Cross-Check Between *Short* Standards

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Description

Four *short* standards were compared in the range 1 MHz - 300 MHz with the purpose of improving the understanding of their characteristics and confirm the information provided by the different manufacturers. The four devices are male, belonging to the following calibration kits:

1. Agilent 85033E (dubbed Agilent 1)
2. Agilent 85033E (dubbed Agilent 2)
3. Maury 8050S
4. Anritsu OSLK50

Agilent 1 corresponds to the calibration kit bought recently by us, to be used for EDGES. Agilent 2 is the same model but does not belong to our group, although we are allowed to use it in the lab. It is good to have two devices of the same model to confirm their consistency.

Initially, the check proceeded as follows:

- The E5072A VNA was calibrated using the Agilent 1 kit (85033E) using its official coefficients.
- After calibration, the four *shorts* were measured.

Description

The left panel of figure 1 shows the measurement of the four *shorts* after calibration. Since the VNA was calibrated using the Agilent 1 *short*, the blue trace is consistent with its expectation with the official coefficients (delay of 31.785 ps, loss of 2.36 GΩ/s, inductance coefficients different from zero). The red trace is very similar as expected, since it is the same model.

The smooth black line corresponds to the expectation for the Maury *short*, with a delay of 16.684 ps, a loss of 1.3 GΩ/s, and inductance coefficients equal to zero. In contrast, the green trace is the measurement of the Maury *short*. The discrepancy is significant.

Unfortunately, Anritsu only provides a delay value for the *short*, corresponding to 12.7 mm of length. They assume that the inductance coefficients as well as the loss are zero. Because of this, it is not possible to produce a realistic model for this device to compare it to the measurement.

The right panel of figure 1 presents a correction of the measurements. This correction consists of assuming that the loss of the Agilent 1 *open* and *short* is in actuality half the value provided by Agilent, i.e., 1.1 and 1.18 GΩ/s respectively. Since the physical length of the Agilent *short* is twice the value of the Maury one (10 mm vs 5 mm), it is assumed that the official delay of the Agilent is correct and therefore this quantity is not changed.

When applying this correction assuming a smaller loss, the blue measurement trace is forced to transform into the expectation and looks like a model itself. All the other measurement traces are also shifted as a result. The most significant shift is that of the Maury measurement trace (green), which now overlaps very well with its expectation (black).

Assuming that after the correction the traces represent the physical characteristics of the standards more closely, a loss of 2.8 GΩ/s is necessary to fit the corrected measurement of the Anritsu *short*, along with a length of 12.7 mm (cyan line on top of magenta trace).

Comparison of Short Standards

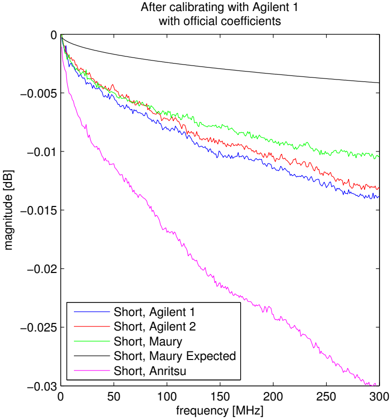

Figure: (1) Comparison of measurements, corrections, and expectations of four *short* standards belonging to different calibration kits. The previous slide provides more details.

Conclusion

If the VNA has been calibrated with the standards belonging to the Agilent 85033E kit, using the official coefficients, the measurement of the Maury *short* is significantly different from its expectation.

If the loss of the Agilent *open* and *short* is decreased to half their official values and the system is re-calibrated, the Maury *short* fits much better its expectation. This test was performed due to the suspicion that the loss of the Agilent standards has been overestimated.

Since the use of smaller loss values for the Agilent kit is only supported by the fit of the Maury trace, we would be depending on the accuracy of the Maury standards if we decided to use these new values for the Agilent kit.

It would have been good to confirm this procedure by comparing the measurement of the Anritsu *short* to its expectation, but due to the lack of a realistic loss value, all I can do is estimate the loss from the *corrected* measurement as a by-product, instead of using this device as a reference. Its loss turns out to be large (2.8 GΩ/s, using a model with 12.7 mm of length).