

# Cross-check of Short and Open Standards

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# Description

The reflection coefficient of the *short* and *open* standards from the two VNA calibration kits available at ASU are compared, after calibrating the VNA with each kit. The kits are the Agilent 85033E, and the Maury 8050S, both 3.5-mm female.

The expectation is for the response of the standards to match their model of equation 1.4 in the Agilent Application Note 1287-11, which considers the termination itself and the transmission line.

The standards are measured with two VNAs: the Agilent E5072A, and the R&S ZVL3. Therefore, the steps involved in this test are:

1. Calibrate the E5072A with 85033E kit
  - ▶ Measure standards of 85033E kit
  - ▶ Measure standards of 8050S
2. Calibrate the E5072A with 8050S kit
  - ▶ Measure standards of 85033E kit
  - ▶ Measure standards of 8050S
3. Calibrate the ZVL3 with 85033E kit
  - ▶ Measure standards of 85033E kit
  - ▶ Measure standards of 8050S
4. Calibrate the ZVL3 with 8050S kit
  - ▶ Measure standards of 85033E kit
  - ▶ Measure standards of 8050S

# 85033E Calibration Kit, 3.5-mm Female

Table: 1. Parameters of the 3.5-mm female Agilent 85033E Standards

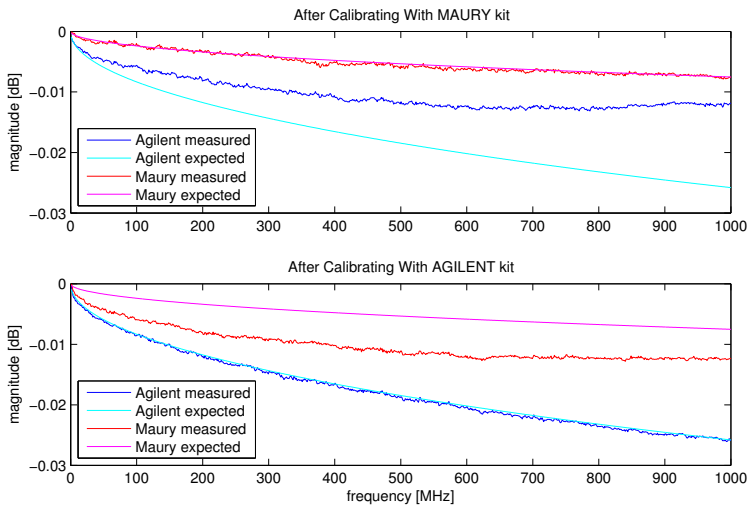
Parameter	Unit	OPEN	SHORT	MATCH
$C_0$	$\times 10^{-15}$ [F]	+49.43		
$C_1$	$\times 10^{-27}$ [F/Hz]	-310.1		
$C_2$	$\times 10^{-36}$ [F/Hz <sup>2</sup> ]	+23.17		
$C_3$	$\times 10^{-45}$ [F/Hz <sup>3</sup> ]	-0.1597		
$L_0$	$\times 10^{-12}$ [H]		+2.077	
$L_1$	$\times 10^{-24}$ [H/Hz]		-108.5	
$L_2$	$\times 10^{-33}$ [H/Hz <sup>2</sup> ]		+2.171	
$L_3$	$\times 10^{-42}$ [H/Hz <sup>3</sup> ]		-0.01	
termination resistance	[ $\Omega$ ]			50
offset $Z_0$	[ $\Omega$ ]	50	50	50
offset delay	[ps]	29.243	31.785	0
offset loss	[G $\Omega$ /s]	2.2	2.36	2.3

# 8050S Calibration Kit, 3.5-mm Female

Table: 2. Parameters of the 3.5-mm female Maury 8050S Standards

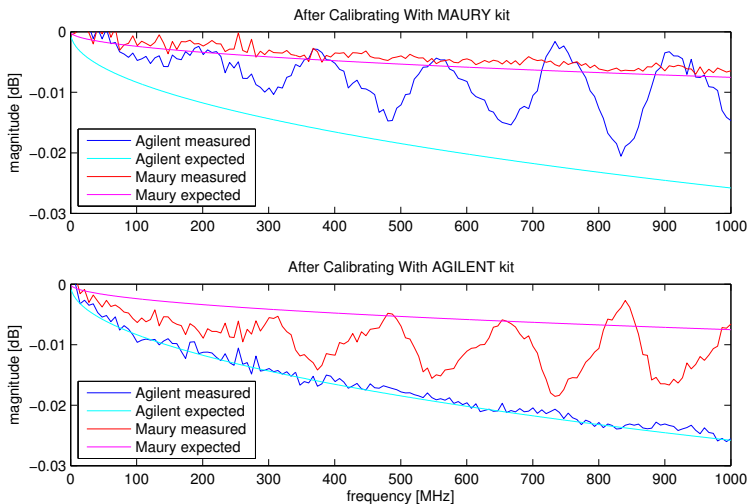
Parameter	Unit	OPEN	SHORT	MATCH
$C_0$	$\times 10^{-15}$ [F]	+63.17		
$C_1$	$\times 10^{-27}$ [F/Hz]	-1178		
$C_2$	$\times 10^{-36}$ [F/Hz <sup>2</sup> ]	+109.6		
$C_3$	$\times 10^{-45}$ [F/Hz <sup>3</sup> ]	-2.146		
$L_0$	$\times 10^{-12}$ [H]		0	
$L_1$	$\times 10^{-24}$ [H/Hz]		0	
$L_2$	$\times 10^{-33}$ [H/Hz <sup>2</sup> ]		0	
$L_3$	$\times 10^{-42}$ [H/Hz <sup>3</sup> ]		0	
termination resistance	[ $\Omega$ ]			50
offset $Z_0$	[ $\Omega$ ]	50	50	50
offset delay	[ps]	14.490	16.684	0
offset loss	[G $\Omega$ /s]	1.3	1.3	1.3

# Shorts, Measured with Agilent VNA



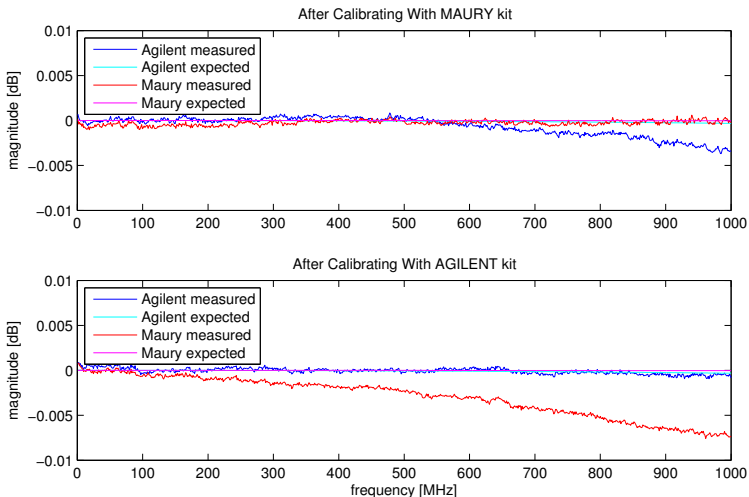
**Figure: 1.** For the *short*, the only measurement that matches the expectation is the one from the kit used for calibration (Maury in the upper plot, and Agilent in lower plot). The other *short* does not agree with the model established using the parameters of tables 1 or 2.

# Shorts, Measured with R&S VNA



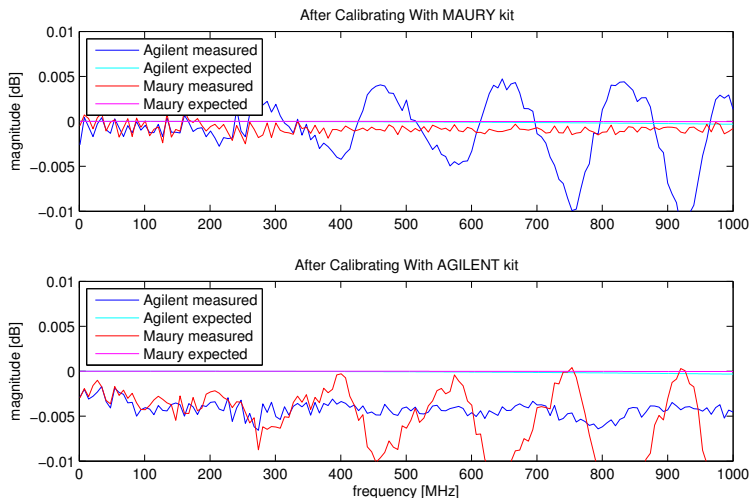
**Figure: 2.** Equivalent to Figure 1, but using R&S VNA. For the *short*, the only measurement that matches the expectation is the one from the kit used for calibration (Maury in the upper plot, and Agilent in lower plot). The other *short* does not agree with the model established using the parameters of tables 1 or 2, and also ripples appear, unlike when using the Agilent VNA.

# Opens, Measured with Agilent VNA



**Figure: 3.** For the *open*, the only measurement that matches the expectation is the one from the kit used for calibration (Maury in the upper plot, and Agilent in lower plot). The other *open* does not agree with the model established using the parameters of tables 1 or 2.

# Opens, Measured with R&S VNA



**Figure: 4.** Equivalent to Figure 3, but using R&S VNA. For the *open*, the only measurement that matches the expectation is the one from the kit used for calibration (Maury in the upper plot, and Agilent in lower plot). Actually, the agreement is not as good as with the Agilent VNA, with a difference of  $\sim 0.005$  dB between the expectation and measurement of the Agilent *open* in the lower plot (cyan and blue traces). The other *open* does not agree with the model established using the parameters of tables 1 or 2, and also ripples appear, unlike when using the Agilent VNA.



# Conclusion

The results of the cross-check were not successful. The measurements of the same standards are different when the VNA is calibrated with different kits (with the appropriate definitions loaded).

With the *short* and *open* standards, the shape of the deviation from expectations with the Agilent VNA is a curvature, and with the R&S VNA it consists of ripples on top of a curvature.