9010 Multifunction Calibrator

HIGHLIGHTS

- **AC/DC voltage/current up to 1050V/20A**
- **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 9010 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 M14x calibrator series, 9010 can now calibrate even 400 MHz scopes, 1.5 kV insulation testers and 1 MW 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 is fully compatible with Meatest 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	25 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max.
Non-sine amplitude uncertainty	0.3 % of range + 50 μV_{rms}
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
0.00000 – 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 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	5 mA	30 mA	50 mA	50 mA	50 mA	5 mA
	45 – 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 µA – 20.00000 A AC Sine: 10.0000 μA_{rms} – 20.00000 A_{rms} Non-sine: 100.0000 μA_{rms} – 2.000000 A_{rms}
Internal ranges	200 µA, 2 mA, 20 mA, 200 mA, 2 A, 20 A
Frequency accuracy and resolution	25 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max.
Non-sine amplitude uncertainty	0.3 % of range + 0.5 μA_{rms}

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 µA	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 µA	0.5 + 1.4 µA
2.00000 – 20.00000 mA	0.015 + 600 nA	0.05 + 2 µA	0.2 + 10 µA	0.5 + 14 µA
20.0000 – 200.0000 mA	0.015 + 6 µA	0.05 + 20 µA	0.2 + 100 µA	0.5 + 140 µA
0.200000 – 2.000000 A	0.02 + 130 µA	0.07 + 200 µA	0.2 + 500 µA	N/A
2.00000 – 20.00000 A *3	0.025 + 2 mA	0.1 + 6 mA	N/A	N/A

Distortion and Load Characteristics

Parameter	Range	200 µA	2 mA	20 mA	200 mA	2 A	20 A
Max. inductive load	15 Hz – 10 kHz	1 H	100 mH	100 mH	10 mH	1 mH	500 µH
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	5.00000 mV – 5.000000 V
Waveform	DC, 15.000 Hz – 400.00 Hz sine
Amplitude uncertainty	0.05 % + 0.04 % of range
Distortion	< 0.1 % in 100 kHz bandwidth
Source impedance	2.2, 22 or 220 Ω

Current coil (option 140-50)

Applicable multiplier	2 – 200
Max. simulated current	multiplier · 20 A (1000 A with 140-50 Current Coil)
Frequency range	45 – 65 Hz
Additional uncertainty	0.25 %

AC/DC Power & Energy

Range summary	power:	40 µW – 5.6 kW
	voltage:	0.2 V – 280 V
	current:	0.2 mA – 20 A
	frequency:	DC, 15 – 1000 Hz
	time period:	10 s – 1999 s
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, φ = 0°	15 Hz – 200 Hz, φ = 60°
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 A	0.037 – 0.13 %	0.14 – 0.41 %	0.47 – 0.61 %

Resistance

Resistance range summary	0.0000 Ω – 100.0000 kΩ in 4W 0.0000 Ω – 1.000000 GΩ in 2W
Modes	2W and 4W continuous range 2W and 4W fixed decadic standards 100 GΩ High Voltage Resistnace (optional)

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

Continuous range mode	4W	2W
0 – 10 Ω	300 + 1 mΩ	300 + 131 mΩ
10 – 33 Ω	250 + 1 mΩ	250 + 131 mΩ
33 – 100 Ω	150 + 1 mΩ	150 + 131 mΩ
100 – 1000 Ω	100 + 3 mΩ	100 + 133 mΩ
1 – 10 kΩ	100 + 30 mΩ	100 + 160 mΩ
10 – 100 kΩ	100 + 300 mΩ	100 + 430 mΩ
100 – 330 kΩ	100 + 3 Ω	100 + 3 Ω
330 – 1000 kΩ	150 + 3 Ω	150 + 3 Ω
1 – 3.3 MΩ	-	150 + 30 Ω
3.3 – 10 MΩ	-	200 + 30 Ω
10 – 33 MΩ	-	1000 + 300 Ω
33 – 100 MΩ	-	2000 + 300 Ω
100 – 330 MΩ	-	3000 + 300 Ω
330 – 1000 MΩ	-	7000 + 1 kΩ

Nominal standard value	4W	2W
0 Ω	< 0.2 mΩ	0.2 Ω
1 Ω	200	0.05 Ω
10 Ω	20	0.05 Ω
100 Ω	15	150
1 kΩ	15	15
10 kΩ	15	15
100 kΩ	15	15
1 MΩ	-	30
10 MΩ	-	500
100 MΩ	-	1000
1 GΩ	-	2500

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
0.8 – 3.3 nF	0.5 % + 15 pF
3.3 nF – 10 µF	0.5 %
10 – 33 µF	1.5 %
33 – 100 µF	2.5 %
0.1 – 1 mF	3 %
1 – 120 mF	5 %

Nominal standard value	Uncertainty
1 nF	2.5 %
10 nF	0.35 %
100 nF	0.25 %
1 µF	0.25 %
10 µF	0.35 %
100 µF	0.8 %

Harmonic distortion

Number of products:	50
Fundamental harmonic range	1 mV – 200 V or 10 µA – 2 A at 15 – 1000 Hz
Fundamental harmonic uncertainty	amplitude: ≥ 0.2% of range frequency: 25 ppm phase shift: 0.2 – 0.5 ˚
Harmonic product amplitude range	0 – 30 % of fundamental
Harmonic product frequency range	30 – 5000 Hz
Harmonic product phase shift unc.	5 µs (typical)

Temperature (RTD, TC)

RTD temperature standards	Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom
RTD R_0 range	20 Ω – 2 kΩ
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

9010/MER Multimeter option

Measurement function	Range	Uncertainty
DC voltage	12 mV 120 mV, 1.2 V, 12 V	50 ppm + 3 µV 50 ppm + [5 – 500] µV
DC current	100 µA, 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 *7	2 kΩ, 20 kΩ	200 ppm + 5 ppm of range
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)

9010/SC 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 %	< 0.7 %	< 1.2 %	< 2.0 %	< 2.5 %
Uncertainty	0.5 % + 350 $µV_{pk}$	2.0 %	2.5 %	3.3 %	3.7 %

LF mode (DC, square wave)

High voltage range:	up to 200 V_{pk} at 1 kHz, 0.3 % amplitude uncertainty
Low voltage range:	up to 10.5 V_{pk} at 100 kHz, 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 %, 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

9010/HR 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	1575 V_{dc}	0.5 %	0.5 % + 5 V
1 – 10 GΩ	1575 V_{dc}	1.0 %	1 % + 5 V
100 GΩ (fixed standard)	1575 V_{dc}	3.0 %	1.5 % + 5 V

GENERAL DATA

Warm-up time	30 minutes
Reference temperature	+22 °C – +24 °C
Operating temperature	+13 °C – +33 °C
Storage temperature	-10 °C – +55 °C
Temperature coefficient	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