



RIGOL



Mechanical Calibration Kits

Product Manual
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Document Overview

A mechanical calibration kit (Cal Kit) is a reference calibration tool used in RF and microwave measurements. By providing known and traceable standard impedance states such as open, short, matched load, and through, it serves as the core basis for calibrating vector network analyzers and scalar network analyzers. It accurately corrects system errors such as port reflections and transmission loss in the test setup, ensuring high accuracy, repeatability, and traceability of the measurement results.

This manual introduces the appearance and specifications of RIGOL mechanical calibration kits. You can download the latest manual for the calibration kits and vector network analyzers from RIGOL official website (www.rigol.com).

RIGOL Mechanical Calibration Kits

Model	Frequency Range	Connector
MCAL104-NM1	DC to 4.5 GHz	Type-N (Male) 50 Ω
MCAL104-NF1	DC to 4.5 GHz	Type-N (Female) 50 Ω
MCAL109-NM1	DC to 9 GHz	Type-N (Male) 50 Ω
MCAL109-NF1	DC to 9 GHz	Type-N (Female) 50 Ω
MCAL109-NK1	DC to 9 GHz	Type-N (Male and Female) 50 Ω
MCAL104-SM1	DC to 4.5 GHz	3.5 mm (Male)
MCAL104-SF1	DC to 4.5 GHz	3.5 mm (Female)
MCAL109-SM1	DC to 9 GHz	3.5 mm (Male)
MCAL109-SF1	DC to 9 GHz	3.5 mm (Female)
MCAL109-SK1	DC to 9 GHz	3.5 mm (Male and Female)
MCAL126-35K1	DC to 26.5 GHz	3.5 mm (Male and Female)
MCAL226-35F5	DC to 26.5 GHz	3.5 mm (Female)

MCAL104-NF1, DC to 4.5 GHz, Type-N (Female) 50 Ω



The MCAL104-NF1 type-N precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 4.5 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open 1 (Female)	1	Beryllium bronze, gold plated	None
2	Open 2 (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
3	Short (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
4	Load (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
5	Adapter Type N(F)-Type N(F)	1	Beryllium bronze, gold plated	Stainless steel, passivated

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Female)	DC to 4.5 GHz	> 2000	Phase deviation: $\leq \pm 1^\circ$
Short (Female)		> 2000	Phase deviation: $\leq \pm 1^\circ$
Load (Female)		> 2000	VSWR: ≤ 1.035 (Return loss: ≥ 35.3 dB)
Adapter Type N (F)-Type N (F)		> 2000	VSWR: ≤ 1.05 (Return loss: ≥ 32.3 dB)

MCAL104-NM1, DC to 4.5 GHz, Type-N (Male) 50 Ω



The MCAL104-NM1 type-N precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 4.5 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Male)	1	None	Stainless steel, passivated
2	Short (Male)	1	Stainless steel	Stainless steel, passivated
3	Load (Male)	1	Beryllium bronze, gold plated	Stainless steel, passivated
4	Adapter Type N (M)-Type N (M)	1	Beryllium bronze, gold plated	Stainless steel, passivated

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Male)	DC to 4.5 GHz	> 2000	Phase deviation: $\leq \pm 1^\circ$
Short (Male)		> 2000	Phase deviation: $\leq \pm 1^\circ$
Load (Male)		> 2000	VSWR: ≤ 1.035 (Return loss: ≥ 35.3 dB)
Adapter Type N (M)-Type N (M)		> 2000	VSWR: ≤ 1.05 (Return loss: ≥ 32.3 dB)

MCAL104-SF1, DC to 4.5 GHz, 3.5 mm (Female)



The MCAL104-SF1 3.5 mm precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 4.5 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
2	Short (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
3	Load (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
4	Adapter Type 3.5 mm (F)-Type 3.5 mm (F)	1	Beryllium bronze, gold plated	Stainless steel, passivated

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Female)	DC to 4.5 GHz	> 2000	Phase deviation: $\leq \pm 1^\circ$
Short (Female)		> 2000	Phase deviation: $\leq \pm 1^\circ$
Load (Female)		> 2000	VSWR: ≤ 1.032 (Return loss: ≥ 36 dB)
Adapter Type 3.5 mm (F)-Type 3.5 mm (F)		> 2000	VSWR: ≤ 1.05 (Return loss: ≥ 32.3 dB)

MCAL104-SM1, DC to 4.5 GHz, 3.5 mm (Male)



The MCAL104-SM1 3.5 mm precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 4.5 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Male)	1	None	Stainless steel, passivated
2	Short (Male)	1	Stainless steel	Stainless steel, passivated
3	Load (Male)	1	Beryllium bronze, gold plated	Stainless steel, passivated
4	Adapter Type 3.5 mm (M)-Type 3.5 mm (M)	1	Beryllium bronze, gold plated	Stainless steel, passivated

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Male)	DC to 4.5 GHz	> 2000	Phase deviation: $\leq \pm 1^\circ$
Short (Male)		> 2000	Phase deviation: $\leq \pm 1^\circ$
Load (Male)		> 2000	VSWR: ≤ 1.032 (Return loss: ≥ 36 dB)
Adapter Type 3.5 mm (M)-Type 3.5 mm (M)		> 2000	VSWR: ≤ 1.05 (Return loss: ≥ 32.3 dB)

MCAL109-NF1, DC to 9 GHz, Type-N (Female) 50 Ω

The MCAL109-NF1 type-N precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 9 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.



Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
2	Short (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
3	Load (Female)	1	Beryllium bronze, gold plated	Stainless steel, passivated
4	Adapter Type N(F)-Type N(F)	1	Beryllium bronze, gold plated	Stainless steel, passivated

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Female)	DC to 9 GHz	> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Short (Female)		> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Load (Female)		> 2000	VSWR: ≤ 1.025 (Return loss: ≥ 38.2 dB)
Adapter Type N (F)-Type N (F)		> 2000	VSWR: ≤ 1.06 (Return loss: ≥ 30.7 dB)

MCAL109-NM1, DC to 9 GHz, Type-N (Male) 50 Ω

The MCAL109-NM1 type-N precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 9 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.



Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Male)	1	Beryllium bronze, gold plated	Stainless steel, passivated
2	Short (Male)	1	Beryllium bronze, gold plated	Stainless steel, passivated
3	Load (Male)	1	Beryllium bronze, gold plated	Stainless steel, passivated
4	Adapter Type N (M)-Type N (M)	1	Beryllium bronze, gold plated	Stainless steel, passivated

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Male)	DC to 9 GHz	> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Short (Male)		> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Load (Male)		> 2000	VSWR: ≤ 1.025 (Return loss: $\geq 38.2\text{dB}$)
Adapter Type N (M)-Type N (M)		> 2000	VSWR: ≤ 1.06 (Return loss: $\geq 30.7\text{dB}$)

MCAL109-SF1, DC to 9 GHz, 3.5 mm (Female)



The MCAL109-SF1 precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 9 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Female)	1	Beryllium bronze, gold plated	Beryllium bronze, gold plated
2	Short (Female)	1	Beryllium bronze, gold plated	Beryllium bronze, gold plated
3	Load (Female)	1	Beryllium bronze, gold plated	Beryllium bronze, gold plated
4	Adapter Type 3.5 mm (F)-Type 3.5 mm (F)	1	Beryllium bronze, gold plated	Stainless steel, passivated
5	Connector body	1		

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Female)	DC to 9 GHz	> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Short (Female)		> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Load (Female)		> 2000	VSWR: ≤ 1.02 (Return loss: ≥ 40 dB)
Adapter Type 3.5 mm (F)-Type 3.5 mm (F)		> 2000	VSWR: ≤ 1.06 (Return loss: ≥ 30.7 dB)

MCAL109-SM1, DC to 9 GHz, 3.5 mm (Male)



The MCAL109-SM1 precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 9 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Quantity	Inner Conductor	External Conductor
1	Open (Male)	1	Beryllium bronze, gold plated	Beryllium bronze, gold plated
2	Short (Male)	1	Beryllium bronze, gold plated	Beryllium bronze, gold plated
3	Load (Male)	1	Beryllium bronze, gold plated	Beryllium bronze, gold plated
4	Adapter Type 3.5 mm (M)-Type 3.5 mm (M)	1	Beryllium bronze, gold plated	Stainless steel, passivated
5	Connector body	1		

Performance Specifications

Component	Frequency	Durability	Parameter
Open (Male)	DC to 9 GHz	> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Short (Male)		> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Load (Male)		> 2000	VSWR: ≤ 1.02 (Return loss: ≥ 40 dB)
Adapter Type 3.5 mm (M)-Type 3.5 mm (M)		> 2000	VSWR: ≤ 1.06 (Return loss: ≥ 30.7 dB)

MCAL109-NK1, DC to 9 GHz, Type-N (Male and Female)

50 Ω

The MCAL109-NK1 type-N precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 9 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.



Kit Contents

Serial No.	Component	Quantity
1	Open (Female)	1
2	Open (Male)	1
3	Short (Female)	1
4	Short (Male)	1
5	Load (Female)	1
6	Load (Male)	1
7	Adapter Type N (M)-Type N (M)	1
8	Adapter Type N (F)-Type N (F)	1
9	Adapter Type N (M)-Type N (F)	1
10	Torque wrench (opening size: 19mm; torque: 1.35Nm)	1

11	Tool kit (size:275 * 200 * 80 mm)	1
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Performance Specifications

Component	Frequency	Durability	Parameter
Open	DC to 9 GHz	> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Short		> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Load		> 2000	VSWR: ≤ 1.025 (Return loss: $\geq 38.2\text{dB}$)
Adapter		> 2000	VSWR: ≤ 1.06 (Return loss: $\geq 30.7\text{dB}$)

Materials/Surface Treatment

Component	Inner Conductor	External Conductor
Open	Beryllium bronze, gold plated	Stainless steel, passivated
Short	Beryllium bronze, gold plated	Stainless steel, passivated
Load	Beryllium bronze, gold plated	Stainless steel, passivated
Adapter	Beryllium bronze, gold plated	Stainless steel, passivated
Torque wrench	Wrench head: tool steel, nickel plated	Wrench handle: aluminum, anodized
Tool kit	Wooden box	

MCAL109-SK1, DC to 9 GHz, 3.5 mm (Male and Female)



The MCAL109-SK1 3.5 mm precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 9 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.

Kit Contents

Serial No.	Component	Quantity
1	Open (Female)	1
2	Open (Male)	1
3	Short (Female)	1
4	Short (Male)	1
5	Load (Female)	1
6	Load (Male)	1
7	Adapter Type 3.5 mm (M)-Type 3.5 mm (M)	1
8	Adapter Type 3.5 mm (F)-Type 3.5 mm (F)	1
9	Adapter Type 3.5 mm (M)-Type 3.5 mm (F)	1
10	Connector body	2

11	Torque wrench (opening size: 8mm; torque: 0.9Nm)	1
12	L-shaped hexagonal wrench	2
13	Tool kit (size: 275 * 200 * 80 mm)	1

Performance Specifications

Component	Frequency	Durability	Parameter
Open	DC to 9 GHz	> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Short		> 2000	Phase deviation: $\leq \pm 0.8^\circ$
Load		> 2000	VSWR: ≤ 1.02 (Return loss: ≥ 40 dB)
Adapter		> 2000	VSWR: ≤ 1.06 (Return loss: ≥ 30.7 dB)

Materials/Surface Treatment

Component	Inner Conductor	External Conductor
Open	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Short	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Load	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Adapter	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Torque wrench	Wrench head: tool steel, nickel plated	Wrench handle: aluminium, anodized
Tool kit	Wooden box	

MCAL126-35K1, DC to 26.5 GHz, 3.5 mm (Male and Female)

The MCAL126-35K1 3.5 mm precision coaxial calibration kit uses known components (standards) to calibrate the transmission system within a certain frequency range, thereby characterizing the system errors of the test system to improve measurement accuracy. The frequency range is DC to 26.5 GHz. The kit mainly includes an open, a short, and a fixed load. It is an indispensable component for accurate calibration of network analyzers, featuring a wide test frequency range, compact size, and stable electrical performance.



Kit Contents

Serial No.	Component	Quantity
1	Open (Female)	1
2	Open (Male)	1
3	Short (Female)	1
4	Short (Male)	1
5	Load (Female)	1
6	Load (Male)	1
7	Adapter Type 3.5 mm (M)-Type 3.5 mm (M)	1
8	Adapter Type 3.5 mm (F)-Type 3.5 mm (F)	1
9	Adapter Type 3.5 mm (M)-Type 3.5 mm (F)	1
10	Torque wrench (opening size: 8mm; torque: 0.9Nm)	1
11	Tool kit (size: 275 * 200 * 80 mm)	1

Performance Specifications

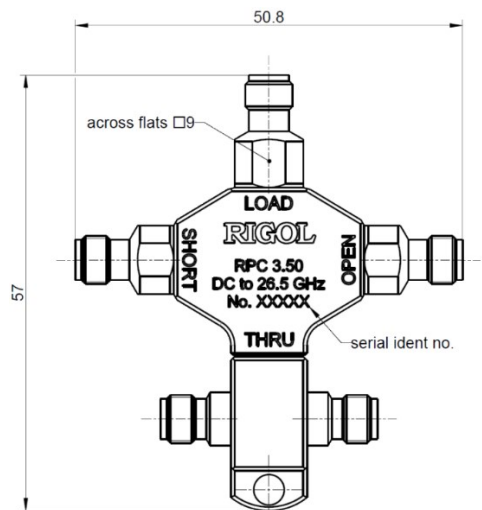
Component	Frequency	Durability	Parameter
Open	DC to 26.5 GHz	> 2000	Phase deviation: $\leq \pm 1.5^\circ$
Short		> 2000	Phase deviation: $\leq \pm 1.5^\circ$
Load		> 2000	VSWR: ≤ 1.04 (Return loss: $\geq 34\text{dB}$)
Adapter		> 2000	VSWR: ≤ 1.08 (Return loss: $\geq 28\text{dB}$)

Materials/Surface Treatment

Component	Inner Conductor	External Conductor
Open	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Short	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Load	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Adapter	Beryllium bronze, gold plated	Beryllium bronze, gold plated
Torque wrench	Wrench head: tool steel, nickel plated	Wrench handle: aluminium, anodized
Tool kit	Wooden box	

MCAL226-35F5, DC to 26.5 GHz, 3.5 mm (Female)

4-in-1 OSLT Mechanical Calibration Kit



Unit: mm

Kit Contents/Materials/Surface Treatment

Serial No.	Component	Material	Plating
1	Center conductor	CuBe	Gold, min. 1.27 μ m, over nickel
2	Outer conductor	Stainless steel	Passivated
3	Body	Aluminum	Black anodized
4	Dielectric	Polystyrene (PS)	—
5	Substrate	Al ₂ O ₃	—

Performance Specifications

Serial No.	Parameter	Specification
1	Frequency range	DC to 26.5 GHz
2	(Open) Error from nominal phase ^[1]	DC to 4 GHz: $\leq 1.0^\circ$ 4 GHz to 8 GHz: $\leq 2.0^\circ$ 8 GHz to 26.5 GHz: $\leq 3.0^\circ$
3	(Short) Error from nominal phase ^[2]	
4	(Thru) Return loss	DC to 4 GHz: ≥ 34 dB 4 GHz to 8 GHz: ≥ 32 dB 8 GHz to 26.5 GHz: ≥ 30 dB

5	(Load) Return loss	DC to 4 GHz: ≥ 40.0 dB 4 GHz to 8 GHz: ≥ 35.0 dB 8 GHz to 26.5 GHz: ≥ 30.0 dB
6	DC Resistance	$50\ \Omega \pm 0.5\ \Omega$
7	Power Handling (at 25°C, sea level)	≤ 0.5 W, derate by 0.005 W/K

[1] The nominal phase is defined by the Offset Delay, the Offset Loss and the Fringing Capacitances

[2] The nominal phase is defined by the Offset Delay, the Offset Loss and the Short Inductance

Open

- Offset Z_0 / Impedance / Z_0 : $50\ \Omega$
- Offset Delay: 33.356 ps
- Length (electrical) / Offset Length: 10.00 mm
- Offset Loss: $2.20\ \text{G}\Omega/\text{s}$
- Loss: $0.0127\ \text{dB}/\sqrt{\text{GHz}}$
- Fringing Capacitances:
 $C_0 = -17.500 \times 10^{-15}\ \text{F} = -17.500\ \text{fF}$
 $C_1 = -2000.0 \times 10^{-27}\ \text{F/Hz} = -2.0000\ \text{fF/GHz}$
 $C_2 = 140.00 \times 10^{-36}\ \text{F/Hz}^2 = 0.1400\ \text{fF/GHz}^2$
 $C_3 = -2.7000 \times 10^{-45}\ \text{F/Hz}^3 = -0.0027\ \text{fF/GHz}^3$

Thru

- Offset Z_0 / Impedance / Z_0 : $50\ \Omega$
- Offset Delay: 84.058 ps
- Length (electrical) / Offset Length: 25.20 mm
- Offset Loss: $2.51\ \text{G}\Omega/\text{s}$
- Loss: $0.0183\ \text{dB}/\sqrt{\text{GHz}}$
- Line Loss @ 1GHz: 0.0007 dB/mm

Mechanical Data

- Mating cycles: ≥ 500
- Maximum torque: 1.70 Nm
- Recommended torque: 0.90 Nm
- Gauge: 0.00 mm to 0.08 mm

Short

- Offset Z_0 / Impedance / Z_0 : $50\ \Omega$
- Offset Delay: 33.356 ps
- Length (electrical) / Offset Length: 10.00 mm
- Offset Loss: $2.36\ \text{G}\Omega/\text{s}$
- Loss: $0.0137\ \text{dB}/\sqrt{\text{GHz}}$
- Short Inductance
 $L_0 = -44.000 \times 10^{-12}\ \text{H} = -44.000\ \text{pH}$
 $L_1 = 3700.0 \times 10^{-24}\ \text{H/Hz} = 3.7000\ \text{pH/GHz}$
 $L_2 = -250.00 \times 10^{-33}\ \text{H/Hz}^2 = -0.2500\ \text{pH/GHz}^2$
 $L_3 = 5.0000 \times 10^{-42}\ \text{H/Hz}^3 = 0.0050\ \text{pH/GHz}^3$

Load

- Offset Z_0 / Impedance / Z_0 : $50\ \Omega$
- Offset Delay: 0.0000 ps
- Length (electrical) / Offset Length: 0.000 mm
- Offset Loss: $0.00\ \text{G}\Omega/\text{s}$
- Loss: $0.0000\ \text{dB}/\sqrt{\text{GHz}}$

Environmental Data

- Operating temperature range^[3]: $+20^\circ\text{C}$ to $+26^\circ\text{C}$
- Rated temperature range of use^[4]: 0°C to $+50^\circ\text{C}$
- Storage temperature range: -40°C to $+85^\circ\text{C}$
- Packing: 1 pce in bag
- Weight: 34.9 g/pce

[3]: Temperature range over which these specifications are valid.

[4]: This range is underneath and above the operating temperature range, within the calibration kit is fully functional and could be used without damage.

Boost Smart World and Technology In



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- Optical Communication

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