

9020

Multifunction Calibrator [preliminary datasheet]



HIGHLIGHTS

- **AC/DC voltage/current up to 1050V/30A**
- **Basic uncertainty 9 ppm**
- **AC/DC power, energy, resistance, capacitance, frequency, TC, RTD**
- **Scope options up to 1100 MHz**
- **High voltage resistance option for 1.5 kV insulation testers**
- **Built-in process multimeter**
- **RS232, LAN, USB and GPIB interfaces as standard**

DESCRIPTION

Multifunction calibrator 9020 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.

Compared to its predecessor, 9020 brings wider frequency ranges in both AC voltage and AC current functions, improved accuracy in most functions, 2MHz frequency output with duty cycle and advanced impedance source to match the latest 6½ digit DMM workload.

9020 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
EMC compliance	Safety class I according to IEC 61010 ed. 2 ESD class I according to EN 61326 Overvoltage CAT II
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, 100V, 280 V, 1050 V
Frequency accuracy and resolution	5 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max; uncertainty: 0.21 % + 0.1 % 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	3 Hz – 10 Hz	10 Hz – 20 kHz	20 – 50 kHz	50 – 100 kHz	100 – 300 kHz
1.00000 – 20.00000 mV	30 + 1.5 μV ^{*1}	2 500 + 25 μV	1 400 + 15 μV	1 500 + 30 μV	2 500 + 35 μV	5 000 + 240 μV
20.0000 – 200.0000 mV	15 + 1.5 μV ^{*1}	2 150 + 20 μV	250 + 10 μV	400 + 30 μV	1 000 + 50 μV	5 000 + 240 μV
0.200000 – 2.000000 V	11 + 4 μV	2 150 + 100 μV	165 + 90 μV	300 + 100 μV	1 000 + 200 μV	5 000 + 800 μV
2.00000 – 20.00000 V ^{*2}	8 + 25 μV	2 150 + 1 mV	160 + 700 μV	300 + 1.2 mV	1 000 + 2 mV	8 000 + 5 mV
20.00001 – 100.0000 V	13 + 150 μV	2 150 + 6 mV	180 + 5 mV	300 + 14 mV	1 000 + 14 mV	N/A
100.00001 – 280.0000 V ^{*3}	15 + 300 μV	2 150 + 13 mV	180 + 10 mV	300 + 40 mV	N/A	N/A
280.000 – 1050.000 V ^{*4}	20 + 3.5 mV	N/A	250 + 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 100 kHz above 12 V.

*3 Frequency is limited to 3 Hz – 10 kHz above 210 V.

*4 Frequency is limited to 20 Hz – 5 kHz.

Distortion and Load Characteristics

Parameter	Range	20mV	200mV	2V	20V	100 V	280V	1050V
THD + noise ^{*5}	3 – 10 Hz	0.25 % + 200 μV	0.25 % + 300 μV	0.25 %	0.25 %	0.25 %	0.25 %	N/A
	10 – 45 Hz	0.05 % + 200 μV	0.05 % + 300 μV	0.15 %	0.15 %	0.15 %	0.15 %	0.25 %
	45 – 20000 Hz	0.05 % + 200 μV	0.05 % + 300 μV	0.05 %	0.05 %	0.05 %	0.05 %	0.20 %
	20 – 50 kHz	0.25 % + 200 μV	0.25 % + 300 μV	0.12 %	0.15 %	0.3 %	0.7 %	N/A
	50 – 100 kHz	0.35 % + 230 μV	0.35 % + 300 μV	0.22 %	0.3 %	0.5 %	N/A	N/A
	100 – 300 kHz	1.5 % + 500 μV	1 % + 700 μV	0.7 %	2.5 %	N/A	N/A	N/A
Burden current	DC active	1 mA	5 mA	30 mA	50 mA	50 mA	50 mA	5 mA
	3 – 20000 Hz	0.5 mA _{RMS}	4 mA _{RMS}	30 mA _{RMS}	50 mA _{RMS}	50 mA _{RMS}	40 mA _{RMS}	4 mA _{RMS}
	20 – 50 kHz	0.5 mA _{RMS}	4 mA _{RMS}	10 mA _{RMS}	10 mA _{RMS}	10 mA _{RMS}	10 mA _{RMS}	N/A
	50 – 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 _{RMS}	5 mA _{RMS}	N/A	N/A	N/A

*5 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	5 ppm, 5 digit
Non-sine waveform types	saw, triangle, square, truncated sin; 1kHz max.
Non-sine amplitude uncertainty	0.21 % of value + 0.1 % of range + 0.7 μ A _{pk}

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

Range	DC	10 Hz – 1 kHz	1 kHz – 5 kHz	5 kHz – 10 kHz	10 kHz – 30 kHz
10.0000 – 200.0000 μ A	200 + 12 nA	500 + 60 nA ^{*6}	3 000+ 150 nA ^{*6}	5 000 + 200 nA ^{*6}	5 500 + 900 nA ^{*6}
0.200000 – 2.000000 mA	150 + 30 nA	500 + 150 nA	1 500+ 500 nA	4 000 + 600 nA	4 000 + 5 μ A
2.000000 – 20.000000 mA	100 + 600 nA	400 + 2 μ A	1 000+ 4 μ A	2 000 + 6 μ A	4 000 + 10 μ A
20.0000 – 200.0000 mA	100 + 2 μ A	400 + 20 μ A	1 000+ 50 μ A	2 000 + 60 μ A	4 000 + 100 μ A
0.200000 – 2.000000 A ^{*7}	160 + 50 μ A	480 + 100 μ A	1 000+ 500 μ A	2 500+ 500 μ A	12 000+ 800 μ A
2.00000 – 20.50000 A	250 + 500 μ A	650 + 4 mA	N/A	N/A	N/A
20.50000 – 30.00000 A ^{*8}	450 + 750 μ A	1 200 + 5 mA	N/A	N/A	N/A

^{*6} Accuracy not specified below 10 μ A.

^{*7} Frequency is limited to 10 kHz above 500 mA.

^{*8} Provides continuous 30A output in reference temperature range.

Distortion and Load Characteristics

Parameter	Range	200 μ A	2mA	20mA	200mA	2A	30A
Max. inductive load	10 Hz – 30 kHz	1 H	100 mH	100 mH	10 mH	1 mH	500 μ H
	10 Hz – 1 kHz	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.3 %
THD + noise ^{*9}	1 kHz – 5 kHz	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	N/A
	5 kHz – 10 kHz	0.5 %	0.4 %	0.4 %	0.4 %	1.5 %	N/A
	10 kHz – 30 kHz	0.8 %	0.8 %	0.8 %	1.5 %	N/A	N/A
Compliance voltage	DC	5 V	5 V	10 V	10 V	5 V	5 V
	10 Hz – 1 kHz	4 V _{rms}	4 V _{rms}	5 V _{rms}	5 V _{rms}	3.5 V _{rms}	3 V _{rms}
	1 kHz – 5 kHz	4 V _{rms}	4 V _{rms}	5 V _{rms}	5 V _{rms}	3.5 V _{rms}	N/A
	5 kHz – 10 kHz	2 V _{rms}	N/A				
	10 kHz – 30 kHz	1 V _{rms}	1 V _{rms}	1 V _{rms}	1 V _{rms}	N/A	N/A
Load adder ^{*10}	DC	50 nA/V	50 nA/V	200 nA/V	2 μ A/V	100 μ A/V	500 μ A/V
	10 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	3 000 μ A/V	N/A
	10 kHz – 30 kHz	4 μ A/V	5 μ A/V	10 μ A/V	20 μ A/V	N/A	N/A

^{*9} THD in bandwidth up to 100 kHz

^{*10} Additional uncertainty for compliance voltage above 0.5 VRMS

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

Frequency

Frequency range	0.10000 Hz – 2.00000 MHz
Frequency accuracy	5 ppm
Waveform type	3V _{pk} , 1V _{pk} , 100mV _{pk} positive square wave
Amplitude accuracy	20 %

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

Resistance

Resistance range summary	0.0000 Ω – 100.0000 k Ω in 4W 0.0000 Ω – 1.100000 G Ω in 2W
Modes	2W, 2W COMP and 4W continuous range 2W and 4W fixed standards

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

Variable mode resistance range ^{*11}	Uncertainty ^{*12}	Fixed mode nominal value	Uncertainty ^{*13}
0.0000 – 10.0000 Ω	35 + 2 m Ω	0.0000 Ω	< 0.5 m Ω
10.0001 – 33.0000 Ω	30 + 2 m Ω	0.1000 Ω	0.5 m Ω
33.0001 – 200.0000 Ω	30 + 3 m Ω	1.0000 Ω	0.5 m Ω
200.001 – 1000.000 Ω	30 + 3 m Ω	10.0000 Ω	1 m Ω
1000.001 – 2000.000 Ω	30 + 30 m Ω	33.0000 Ω	2 m Ω
2.00001 – 10.00000 k Ω	30 + 30 m Ω	100.0000 Ω	3 m Ω
10.00001 – 20.00000 k Ω	30 + 300 m Ω	330.0000 Ω	25 ppm
20.0001 – 100.0000 k Ω	30 + 300 m Ω	1 000.000 Ω	15 ppm
100.0001 – 200.0000 k Ω	30 + 3 Ω	3 300.000 Ω	15 ppm
200.001 – 330.000 k Ω	30 + 3 Ω	10.00000 k Ω	15 ppm
330.001 – 1000.000 k Ω	50 + 3 Ω	33.00000 k Ω	15 ppm
1000.001 – 2000.000 k Ω	50 + 30 Ω	100.0000 k Ω	15 ppm
2.00001 – 3.30000 M Ω	50 + 30 Ω	330.0000 k Ω	20 ppm
3.30001 – 10.00000 M Ω	100 + 30 Ω	1 000.000 k Ω	20 ppm
10.00001 – 20.00000 M Ω	2000 + 300 Ω	3 300.000 k Ω	80 ppm
20.0001 – 100.0000 M Ω	2000 + 300 Ω	10.00000 M Ω	130 ppm
100.0001 – 200.0000 M Ω	3000 + 3 k Ω	33.00000 M Ω	250 ppm
200.001 – 330.000 M Ω	3000 + 3 k Ω	100.0000 M Ω	1000 ppm
330.001 – 1100.000 M Ω	10000 + 10 k Ω	330.0000 M Ω	1500 ppm
		1 000.000 M Ω	2500 ppm

*11 Range boundaries are based on calibration values of fixed resistance mode standards and as such may deviate from nominal values by up to 5%.

*12 Uncertainty in 4W and 2W COMP modes. Add 30 m Ω in 2W mode. Uncertainty is specified for test voltages above 0.1 V

*13 Uncertainty in 4W mode. Add 30 + (0.015 / test current) milliohms in 2W mode.

Capacitance

Capacitance range summary
Modes

0.600000 nF – 120.0000 mF in 2W
2W continuous range
2W fixed standards

Capacitance modes, 1 year uncertainty and frequency limits

Variable mode capacitance range ^{*14}	Uncertainty	Fixed mode nominal value	Uncertainty ^{*15}
0.600000 – 2.000000 nF	0.15 % + 10 pF	1.000000 nF	0.30 %
2.000001 – 3.300000 nF	0.15 % + 10 pF	3.300000 nF	0.25 %
3.300001 – 20.000000 nF	0.15 %	10.000000 nF	0.12 %
20.000001 – 33.000000 nF	0.15 %	33.000000 nF	0.12 %
33.000001 – 100.000000 nF	0.15 %	100.000000 nF	0.12 %
100.000001 – 200.000000 nF	0.15 %	330.000000 nF	0.12 %
0.2000001 – 2.0000000 μF	0.15 %	1.0000000 μF	0.12 %
2.000001 – 3.300000 μF	0.15 %	3.3000000 μF	0.12 %
3.300001 – 10.000000 μF	0.15 %	10.000000 μF	0.12 %
10.000001 – 20.000000 μF	0.15 %	33.000000 μF	0.15 %
20.000001 – 33.000000 μF	0.15 %	100.000000 μF	0.15 %
33.000001 – 100.000000 μF	0.15 %		
100.000001 – 200.000000 μF	0.25 %		
0.2000001 – 1.1000000 mF	0.25 %		
1.1000001 – 2.0000000 mF	0.25 %		
2.000001 – 11.000000 mF	0.25 %		
11.000001 – 20.000000 mF	0.25 %		
20.000001 – 120.000000 mF	0.45 %		

^{*15} Specification applies to Relative mode of capacitance, for Absolute mode add additional floor 15 pF.

^{*14} Range boundaries up to 1.1 mF are based on calibration values of fixed capacitance mode standards and as such may deviate from nominal values by up to 10 %.

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 – 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 %	0.071 %	0.071 %	0.074 %
1 A	0.069 %	0.069 %	0.069 %	0.073 %
10 A	0.111 %	0.111 %	0.111 %	0.114 %
30 A	0.142 %	0.142 %	0.142 %	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)

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 ¹⁶	2 k Ω , 20 k Ω	200 ppm + [10 – 50] m Ω
RTD temperature ¹⁶	Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom	0.08 – 0.42 °C
TC temperature	BCDEG ₂ JKMNRST	0.22 – 1 °C

¹⁶ 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

HF mode (levelled sine)

Amplitude range 1.400 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 % + 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.