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Building a Waveguide to Coax Transition

2/2/19

N5BRG

Commercial Rectangular Brass Tubing Frequency Cutoff

Retangular Waveguide	TE10 Mode	Dominant Mode			
	(in)	(in)	(m)	(m)	(GHz)
	a	b	a	b	Fc
Pozar Example -->	0.421259	0.4	0.011	0.010	9.71
	0.9	0.4	0.023	0.010	6.56
	1.122	0.497	0.028	0.013	5.26
	0.622	0.311	0.016	0.008	9.49
	0.875	0.375	0.022	0.010	6.74

Round Pipe	TE11 Mode	Radius			
	a	a	P'11=	1.841	
	in	(cm)			
	0.20	0.5			12.19
	0.375	0.95			9.23
	0.5	1.27			6.92
	0.75	1.91			4.61
	1	2.54			3.46
	1.25	3.18			2.77
	1.5	3.81			2.31
	2	5.08			1.73
	3	7.62			1.15

Assumes dielectric is air. Consider using a filler material (Teflon).

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Tools Used and Tubing

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Vendor

Mc Murray Metals Co
https://www.mcmurraymetals.com/
3000 Elm St
Dallas, TX 75226
214-742-5654
800-658-5655

Purchased: Tubing ¾ X ½ inches
Square Plates 1/8 X 1 5/8 X 1 5/8 inches

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W1GHZ QEX Paper

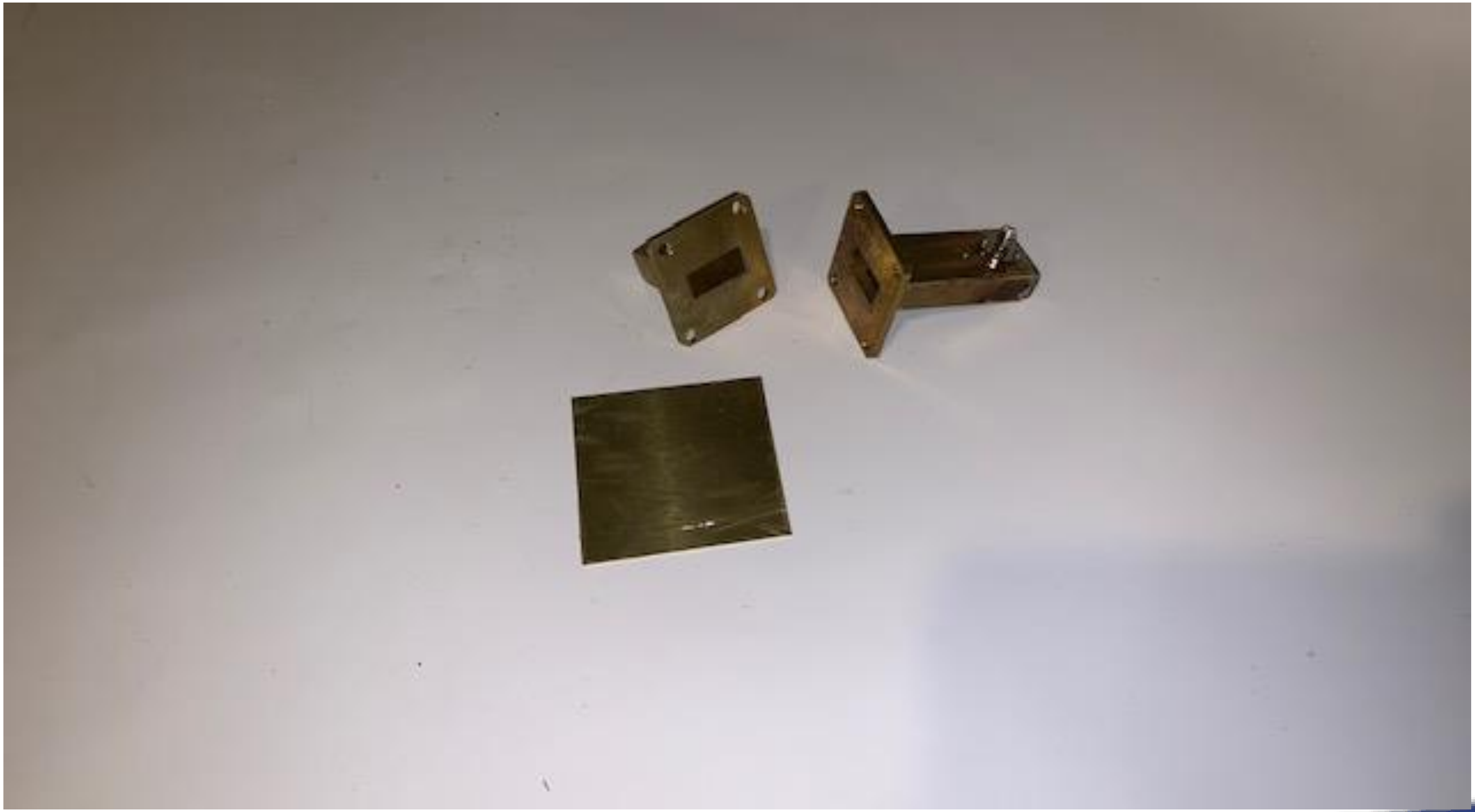
Rectangular Waveguide to Coax Transition Design from *QEX, Nov/Dec 2006.*

Rectangular waveguide transitions to

Table 1
Rectangular Waveguide to Coax Transitions W1GHZ 2006

Waveguide	*Frequency (GHz)*	*Probe Diameter (mm)*	*Probe Length (mm)*	*Backshort Length (mm)*	*Bandwidth*	*Number Tested*
WR-42	24.192	1.27	2.41	2.49	>17%	4
WR-75	10.368	1.27	5.49	5.26	14%	1
WR-90	10.368	1.27	5.89	5.46	7%	5
WR-112	10.368	1.27	6.5	6.6	15%	1
WR-112	5.76	1.27	~~9.8~~ 8.8	~~5.8~~ 9.8	7%	
WR-137	5.76	1.27	10.5	8.5	10%	1
WR-159	5.76	1.27	11.17	10.0	11%	1
WR-159	5.76	AWG no. 12	10.9	10.0	14%	
WR-187	5.76	2.36	11.3	11.0	16%	
WR-187	5.76	SMA to 2.36	11.6	9.7	16%	1
WR-187	5.76	AWG no. 12	11.3	11.2	14%	
WR-187	3.456	2.36	14.5	18.0	5%	
WR-187	3.456	SMA to 2.36	15	16.5	5%	1
WR-187	3.456	AWG no. 12	14.9	17.4	7%	
WR-229	3.456	1.27	18.2	15.0	8%	
WR-229	3.456	AWG no. 12	17.7	15.1	10%	
WR-229	3.456	2.36	17.4	15.06	11%	
WR-229	3.456	3.175	17	15.6	11%	

Two Completed Coax to WG Transitions and Back plate material



Completed Coax to Waveguide Transition

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HP8909B Slotted Line Fixture

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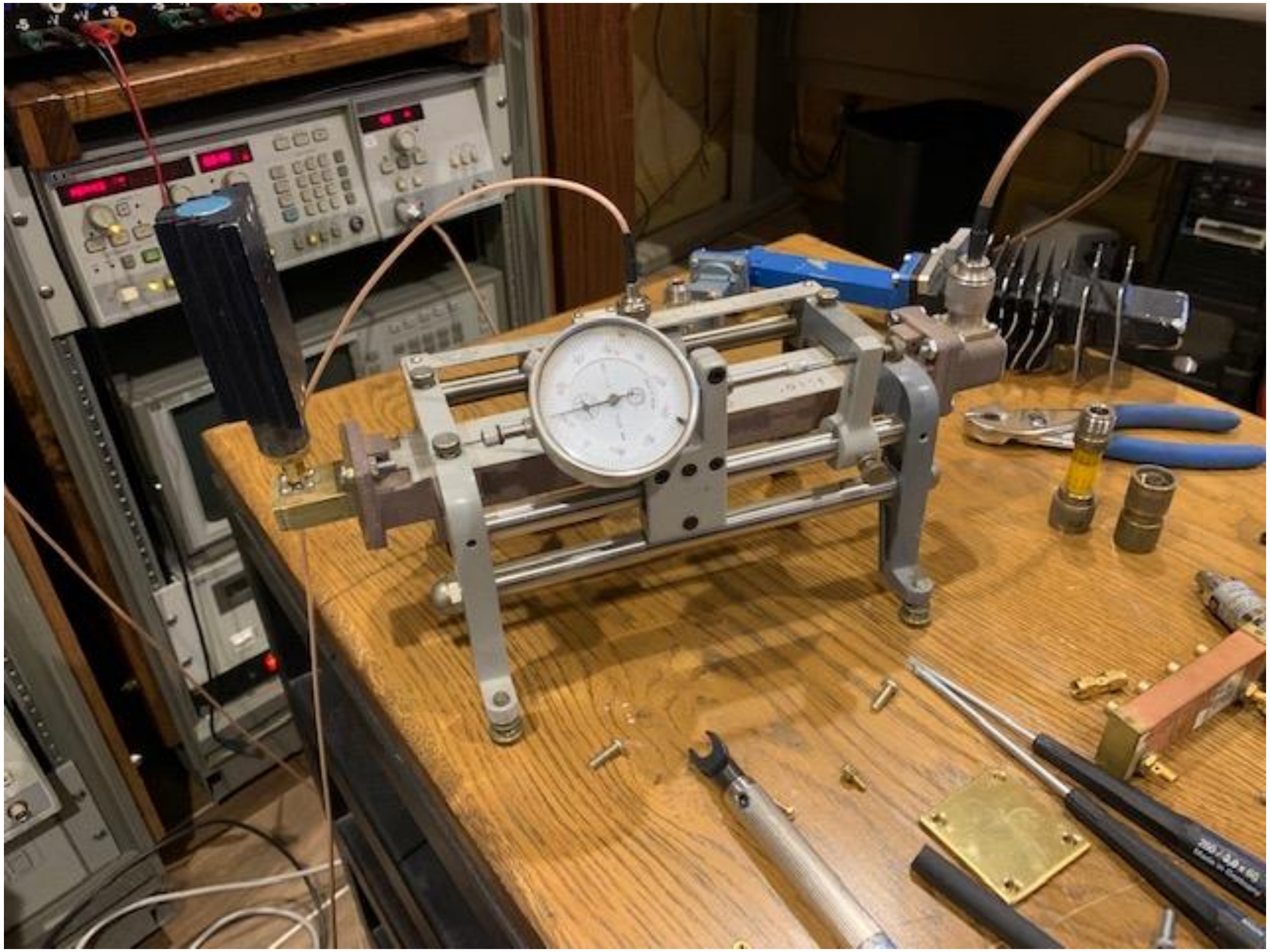

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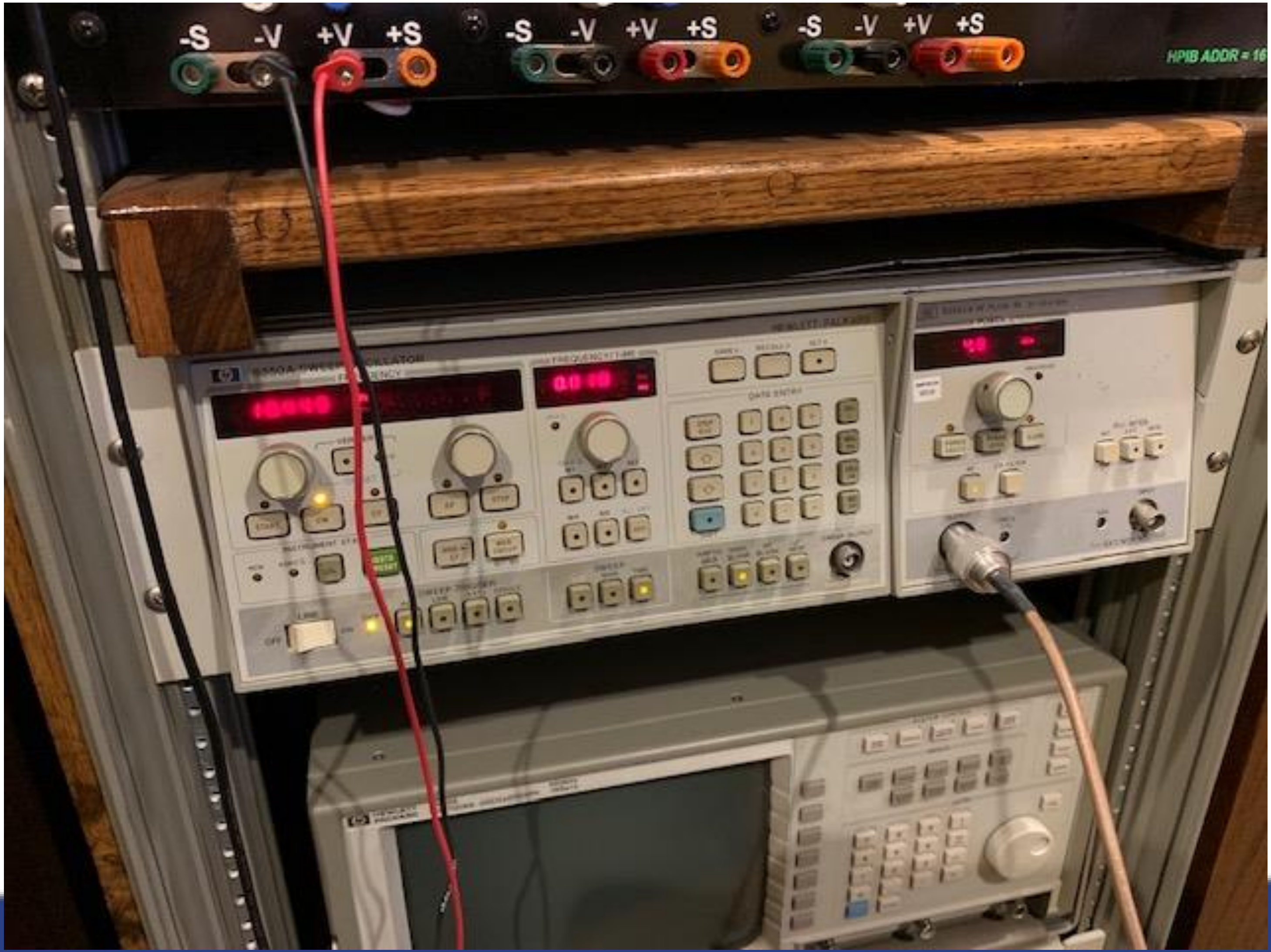
HP8350A



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Testing

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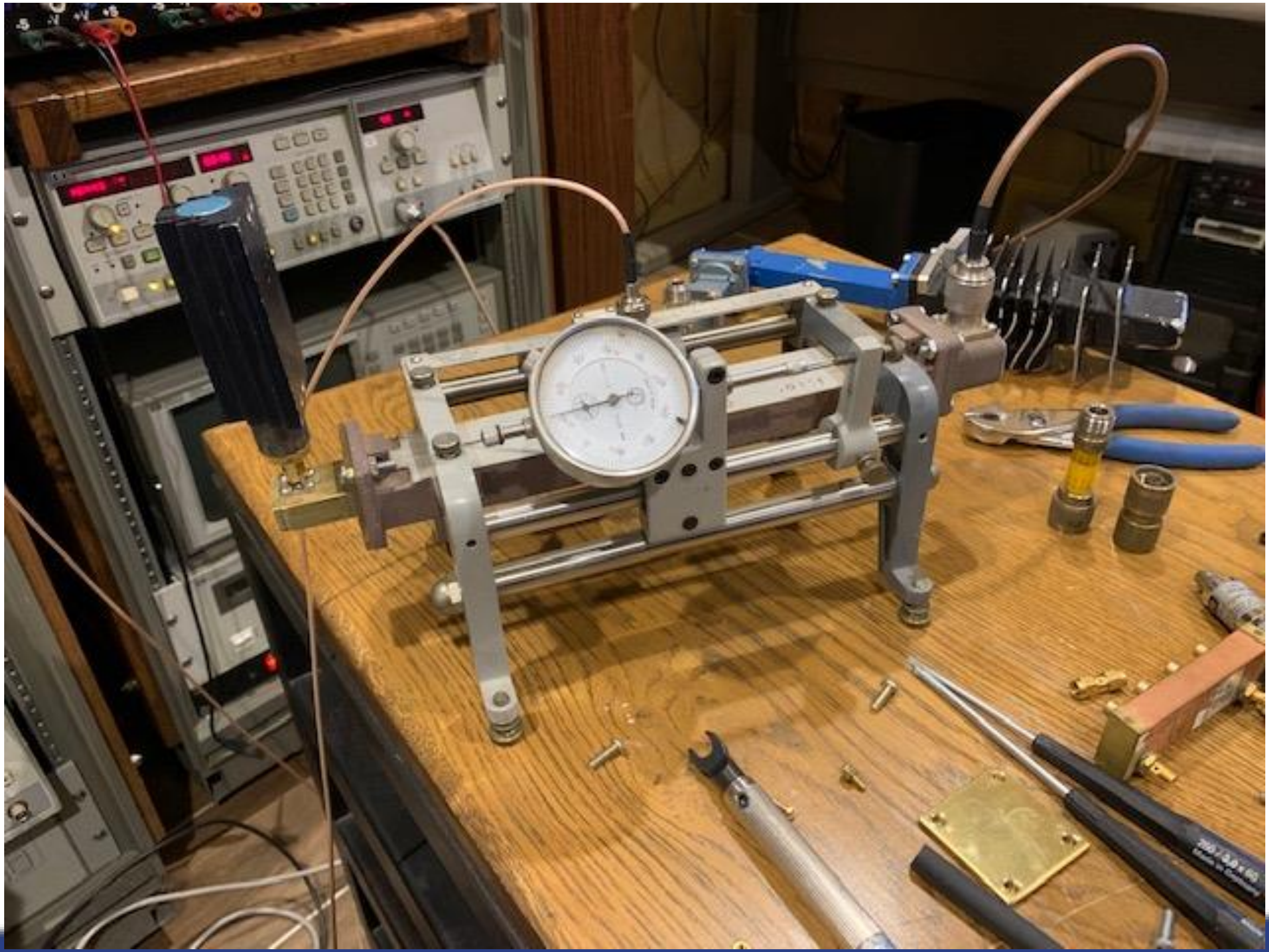

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Spectrum Analyzer

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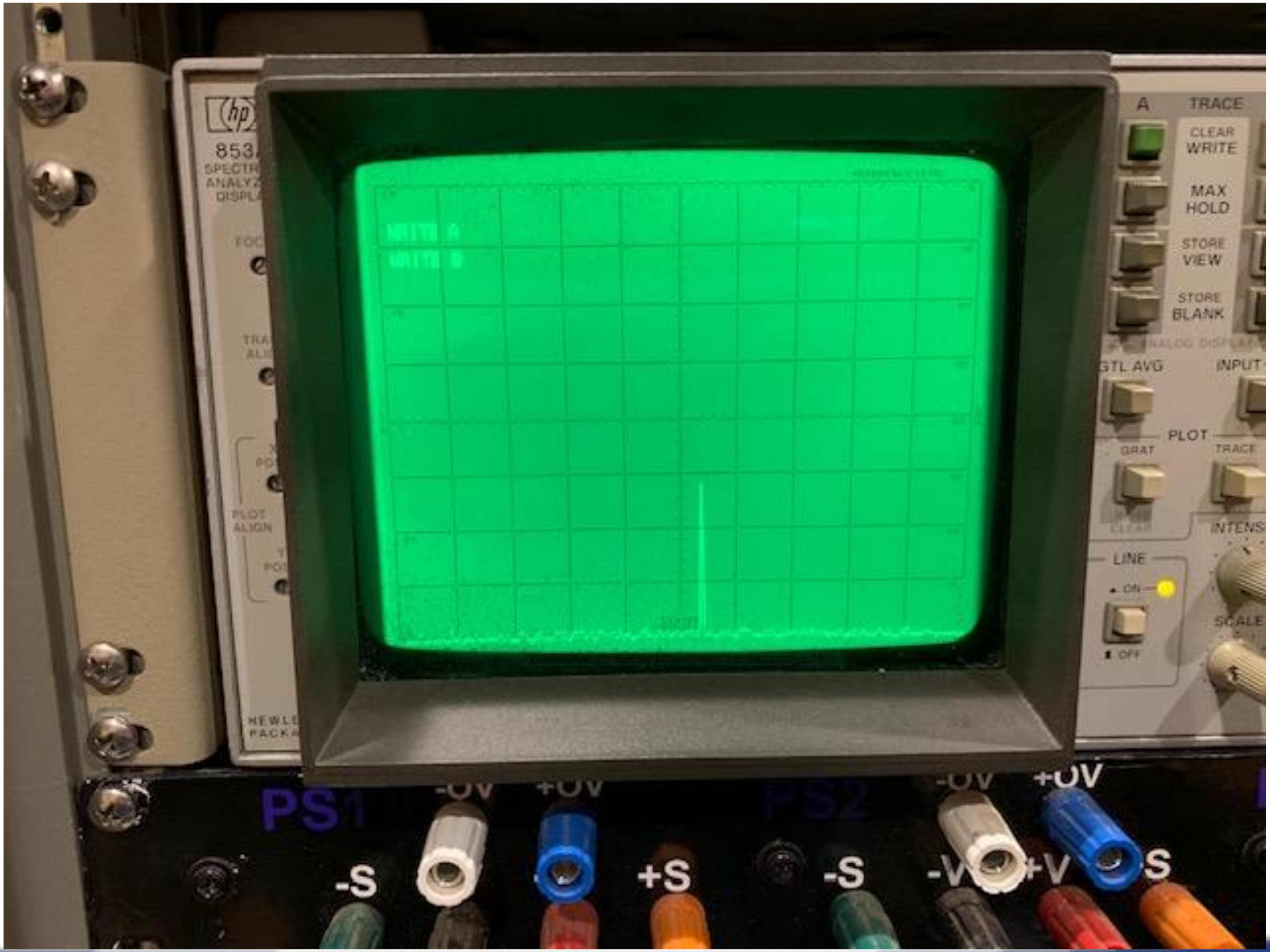

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10.368 GHz Wavelength in Waveguide

WAVELENGTH

dielectric (air)	1		
pi	3.14		
2 pi	6.28		
c	300		
f	10368		
a	0.0222 meters	0.875 inches	
		full	half
Wavelength(g)	0.0381 meters	1.501 inches	0.750 inches
Wavelength	0.0289	1.139	0.570

Error Sources

- dielectric ; moisture - humidity&temp, homgeneous
- a; dimensional varations, contamination, burrs
- f: errors in test frequency accuracy

Measurement issues; X position, Power resolution and stability

Ref: Microwave Engineering Third Edition by Pozar

HP809B
Manual
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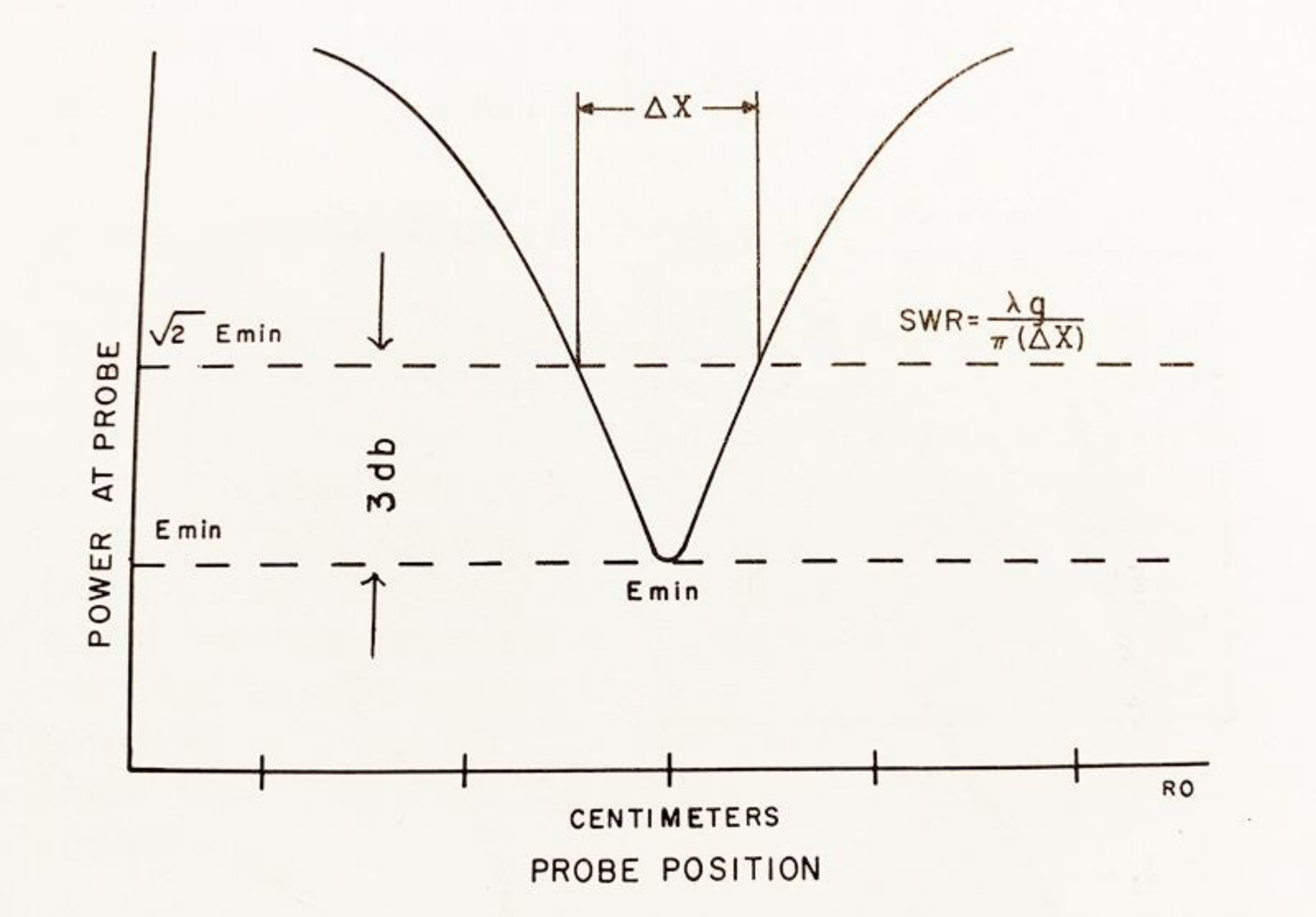

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$$z_L = \frac{1 - j(SWR)\,\mathrm{Tan}\,X}{(SWR) - j\,\mathrm{Tan}\,X}$$

where $X = \dfrac{180^{\circ}\,(\pm\,\Delta d)}{\frac{\lambda}{2}}$

and $\pm\,\Delta d$ = Shift in centimeters of the minimum point when the short is applied.

Δd takes a positive (+) sign when the minimum shifts toward the load.

Δd takes a negative (-) sign when the minimum shifts toward the generator.

$\frac{\lambda}{2}$ = One-half line or guide wavelength. It is the distance in centimeters as measured between two adjacent minima.

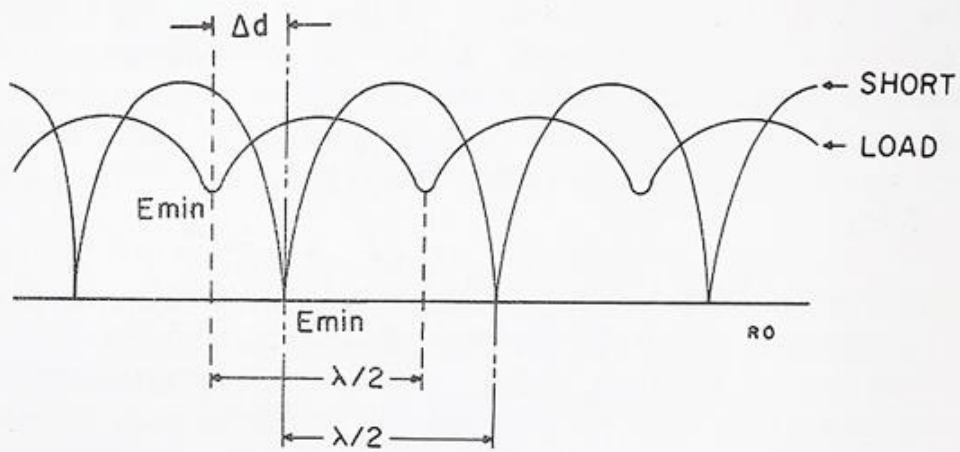

Figure 2-4. Graph Showing Standing Wave Patterns with a Load and Short

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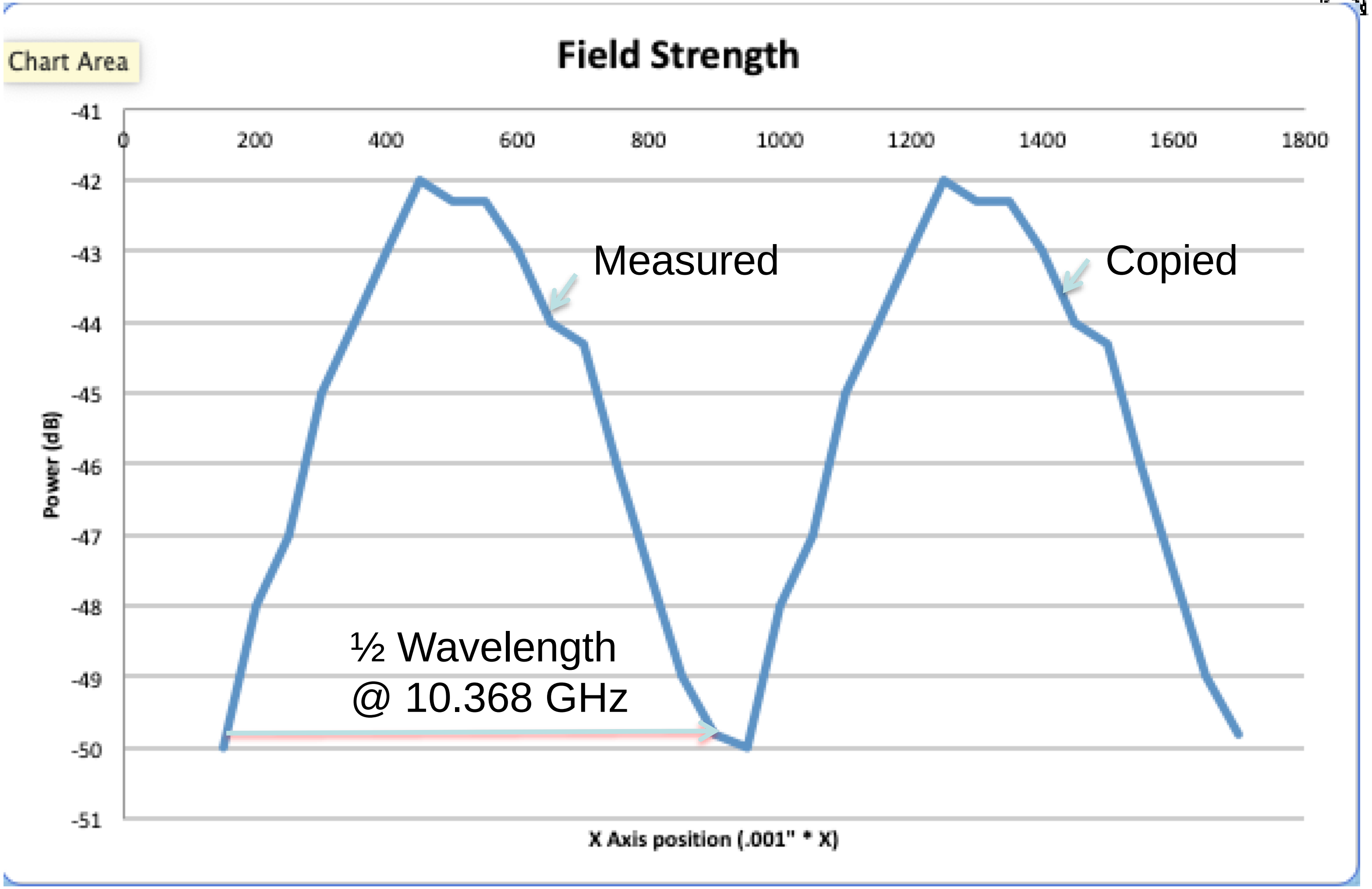
Test Results



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Using Waveguide Load with directional coupler

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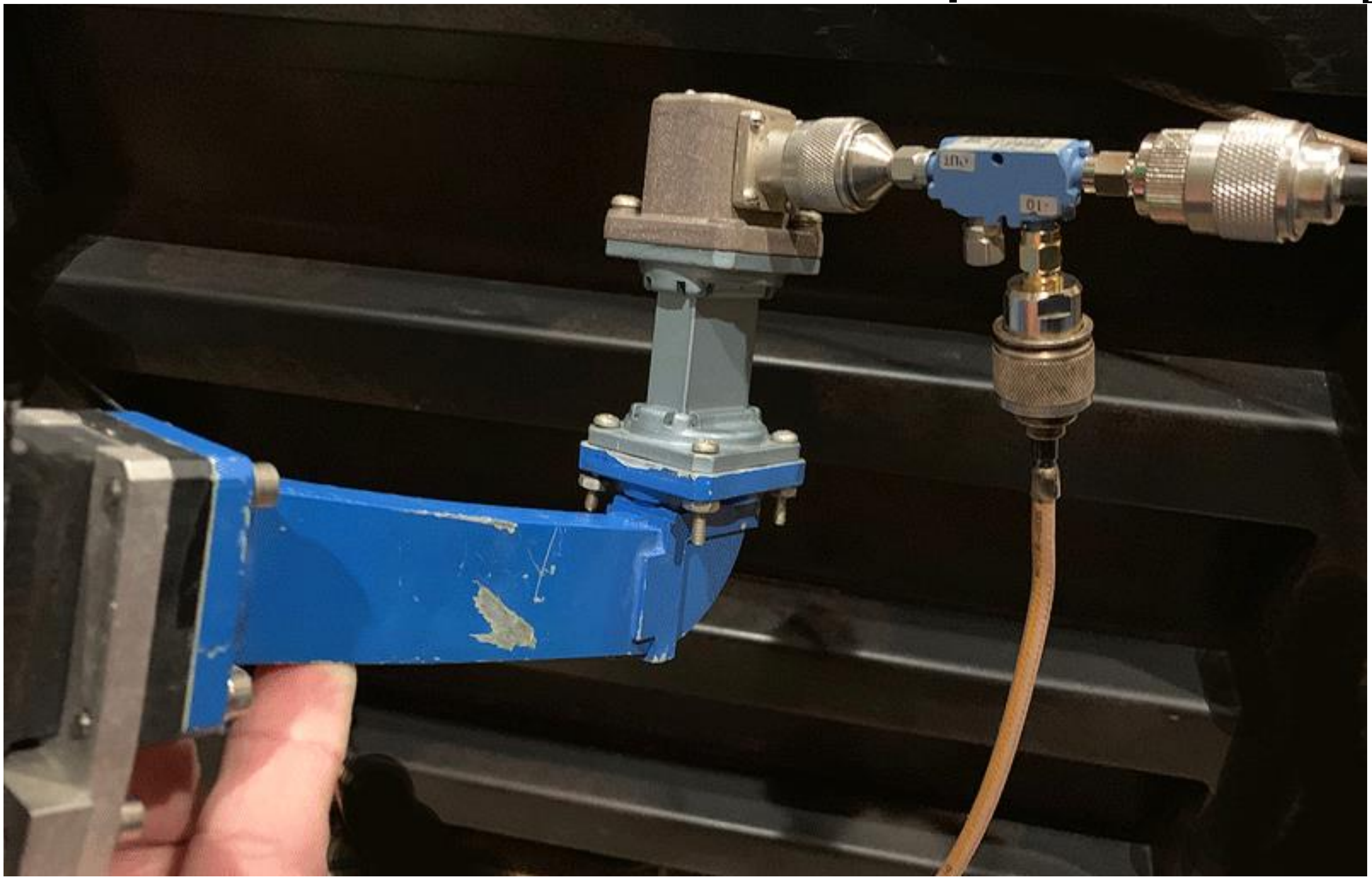

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Using Directional Coupler 2nd Transition + 50 Ohm Load

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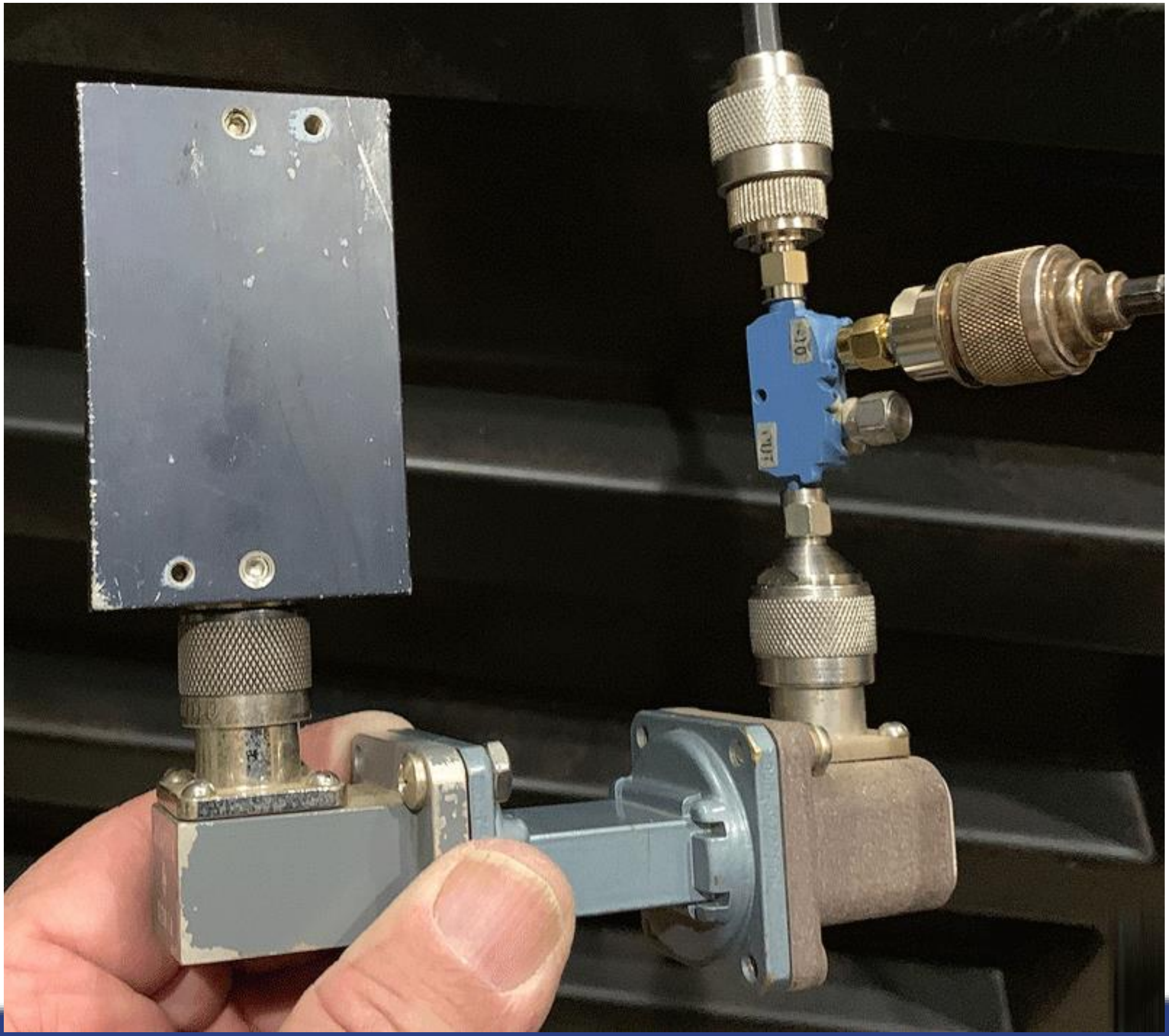

Return Power using Directional Coupler

Transition Tested	(dB)	(dB)	
A	-9	-19	Waveguide 50 ohm
X281A Gray	1	-32	Waveguide 50 ohm
B	-20	-30	Waveguide 50 ohm
C	-20	-34	Waveguide 50 ohm
X281A Gray	-22	-22	Waveguide 50 ohm
X281A Black	-22.5	-21	Waveguide 50 ohm
X281A Gray X281A Brown	-20	-22	No load - Open
	-20	-21	N 50 Ohm Load
A	-20	-27	N 50 Ohm Load

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Minicircuits SWR Chart
Fwd_Pwr vs. Rtn_Pwr = Return Loss

- https://www.minicircuits.com/app/DG03-111.pdf

RETURN LOSS (dB)	VSWR	RETURN LOSS (dB)	VSWR	RETURN LOSS (dB)	VSWR	RETURN LOSS (dB)	VSWR	RETURN LOSS (dB)	VSWR
46.064	1.01	13.842	1.51	9.485	2.01	7.327	2.51	5.999	3.01
40.086	1.02	13.708	1.52	9.428	2.02	7.294	2.52	5.970	3.02
36.607	1.03	13.577	1.53	9.372	2.03	7.262	2.53	5.956	3.03
34.151	1.04	13.449	1.54	9.317	2.04	7.230	2.54	5.935	3.04
32.256	1.05	13.324	1.55	9.262	2.05	7.198	2.55	5.914	3.05
30.714	1.06	13.201	1.56	9.208	2.06	7.167	2.56	5.893	3.06
29.417	1.07	13.081	1.57	9.155	2.07	7.135	2.57	5.872	3.07
28.299	1.08	12.964	1.58	9.103	2.08	7.105	2.58	5.852	3.08
27.318	1.09	12.849	1.59	9.051	2.09	7.074	2.59	5.832	3.09
26.444	1.10	12.736	1.60	8.999	2.10	7.044	2.60	5.811	3.10
25.658	1.11	12.625	1.61	8.949	2.11	7.014	2.61	5.791	3.11
24.943	1.12	12.518	1.62	8.899	2.12	6.984	2.62	5.771	3.12
24.289	1.13	12.412	1.63	8.849	2.13	6.954	2.63	5.751	3.13
23.686	1.14	12.308	1.64	8.800	2.14	6.925	2.64	5.732	3.14
23.127	1.15	12.207	1.65	8.752	2.15	6.896	2.65	5.712	3.15
22.607	1.16	12.107	1.66	8.705	2.16	6.867	2.66	5.693	3.16
22.120	1.17	12.009	1.67	8.657	2.17	6.839	2.67	5.674	3.17
21.664	1.18	11.913	1.68	8.611	2.18	6.811	2.68	5.654	3.18
21.234	1.19	11.818	1.69	8.565	2.19	6.783	2.69	5.635	3.19
20.828	1.20	11.725	1.70	8.519	2.20	6.755	2.70	5.617	3.20
20.443	1.21	11.634	1.71	8.474	2.21	6.728	2.71	5.598	3.21
20.079	1.22	11.545	1.72	8.430	2.22	6.700	2.72	5.579	3.22
19.732	1.23	11.457	1.73	8.386	2.23	6.673	2.73	5.561	3.23
19.401	1.24	11.370	1.74	8.342	2.24	6.646	2.74	5.542	3.24
19.085	1.25	11.285	1.75	8.299	2.25	6.620	2.75	5.524	3.25
18.783	1.26	11.202	1.76	8.257	2.26	6.594	2.76	5.506	3.26
18.493	1.27	11.120	1.77	8.215	2.27	6.567	2.77	5.488	3.27
18.216	1.28	11.039	1.78	8.173	2.28	6.541	2.78	5.470	3.28
17.949	1.29	10.960	1.79	8.138	2.29	6.516	2.79	5.452	3.29
17.690	1.30	10.881	1.80	8.091	2.30	6.490	2.80	5.435	3.30
17.445	1.31	10.804	1.81	8.051	2.31	6.465	2.81	5.417	3.31
17.207	1.32	10.729	1.82	8.011	2.32	6.440	2.82	5.400	3.32
16.977	1.33	10.654	1.83	7.972	2.33	6.415	2.83	5.383	3.33
16.755	1.34	10.581	1.84	7.933	2.34	6.390	2.84	5.365	3.34
16.540	1.35	10.509	1.85	7.894	2.35	6.366	2.85	5.348	3.35
16.332	1.36	10.437	1.86	7.856	2.36	6.341	2.86	5.331	3.36
16.131	1.37	10.367	1.87	7.818	2.37	6.317	2.87	5.315	3.37
15.936	1.38	10.298	1.88	7.781	2.38	6.293	2.88	5.298	3.38
15.747	1.39	10.230	1.89	7.744	2.39	6.270	2.89	5.281	3.39
15.563	1.40	10.163	1.90	7.707	2.40	6.246	2.90	5.265	3.40
15.385	1.41	10.097	1.91	7.671	2.41	6.223	2.91	5.248	3.41
15.211	1.42	10.032	1.92	7.635	2.42	6.200	2.92	5.232	3.42
15.043	1.43	9.968	1.93	7.599	2.43	6.177	2.93	5.216	3.43
14.879	1.44	9.904	1.94	7.564	2.44	6.154	2.94	5.200	3.44
14.719	1.45	9.842	1.95	7.529	2.45	6.131	2.95	5.184	3.45
14.564	1.46	9.780	1.96	7.494	2.46	6.109	2.96	5.168	3.46
14.412	1.47	9.720	1.97	7.460	2.47	6.086	2.97	5.152	3.47
14.264	1.48	9.660	1.98	7.426	2.48	6.064	2.98	5.137	3.48
14.120	1.49	9.601	1.99	7.393	2.49	6.042	2.99	5.121	3.49

Sweep Frequencies to find

- Using a directional coupler monitor return power and sweep carrier frequency over band of interest.
- The minimum dip will occur at ideal frequency for coupler. (Showed Movie)
- Ideal for my Transition ‘A’ was 9.8 GHz.
- Design needs modification!

Conclusion

- A method for building coax to waveguide transitions using standard tubing shown.
- Three methods for testing a hand made coax to waveguide transition where shown.
- Possible to build and test a transition using these methods that will work on any band.
- Important to test your transition commercial or hand made to be sure you are radiating the max and not reflecting back into your transmitter/amp.