

9010+

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 1100 MHz**
- **High voltage resistance option for 1.5 kV insulation testers**
- **Built-in process multimeter**
- **Interface RS232, LAN, USB, GPIB**

DESCRIPTION

Multifunction calibrator 9010+ is designed as universal calibration tool for electrical calibration laboratories, covering most of their workload like multimeters, 6½ digit DMMs, 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 M14x calibrator series, 9010+ can now calibrate even 1.1 GHz scopes, 6½ digit DMMs, 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.

9010+ calibrator can be fully integrated into commonly used calibration automation platforms. Unique camera readout module CamOCR, available in Meatest's SW package Caliber/WinQbase, allows for semi-automated calibrations of multimeters with no remote control interface.

SPECIFICATION

All absolute uncertainty specifications in this document are defined at a confidence interval of 95%, extension coefficient $k = 2$. Product specifications include 12-month stability, resolution (in measurement functions if any), temperature and humidity effects (within specified limits), linearity, load and line regulation and uncertainty of calibration standards (calibration traceability).

GENERAL DATA

Warm-up time	30 minutes
Reference temperature	+21 °C – +25 °C
Operating temperature	+13 °C – +33 °C
Storage temperature	-10 °C – +55 °C
Temperature coefficient	10 % of accuracy / °C outside T_{REF}
Max relative humidity	70 %
Power supply	115/230V - 50/60 Hz, 450 VA max
Dimensions (W x H x D)	434 x 191 x 641 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	10 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max; uncertainty: 0.21 % + 70 μ V _{PK}
Voltage output modes	passive 50 Ω 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
0.00000 – 20.00000 mV	30 + 1.5 μ V ^{*1}	1500 + 25 μ V	1500 + 30 μ V	2500 + 35 μ V	5000 + 300 μ V
20.00001 – 200.00000 mV	15 + 1.5 μ V ^{*1}	350 + 40 μ V	500 + 60 μ V	800 + 100 μ V	5000 + 500 μ V
0.2000001 – 2.0000000 V	12 + 5 μ V	165 + 90 μ V	250 + 100 μ V	600 + 200 μ V	5000 + 800 μ V
2.000001 – 20.000000 V	10 + 35 μ V	160 + 700 μ V	300 + 1.2 mV	500 + 4 mV	N/A
20.00001 – 100.00000 V	15 + 150 μ V	180 + 5 mV	400 + 14 mV	N/A	N/A
100.00001 – 280.00000 V ^{*2}	15 + 400 μ V	180 + 10 mV	300 + 40 mV	N/A	N/A
280.0001 – 1050.0000 V ^{*3}	20 + 3.5 mV	300 + 30 mV	N/A	N/A	N/A

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

*2 Frequency 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	1050V
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	5 mA	30 mA	50 mA	50 mA	50 mA	5 mA
	15 – 10000 Hz	0.5 mA _{RMS}	4 mA _{RMS}	30 mA _{RMS}	50 mA _{RMS}	50 mA _{RMS}	40 mA _{RMS}	3 mA _{RMS}
	10 – 30 kHz	0.5 mA _{RMS}	4 mA _{RMS}	10 mA _{RMS}	10 mA _{RMS}	10 mA _{RMS}	10 mA _{RMS}	N/A
	30 – 100 kHz	0.5 mA _{RMS}	2 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, 20.5 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 % + 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 – 20.5 A	250 + 500 μ A	750 + 4 mA	N/A	N/A
20.5 A – 30 A ^{*6}	450 + 750 μ A	1 200 + 5 mA	N/A	N/A

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

^{*6} 30 – 5 min maximum continuous output time. Depleted time regenerates 2x slower.

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
THD + noise ^{*7}	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	DC	5 V	5 V	10 V	10 V	5 V	5 V
	15 – 1000 Hz	5.7 V _{pk}	5.7 V _{pk}	7.1 V _{pk}	7.1 V _{pk}	4.9 V _{pk}	4.2 V _{pk}
	1 – 5 kHz	5.7 V _{pk}	5.7 V _{pk}	7.1 V _{pk}	7.1 V _{pk}	4.9 V _{pk}	N/A
	5 – 10 kHz	2.8 V _{pk}	2.8 V _{pk}	2.8 V _{pk}	2.8 V _{pk}	N/A	N/A
Load adder ^{*8}	DC	50 nA/V	50 nA/V	200 nA/V	2 μ A/V	100 μ A/V	500 μ A/V
	15 Hz – 1 kHz	70 nA/V	100 nA/V	200 nA/V	2 μ A/V	100 μ A/V	500 μ A/V
	1 kHz – 5 kHz	1.5 μ A/V	1.5 μ A/V	1.5 μ A/V	2 μ A/V	200 μ A/V	N/A
	5 kHz – 10 kHz	2 μ A/V	2 μ A/V	2 μ A/V	3 μ A/V	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

2.5000 mV – 5.00000 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

Source impedance

2.2, 22 or 220 Ω

Current coil (option 0950)

Applicable multiplier

2 – 200

Max. simulated current

multiplier $\times$ 30 A
(1500 A with 0950 Current Coil)

Frequency range

45 – 65 Hz

Additional uncertainty

0.3 % with 0950 Current Coil

Resistance

Resistance range summary

0.0000 Ω – 1000.000 k Ω in 4W
0.0000 Ω – 1.100000 G Ω in 2W

Modes

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

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

Variable range	4W	2W	Fixed nominal value	4W	2W
0 – 10 Ω	300 ppm + 2 m Ω	300 ppm + 32 m Ω	0 Ω	< 0.5 m Ω	25 m Ω
10 – 33 Ω	250 ppm + 2 m Ω	250 ppm + 32 m Ω	100 m Ω	0.5 m Ω	25 m Ω
33 – 100 Ω	150 ppm + 3 m Ω	150 ppm + 32 m Ω	1 Ω	0.5 m Ω	25 m Ω
100 – 1000 Ω	100 ppm + 3 m Ω	100 ppm + 33 m Ω	10 Ω	1 m Ω	30 m Ω
1 – 10 k Ω	90 ppm + 30 m Ω	90 ppm + 60 m Ω	100 Ω	3 m Ω	30 m Ω
10 – 100 k Ω	90 ppm + 300 m Ω	90 ppm + 330 m Ω	1 k Ω	15 ppm	40 ppm
100 – 330 k Ω	100 ppm + 3 Ω	100 ppm + 3 Ω	10 k Ω	15 ppm	20 ppm
330 – 1000 k Ω	150 ppm + 3 Ω	150 ppm + 3 Ω	100 k Ω	15 ppm	15 ppm
1 – 3.3 M Ω	-	150 ppm + 30 Ω	1 M Ω	-	30 ppm
3.3 – 10 M Ω	-	200 ppm + 30 Ω	10 M Ω	-	130 ppm
10 – 100 M Ω	-	0.2 % + 300 Ω	100 M Ω	-	1000 ppm
100 – 330 M Ω	-	0.3 % + 3 k Ω	1 G Ω	-	2500 ppm
330 – 1100 M Ω	-	1 % + 10 k Ω			

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

Variable range	Uncertainty	Fixed nominal value	Uncertainty
0.8 – 3.3 nF	0.5 % + 15 pF	1 nF	1.25 %
3.3 nF – 11 mF	0.5 %	10 nF	0.35 %
11 – 20 mF	0.7 %	100 nF	0.25 %
20 – 120 mF	1.0 %	1 μ F	0.25 %
		10 μ F	0.35 %
		100 μ F	0.45 %

Temperature (RTD, TC)

RTD temperature standards

Pt385, Pt3916, Pt3926, Ni672, Cu427, Cu428, custom

RTD R_0 range

20 Ω – 2 k Ω

Thermocouple types

A, B, C, D, E, G, J, K, L, M, N, R, S, T, U, XK

TC cold junction compensation

Manual or automatic with adapter 91

Uncertainty

0.03 $^{\circ}$ C – 0.17 $^{\circ}$ C in RTD
0.05 $^{\circ}$ C – 0.55 $^{\circ}$ C in TC

Duty cycle

Duty cycle range

0.1 % – 99.9 %

Accuracy

0.05 %

Frequency range

0.1 Hz – 1 kHz

Voltage range

1 mV_{pk} – 28.2 V_{pk}

Amplitude accuracy

0.5 % + 100 μ V

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 %	0.072 %	0.072 %	0.077 %
1 A	0.069 %	0.071 %	0.071 %	0.075 %
10 A	0.121 %	0.122 %	0.122 %	0.124 %
30 A	0.142 %	0.142 %	0.142 %	0.145 %

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)

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	1 Hz – 100 kHz	50 ppm
Resistance ^{*9}	2 k Ω , 20 k Ω	200 ppm + [10 – 50] m Ω
RTD temperature ^{*9}	Pt385, Pt3916, Pt3926, Ni672, Cu427, Cu428, custom	0.03 – 0.35 °C
TC temperature	A, B, C, D, E, G, J, K, L, M, N, R, S, T, U, XK	0.08 – 0.95 °C

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

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

SCO Frequency / Scope option

SINE mode (levelled sine)

Amplitude range 2.800 mV_{pp} – 3.0000 V_{pp}

Freq. range	15 Hz – 100 kHz	100 – 500 kHz	0.5 – 10 MHz	10 – 100 MHz	100 – 400 MHz
Harmonic distortion	-55 dB	-33 dB (< 10 dBm)	-33 dB (< 10 dBm)	-33 dB (< 10 dBm)	-30 dB (< 10 dBm)
Flatness	< 0.2 % + 200 µV _{pp}	< 0.5 % + 200 µV _{pp}	< 1.2 % + 200 µV _{pp}	< 2.0 % + 400 µV _{pp}	< 2.5 % + 400 µV _{pp}
Amplitude uncertainty	0.5 % + 700 µV _{pp}	2.0 % + 500 µV _{pp}	2.5 % + 500 µV _{pp}	3.3 % + 500 µV _{pp}	3.7 % + 500 µV _{pp}

VOLTAGE mode

Frequency range DC, 15 Hz – 1 kHz

Function	DUT Impedance	Voltage range	Uncertainty (% of value + % of range + floor)
DC voltage	50 Ω	-3.5 – +3.5 V	0.15 % + 0.002% + 30 µV
	1 MΩ	-200 – +200 V	0.03 % + 0.002% + 30 µV
Sine voltage	50 Ω	0 – 3.5 V _{rms}	0.25 % + 0.005% + 30 µV _{rms}
	1 MΩ	0 – 200 V _{rms}	0.10 % + 0.005% + 30 µV _{rms}
Square voltage	50 Ω	0 – 7 V _{pp}	0.40 % + 0.15%
	1 MΩ	0 – 400 V _{pp}	0.25 % + 0.15%

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
Frequency range 15 Hz – 400 MHz
Rise time < 1 ns

Input impedance measurement

Ranges 100 Ω, 2 MΩ
Measurement accuracy 0.1 % in 10 – 100 % of range

SCI Frequency / Scope option

SINE mode (levelled sine)

Amplitude range 2.800 mV_{pp} – 3.0000 V_{pp}

Freq. range	15 Hz – 100 kHz	100 – 500 kHz	0.5 – 10 MHz	10 – 100 MHz	100 – 600 MHz	600 – 1100 MHz
Harmonic distortion	-55 dB	-33 dB (< 10 dBm)	-33 dB (< 10 dBm)	-33 dB (< 10 dBm)	-30 dB (< 10 dBm)	-30 dB (< 10 dBm)
Flatness	< 0.2 % + 200 µV _{pp}	< 0.5 % + 200 µV _{pp}	< 1.2 % + 200 µV _{pp}	< 2.0 % + 200 µV _{pp}	< 2.5 % + 400 µV _{pp}	< 4.5 % + 400 µV _{pp}
Amplitude uncertainty	0.5 % + 700 µV _{pp}	2.0 % + 500 µV _{pp}	2.5 % + 500 µV _{pp}	3.3 % + 500 µV _{pp}	3.7 % + 500 µV _{pp}	6.5 % + 600 µV _{pp}

PULSE WIDTH and TIME MARKER modes

Frequency range 0.1 Hz – 400 MHz square wave
400 – 1100 MHz sine
Frequency uncertainty 0.1 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

LF mode, TRIGGER mode and Input impedance measurement function specifications are the same as in SCO option.