	
8472A	08472-60001
8472A Option 001*	08472-60005
H01-8472A	08472-60001
H01-8472A Option 001*	08472-60005
8 Positive Crystal Diode (Option 003)	
8472A	08472-60002
8472A Option 001*	08472-60006
H01-8472A	08472-60002
H01-8472A Option 001*	08472-60006

*Matched Pair of Diodes.

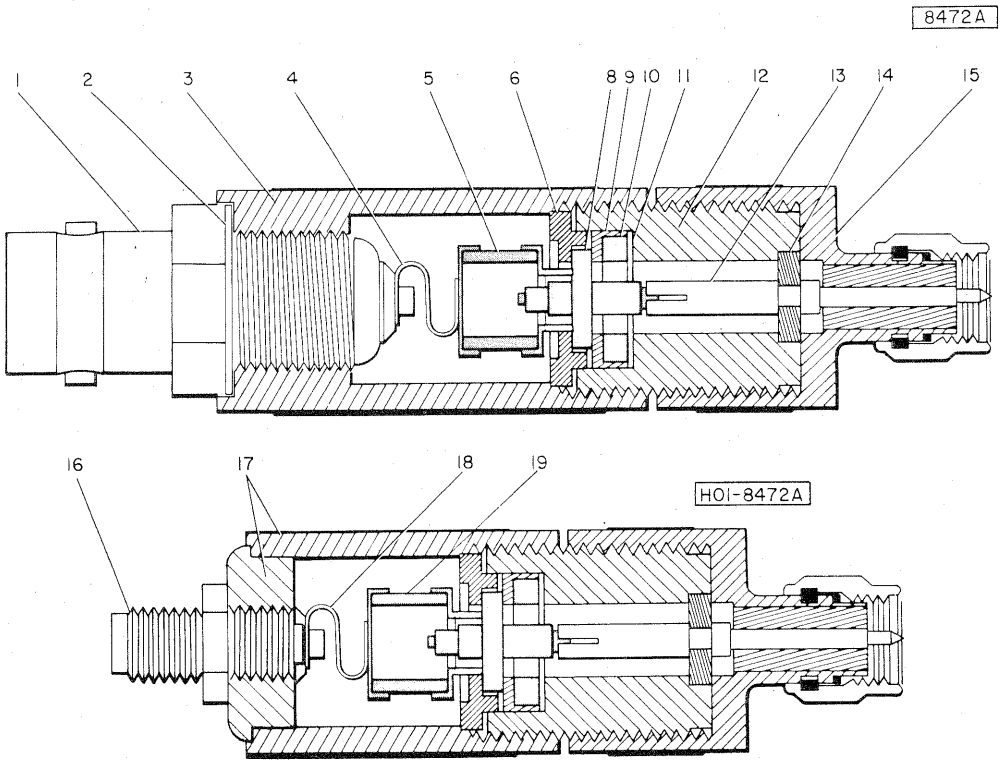

Figure 2. Models 8472A and H01-8472A Cutaway View (Refer to Table 2 for Callout Identification)

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, then 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.

d. Replace connector cap and *tighten firmly.*

Replacing 8472A 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 2 and 3.

a. Remove BNC connector and lockwasher.

b. Unsolder contact spring soldered to center conductor lead.

(1) Cut center conductor lead to approximately 1/32 inch (see Figure 3).

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

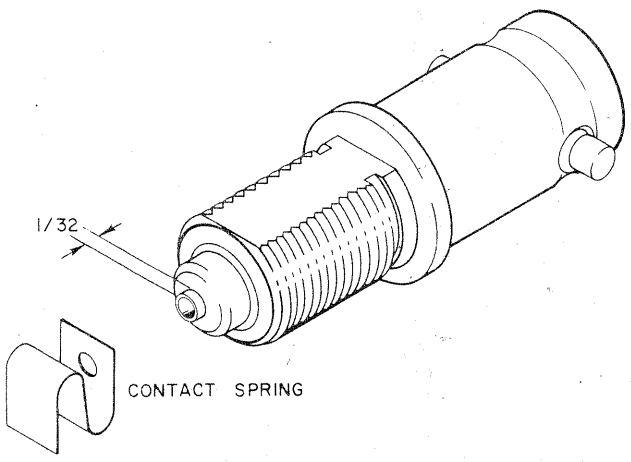

Figure 3. Cutting Center Conductor Lead to Accommodate Contact Spring

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.

Replacing H01-8472A Output OSSM Connector

To replace the OSSM connector, the procedure is the same as replacing the BNC output connector for the 8472A. Refer to the Parts List in Table 2 for the part numbers of the connector, and the center conductor contact spring.

The H01-8472A Sleeve Assembly

The sleeve assembly consists of the outer sleeve and the plug in which the OSSM connector is mounted. The plug is press-fitted into the sleeve, and is not field replaceable. If the plug or the sleeve is damaged, the entire sleeve assembly must be ordered to replace it. Table 2 lists HP part numbers for replacement.

REPLACEABLE PARTS

This section contains information pertaining to replaceable parts (see Table 2) and the ordering of these parts for the Models 8742A and H01-8472A.

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 part number

c. Description of part.

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 12.4 GHz signal source and an SWR Meter as the indicator, connect the detector to the signal source and set any convenient upper scale reference on the SWR meter.

b. Maintaining the RF output level set on the SWR meter, 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.

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. The SWR meter indication should be within 1.0 dB of original reference.

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. Specification : less than 0.35 mW should produce 100 mV detected output.

SWR Check

a. Equipment required:

(1) HP 250A RX Meter

(2) HP 803A VHF Bridge

(3) HP 417A Detector

(4) HP 809B/806B/444A Slotted Line

(5) HP 805C Slotted Line

(6) Signal sources: 10 MHz to 18.4 GHz

(7) OSM-to-Type N adapter

b. To measure the SWR of the detector in the 10- to 250-MHz range an RX meter should be used. The method of measurement is explained below.

c. Using the HP 250A RX Meter, measure the resistance (R) and capacitance (C) of the detector. Calculate the reactance of the detector from the equation: X equals 1 divided by 2 times 3.1416 times the frequency of measurement (neglecting the sign of C). Calculate the Q (when Q equals R divided by X).

d. Calculate the detector load impedance Z_L from the equation:

$$Z_L = R\sqrt{1 + (R/X)^2}$$

where Z_L = Detector load impedance.

e. Calculate the SWR of the Detector from the following two equations:

$$(1) \qquad \rho = \frac{(Z_L/Z_o) - 1}{(Z_L/Z_o) + 1};$$

$$(2) \quad SWR = \frac{1 + \rho}{1 - \rho}$$

where ρ = reflection coefficient

Z_o = characteristic impedance.

f. To measure SWR in the 250-MHz to 500-MHz range use HP 803A and HP 417A.

g. To measure SWR in 500- to 4000-MHz use 805C Slotted Line and 415E SWR Meter.

h. To measure SWR in 4- to 12.4-GHz range use the HP 809B/806B/444A Slotted Line combination.