Certificate of Calibration

Kirkby Microwave Calibration

Calibration Certificate number 85033-0806-24-02-2026

Model Number	85033
Manufacturer	Kirkby Microwave Ltd
Description	SMA calibration and verification kit
Serial number	0806
Options	003D, 003E, 022
Maximum frequency	GHz
Date of Calibration	25th February 2026
Calibration due	25th February 2027
Procedure	85033-5
Temperature	$(21 \pm 2)°C$

Location of calibration	**Customer**
Kirkby Microwave Ltd	*****
Stokes Hall Lodge	*****
Burnham Road	*****
Althorne	*****
Chelmsford	*****
Essex	*****
CM3 6DT	*****
UNITED KINGDOM	

As Received Conditions

No applicable, as this was a new kit.

Action taken

Full calibration, as per any new calibration kit.

As Completed Conditions

The measured values of the were observed in specification at the points tested.

Notes

This certificate shall not be reproduced, except in full.

Calibration data

Since there are measurements at 1601 frequencies, on several devices, it is impractical to provided the measured results on the calibration certificate, although they are provided on a USB stick included with the calibration kit. However, the coefficients of the calibration standards derived from the measurements are listed below.

1 Notes on the format of the data

Different manufacturers use a slightly different format to one another.

1.(a) Format used by HP, Agilent, Keysight, Copper Mountain, and most other manufacturers of VNAs for the calibration standards.

The open calibration standards are modelled as a transmission line of some physical length, terminated in a capacitor. The fringing capacitance C of the open calibration standard is given by the following 3^{rd} order polynomial

$$C(f) = C0 \times 10^{-15} + C1 \times 10^{-27} f + C2 \times 10^{-36} f^2 + C3 \times 10^{-45} f^3$$

where C is in farads and f in Hz. The delay, caused by the length of the transmission line is given in ps. The loss is given in a bizarre unit of GΩ/s.

The short calibration standards are modelled as a length of transmission line terminated in an inductor. This inductance is frequency dependant. The inductance L is given by the following 3^{rd} order polynomial

$$L(f) = L0 \times 10^{-12} + L1 \times 10^{-24} f + L2 \times 10^{-33} f^2 + L3 \times 10^{-42} f^3$$

where L is in henrys and f in Hz. The transmission line has some length, and so delay, which is quoted in ps. However, the variation of inductance with frequency is small, and so some VNAs assume this variation to be zero. For VNAs supporting entry of $L0, L1, L2$ and $L3$, the data is given. For VNAs not supporting the entry of $L0, L1, L2$ and $L3$, the inductance is compensated for by assuming a slightly longer delay. For this reason data is provided in two formats for the shorts.

1.(b) Format used by Anritsu for the calibration standards.

Anritsu use a similar, but not identical method to that of Keysight described above. The open calibration standards are again modelled as a transmission line of some physical length, terminated in a capacitor. The fringing capacitance C of the open calibration standard is given by the same 3^{rd} order polynomial

$$C(f) = C0 \times 10^{-15} + C1 \times 10^{-27} f + C2 \times 10^{-36} f^2 + C3 \times 10^{-45} f^3$$

where C is in farads and f in Hz. Anritsu use the physical length of the open transmission line, rather than quote a delay like Keysight do.

Anritsu model the short calibration standards as a length of transmission line terminated in an inductor, just as Keysight do. This inductance is frequency dependant. The inductance L is given by the same 3^{rd} order polynomial as Keysight use.

$$L(f) = L0 \times 10^{-12} + L1 \times 10^{-24} f + L2 \times 10^{-33} f^2 + L3 \times 10^{-42} f^3$$

where L is in henrys and f in Hz. Again, Anritsu use a length, not a delay for the transmission line.

1.(c) Format used by Rohde and Schwarz for open calibration standards.

Rohde and Schwarz use a mixture of the methods of Keysight and Anritsu. The open calibration standards are modelled as a transmission line of some physical length, terminated in a capacitor. The fringing capacitance C of

the open calibration standard is given by the following 3rd order polynomial, which is different to that of most other manufacturers.

$$C(f) = C0\,fF + C1\,fF/GHz + C2\,fF/GHz^2 + C3\,fF/GHz^3$$

where C is in fF and the frequency in GHz. The delay is given in ps. The loss is given in units of dB $\sqrt{GHz}$. Npte using this model, the value of $C0$ is the same as used by both Keysight and Anritsu, but values of $C1, C2$ and $C3$ are 1000x smaller.

The short calibration standards are modelled as a length of transmission line terminated in an inductor. This inductance is frequency dependant. The inductance L is given by the following 3rd order polynomial which is different to that of Keysight and Anritsu.

$$L(f) = L0\,pH + L1\,pH/GHz + L2\,pH/GHz^2 + C3\,pH/GHz^3$$

where L is in fF and the frequency in GHz. The delay is given in terms of a length in mm. The loss is given in units of dB $\sqrt{GHz}$. Npte using this model, the value of $L0$ is the same as used by both Keysight and Anritsu, but values of $L1, L2$ and $L3$ are 1000x smaller.

Note, if an instrument supports reading of Touchstone files for the calibration standards, then that is the most accurate way of using the data. However, not many instruments support this.

2 Important

- Please read the user manual on the SMA calibration kit, which may be downloaded from https://kirkbymicrowave.co.uk/Downloads/User-Manual-for-85033-SMA-calibration-kit.pdf
- HP/Agilent/Keysight have changed the way they refer to the gender of calibration standards. The female short used to be denoted as `SHORT (M)`, to indicate it connected to a male test port, but in later instruments the female short is denoted as `SHORT -F-`. Note the change of M to F and parentheses to hyphens. This is discussed more fully in the user manual.

3 Coefficients of calibration standards

This is given in three formats covering the vast majority of instrument manufacturers.

- The format used by HP, Agilent, Keysight, Copper Mountain, and most other VNA manufacturers.
- The format used by Anritsu.
- The format used by Rohde and Schwarz.

All VNAs should accept a 3rd order polynomial for the fringing capacitance of an open standard, but not all VNAs accept a polynomial for the inductance of a short. We provide data for use with instruments that accept this, and those that do not.

3.(a) Calibration coefficients for female calibration standards

3.(a).(i) Female short, for VNAs accepting inductance coefficients. (This includes Agilent 8510C but not the 8753)

This will be `SHORT (M)` for some older HP/Agilent instruments, and `SHORT -F-` for newer HP/Agilent instruments, as well as instruments made by Advantest, Anritsu, Copper Mountain, Deepace, LA Techniques, Keysight, National Instruments, Pico Technology, Rohde & Schwarz, SDR-kits, Siglent, and Tektronix.

```
Optimization results from file female-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Format used by HP, Agilent, Keysight, Copper Mountain and most other VNA manufacturers.
Offset delay  =    75.00000007 ps.
Offset loss   =  6389.67581950 Mohm/s.
Offset Z0     =    50.04215059 ohms.
L0            =   130.74998482 * 1e-12 H.
L1            = -2794.86312603 * 1e-24 H/Hz.
L2            =  3662.37952964 * 1e-33 H/Hz^2.
L3            =  -348.54289594 * 1e-42 H/Hz^3.

Format used by Anritsu.
Offset length =    22.48443437 mm.
Offset loss   =     0.08325000 dB/sqrt(GHz).
Offset Z0     =    50.04215059 ohms.
L0            =   130.74998482 * 1e-12 H.
L1            = -2794.86312603 * 1e-24 H/Hz.
L2            =  3662.37952964 * 1e-33 H/Hz^2.
L3            =  -348.54289594 * 1e-42 H/Hz^3.

Format used by Rohde & Schwarz (R&S).
Offset length =    22.48443437 mm.
Offset loss   =     0.08325000 dB/sqrt(GHz).
Offset Z0     =    50.04215059 ohms.
L0            =   130.74998482 pH.
L1            =    -2.79486313 pH/GHz.
L2            =     3.66237953 pH/GHz^2.
L3            =    -0.34854290 pH/GHz^3.
```

3.(a).(ii) Female short, for VNAs not accepting inductance coefficients. (The Agilent 8753 does not accept inductance coefficients.)

This will be `SHORT (M)` for some older HP/Agilent instruments, and `SHORT -F-` for newer Agilent instruments, as well as instruments made by Advantest, Anritsu, Copper Mountain, Deepace, LA Techniques, Keysight, National Instruments, Pico Technology, Rohde & Schwarz, SDR-kits, Siglent, and Tektronix.

```
Optimization results from file female-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Format used by HP, Agilent, Keysight, Copper Mountain and most other VNA manufacturers.
```

```
Offset delay  =    78.26772464 ps.
Offset loss   =  5411.36308355 Mohm/s.
Offset Z0     =    49.81733901 ohms.
L0            =     0.00000000 * 1e-12 H.
L1            =     0.00000000 * 1e-24 H/Hz.
L2            =     0.00000000 * 1e-33 H/Hz^2.
L3            =     0.00000000 * 1e-42 H/Hz^3.

Format used by Anritsu.
Offset length =    23.46407355 mm.
Offset loss   =     0.07357556 dB/sqrt(GHz).
Offset Z0     =    49.81733901 ohms.
L0            =     0.00000000 * 1e-12 H.
L1            =     0.00000000 * 1e-24 H/Hz.
L2            =     0.00000000 * 1e-33 H/Hz^2.
L3            =     0.00000000 * 1e-42 H/Hz^3.

Format used by Rohde & Schwarz (R&S).
Offset length =    23.46407355 mm.
Offset loss   =     0.07357556 dB/sqrt(GHz).
Offset Z0     =    49.81733901 ohms.
L0            =     0.00000000 pH.
L1            =     0.00000000 pH/GHz.
L2            =     0.00000000 pH/GHz^2.
L3            =     0.00000000 pH/GHz^3.
```

3.(a).(iii) Female open

This will be `OPEN (M)` for some older HP/Agilent instruments, and `OPEN -F-` for newer Agilent instruments, as well as instruments made by Advantest, Anritsu, Copper Mountain, Deepace, LA Techniques, Keysight, National Instruments, Pico Technology, Rohde & Schwarz, SDR-kits, Siglent and Tektronix.

```
Optimization results from file female-open-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Format used by HP, Agilent, Keysight, Copper Mountain and most other VNA manufacturers.
Offset delay  =    75.00000000 ps.
Offset loss   =  4649.87857792 Mohm/s.
Offset Z0     =    50.22722670 ohms.
C0            =    73.45914370 * 1e-15 F.
C1            = -3199.33194408 * 1e-27 F/Hz.
C2            =  -406.72120208 * 1e-36 F/Hz^2.
C3            =    76.11226252 * 1e-45 F/Hz^3.

Format used by Anritsu.
Offset length =    22.48443435 mm.
Offset loss   =     0.06058248 dB/sqrt(GHz).
Offset Z0     =    50.22722670 ohms.
```

```
C0            =    73.45914370 * 1e-15 F.
C1            = -3199.33194408 * 1e-27 F/Hz.
C2            =  -406.72120208 * 1e-36 F/Hz^2.
C3            =    76.11226252 * 1e-45 F/Hz^3.

Format used by Rohde & Schwarz (R&S).
Offset length =    22.48443435 mm.
Offset loss   =     0.06058248 dB/sqrt(GHz).
Offset Z0     =    50.22722670 ohms.
C0            =    73.45914370 fF.
C1            =    -3.19933194 fF/GHz.
C2            =    -0.40672120 fF/GHz^2.
C3            =     0.07611226 fF/GHz^3.
```

3.(b) Calibration coefficients for male calibration standards

3.(b).(i) Male short, for VNAs accepting inductance coefficients. (This includes the Agilent 8510C, but not the 8753)

This will be `SHORT (F)` for older HP/Agilent instruments, and `SHORT -M-` for newer Agilent instruments, as well as instruments made by Advantest, Anritsu, Copper Mountain, Deepace, LA Techniques, Keysight, National Instruments, Pico Technology, Rohde & Schwarz, SDR-kits, Siglent, and Tektronix.

```
Optimization results from file male-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Format used by HP, Agilent, Keysight, Copper Mountain and most other VNA manufacturers.
Offset delay  =    75.00000000 ps.
Offset loss   =  4555.83300500 Mohm/s.
Offset Z0     =    49.83043427 ohms.
L0            =   160.98156425 * 1e-12 H.
L1            =  8516.71968569 * 1e-24 H/Hz.
L2            = -2317.84965890 * 1e-33 H/Hz^2.
L3            =   152.16763986 * 1e-42 H/Hz^3.

Format used by Anritsu.
Offset length =    22.48443435 mm.
Offset loss   =     0.05935718 dB/sqrt(GHz).
Offset Z0     =    49.83043427 ohms.
L0            =   160.98156425 * 1e-12 H.
L1            =  8516.71968569 * 1e-24 H/Hz.
L2            = -2317.84965890 * 1e-33 H/Hz^2.
L3            =   152.16763986 * 1e-42 H/Hz^3.

Format used by Rohde & Schwarz (R&S).
Offset length =    22.48443435 mm.
Offset loss   =     0.05935718 dB/sqrt(GHz).
Offset Z0     =    49.83043427 ohms.
L0            =   160.98156425 pH.
```

```
L1            =     8.51671969 pH/GHz.
L2            =    -2.31784966 pH/GHz^2.
L3            =     0.15216764 pH/GHz^3.
```

3.(b).(ii) Male short, for VNAs not accepting inductance coefficients. (The Agilent 8753 series do not accept the inductance coefficients)

```
Optimization results from file male-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Format used by HP, Agilent, Keysight, Copper Mountain and most other VNA manufacturers.
Offset delay  =    78.25757178 ps.
Offset loss   =  4424.07168700 Mohm/s.
Offset Z0     =    49.83647170 ohms.
L0            =     0.00000000 * 1e-12 H.
L1            =     0.00000000 * 1e-24 H/Hz.
L2            =     0.00000000 * 1e-33 H/Hz^2.
L3            =     0.00000000 * 1e-42 H/Hz^3.

Format used by Anritsu.
Offset length =    23.46102980 mm.
Offset loss   =     0.06014405 dB/sqrt(GHz).
Offset Z0     =    49.83647170 ohms.
L0            =     0.00000000 * 1e-12 H.
L1            =     0.00000000 * 1e-24 H/Hz.
L2            =     0.00000000 * 1e-33 H/Hz^2.
L3            =     0.00000000 * 1e-42 H/Hz^3.

Format used by Rohde & Schwarz (R&S).
Offset length =    23.46102980 mm.
Offset loss   =     0.06014405 dB/sqrt(GHz).
Offset Z0     =    49.83647170 ohms.
L0            =     0.00000000 pH.
L1            =     0.00000000 pH/GHz.
L2            =     0.00000000 pH/GHz^2.
L3            =     0.00000000 pH/GHz^3.
```

3.(b).(iii) Male open

This will be `OPEN (F)` for some older HP/Agilent instruments, and `OPEN -M-` for newer Agilent instruments, as well as instruments made by Advantest, Anritsu, Copper Mountain, Deepace, LA Techniques, Keysight, National Instruments, Pico Technology, Rohde & Schwarz, SDR-kits, Siglent, and Tektronix.

```
Optimization results from file male-open-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Format used by HP, Agilent, Keysight, Copper Mountain and most other VNA manufacturers.
Offset delay  =    75.00000000 ps.
Offset loss   =  4549.25525335 Mohm/s.
```

```
Offset Z0     =    50.20795493 ohms.
C0            =    73.30859769 * 1e-15 F.
C1            = -4439.48983550 * 1e-27 F/Hz.
C2            =   206.72981545 * 1e-36 F/Hz^2.
C3            =    32.97018044 * 1e-45 F/Hz^3.

Format used by Anritsu.
Offset length =    22.48443435 mm.
Offset loss   =     0.05927147 dB/sqrt(GHz).
Offset Z0     =    50.20795493 ohms.
C0            =    73.30859769 * 1e-15 F.
C1            = -4439.48983550 * 1e-27 F/Hz.
C2            =   206.72981545 * 1e-36 F/Hz^2.
C3            =    32.97018044 * 1e-45 F/Hz^3.

Format used by Rohde & Schwarz (R&S).
Offset length =    22.48443435 mm.
Offset loss   =     0.05927147 dB/sqrt(GHz).
Offset Z0     =    50.20795493 ohms.
C0            =    73.30859769 fF.
C1            =    -4.43948984 fF/GHz.
C2            =     0.20672982 fF/GHz^2.
C3            =     0.03297018 fF/GHz^3.
```

3.(c) Calibration of the thrus

This information will not be needed on 2-port VNAs with 4 receivers supporting unknown thru or UOSM calibration.

3.(c).(i) Male-Female thru (only option 003E or 003F)

```
Optimization results from file male-female-thru-with-85052B-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Offset Z0     =    50.00000000 ohms.
Offset delay  =    77.84640942 ps.
Offset length =    23.33386912 mm.
Offset loss   =  3000.00000000 Mohm/s.
Offset loss   =     0.02028157 dB/sqrt(GHz).
```

3.(c).(ii) Male-Male thru

```
Optimization results from file male-male-thru-with-85052B-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Offset Z0     =    50.00000000 ohms.
Offset delay  =    78.42457415 ps.
Offset length =    23.50719855 mm.
Offset loss   =  3000.00000000 Mohm/s.
Offset loss   =     0.02043222 dB/sqrt(GHz).
```

3.(c).(iii) Female-Female thru

```
Optimization results from file female-female-thru-with-85052B-short-0806.s1p.
Data fitted from 0.20 GHz to 7.00 GHz.

Offset Z0     =    50.00000000 ohms.
Offset delay  =    78.35447193 ps.
Offset length =    23.48618243 mm.
Offset loss   =  3000.00000000 Mohm/s.
Offset loss   =     0.02041395 dB/sqrt(GHz).
```

4 Measurements of male-female attenuator for verification purposes

Measured data on the male-female attenuator may be found on the USB stick. Port 1 is the female port.

5 Measurements of female-female attenuator for verification purposes (option 022)

Measured data on the female-female attenuator may be found on the USB stick, if option 022 was ordered.

6 Measurements of male-male attenuator for verification purposes (option 023)

Measured data on the male-male attenuator may be found on the USB stick, if option 022 was ordered.

7 Optional adapters, with one port not SMA

Option	Description	Delay (ps)
001	Male SMA to female RP SMA	57
001	Female SMA to male RP SMA	57
002	Male SMA to male U.FL	35
002	Female SMA to female U.FL	56
003A	Male SMA to female MMCX	56
003A	Female SMA to male MMCX	81
003B	Male SMA to female SMB	67
003B	Female SMA to male SMB	71
003C	Male SMA to female SMC	86
003C	Female SMA to male SMC	84
003D	Male SMA to female MCX	64
003D	Female SMA to male MCX	91