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

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	+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)	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, 100V, 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 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
0.00000 – 20.00000 mV	30 + 1.5 µV *1	1500 + 25 µV	1500 + 30 µV	2500 + 35 µV	5000 + 300 µV
20.0001 – 200.0000 mV	15 + 1.5 µV *1	350 + 40 µV	500 + 60 µV	800 + 100 µV	5000 + 500 µV
0.200001 – 2.000000 V	12 + 5 µV	165 + 90 µV	250 + 100 µV	600 + 200 µV	5000 + 800 µV
2.00001 – 20.00000 V	10 + 35 µV	160 + 700 µV	300 + 1.2 mV	500 + 4 mV	N/A
20.0001 – 100.0000 V	15 + 150 µV	180 + 5 mV	400 + 14 mV	N/A	N/A
100.0001 – 280.0000 V *2	15 + 400 µV	180 + 10 mV	300 + 40 mV	N/A	N/A
280.001 – 1050.000 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 µV and 15 ppm + 10 µV 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	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 – 30.00000 A AC Sine: 10.0000 μA_{RMS} – 30.00000 A_{RMS} Non-sine: 100.0000 μA_{RMS} – 2.000000 A_{RMS}
Internal ranges	200 µA, 2 mA, 20 mA, 200 mA, 2 A, 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 μA_{pk}

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

Range	DC	15 Hz – 1 kHz	1 kHz – 5 kHz	5 kHz – 10 kHz
0 µA – 200 µA	200 + 20 nA	1 250 + 80 nA *5	3 000 + 150 nA *5	5 000 + 200 nA *5
200 µA – 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 µA	1 000 + 4 µA	2 000 + 6 µA
20 mA – 200 mA	100 + 5 µA	400 + 20 µA	1 000 + 50 µA	2 000 + 100 µA
200 mA – 2 A	160 + 50 µA	480 + 100 µA	1 000 + 500 µA	N/A
2 A – 20.5 A	250 + 500 µA	750 + 4 mA	N/A	N/A
20.5 A – 30 A *6	450 + 750 µA	1 200 + 5 mA	N/A	N/A

*5 Accuracy not specified below 10 µA.
*6 30 – 5 min maximum continuous output time. Depleted time regenerates 5x slower.

Distortion and Load Characteristics

Parameter	Range	200µA	2mA	20mA	200mA	2A	30A
Max. inductive load	15 Hz – 10 kHz	1 H	100 mH	100 mH	10 mH	1 mH	500 µH
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	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
Load adder *8	DC	50 nA/V	50 nA/V	200 nA/V	2 µA /V	100 µA/V	500 µA/V
	15 Hz – 1 kHz	70 nA/V	100 nA/V	200 nA/V	2 µA /V	100 µA/V	500 µA/V
	1 kHz – 5 kHz	1.5 µA/V	1.5 µA/V	1.5 µA/V	2 µA/V	200 µA/V	N/A
	5 kHz – 10 kHz	2 µA/V	2 µA/V	2 µA/V	3 µA/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 × 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 – 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
0 – 10 Ω	300 ppm + 2 mΩ	300 ppm + 32 mΩ
10 – 33 Ω	250 ppm + 2 mΩ	250 ppm + 32 mΩ
33 – 100 Ω	150 ppm + 3 mΩ	150 ppm + 33 mΩ
100 – 1000 Ω	100 ppm + 3 mΩ	100 ppm + 33 mΩ
1 – 10 kΩ	90 ppm + 30 mΩ	90 ppm + 60 mΩ
10 – 100 kΩ	90 ppm + 300 mΩ	90 ppm + 330 mΩ
100 – 330 kΩ	100 ppm + 3 Ω	100 ppm + 3 Ω
330 – 1000 kΩ	150 ppm + 3 Ω	150 ppm + 3 Ω
1 – 3.3 MΩ	-	150 ppm + 30 Ω
3.3 – 10 MΩ	-	200 ppm + 30 Ω
10 – 100 MΩ	-	0.2 % + 300 Ω
100 – 330 MΩ	-	0.3 % + 3 kΩ
330 – 1100 MΩ	-	1 % + 10 kΩ

Nominal standard value	4W	2W
0 Ω	< 0.5 mΩ	25 mΩ
100 mΩ	0.5 mΩ	25 mΩ
1 Ω	0.5 mΩ	25 mΩ
10 Ω	1 mΩ	30 mΩ
100 Ω	3 mΩ	30 mΩ
1 kΩ	15 ppm	40 ppm
10 kΩ	15 ppm	20 ppm
100 kΩ	15 ppm	15 ppm
1 MΩ	-	30 ppm
10 MΩ	-	130 ppm
100 MΩ	-	1000 ppm
1 GΩ	-	2500 ppm

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 – 11 mF	0.5 %
11 – 20 mF	0.7 %
20 – 120 mF	1.0 %

Nominal standard value	Uncertainty
1 nF	1.25 %
10 nF	0.35 %
100 nF	0.25 %
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 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

AC/DC Power & Energy

Range summary	power:	40 µW – 31.5 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:	≥ 0.2% of range
	frequency:	25 ppm
	phase shift:	0.2 – 0.5 °
Frequency range	1st product:	15 – 1000 Hz
	2nd – 50th product:	30 – 5000 Hz
Harmonic product amplitude range	0 – 30 % of fundamental	
Harmonic product phase shift unc.	5 µs (typical)	

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 *9	2 kΩ, 20 kΩ	200 ppm + [10 – 50] mΩ
RTD temperature *9	Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom	0.08 – 0.42 °C
TC temperature	BCDEG$_2$JKMNRST	0.22 – 1 °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 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

SCO Frequency / Scope option

HF mode (levelled sine)

Amplitude range: 1.400 m V_{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 % + 100 μV_{PK}	< 0.7 % + 100 μV_{PK}	< 1.2 % + 100 μV_{PK}	< 2.0 % + 200 μV_{PK}	< 2.5 % + 200 μV_{PK}
Amplitude uncertainty	0.5 % + 350 μV_{PK}	2.0 % + 250 μV_{PK}	2.5 % + 250 μV_{PK}	3.3 % + 250 μV_{PK}	3.7 % + 250 μV_{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
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

SC1 Frequency / Scope option

HF mode (levelled sine)

Amplitude range: 1.400 mV_{PK} – 1.5000 V_{PK} up to 1 GHz

1.400 mV_{PK} – 1.0000 V_{PK} above 1 GHz

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 % + 100 μV_{PK}	< 0.7 % + 100 μV_{PK}	< 1.2 % + 100 μV_{PK}	< 2.0 % + 100 μV_{PK}	< 2.5 % + 200 μV_{PK}	< 4.5 % + 200 μV_{PK}
Amplitude uncertainty	0.5 % + 350 μV_{PK}	2.0 % + 250 μV_{PK}	2.5 % + 250 μV_{PK}	3.3 % + 250 μV_{PK}	3.7 % + 250 μV_{PK}	6.5 % + 300 μV_{PK}

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.