SMA-Calibration-Kit

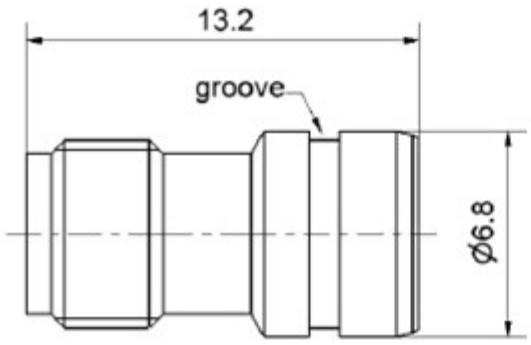
For a quick and easy calibration of a network analyzer up 4-5 GHz, it is not necessary to use an expensive calibration-kit. An accurate calibration can be achieved with three simple SMA-components [Short, Termination Load and Thru Adaptor].
We use this cal.-kit for the workaday-calibration, because it's low-priced and easy to implement. This kit fits in your pocket for easy calibration checks.

The following section describes the necessary components and the corresponding process in more details.
Here are the specifications and calibration reference for Our kit.

E_r = 0.688 (calculated from offset length short 1.96/1.25)

Match/Load (female)

$a.\ |S_{11}| \leq -32\ dB\ 2\ GHz;\ |S_{11}| \leq -21\ dB\ to\ 12\ GHz$
$b.\ R = 50\ \Omega \pm 1.5\ \Omega;\ P_{max} = 1\ W$



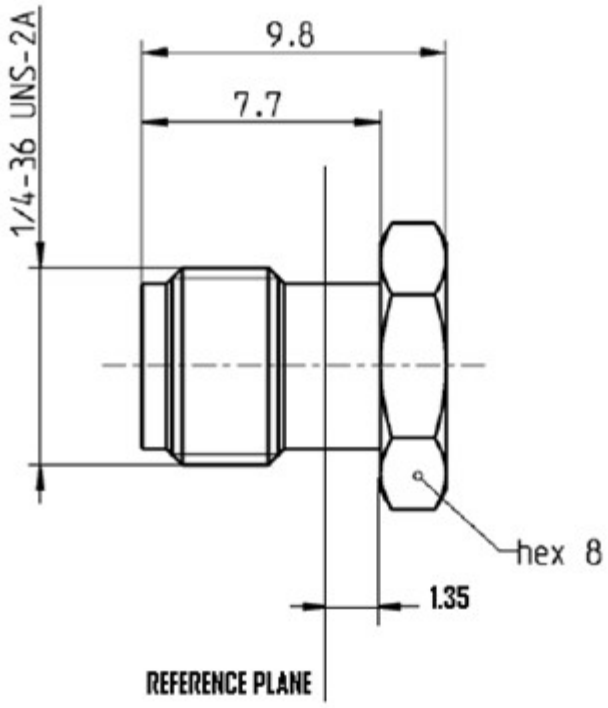
Short (female)

$a.\ Offset\ lenght\ 1.96\ mm\ \ b.\ |S_{11}| \geq 0.97\ to\ 4\ GHz;\ |S_{11}| \geq -0.95\ to\ 12\ GHz$
$c.\ Ang(S_{11}) = 180^\circ \pm 0.5^\circ\ to\ 4\ GHz;\ Ang(S_{11}) = 180^\circ \pm 1.5^\circ\ to\ 12\ GHz$

offset length: 1.96 = 1.35/0.688

ref plane left, 2mm from left end => + (7.7-1.35-2)/0.688 = 4.35/0.688 = 6.32

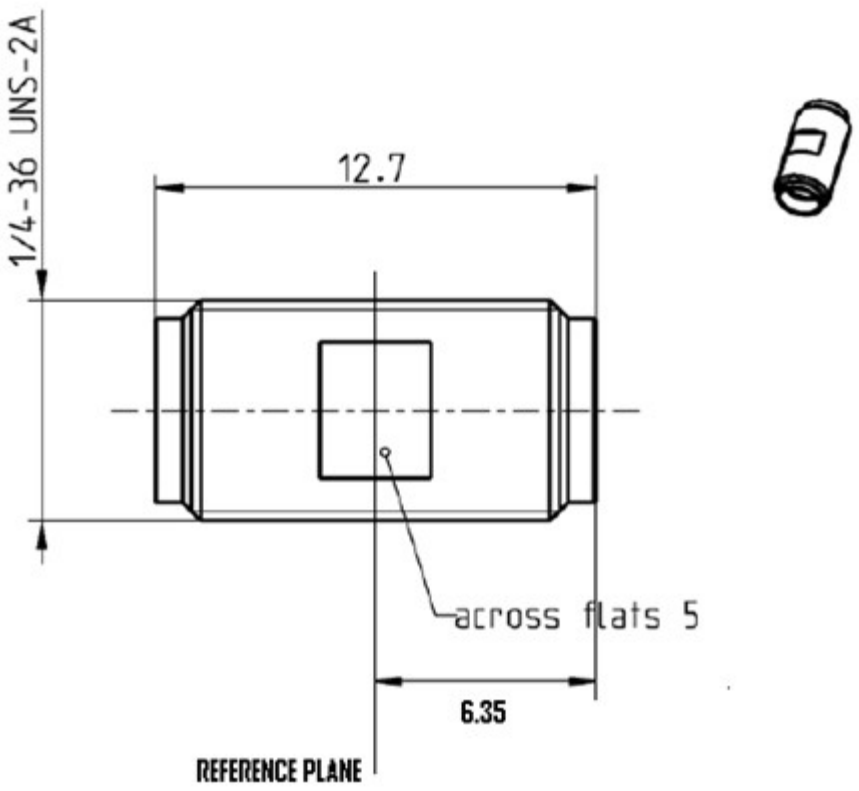
=> offset length = 6.32 + 1.96 = 8.28



Open (female) (used as a Thru as an Open-Standard)

a. Offset lenght: 7 mm (with end capacity)
b. $|S_{ii}| \leq -32\ dB$ *to 4 GHz;* $|S_{ii}| \leq -21\ dB$ *to 12 GHz*

ref plane left: +6.32 => offset length = 6.32 + 7 = 13.32



Justierte Werte nach Messungen:

Standard	Ref plane left [ps]	Ref plane middle thru [ps]
open	44,77	23,52
short	27,95	6,7
thru	42,5	0

After the acquisition of these components you only need to enter the following parameters in the network analyzer.

Match / Load (female):

- Offset Length: 0 mm
- C-coefficients: all = 0 F / Hz
- L-coefficients: all = 0 H / Hz

Short (female):

- Offset length: 1,96 mm
- C-Coefficients: all = 0 F / Hz

- L-Coefficients: all = 0 H / Hz

Open (female):

- Offset Length: 7 mm (The reference plane for the open-standard lies in the middle of the thru-connection)
- C-Coefficients: all = 0 F / Hz
- L-Coefficients: all = 0 H / Hz

Thru (female / female):

- Offset Length: 0 mm (The reference plane lies in the middle of the thru-connection) ref plane left: offset length = 2 * 4.35/0.688 = 12.64

After all these parameters were given, the usual calibration with this calibration-kit can be carried out. Of course the measuring accuracy is lower than with the 3.5mm calibration-kit, because the 3.5mm type can be described more exactly. Still the advantage of the SMA cal.-kit is, **that no mismatching is given with the calibration, because we connect from SMA to SMA and not on another standard.**

The exactness of this procedure is made clear with the help of the ripple-test (References: *Heuermann, H.*, Old and New Accuracy Estimation of S-Parameter Measurements with the Ripple-Test, MTT-S International Microwave Symposium Workshop TMB, San Francisco, June 2006.

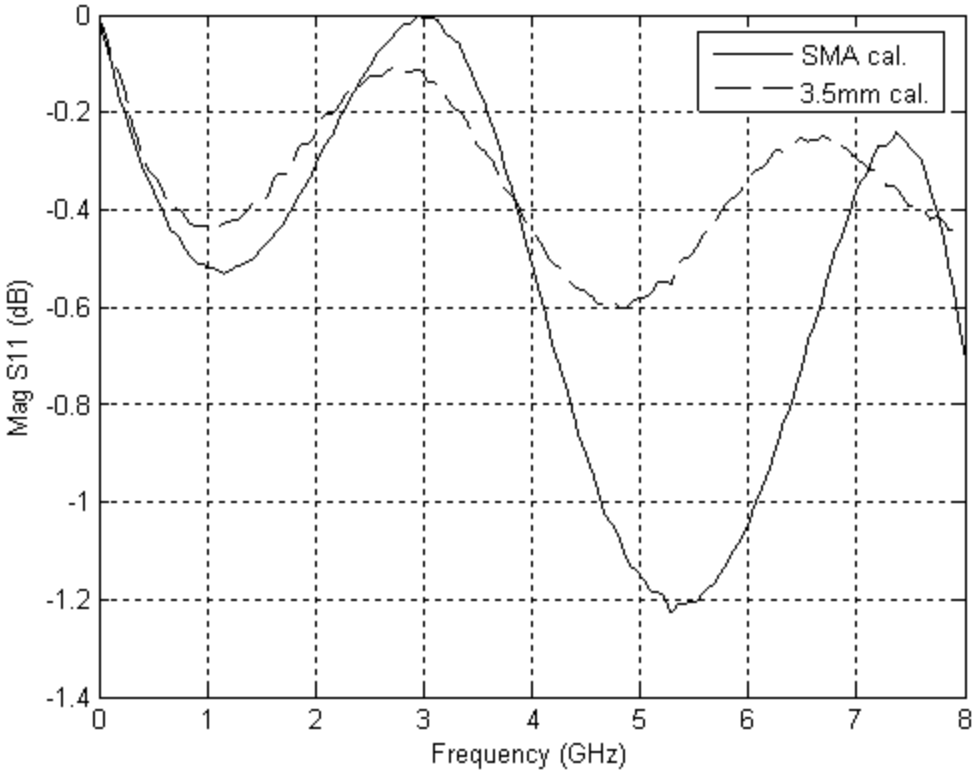


Fig. 1: *Reflection of an air line loaded with a short calibrated with SMA and 3,5mm-cal.-kit*

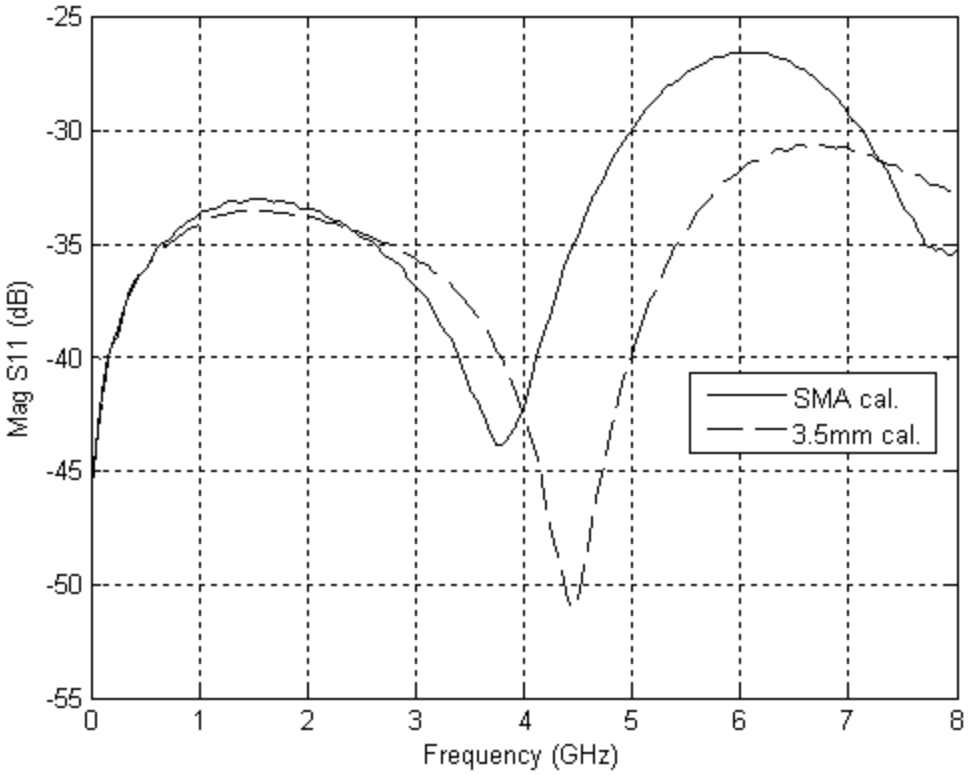


Fig. 2: *Reflection of an air line loaded with a match calibrated with SMA and 3,5mm-cal.-kit*

From figures 1 and 2 can be seen, that the ripples are stronger after the SMA-calibration than after the 3,5mm-calibration. This is because the 3.5mm cal.-kit can be more accurately described than the SMA cal.-kit. **Nevertheless, until 4GHz the ripples are roughly equally strong and therefore we have nearly the same accuracy.** From this follows that the measurement accuracy, for such a reasonable calibration-kit, is precise enough to carry out well measurements. This is made clear in the following segment.

To verify the measuring exactness a little wide a bandpass filter was also measured after a SMA-calibration, the following pictures show the measuring results.

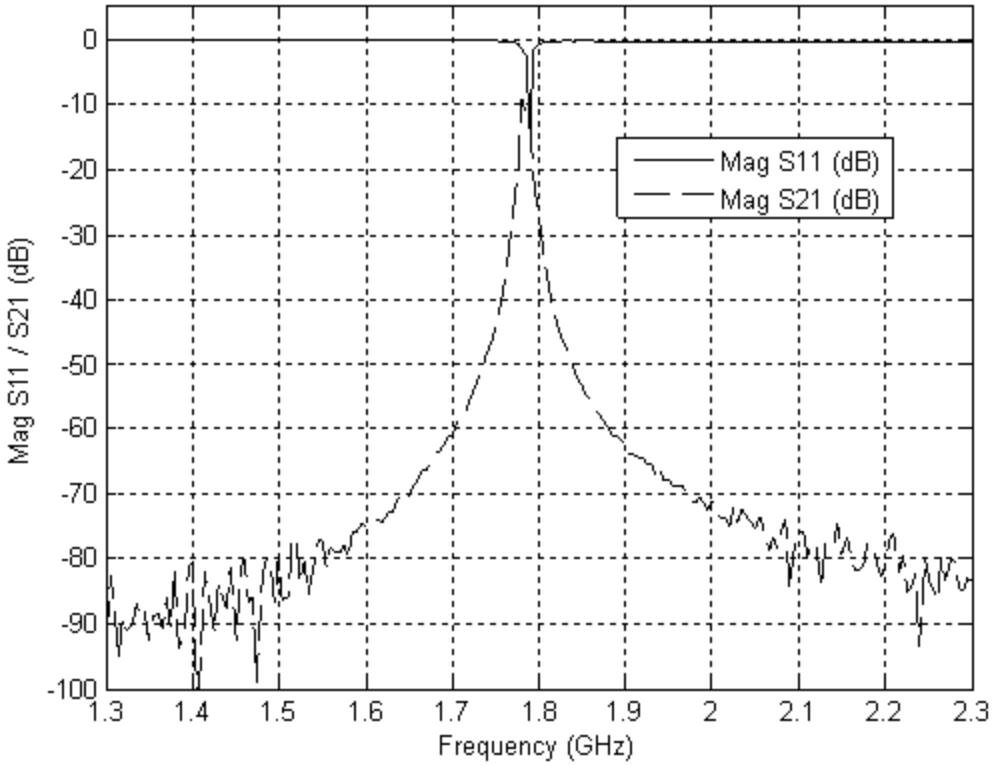


Fig. 3: *Measurement of a bandpass filter after SMA-calibration*

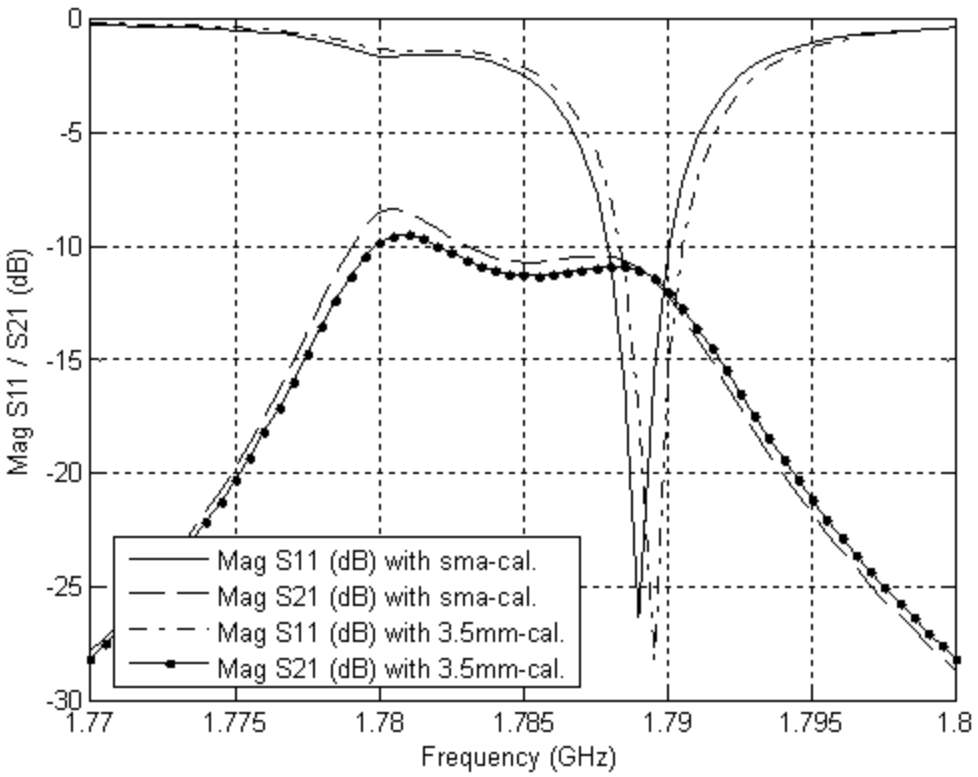


Fig. 4: *Measurement of a lossy bandpass filter after SMA- and 3.5mm-calibration (after reconnection)*

If you have a f-f adapter, you can modify the cal kit to add the delay of the adapter to the calkit and then it will work fine for calibration. A typical SMA "bullet" is about 90 psec of delay.

You can measure it directly by doing a 1 port cal, then adding a short from the calkit (this will be the F short), then doing a data->mem and data/mem to normalize out the short delay and get a flat line, change the format to phase. Then add the SMA bullet (f-f adapter) and put the other sex short (male) on the output and see the phase slope. You can use port extensions to dial in extension until the slope is flat, then this is the 1-way delay of the adapter.

do this from maybe 1 Mhz to 3 Ghz for the freq span (even if your DUT is narrower, as it will give some good phase slope for a short adapter).

It turns out we make the m and f shorts so that they have the same phase and delay in the 3.5 mm case.

It is very common for customers to incorrectly modify cal kits because the interface is quite confusing.

Let explain the WRONG process: Go to cal, kits, modify calkits, define standards and you see the standards; then you press the thru standard ---BZZZZ wrong. When you start

to modify the standards, the standard number is 1 and the first standard is underlined (it is typically a short). IF you then pressed the thru button, what you have done is re-defined the standard 1 to be a thru, and then modified the delay of the short to be a thru.

The clue here is that the delay was 16 ps before you modified, which is the delay of an open or short.

What you need to do, and the onscreen instructions say this, is after you press the define standads key, you need to use the knob or up/down arrow keys to change the standard number until the thru is underlined, then you need to hit the modify standard key (never hit the thru key), and then you specify offset, and you will see it is zero so you change it to 98 ps.