Laboratory Use of the Agilent E5071C Network Analyzer

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***Abstract*—This report documents the use of the Agilent E5071C Vector Network Analyzer (VNA) to characterize the performance of a Mini-Circuits ZAPDQ-2-S power splitter over the 0.8–2.2 GHz frequency range. Utilizing the 85052D calibration kit, S-parameters were measured at five distinct frequencies (0.85, 1.15, 1.5, 1.85, and 2.15 GHz) to assess insertion loss, return loss, phase imbalance, amplitude imbalance, isolation, and VSWR. The results are compared with theoretical and specified values to evaluate the device's compliance with nominal performance criteria. Key deviations were observed, particularly in phase imbalance, while amplitude and isolation generally aligned with expectations.**

***Index Terms*—VNA, S-parameters, Power Splitter**

I. Introduction

The Agilent E5071C Vector Network Analyzer (VNA) is a crucial tool for characterizing high-frequency components in RF systems. Its ability to measure S-parameters enables the analysis of both magnitude and phase response in linear, passive networks. This lab introduces practical operation of a VNA by evaluating a Mini-Circuits ZAPDQ-2-S two-way power splitter—a device expected to exhibit equal power division, 90° phase shift between outputs, and high port-to-port isolation within the 1.0–2.0 GHz range.

The primary objectives of this experiment were to develop proficiency in using the VNA and to compare theoretical circuit behavior to empirical RF measurements.

II. Methodology

This lab uses the Agilent E5071C Vector Network Analyzer (with S/N MY46111282) [1] with the 85052D calibration kit (S/N MY43252832) [2], measuring the ZAPQD-2 (S/N SF191101152) [3] from 0.8-2.2GHz. S parameters were measured at 0.85 GHz, 1.15 GHz, 1.5 GHz, 1.85 GHz, and 2.15 GHz.

III. Results and Discussion

The average deviation of the amplitude of the s-parameters is shown in Table III. The deviation is calculated by taking the difference between the experimental and theoretical values of the log magnitude of the s-parameters. The deviation is within 1.5 dB for all frequencies except for 1.15 GHz, where the deviation is 2.415 dB.

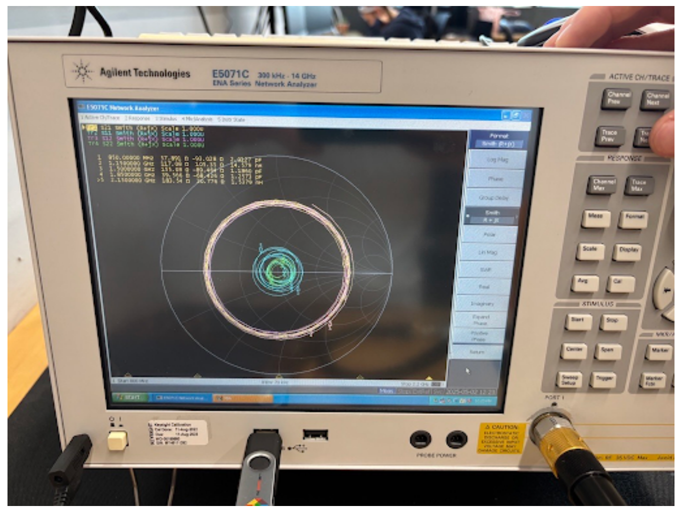

Fig. 1: Smith Chart of Reflection Coefficient with Port 1 = Splitter Port S and Port 2 = Splitter Port 1 over the Frequency Range Specified

Table IV shows the amplitude imbalance, phase imbalance, and isolation of the splitter. The experimental amplitude imbalance appears relatively close enough with the theoretical values; the phase imbalance on the other hand is not. The isolation also appears to match the specs as the signal is still attenuated significantly in the experimental results.

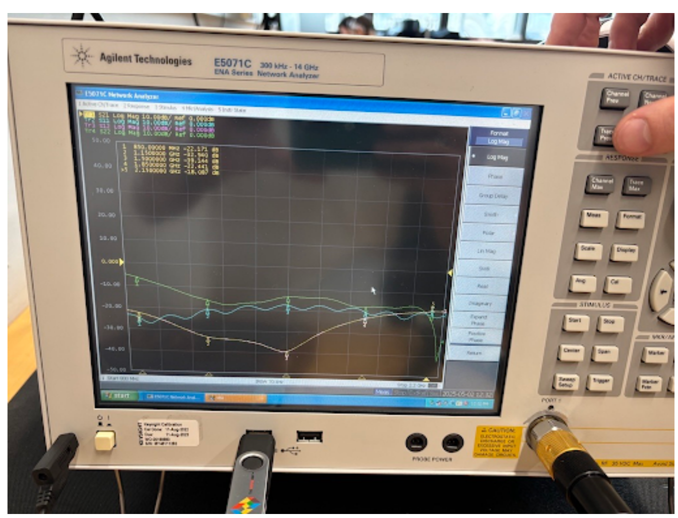

Fig. 2: Isolation between ports 1 and 2.

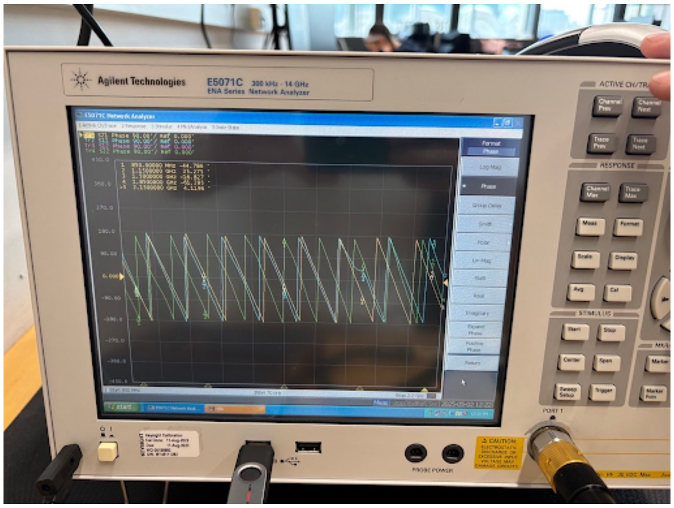

Fig. 3: Phase between Input Port S and Output Port 1.

TABLE I: Experimental Log Magnitude

0.850 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−13.584/-13.274	−3.6663	−5.3215
Port 1	−3.6413	−24.532/-23.844	−22.215
Port 2	−5.2934	−22.171	−6.4609/-6.2515

1.15 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−17.091/18.416	−4.0563	−4.2405
Port 1	−3.9801	−20.14/-21.036	−32.915
Port 2	−4.1723	−32.94	−15.32/-15.751

1.5 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−17.378/-16.353	−4.1753	−4.3716
Port 1	−4.1942	−17.218/-21.291	−39.204
Port 2	−4.3364	−39.144	−14.643/-13.331

1.85 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−22.263/23.502	−4.3136	−4.5145
Port 1	−4.2347	−19.661/18.607	−22.564
Port 2	−4.426	−22.441	−16.367/-17.-019

2.15 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−14.578/-13.071	−4.6871	−4.78
Port 1	−4.6731	−20.275/-21.028	−18.166
Port 2	−4.7006	−18.087	−23.671/-23.118

TABLE II: Ideal Log Magnitude

0.850 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−12.24	−3.306	−4.863
Port 1	−3.305	−18.79	−23.79
Port 2	−4.865	−23.78	−5.959

1.15 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−17.11	−3.467	−3.647
Port 1	−3.463	−19.89	−39.07
Port 2	−3.649	−39.05	−14.07

1.50 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−15.78	−3.569	−3.815
Port 1	−3.562	−18.75	−39.52
Port 2	−3.819	−39.52	−11.97

1.85 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−23.76	−3.631	−3.838
Port 1	−3.63	−16.47	−21.19
Port 2	−3.841	−21.19	−14.76

2.15 GHz			
Out\In	**Port S**	**Port 1**	**Port 2**
Port S	−14.02	−3.856	−3.945
Port 1	−3.8497	−22.89	−15.45
Port 2	−3.941	−15.45	−32.73

TABLE III: Deviation From Ideal Log Magnitude

Frequency [GHz]	Deviation [dB]
0.850	0.795
1.15	2.415
1.50	0.501
1.85	0.862
2.15	1.434

TABLE IV: Supplementary Measurements

Experimental			
Frequency [GHz]	**Amplitude Imbalance [dB]**	**Phase Imbalance [dB]**	**Isolation [dB]**
0.850	1.6521	12.7545	22.1930
1.15	0.1922	76.2295	32.9275
1.50	0.1422	42.835	39.1740
1.85	0.1913	29.8205	22.5025
2.15	0.0275	15.2225	18.1265

Theoretical			
Frequency [GHz]	**Amplitude Imbalance [dB]**	**Phase Imbalance [dB]**	**Isolation [dB]**
0.850	0.34	3.35	32.84
1.15	0.1	1.03	37.41
1.50	0.06	1.9	35.64
1.85	0.14	0.61	23.99
2.15	0.14	1.07	19.65

TABLE V: Experimental Phase Results

	Phase		Phase Imbalance	
Frequency [GHz]	**Port 1>2**	**Port 2>1**	**Port 1>2 +90°**	**Port 2>1 +90°**
0.850	−77.866	−76.625	12.134	13.375
1.15	−13.795	−13.746	76.205	76.254
1.50	−132.81	−132.86	42.81	42.86
1.85	60.153	60.206	29.847	29.794
2.15	74.559	74.996	15.441	15.004

TABLE VI: Experimental VSWR Values

Frequency [GHz]	Port S	Port 1	Port 2
0.850	1.5416	1.1315	2.85565
1.15	1.2998	1.207	1.40175
1.50	1.33545	1.25375	1.502
1.85	1.15485	1.249	1.3433
2.15	1.515	1.20515	1.14535

References

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[3] “ZAPDQ-2 Coaxial Power Splitter/Combiner.” Accessed: May 06, 2025. [Online]. Available: https://www.minicircuits.com/pdfs/ZAPDQ-2.pdf?srsltid=AfmBOorhEGcyNVrwyMhIl8zId52fCC_CTPDtofbeTnjR0tlNgR93_HoY