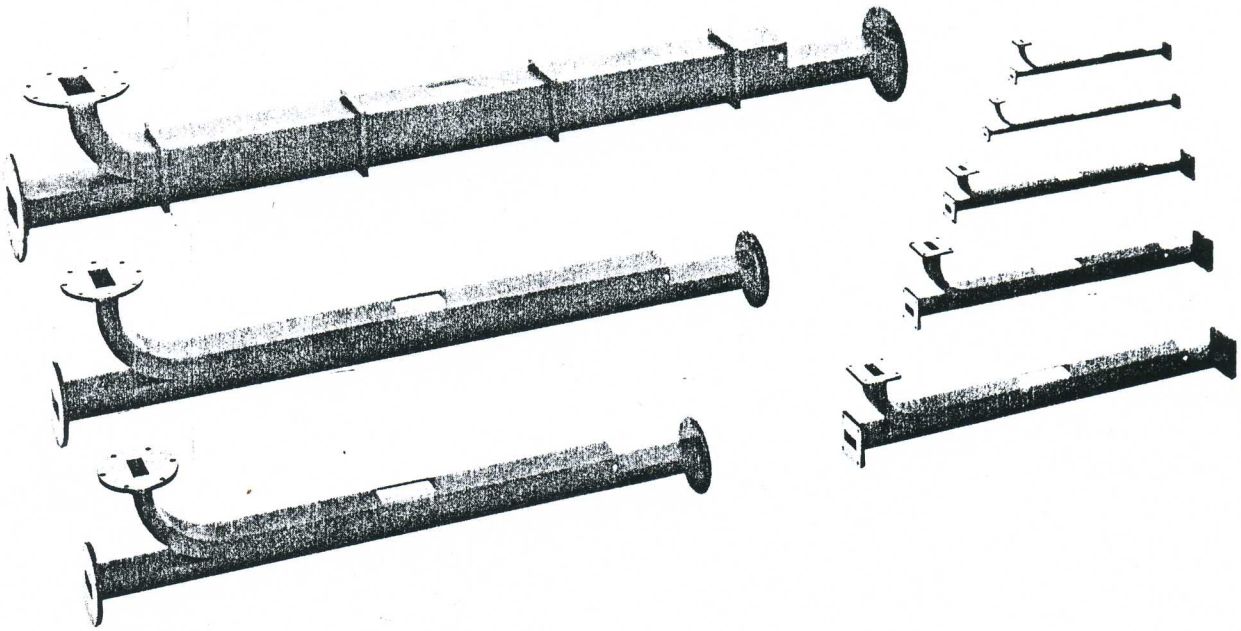
HEWLETT hp PACKARD

DIRECTIONAL COUPLER

model 752

OPERATING NOTE 1 SEPT 67



1. INTRODUCTION.

2. The uni-directional characteristic of the Model 752 Multi-hole Directional Coupler makes it an important tool in waveguide measurement systems. The Model 752 has the property of inducing, in an auxiliary guide, power flowing essentially in one direction which is proportional to the power flowing in the main guide. High directivity couplers such as the 752 series may be used in the measurement of reflection coefficients or SWR. The relatively constant coupling across the waveguide band and stability of the coupling with time make the 752 useful, also, as a wideband attenuator or for power-monitoring applications.

3. DESCRIPTION.

4. A Model 752 Directional Coupler consists of two waveguide sections, the main guide and the auxiliary guide, bonded together along their broad surfaces. One end of the auxiliary guide has a built-in matched termination. The other end has a flanged port. An array of holes in the common wall between the two guides transfers power from one guide to the other.

5. Power entering at the input of the coupler flows along the main guide and divides at the coupling array. Part is coupled into the auxiliary guide, the rest continues along the main guide. The amount of power coupled into the auxiliary guide, depends upon the coupling factor (defined in Figure 1). With the Model 752 coupling factors, the power coupled into the auxiliary guide can be 50 (3dB), 10 (10dB), or 1 (20dB) per cent of the power entering the main guide.

6. Ideally, all of the power coupled into the auxiliary guide flows to the output. In practice, however, a small fraction flows in the opposite direction and is absorbed in the termination. As shown in Figure 1, the ratio in dB of forward to reverse power in the auxiliary guide is the directivity of the coupler.

Model X 752 D Serial 16884

TEST DATA COUPLING CHARACTERISTICS.

Frequency (GHz)	Coupling (dB)
8.20	19.5
9.25	20.3
10.30	20.4
11.35	20.1
12.40	19.6

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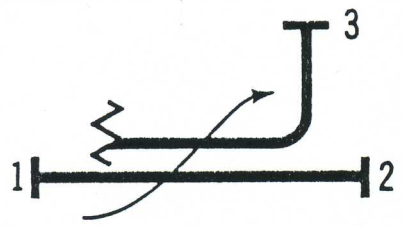


$$\text{COUPLING} = 20 \log \left(\frac{1}{S_{31}}\right)$$

$$\text{DIRECTIVITY} = 20 \log \left(\frac{S_{31}}{S_{32}}\right)$$

S_{31} = Wave amplitude out at port 3 for unity input at port 1 with port 2 perfectly terminated

S_{32} = Wave amplitude out at port 3 for unity input at port 2 with port 1 perfectly terminated.

Figure 1. Basic Directional Coupler Definitions

7. Although directivity varies somewhat with frequency, and the directivity characteristics of couplers in the same frequency range differ to some extent, the minimum directivity of Model 752 couplers is 40 dB.

8. OPERATION.

9. PRECAUTIONS.

10. PROTECT FLANGES. Protect the surfaces of the coupling flanges from damage. Surface irregularities cause discontinuity and increased SWR. The supplied plastic covers should be used to protect the flanges when the coupler is not in use.

11. AVOID MECHANICAL SHOCK. Mechanical shock perpendicular to the long axis of the coupler can break the tapered terminations in the auxiliary guide.

12. POWER SAMPLING.

13. The coupler ports are identified in Figure 1. Apply power to be sampled to port 1, and take the sample from port 3.

TABLE 1. SPECIFICATIONS

Band[1] (Prefix)	Frequency (GHz)	Fits Waveguide Size Nominal OD (In.)	EIA	Mean Coupling Accuracy[2]	Coupling Variation[3]	Directivity[4]	SWR[4,5] Main Guide 752A	SWR[4,5] Main Guide 752C/D	Average Power Aux Guide Load (W)
S	2.6 - 3.95	3 x 1 1/2	WR 284	≤ ±0.4 dB	≤ ±0.5 dB	≥ 40 dB	≤ 1.1	≤ 1.05	2
G	3.95 - 5.85	2 x 1	WR 187						2
J*	5.85 - 8.2	1 1/2 x 3/4	WR 137						1
H	7.05 - 10.0	1 1/4 x 5/8	WR 112						1
X	8.2 - 12.4	1 x 1/2	WR 90						1
M	10.0 - 15.0	0.850 x 0.475	WR 75						1
P	12.4 - 18.0	0.702 x 0.391	WR 62						1
K†	18.0 - 26.5	0.500 x 0.250	WR 42	≤ ±0.7					0.5
R†	26.5 - 40.0	0.360 x 0.220	WR 28	≤ ±0.7	752D ≤ ±0.6 dB				0.5

Band[1] (Prefix)	Length 752A (in.)	Length 752A (mm)	Length 752C (in.)	Length 752C (mm)	Length 752D (in.)	Length 752D (mm)	Weight Net (lb.)	Weight Net (kg)
S	50 1/4	1276	48	1219	48	1219	23 3/4	10,7
G	34 1/2	876	33	838	33	838	8 3/4	3,9
J*	26 1/2	673	25 9/16	649	25 9/16	649	5 1/4	2,4
H	18 5/8	473	17 1/2	445	17 1/2	445	2 3/4	1,2
X	16 11/16	424	15 11/16	399	15 11/16	399	1 3/4	0,8
M	16 5/16	414	15 11/16	399	15 11/16	399	1 1/4	0,56
P	13 3/4	349	12 1/4	311	12 1/4	311	3/4	0,34
K†	10 5/8	270	9 15/16	252	9 15/16	252	1/2	0,23
R†	11 5/8	295	8 5/8	219	8 23/32	222	1/4	0,11

[1] Letter suffix indicates nominal coupling, "A" for 3 dB, "C" for 10 dB, "D" for 20 dB (example: S-band, 3-dB coupling Model S752A).

[2] Mean coupling is the average of the maximum and minimum coupling values in the rated frequency range.

[3] ±0.6 dB for R752D.

[4] Swept-frequency tested.

[5] Auxiliary arm SWR is 1.15 except for P, K and R band, for which it is 1.2.

*J752 couplers operate to 5.3 GHz with reduced performance. Directivity: Greater than 40 dB, 5.85 to 5.5 GHz; greater than 36 dB, 5.5 to 5.3 GHz. Variation of coupling from nominal value: not more than - 1.2 dB at 5.5 GHz; not more than -1.7 dB at 5.3 GHz.

† Circular flange adapters available: HP 11515A for K-band (UG-425), HP 11516A for R-band (UG-381).

14. APPLICATIONS.

15. The use of directional couplers for transmission and reflection measurements is detailed in Hewlett-Packard Application Note 65, Swept Frequency Techniques. Copies of this Note can be obtained from the HP sales and service offices listed on the back pages of this Operating Note.

16. PERFORMANCE CHECK.

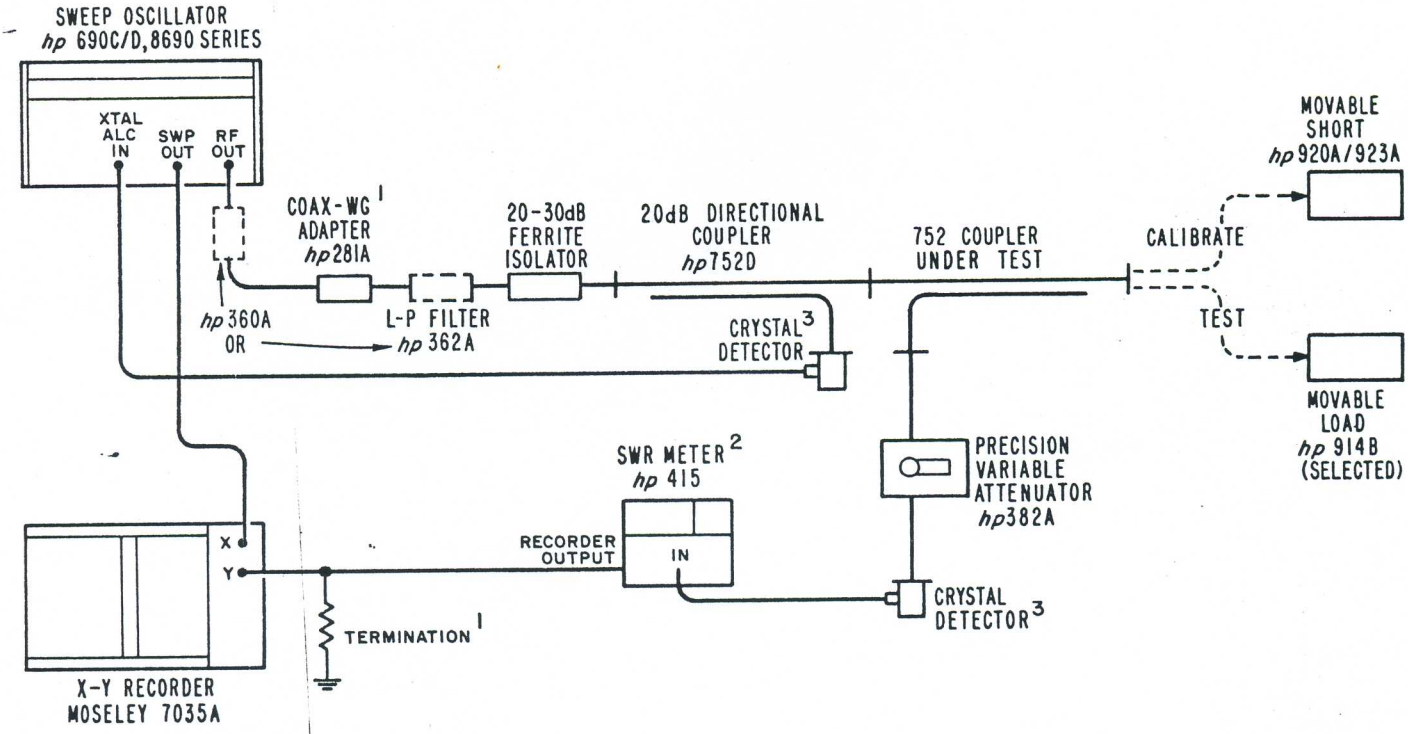
17. DIRECTIVITY.

18. Directivity is the ratio in dB of forward to reverse power in the auxiliary guide when all of the power in the main guide is flowing in the forward direction. To sweep-test the directivity of the Model 752, use the setup of Figure 2. The standing wave meter is used for amplifying the detected signal to obtain maximum sensitivity. When using a Model 415 the sweep oscillator output must be amplitude modulated at 1 kHz. The PIN modulated HP 690/8690 series Sweep Oscillators are especially well suited to this application because of their superior amplitude stability during the combined operation of leveling and modulating. The dc recorder output from the SWR meter drives the X-Y recorder.

19. With the short connected as shown in Figure 2, set the variable attenuator to values of attenuation near the anticipated directivity of the coupler in test, and plot calibration grid lines on the recorder at each attenuator setting. For better accuracy, use a movable short and rapidly phase the short during each calibration sweep. Now return the attenuator to zero and replace the calibrating short with the best available load.

20. With the sweep oscillator set for about a 40-second sweep time, trigger a final sweep and continuously phase the sliding load during the sweep.

21. By sliding the load and sweeping slowly, all possible phase combinations of true directivity signal and the load reflections are encountered. Thus, the combined signal arriving at the reverse detector swings between the vector sum and difference of the two signal components. If the swing is small as shown throughout most of Figure 3, the load reflection is small compared to the directivity phasor or the directivity is very high. Under these conditions, a good approximation of the highest reflection is the average of the swing and, by definition of directivity, one can add the transmission loss of the coupler to the measured average of the reflection swing to determine if



1. AS REQUIRED
2. 415D METER DAMP switch to OUT
3. *hp* 424A (Option 01 recommended), 2.6 - 18GHz
   hp Option 01 422A (loads removed), 18 - 40GHz

752 - A - 48

Figure 2. Setup for Swept-frequency Directivity Test

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