

MC9010

Multifunction Calibrator



HIGHLIGHTS

- AC/DC voltage/current up to 1050 V/20.5 A
- Basic uncertainty 35 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) and current 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 287 kW 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 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.

GENERAL DATA

Warm-up time	30 minutes
Reference temperature Operating temperature	+21 °C – +25 °C
	+13 °C – +33 °C
Storage temperature Temperature coefficient	-10 °C – +55 °C
	10 % of accuracy / °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

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, 100 V, 280 V, 1050 V
Frequency accuracy and resolution	25 ppm, 5 digit
Non-sine waveform types	saw, triang., square, truncated sin; 1kHz max 0.21 % of range + 70 μV _{pk}
Non-sine amplitude uncertainty	passive 50Ω output up to 200 mV _{dc}
Voltage output modes	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
0.00000 – 20.00000 mV	220 + 3 μV ^{*1}	2000 + 30 μV	2000 + 40 μV	10000 + 100 μV	50000 + 900 μV
20.0001 – 200.0000 mV	45 + 3 μV ^{*1}	1000 + 80 μV	1500 + 120 μV	3000 + 300 μV	5000 + 1 mV
0.200001 – 2.000000 V	35 + 10 μV	250 + 120 μV	500 + 300 μV	2000 + 1 mV	5000 + 1 mV
2.00001 – 20.00000 V	35 + 40 μV	250 + 700 μV	500 + 1.5 mV	2000 + 10 mV	N/A
20.0001 – 100.0000 V	42 + 250 μV	270 + 5 mV	500 + 15 mV	N/A	N/A
100.0001 – 280.0000 V ^{*2}	42 + 500 μV	300 + 12 mV	500 + 50 mV	N/A	N/A
280.001 – 1050.000 V ^{*3}	50 + 7 mV	420 + 85 mV	N/A	N/A	N/A

^{*1} Uncertainty in passive mode. Active mode uncertainty is 220 ppm + 20 μV and 45 ppm + 20 μV respectively.

^{*2} Frequency is limited to 15 – 10 kHz above 200 V.

^{*3} Frequency is limited to 20 – 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 μ V	0.05 % + 300 μ V	0.15 %	0.15 %	0.15 %	0.15 %	0.25 %
	45 – 10000 Hz	0.05 % + 200 μ V	0.05 % + 300 μ V	0.05 %	0.05 %	0.05 %	0.05 %	0.20 %
	10 – 30 kHz	0.25 % + 200 μ V	0.25 % + 300 μ V	0.12 %	0.15 %	0.3 %	0.3 %	N/A
	30 – 100 kHz	0.35 % + 230 μ V	0.35 % + 300 μ V	0.22 %	0.3 %	N/A	N/A	N/A
	100 – 300 kHz	1.5 % + 500 μ V	1 % + 700 μ V	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 – 20.50000 A
AC Sine: 10.0000 μ A_{rms} – 20.50000 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, 20.5 A

Frequency accuracy and resolution

25 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 [% of value]

Range	DC	15 Hz – 1 kHz	1 kHz – 5 kHz	5 kHz – 10 kHz
0.0000 – 200.0000 μ A	0.05 + 20 nA	0.15 + 150 nA	0.3 + 200 nA	0.5 + 500 nA
0.200000 – 2.000000 mA	0.028 + 100 nA	0.085 + 300 nA	0.2 + 1 μ A	0.5 + 1.4 μ A
2.000000 – 20.000000 mA	0.015 + 600 nA	0.05 + 2 μ A	0.2 + 10 μ A	0.5 + 14 μ A
20.0000 – 200.0000 mA	0.015 + 6 μ A	0.05 + 20 μ A	0.2 + 100 μ A	0.5 + 140 μ A
0.200000 – 2.000000 A	0.02 + 130 μ A	0.07 + 200 μ A	0.2 + 500 μ A	N/A
2.000000 – 20.500000 A	0.025 + 2 mA	0.1 + 6 mA	N/A	N/A

Distortion and Load Characteristics

Parameter	Range	200 μ A	2mA	20mA	200mA	2A	20.5A
Max. inductive load	15 Hz – 10 kHz	1 H	100 mH	100 mH	10 mH	1 mH	500 μ H
THD + noise ^{*5}	15 – 1000 Hz	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.3 %
	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 ^{*6}	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

^{*5} THD in bandwidth up to 100 kHz

^{*6} Additional uncertainty for compliance voltage above 0.5 V_{rms}

Voltage from current

Voltage range	2.50000 mV – 5.000000 V
Waveform	DC, 15.000 Hz – 400.00 Hz sine
Amplitude uncertainty	0.05 % + [0.02 – 0.04] % of range <
Distortion	0.1 % in 100 kHz bandwidth 2.2, 22
Source impedance	or 220 Ω

Current coil (option 140-50)

Applicable multiplier Max. simulated current	2 – 200 multiplier × 20.5 A (1025 A with 140-50 Current Coil)
Frequency range Additional uncertainty	45 – 65 Hz 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 + 2 mΩ	300 + 32 mΩ	0 Ω	< 0.5 mΩ	25 mΩ
10 – 33 Ω	250 + 2 mΩ	250 + 32 mΩ	1 Ω	0.5 mΩ	25 mΩ
33 – 100 Ω	300 + 2 mΩ	300 + 32 mΩ	10 Ω	2 mΩ	30 mΩ
100 – 1000 Ω	130 + 3 mΩ	130 + 33 mΩ	100 Ω	4 mΩ	30 mΩ
1 – 10 kΩ	130 + 30 mΩ	130 + 60 mΩ	1 kΩ	15 ppm	40 ppm
10 – 100 kΩ	130 + 300 mΩ	130 + 330 mΩ	10 kΩ	15 ppm	20 ppm
100 – 330 kΩ	130 + 3 Ω	130 + 3 Ω	100 kΩ	15 ppm	15 ppm
330 – 1000 kΩ	150 + 3 Ω	150 + 3 Ω	1 MΩ	-	30 ppm
1 – 10 MΩ	-	300 + 30 Ω	10 MΩ	-	500 ppm
10 – 100 MΩ	-	2000 + 300 Ω	100 MΩ	-	1000 ppm
100 – 330 MΩ	-	3000 + 3 kΩ	1 GΩ	-	2500 ppm
330 – 1100 MΩ	-	10000 + 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 R_0 range	20 Ω – 2 k Ω
Thermocouple types	B,C,D,E,G ₂ ,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 – 5.74 kW voltage: 0.2 V – 280 V current: 0.2 mA – 20.5 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
Energy period uncertainty	0.01% + 0.3 s
Additional features	Harmonic distortion, voltage from current, current coil multiplication

Total 1 year uncertainty overview [% of value]

Current range	DC	15 Hz – 1 kHz, $\phi = 0^\circ$	15 Hz – 200 Hz, $\phi = 60^\circ$
2 mA	0.035 – 0.079 %	0.11 – 0.25 %	0.47 – 0.52 %
20 mA, 200 mA	0.021 – 0.047 %	0.073 – 0.18 %	0.46 – 0.49 %
2 A	0.029 – 0.086 %	0.090 – 0.19 %	0.46 – 0.49 %
20.5 A	0.037 – 0.13 %	0.14 – 0.41 %	0.47 – 0.61 %

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 5
Harmonic product phase shift unc.	μ s (typical)

MC9010/SCO Frequency / Scope option

HF mode (levelled sine)

Amplitude range: 1.400 mV_{pk} – 1.5000 V_{pk}

Freq. range	20 Hz – 100 kHz	100 – 500 kHz	0.5 – 10 MHz	10 – 100 MHz	100 – 400 MHz
Harmonic distortion	-55 dB	-38 dB	-38 dB	-38 dB	-30 dB
Flatness	< 0.2 %	< 0.5 % + 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: up to 200 V_{pk} at 1 kHz, 0.3 % amplitude uncertainty
up to 10.5 V_{pk} at 100 kHz, 0.1 – 0.2 % amp. uncertainty

Low voltage range:

PULSE WIDTH and TIME MARKER modes

Frequency range:	0.1 Hz – 400 MHz
Frequency uncertainty:	2.5 ppm
Amplitude ranges: Duty cycle ratios:	50 mV _{pk} , 100 mV _{pk} , 500 mV _{pk} , 1 V _{pk} 1 %, 10 %, 20 %, 30 %, 40 %, 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

Range	Maximum test voltage	Resistance uncertainty	Test voltage uncertainty
100 – 200 kΩ	800 V _{dc}	0.2 %	0.3 % + 2 V
200 kΩ - 1 MΩ	1100 V _{dc}	0.2 %	0.3 % + 2 V
1 – 10 MΩ	1150 V _{dc}	0.3 %	0.5 % + 5 V
10 MΩ – 1 GΩ	1500 V _{dc}	0.5 %	0.5 % + 5 V
1 – 10 GΩ	1500 V _{dc}	1.0 %	1 % + 5 V
100 GΩ (fixed standard)	1500 V _{dc}	3.0 %	1.5 % + 5 V

MC9010/MER Multimeter option

Measurement function	Range	Uncertainty
DC voltage	12 mV	50 ppm + 3 μV
	120 mV, 1.2 V, 12 V	50 ppm + [5 – 500] μV
DC current	100 μA, 1 mA	200 ppm + [20 – 100] nA
	2.4 mA, 24 mA	150 ppm + 800 nA
Frequency	0.1 Hz – 100 kHz	50 ppm
Resistance ^{*7}	2 kΩ, 20 kΩ	200 ppm + [10 – 50] mΩ
RTD temperature ^{*7}	Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom	0.08 – 0.42 °C
TC temperature	BCDEG ₂ JKMNRST	0.22 – 1 °C

^{*7} Using 9000-60 4W measurement adapter (comes as standard with MER option)