

MC9010+

Multifunction Calibrator



HIGHLIGHTS

- AC/DC voltage/current up to 1050V/30A
- Basic uncertainty 10 ppm
- AC/DC power, energy, resistance, capacitance, frequency, TC, RTD
- Scope option up to 400 MHz
- High voltage resistance option for 1.5 kV insulation testers
- Built-in process multimeter
- Interface RS232, LAN, USB, GPIB

DESCRIPTION

Multifunction calibrator MC9010+ is designed as universal calibration tool for electrical calibration laboratories, covering most of their workload like multimeters clamp meters, ohm meters, power meters and power analyzers, energy meters, transducers, insulation testers, process meters, scopes and many others. High load capacity of both voltage (up to 50 mA) output allows for calibration of high-consumption analogue meters. Installed harmonic and non-harmonic shape signals allow for testing meter sensitivity to distorted signals by a signal with various crest factor. Advancing from previous MC14x calibrator series, MC9010+ can now calibrate even 400 MHz scopes, 1.5 kV insulation testers and power meters. On the other hand we kept all the popular functions including complete transducer and external sensor calibration (strain gauge, pressure, torsion, strength, etc.) using built-in multimeter, automatic uncertainty calculation, remote control and easy recalibration.

MC9010+ Multifunction Calibrator is fully compatible with Powertek calibration SW package CALIBER/WinQbase which allows for time saving automated calibrations using any of the four installed remote control interfaces.

SPECIFICATION

Specifications below describe 1-year absolute uncertainty at a confidence interval of 95%, including long-term stability, linearity, load and line regulation and reference standard measurement uncertainty as well as ambient conditions within specified limits.

DC/AC Voltage

Voltage range summary	DC: 0 mV – 1050 V AC sine: 1 mV _{rms} – 1050 V _{rms} Non-sine: 1 mV _{rms} – 200 V _{rms}
Internal ranges	20 mV, 200 mV, 2 V, 20 V, 280 V, 1050 V
Frequency accuracy and resolution	10 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max.
Non-sine amplitude uncertainty	0.21 % of range + 70 μV _{pk}
Voltage output modes	passive 50Ω output up to 200 mV _{dc} active output in all DC and AC ranges

Ranges, resolution, 1 year uncertainty [ppm of value]

Range	DC	15 Hz – 10 kHz	10 kHz – 30 kHz	30 kHz – 100 kHz	100 kHz – 300 kHz
0 mV – 20 mV	30 + 1.5 μV ^{*1}	800 + 8 μV	1000 + 20 μV	2000 + 25 μV	5000 + 150 μV
20 mV – 200 mV	15 + 1.5 μV ^{*1}	280 + 8 μV	350 + 15 μV	600 + 25 μV	5000 + 300 μV
200 mV – 2V	12 + 5 μV	165 + 90 μV	250 + 100 μV	600 + 200 μV	5000 + 800 μV
2 V – 20 V	10 + 35 μV	160 + 700 μV	250 + 1 mV	500 + 1.5 mV	N/A
20 V – 100 V	15 + 150 μV	200 + 5 mV	300 + 12 mV	N/A	N/A
100 V – 280 V ^{*2}	15 + 400 μV	200 + 10 mV	300 + 40 mV	N/A	N/A
280 V – 1050 V ^{*3}	20 + 3.5 mV	300 + 15 mV	N/A	N/A	N/A

*1 Uncertainty in passive mode. Active mode uncertainty is 100 ppm + 10 μV and 15 ppm + 10 μV respectively. Frequency

*2 is limited to 15 Hz – 10 kHz above 200 V.

*3 Frequency is limited to 20 Hz – 1 kHz.

Distortion and Load Characteristics

Parameter	Range	20mV	200mV	2V	20V	100 V	280V	1000V
THD + noise ^{*4}	15 – 45 Hz	0.05 % + 200 μV	0.05 % + 300 μV	0.15 %	0.15 %	0.15 %	0.15 %	0.25 %
	45 – 10000 Hz	0.05 % + 200 μV	0.05 % + 300 μV	0.05 %	0.05 %	0.05 %	0.05 %	0.20 %
	10 – 30 kHz	0.25 % + 200 μV	0.25 % + 300 μV	0.12 %	0.15 %	0.3 %	0.3 %	N/A
	30 – 100 kHz	0.35 % + 230 μV	0.35 % + 300 μV	0.22 %	0.3 %	N/A	N/A	N/A
	100 – 300 kHz	1.5 % + 500 μV	1 % + 700 μV	0.7 %	N/A	N/A	N/A	N/A
Burden current	DC active	1 mA	4 mA _{rms} ⁴	30 mA	50 mA	50 mA	50 mA	5 mA
	45 – 10000 Hz	0.5 mA _{rms}	mA _{rms} ²	30 mA _{rms}	50 mA _{rms}	50 mA _{rms}	40 mA _{rms}	3 mA _{rms}
	10 – 30 kHz	0.5 mA _{rms}	mA _{rms}	10 mA _{rms}	10 mA _{rms}	10 mA _{rms}	10 mA _{rms}	N/A
	30 – 100 kHz	0.5 mA _{rms}		5 mA _{rms}	5 mA _{rms}	N/A	N/A	N/A
	100 – 300 kHz	100 Ω min. load	100 Ω min. load	1 mA	N/A	N/A	N/A	N/A

*4 THD in bandwidth up to 500 kHz or 10 lowest harmonics.

DC/AC Current

Current range summary	DC: 0.0000 μ A – 30.00000 A AC Sine: 10.0000 μ A _{rms} – 30.00000 A _{rms} Non-sine: 100.0000 μ A _{rms} – 2.000000 A _{rms}
Internal ranges	200 μ A, 2 mA, 20 mA, 200 mA, 2 A, 30 A
Frequency accuracy and resolution	10 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max.
Non-sine amplitude uncertainty	0.21 % of range + 0.7 μ A _{pk}

Ranges, resolution, 1 year uncertainty [ppm of value]

Range	DC	15 Hz – 1 kHz	1 kHz – 5 kHz	5 kHz – 10 kHz
0 μ A – 200 μ A	200 + 20 nA	1 250 + 80 nA ^{*5}	3 000 + 150 nA ^{*5}	5 000 + 200 nA ^{*5}
200 μ A – 2 mA	150 + 50 nA	850 + 200 nA	1 500 + 500 nA	4 000 + 600 nA
2 mA – 20 mA	100 + 600 nA	400 + 2 μ A	1 000 + 4 μ A	2 000 + 6 μ A
20 mA – 200 mA	100 + 5 μ A	400 + 20 μ A	1 000 + 50 μ A	2 000 + 100 μ A
200 mA – 2 A	160 + 50 μ A	480 + 100 μ A	1 000 + 500 μ A	N/A
2 A – 20 A	250 + 500 μ A	550 + 2 mA	N/A	N/A
20 A – 30 A ^{*6}	1000 + 750 μ A	1 200 + 5 mA	N/A	N/A

^{*5} Accuracy not specified below 10 μ A. 300s

^{*6} maximum continuous output time.

Distortion and Load Characteristics

Parameter	Range	200 μ A	2mA	20mA	200mA	2A	30A
Max. inductive load	15 Hz – 10 kHz	1 H	100 mH	100 mH	10 mH	1 mH	500 μ H
	15 – 1000 Hz	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.3 %
THD + noise ^{*7}	1 – 5 kHz	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	N/A
	5 – 10 kHz	0.5 %	0.4 %	0.4 %	0.4 %	N/A	N/A
Compliance voltage ^{*8}	DC	5 V	5 V	10 V	10 V	5 V	5 V
	15 – 1000 Hz	4 V _{rms}	4 V _{rms}	5 V _{rms}	5 V _{rms}	3.5 V _{rms}	3 V _{rms}
	1 – 5 kHz	4 V _{rms}	4 V _{rms}	5 V _{rms}	5 V _{rms}	3.5 V _{rms}	N/A
	5 – 10 kHz	2 V _{rms}	2 V _{rms}	2 V _{rms}	2 V _{rms}	N/A	N/A

^{*7} THD in bandwidth up to 100 kHz

^{*8} Additional uncertainty for compliance voltage above 0.5 V_{rms}

Voltage from current

Voltage range	Waveform	5.00000 mV – 5.000000 V
Amplitude uncertainty		DC, 15.000 Hz – 400.00 Hz sine 0.05 % + 0.04
Distortion		% of range
Source impedance		< 0.1 % in 100 kHz bandwidth 2.2, 22 or 220 Ω

Current coil (option 140-50)

Applicable multiplier	2 – 200
Max. simulated current	multiplier \times 30 A (1500 A with 140-50 Current Coil)
Frequency range	45 – 65 Hz
Additional uncertainty	0.3 % with 140-50 Current Coil

Resistance

Resistance range summary

0.0000 Ω – 100.0000 kΩ in 4W
0.0000 Ω – 1.100000 GΩ in 2W

Modes

2W and 4W continuous range
2W and 4W fixed decadic standards
100 GΩ High Voltage Resistance (optional)

Basic resistance modes and 1 year uncertainty [ppm of value + absolute]

Continuous range mode	4W	2W	Nominal standard value	4W	2W
0 – 10 Ω	300 ppm + 2 mΩ	300 ppm + 32 mΩ	0 Ω	< 0.5 mΩ	25 mΩ
10 – 33 Ω	250 ppm + 2 mΩ	250 ppm + 32 mΩ	100 mΩ	0.5 mΩ	25 mΩ
33 – 100 Ω	150 ppm + 3 mΩ	150 ppm + 33 mΩ	1 Ω	0.5 mΩ	25 mΩ
100 – 1000 Ω	100 ppm + 3 mΩ	100 ppm + 33 mΩ	10 Ω	1 mΩ	30 mΩ
1 – 10 kΩ	90 ppm + 30 mΩ	90 ppm + 60 mΩ	100 Ω	3 mΩ	30 mΩ
10 – 100 kΩ	90 ppm + 300 mΩ	90 ppm + 330 mΩ	1 kΩ	15 ppm	40 ppm
100 – 330 kΩ	100 ppm + 3 Ω	100 ppm + 3 Ω	10 kΩ	15 ppm	20 ppm
330 – 1000 kΩ	150 ppm + 3 Ω	150 ppm + 3 Ω	100 kΩ	15 ppm	15 ppm
1 – 3.3 MΩ	-	150 ppm + 30 Ω	1 MΩ	-	30 ppm
3.3 – 10 MΩ	-	200 ppm + 30 Ω	10 MΩ	-	130 ppm
10 – 100 MΩ	-	0.2 % + 300 Ω	100 MΩ	-	1000 ppm
100 – 330 MΩ	-	0.3 % + 3 kΩ	1 GΩ	-	2500 ppm
330 – 1100 MΩ	-	1 % + 10 kΩ			

Capacitance

Capacitance range summary

0.800000 nF – 120.0000 mF in 2W

Modes

2W continuous range
2W fixed decadic standards

Capacitance modes, 1 year uncertainty and frequency limits

Continuous range mode	Uncertainty	Nominal standard value	Uncertainty
0.8 – 3.3 nF	0.5 % + 15 pF	1 nF	1.25 %
3.3 nF – 10 mF	0.5 %	10 nF	0.35 %
10 – 20 mF	0.7 %	100 nF	0.25 %
20 – 120 mF	1.0 %	1 μF	0.25 %
		10 μF	0.35 %
		100 μF	0.45 %

Temperature (RTD, TC)

RTD temperature standards

Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom

RTD R₀ range

20 Ω – 2 kΩ

Thermocouple types

B,C,D,E,G₂,J,K,M,N,R,S,T

TC cold junction compensation

Manual or automatic with adapter 91

Uncertainty

0.03 °C – 0.18 °C in RTD
0.18 °C – 0.96 °C in TC

AC/DC Power & Energy

Range summary	power: 40 μ W – 30 kW voltage: 0.2 V – 1050 V current: 0.2 mA – 30 A frequency: DC, 15 – 1000 Hz time period: 2 s – 1 hour
Total uncertainty	based on voltage, current, phase shift and energy period specifications.
Phase shift uncertainty	0.15° up to 200 Hz 0.25° above 200 Hz 0.5° in 1050V range, 20 – 500 Hz
Energy period uncertainty	0.01% + 0.3 s
Additional features	Harmonic distortion, voltage from current, current coil multiplication

Total 1 year power accuracy in common applications [% of value]

Set current	EU grid power (230 V, 50 Hz)	US grid power (115 V, 60 Hz)	Aircraft onboard power (115 V, 400 Hz)	Ship onboard power (440 V, 60 Hz)
100 mA	0.071 %	0.073 %	0.073 %	0.075 %
1 A	0.070 %	0.071 %	0.071 %	0.073 %
10 A	0.084 %	0.086 %	0.086 %	0.087 %
30 A	0.142 %	0.143 %	0.143 %	0.144 %

Harmonic distortion (all AC functions)

Number of products	50
Fundamental harmonic uncertainty	amplitude: \geq 0.2% of range frequency: 25 ppm phase shift: 0.2 – 0.5 °
Frequency range	1 st product: 15 – 1000 Hz 2 nd – 50 th product: 30 – 5000 Hz
Harmonic product amplitude range	0 – 30 % of fundamental
Harmonic product phase shift unc.	5 μ s (typical)

MC9010/SCO Frequency / Scope option

HF mode (levelled sine)

Amplitude range: 1400 mV_{pk} – 1.5000 V_{pk}

Freq. range	15 Hz – 100 kHz	100 – 500 kHz	0.5 – 10 MHz	10 – 100 MHz	100 – 400 MHz
Harmonic distortion	-55 dB	-38 dB (< 10 dBm)	-38 dB (< 10 dBm)	-38 dB (< 10 dBm)	-30 dB (< 10 dBm)
Flatness	< 0.2 %	< 0.7 % + 100 μ V _{pk}	< 1.2 % + 100 μ V _{pk}	< 2.0 % + 100 μ V _{pk}	< 2.5 % + 100 μ V _{pk}
Amplitude uncertainty	0.5 % + 350 μ V _{pk}	2.0 % + 250 μ V _{pk}	2.5 % + 250 μ V _{pk}	3.3 % + 250 μ V _{pk}	3.7 % + 250 μ V _{pk}

LF mode (DC, square wave)

High voltage range:	0 – 200 V _{pk} at 1 kHz max, 0.3 % amplitude uncertainty
Low voltage range:	0 – 10.5 V _{pk} at 100 kHz max, 0.1 – 0.2 % amp. uncertainty

PULSE WIDTH and TIME MARKER modes

Frequency range:	0.1 Hz – 400 MHz
Frequency uncertainty:	2.5 ppm
Amplitude ranges:	50 mV _{pk} , 100 mV _{pk} , 500 mV _{pk} , 1 V _{pk}
Duty cycle ratios:	1 – 50 %
TM waveforms:	PWM up to 25 MHz, 2 ns spike otherwise
Jitter:	< 2 ns
Rise time:	< 1 ns

TRIGGER mode

Amplitude:	> 1 V _{pk}
Division ratio:	off, /1, /10, /100
Rise time:	< 1 ns

MC9010/HVR High Voltage Resistance option

Resistance range	Maximum test voltage	Resistance uncertainty	Test voltage uncertainty
100 – 200 k Ω	800 V _{dc}	0.2 %	0.3 % + 2 V
200 k Ω - 1 M Ω	1100 V _{dc}	0.2 %	0.3 % + 2 V
1 – 10 M Ω	1150 V _{dc}	0.3 %	0.5 % + 5 V
10 M Ω – 1 G Ω	1500 V _{dc}	0.5 %	0.5 % + 5 V
1 – 10 G Ω	1500 V _{dc}	1.0 %	1 % + 5 V
100 G Ω (fixed standard)	1500 V _{dc}	3.0 %	1.5 % + 5 V

MC9010/MER Multimeter option

Measurement function	Range	Uncertainty
DC voltage	12 mV 120 mV, 1.2 V, 12 V	50 ppm + 3 μ V 50 ppm + [5 – 500] μ V
DC current	100 μ A, 1 mA 2.4 mA, 24 mA	200 ppm + [20 – 100] nA 150 ppm + 800 nA
Frequency	0.1 Hz – 100 kHz	50 ppm
Resistance ^{*9}	2 k Ω , 20 k Ω	200 ppm + 5 ppm of range
RTD temperature ^{*9}	Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom	0.08 – 0.42 $^{\circ}$ C
TC temperature	BCDEG ₂ JKMNRST	0.22 – 1 $^{\circ}$ C

*9 Using 9000-60 4W measurement adapter (comes as standard with MER option)

GENERAL DATA

Warm-up time	30 minutes
Reference temperature	+21 $^{\circ}$ C – +25 $^{\circ}$ C
Operating temperature	+13 $^{\circ}$ C – +33 $^{\circ}$ C
Storage temperature	-10 $^{\circ}$ C – +55 $^{\circ}$ C
Temperature coefficient	10 % of accuracy / $^{\circ}$ C outside Tref
Max relative humidity	70 %
Power supply	115/230V - 50/60 Hz, 450 VA max
Dimensions (W x H x D)	435 x 175 x 620 mm
Weight	24 kg
Interfaces	RS232, IEEE488, USB, Ethernet