

Specifications Sheet

Model SM2060 7½ Digit Digital PCI Multimeter

Model SMX2060 7½ Digit Digital PXI Multimeter

Model SM2064 7½ Digit High Work Load PCI Digital Multimeter

Model SMX2064 7½ Digit High Work Load PXI Digital Multimeter

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The following specifications are based on both, verification of large number of units as well as mathematical evaluation. They should be considered under the environment specified.

It is important to note that a DMM specified range is expressed as a numeric value indicating the highest absolute voltage that can be measured. The lowest value that can be detected is expressed by the corresponding resolution for the range.

1.1 DC Voltage Measurement

Input Characteristics

- **Input Resistance 240 mV, 2.4 V Ranges:** >10 GΩ, with typical leakage of 50pA
 - **Input Resistance 24 V, 240 V, 330V Ranges:** 10.00 MΩ
- Accuracy ± (% of reading + Volts) [1]

Range	Full Scale 7-½ Digits	Resolution	24 hours 23°C ± 1°C	90 Days 23°C ± 5°C	One Year 23°C ± 5°C
240 mV	240.00000 mV	10 nV	0.003 + 1 μV	0.004 + 1.5 μV	0.005 + 2 μV
2.4 V	2.4000000 V	100 nV	0.002 + 3 μV	0.0025 + 5 μV	0.003 + 10 μV
24 V	24.000000 V	1 μV	0.003 + 150 μV	0.004 + 250 μV	0.005 + 300 μV
240 V	240.00000 V	10 μV	0.004 + 200 μV	0.005 + 300 μV	0.006 + 0.5 mV
330 V	330.00000 V	10 μV	0.005 + 250 μV	0.01 + 400 μV	0.015 + 0.7 mV

[1] With Aperture set to ≥ 0.5 Sec, and within one hour from Self Calibration (S-Cal).

For resolution at smaller Apertures, see the following table. Use this table for DC Volts, DC current and Resistance measurements.

Measurement Aperture SM2060, SM2064	Maximum reading rate	Resolution	
0.5 s ≤ Aperture	2 / second	7-1/2 digits	25 bits
10 ms ≤ Aperture	100 / second	6-1/2 digits	22 bits
625 μs ≤ Aperture	1200 / second	5-1/2 digits	18 bits
2.5 μs ≤ Aperture [2]	20,000 / second [2]	4-1/2 digits	14 bits

[2] Available only with the SM2064.

DCV Noise Rejection Normal Mode Rejection, at 50, 60, or 400 Hz ± 0.5%, is better than 95 dB for apertures of 0.160s and higher. Common Mode Rejection (with 1 kΩ lead imbalance) is better than 120 dB for these conditions.

1.2 DC Current Measurement

Input Characteristics

- **Number of shunts** Five in SM2064, two in the SM2060
- **Protected** with 2.5A Fast blow fuse

Accuracy ± (% of reading + Amps) [1]

Range	Full Scale 6-½ Digits	Resolution	Max Burden Voltage	24 hours 23°C ± 5°C	90 Days 23°C ± 5°C	One Year 23°C ± 5°C
240 nA [2]	240.0000 nA	0.1 pA	100 μV	0.07 + 40pA	0.1 + 45pA	0.17 + 60pA
2.4 μA [2]	2.400000 μA	1 pA	100 μV	0.05 + 70pA	0.08 + 90pA	0.21 + 150pA
24 μA [2]	24.00000 μA	10 pA	100 μV	0.05 + 400pA	0.08 + 600pA	0.13 + 0.8nA
240 μA [2]	240.000 μA	10 nA	2.5mV	0.052 + 200 nA	0.07 + 300 nA	0.1 + 400 nA
2.4 mA	2.40000 mA	10 nA	25mV	0.05 + 300 nA	0.06 + 400 nA	0.07 + 550 nA
24 mA	24.0000 mA	100 nA	250mV	0.05 + 350 nA	0.065 + 450 nA	0.08 + 550 nA
240 mA	240.000 mA	1 μA	55mV	0.05 + 50 μA	0.055 + 60 μA	0.065 + 80 μA
2.4 A	2.40000 A	10 μA	520mV	0.3 + 60 μA	0.4 + 70 μA	0.45 + 90 μA

[1] With Aperture set to ≥ 0.96 Sec, and within one hour from Zero (Relative control).

[2] Available only with the SM2064.

1.3 Resistance Measurements

1.3.1 2-wire

Accuracy ± (% of reading + Ω) [1]

Range [4]	Full Scale 7 ½ Digits	Resolution	Source current	24 hours 23°C ± 1°C	90 Days 23°C ± 5°C	One Year 23°C ± 5°C
24 Ω [3]	24.000000 Ω	1 μΩ	10 mA	0.0038 + 1.4 mΩ [2]	0.005 + 1.6 mΩ [2]	0.008 + 2 mΩ [2]
240 Ω	240.00000 Ω	10 μΩ	1 mA	0.0037 + 4.5 mΩ [2]	0.0046 + 5 mΩ [2]	0.007 + 6 mΩ [2]
2.4 kΩ	2.4000000 kΩ	100 μΩ	1 mA	0.0023 + 28 mΩ	0.004 + 32 mΩ	0.006 + 33 mΩ

24 k Ω	24.000000 k Ω	1 m Ω	100 μ A	0.0025 + 300 m Ω	0.004 + 330 m Ω	0.006 + 350 m Ω
240 k Ω	240.00000 k Ω	10 m Ω	10 μ A	0.0055 + 3.2 Ω	0.006 + 4 Ω	0.007 + 5 Ω
2.4 M Ω	2.4000000 M Ω	100 m Ω	1 μ A	0.018 + 40 Ω	0.03 + 50 Ω	0.04 + 70 Ω
24 M Ω	24.0000 M Ω	100 Ω	100 nA	0.12 + 400 Ω	0.13 + 500 Ω	0.2 + 600 Ω
240 M Ω [3]	240.000 M Ω	1 k Ω	10 nA	0.8 + 20 k Ω	1.0 + 30 k Ω	1.3 + 50 k Ω

[1] With Aperture set to ≥ 0.5 Sec, and within one hour from Self Calibration (S-Cal).

[2] Use of S-Cal and Relative to improve measurement floor.

[3] Ranges are only available with the SM2064.

[4] Test voltages are 2.4V max with the exception of the 24 Ω and 240 Ω ranges 240 mV.

1.3.2 4-wire

Accuracy $\pm$ (% of reading + Ω) [1]

Range [4]	Full Scale 7 ½ Digits	Resolution	Source current	24 hours 23°C $\pm$ 1°C	90 Days 23°C $\pm$ 5°C	One Year 23°C $\pm$ 5°C
24 Ω [3]	24.000000 Ω	1 $\mu\Omega$	10 mA	0.0038 + 0.7 m Ω [2]	0.005 + 0.8 m Ω [2]	0.008 + 1 m Ω [2]
240 Ω	240.00000 Ω	10 $\mu\Omega$	1 mA	0.0037 + 3 m Ω [2]	0.0046 + 4 m Ω [2]	0.007 + 5 m Ω [2]
2.4 k Ω	2.4000000 k Ω	100 $\mu\Omega$	1 mA	0.0023 + 28 m Ω	0.004 + 32 m Ω	0.006 + 33 m Ω
24 k Ω	24.000000 k Ω	1 m Ω	100 μ A	0.0025 + 300 m Ω	0.004 + 330 m Ω	0.006 + 350 m Ω
240 k Ω	240.00000 k Ω	10 m Ω	10 μ A	0.0055 + 3.2 Ω	0.007 + 4 Ω	0.007 + 5 Ω
2.4 M Ω	2.4000000 M Ω	100 m Ω	1 μ A	0.018 + 40 Ω	0.03 + 50 Ω	0.04 + 70 Ω
24 M Ω	24.0000 M Ω	100 Ω	100 nA	0.12 + 400 Ω	0.13 + 500 Ω	0.2 + 600 Ω

[1] With Aperture set to ≥ 0.5 Sec, and within one hour from Self Calibration (S-Cal).

[2] Use of Relative to facilitate indicated floor (adder part of spec).

[3] 24 Ω range only available with SM2064.

[4] Test voltages are 2.4V max with the exception of the 24 Ω and 240 Ω ranges 240 mV.

1.3.3 6-wire Guarded Resistance Measurement (SM2064)

This is an in-circuit forced guard measurement method, as implemented in ICT testers. Add this typical additional error to the above specification.

Accuracy $\pm$ (% of reading + Ω)

Range	Guard forced current	One Year 23°C $\pm$ 5°C [1]
24 Ω [3]	10 mA	0.3 + 4 m Ω
240 Ω	1 mA	0.003 + 20 m Ω
2.4 k Ω	1 mA	0.005 + 100 m Ω
24 k Ω	100 μ A	0.03 + 1 Ω
240 k Ω	10 μ A	0.35 + 10 Ω
24 M Ω	1 μ A	0.85 + 1000 Ω

[1] This table should be used in conjunction with the 2-wire and 4-wire table above.

1.3.4 Extended Resistance Measurements (SM2064)

Characteristics

- **Test Voltage** Adjustable between -10V and +10V in 5mV steps

Accuracy $\pm$ (% of reading + Amps) [1]

Range	Measurement range	Resol ution	Current Limit [3]	90 Days 23°C $\pm$ 5°C	One Year 23°C $\pm$ 5°C
400k Ω	1k Ω to 100M Ω	10 Ω	25 μ A	0.2 + 50 Ω	0.33 + 90 Ω
4M Ω	10k Ω to 1G Ω	100 Ω	2.5 μ A	0.3 + 350 Ω	0.43 + 550 Ω
40M Ω	100k Ω to 10G Ω	1k Ω	250nA	0.4 + 3k Ω	0.55 + 4.5k Ω

[1] With Aperture set to ≥ 0.5 Sec, and within one hour from Zero (Relative control).

[2] Multiply “% of reading” by 1/Voltage Source for applied voltages below 1V

[3] Limit is reached when the test current exceeds the Current Limit, or it is below 0.04% of

this value.

1.4 AC Voltage Measurements

Input Characteristics

- **Input Resistance** 1 M Ω , shunted by < 300 pF, all ranges
- **Max. Crest Factor** 4 at Full Scale, increasing to 7 at Lowest Specified Voltage
- **AC coupled** Specified range: 10 Hz to 100 kHz
- **Typical Settling time** < 0.5 sec to within 0.1% of final value
- **Typical Settling time Fast RMS** < 0.05 sec to within 0.1% of final value

1.4.1 AC Voltage True RMS Measurement

Range	Full Scale 7-½ Digits	Lowest specified Voltage	Resolution
240 mV	240.0000 mV	5 mV [1]	100 nV
2.4 V	2.400000 V	10 mV	1 μ V
24 V	24.00000 V	100 mV	10 μ V
240 V	240.0000 V	1 V	100 μ V
330 V	330.0000 V	2 V	100 μ V

[1] Between 5 mV and 10 mV, add 100 μ V additional errors to the accuracy table below.

[2] Signal is limited to 8×10^6 Volt Hz Product. For example, the largest frequency input at 250 V is 32 kHz, or 8×10^6 Volt x Hz.

AC Volts Accuracy with Fast RMS disabled (default).

With Fast RMS disabled, settling time to rated accuracy is within 0.5

s.

Accuracy $\pm$ (% of reading + Volts) [1]

Range	Frequency	24 hours 23°C $\pm$ 1°C	90 Days 23°C $\pm$ 5°C	One Year 23°C $\pm$ 5°C
240 mV	10 Hz - 20 Hz	3.0 + 350 μ V	3.1 + 380 μ V	3.2 + 430 μ V
	20 Hz - 47 Hz	0.92 + 150 μ V	0.93 + 170 μ V	0.95 + 200 μ V
	47 Hz - 10 kHz	0.13 + 100 μ V	0.14 + 110 μ V	0.15 + 120 μ V
	10 kHz - 50 kHz	0.55 + 160 μ V	0.6 + 200 μ V	0.63 + 230 μ V
	50 kHz - 100 kHz	5.3 + 350 μ V	5.4 + 370 μ V	5.6 + 400 μ V
2.4 V	10 Hz - 20 Hz	3.0 + 2 mV	3.1 + 2.2 mV	3.2 + 2.5 mV
	20 Hz - 47 Hz	0.93 + 1.3 mV	0.96 + 1.5 mV	1.0 + 1.7 mV
	47 Hz - 10 kHz	0.05 + 1 mV	0.055 + 1.1 mV	0.065 + 1.2 mV
	10 kHz - 50 kHz	0.62 + 1.2 mV	0.65 + 1.3 mV	0.70 + 1.5 mV
	50 kHz - 100 kHz	5.1 + 1.5 mV	5.2 + 1.7 mV	5.3 + 2 mV
24 V	10 Hz - 20 Hz	3.0 + 14 mV	3.1 + 16 mV	3.3 + 20 mV
	20 Hz - 47 Hz	0.93 + 12 mV	0.96 + 14 mV	1.0 + 16 mV
	47 Hz - 10 kHz	0.06 + 10 mV	0.065 + 11 mV	0.073 + 13 mV
	10 kHz - 50 kHz	0.31 + 18 mV	0.33 + 21 mV	0.35 + 25 mV
	50 kHz - 100 kHz	2.0 + 30 mV	2.2 + 35 mV	2.4 + 40 mV
240 V	10 Hz - 20 Hz	3.0 + 140 mV	3.1 + 160 mV	3.3 + 200 mV
	20 Hz - 47 Hz	0.93 + 120 mV	0.96 + 130 mV	1.0 + 150 mV
	47 Hz - 10 kHz	0.04 + 100 mV	0.045 + 110 mV	0.06 + 130 mV
	10 kHz - 50 kHz	0.32 + 150 mV	0.4 + 170 mV	0.45 + 200 mV
	50 kHz - 100 kHz	2.5 + 200 mV	2.8 + 240 mV	3.2 + 300 mV
330 V	10 Hz - 20 Hz	3.0 + 200 mV	3.1 + 160 mV	3.3 + 200 mV
	20 Hz - 47 Hz	1.0 + 180 mV	1.1 + 200 mV	1.1 + 250 mV
	47 Hz - 10 kHz	0.05 + 150 mV	0.07 + 200 mV	0.08 + 230 mV
	10 kHz - 50 kHz	0.34 + 200 mV	0.45 + 250 mV	0.5 + 300 mV
	50 kHz - 100 kHz	2.5 + 270 mV	2.8 + 350 mV	3.2 + 400 mV

ACV Noise Rejection Common Mode rejection, for 50 Hz or 60 Hz with 1 k Ω imbalance in either lead, is better than 60 dB.

AC Volts Accuracy with Fast RMS enabled.

Fast RMS settles to rated accuracy within 50ms.

Accuracy $\pm$ (% of reading + Volts) [1]

Range	Frequency	24 hours 23°C $\pm$ 1°C	90 Days 23°C $\pm$ 5°C	One Year 23°C $\pm$ 5°C
240 mV	350 Hz - 800 Hz	0.6 + 150 μ V	0.65 + 170 μ V	0.7 + 200 μ V
	800 Hz - 10 kHz	0.13 + 100 μ V	0.14 + 110 μ V	0.15 + 120 μ V
	10 kHz - 50 kHz	0.55 + 160 μ V	0.6 + 200 μ V	0.63 + 230 μ V
	50 kHz - 100 kHz	5.3 + 350 μ V	5.4 + 370 μ V	5.6 + 400 μ V
2.4 V	350 Hz - 800 Hz	0.93 + 1.3 mV	0.96 + 1.5 mV	1.0 + 1.7 mV
	800 Hz - 10 kHz	0.068 + 1 mV	0.075 + 1.1 mV	0.08 + 1.2 mV
	10 kHz - 50 kHz	0.62 + 1.2 mV	0.65 + 1.3 mV	0.70 + 1.5 mV
	50 kHz - 100 kHz	5.1 + 1.5 mV	5.2 + 1.7 mV	5.3 + 2 mV
24 V	350 Hz - 800 Hz	0.93 + 12 mV	0.96 + 14 mV	1.0 + 16 mV
	800 Hz - 10 kHz	0.065 + 10 mV	0.068 + 11 mV	0.073 + 13 mV
	10 kHz - 50 kHz	0.31 + 18 mV	0.33 + 21 mV	0.35 + 25 mV
	50 kHz - 100 kHz	2.0 + 30 mV	2.2 + 35 mV	2.4 + 40 mV
240 V	350 Hz - 800 Hz	0.93 + 120 mV	0.96 + 130 mV	1.0 + 150 mV
	800 Hz - 10 kHz	0.062 + 100 mV	0.065 + 110 mV	0.08 + 130 mV
	10 kHz - 50 kHz	0.32 + 150 mV	0.4 + 170 mV	0.45 + 200 mV
	50 kHz - 100 kHz	2.5 + 200 mV	2.8 + 240 mV	3.2 + 300 mV
330 V	350 Hz - 800 Hz	1.0 + 180 mV	1.1 + 200 mV	1.1 + 250 mV
	800 Hz - 10 kHz	0.065 + 150 mV	0.07 + 200 mV	0.08 + 230 mV
	10 kHz - 50 kHz	0.34 + 200 mV	0.45 + 250 mV	0.5 + 300 mV
	50 kHz - 100 kHz	2.5 + 270 mV	2.8 + 350 mV	3.2 + 400 mV

AC Volts Accuracy with Slow RMS (default).

Settles to rated accuracy within 1X to 10X signal period, settable by user.

Range	Frequency	24 hours 23°C $\pm$ 1°C	90 Days 23°C $\pm$ 5°C	One Year 23°C $\pm$ 5°C
240 mV	0.5 Hz - 10 Hz	0.25 + 100 μ V	0.3 + 200 μ V	0.35 + 300 μ V
	10 Hz - 20 Hz	0.3 + 150 μ V	0.35 + 170 μ V	0.4 + 200 μ V
	20 Hz - 60 Hz	0.13 + 100 μ V	0.14 + 110 μ V	0.15 + 120 μ V
	60 kHz - 200 Hz	0.55 + 160 μ V	0.6 + 200 μ V	0.63 + 230 μ V
2.4 V	0.5 Hz - 10 Hz	0.2 + 2 mV	0.25 + 2.2 mV	0.3 + 2.5 mV
	10 Hz - 20 Hz	0.3 + 1.3 mV	0.35 + 1.5 mV	1.0 + 1.7 mV
	20 Hz - 60 Hz	0.5 + 1 mV	0.55 + 1.1 mV	0.65 + 1.2 mV
	60 kHz - 200 Hz	0.62 + 1.2 mV	0.65 + 1.3 mV	0.70 + 1.5 mV
24 V	0.5 Hz - 10 Hz	3.0 + 14 mV	3.1 + 16 mV	3.3 + 20 mV
	10 Hz - 20 Hz	0.93 + 12 mV	0.96 + 14 mV	1.0 + 16 mV
	20 Hz - 60 Hz	0.06 + 10 mV	0.065 + 11 mV	0.073 + 13 mV
	60 kHz - 200 Hz	0.31 + 18 mV	0.33 + 21 mV	0.35 + 25 mV
240 V	0.5 Hz - 10 Hz	3.0 + 140 mV	3.1 + 160 mV	3.3 + 200 mV
	10 Hz - 20 Hz	0.93 + 120 mV	0.96 + 130 mV	1.0 + 150 mV
	20 Hz - 60 Hz	0.04 + 100 mV	0.045 + 110 mV	0.06 + 130 mV
	60 kHz - 200 Hz	0.32 + 150 mV	0.4 + 170 mV	0.45 + 200 mV
330 V	0.5 Hz - 10 Hz	3.0 + 200 mV	3.1 + 160 mV	3.3 + 200 mV
	10 Hz - 20 Hz	1.0 + 180 mV	1.1 + 200 mV	1.1 + 250 mV
	20 Hz - 60 Hz	0.05 + 150 mV	0.07 + 200 mV	0.08 + 230 mV
	60 kHz - 200 Hz	0.34 + 200 mV	0.45 + 250 mV	0.5 + 300 mV

1.4.2 AC Peak-to-Peak Measurement (SM2064)

- Measures the peak-to-peak value of a repetitive waveform.

ACV Range	Lowest specified input voltage (Vp-p)	Full Scale reading (Vp-p)	Resolution	Typical Accuracy 23°C ± 5°C One Year [1]
240 mV	0.1 V	1.9 V	1 mV	0.5 ± 3 mV
2.4 V	1.0 V	16 V	10 mV	0.5 ± 40 mV
24 V	10 V	190 V	100 mV	0.5 ± 700 mV
240 V	100 V	850 V	1 V	0.55 ± 6 V

[1] Signal frequency range 30 Hz to 60 kHz.

1.4.3 AC Crest Factor Measurement (SM2064)

- Measures the crest factor (CF) of a repetitive waveform

ACV Range	Lowest specified input voltage (Vp-p)	Highest specified input voltages (Vp-p)	Resolution	Typical Accuracy 23°C ± 5°C One Year [1]
240 mV	0.1 V	1.9 V	0.01	2.2 ±0.3
2.4 V	1.0 V	16 V	0.01	2.1 ±0.1
24 V	10 V	190 V	0.01	2.0 ±0.1
240 V	100 V	700 V	0.01	2.0 ±0.1
330 V	100 V	850 V	0.01	2.0 ±0.1

[1] Crest factor measurement requires signal frequency of 30 Hz to 60 kHz.

1.4.4 AC Median Value Measurement (SM2064)

- Measures the mid-point between the positive and negative peaks of a repetitive waveform
- Used to determine the Threshold DAC setting for optimal frequency and timing measurements

ACV Range	Lowest specified input voltage (Vp-p)	Full Scale reading	Resolution	Typical Accuracy 23°C ± 5°C One Year [1]
240 mV	0.08 V	±0.95 V	1 mV	2.0% ±17 mV
2.4 V	0.80 V	±9.5 V	10 mV	3% ±160 mV
24 V	8 V	±95.0 V	100 mV	3% ±1.4 V
240 V	80 V	±350.0 V	1 V	3% ±12 V
330 V	80 V	±350.0 V	1 V	3% ±12 V

[1] Median measurements require a repetitive signal with frequency range of 30 Hz to 30 KHz.

1.5 AC Current Measurement, True RMS

Input Characteristics

- **Crest Factor** 4 at Full Scale, increasing to 10 at Lowest Specified Current
- **Protected** with 2.5 A Fast Blow fuse

Range	Full Scale 6 1/2 Digits	Lowest Specified Current	Maximum Burden Voltage (RMS)	Resolution
2.4 mA	2.400000 mA	60 μ A	25mV	1 nA
24 mA	24.00000 mA	300 μ A	250mV	10 nA
240 mA	240.0000 mA	3 mA	55mV	100 nA
2.4 A	2.400000 A	30 mA	520mV	1 μ A

Accuracy $\pm$ (% of reading + Amps)

Range	Frequency [1]	24 hours 23°C $\pm$ 1°C	90 Days 23°C $\pm$ 10°C	One Year 23°C $\pm$ 10°C
2.4 mA	10 Hz - 20 Hz	3.8 + 4 μ A	2.7 + 4 μ A	2.9 + 4 μ A
	20 Hz - 47 Hz	0.9 + 4 μ A	0.9 + 4 μ A	1.0 + 4 μ A
	47 Hz - 1 kHz	0.04 + 1.5 μ A	0.08 + 3 μ A	0.12 + 4 μ A
	1 kHz - 10 kHz	0.12 + 4 μ A	0.14 + 4 μ A	0.22 + 4 μ A
24 mA	10 Hz - 20 Hz	1.8 + 30 μ A	2.6 + 30 μ A	2.8 + 30 μ A
	20 Hz - 47 Hz	0.6 + 30 μ A	0.9 + 30 μ A	1.0 + 30 μ A
	47 Hz - 1 kHz	0.07 + 10 μ A	0.15 + 20 μ A	0.16 + 30 μ A
	1 kHz - 10 kHz	0.21 + 30 μ A	0.3 + 40 μ A	0.4 + 40 μ A
240 mA	10 Hz - 20 Hz	1.8 + 400 μ A	2.7 + 400 μ A	2.8 + 400 μ A
	20 Hz - 47 Hz	0.6 + 400 μ A	0.9 + 400 μ A	1.0 + 400 μ A
	47 Hz - 1 kHz	0.1 + 100 μ A	0.17 + 180 μ A	0.2 + 220 μ A
	1 kHz - 10 kHz	0.3 + 300 μ A	0.35 + 350 μ A	0.4 + 400 μ A
2.4 A	10 Hz - 20 Hz	1.8 + 4 mA	2.5 + 4.5 mA	2.7 + 5 mA
	20 Hz - 47 Hz	0.66 + 4 mA	0.8 + 6 mA	0.9 + 6 mA
	47 Hz - 1 kHz	0.3 + 3.8mA	0.33 + 3.8 mA	0.35 + 4 mA
	1 kHz - 10 kHz	0.4 + 4mA	0.45 + 4.5 mA	0.5 + 5 mA

[1] All AC Current ranges have typical measurement capability of at least 20 kHz.

1.6 Leakage Measurement (SM2064)

Characteristics

- **Burden Voltage:** < 100 μ V
- **Test Voltage:** Adjustable between -10V to +10V in 5mV steps

Accuracy $\pm$ (% of reading + Amps) [1]

Range	Full Scale 6-1/2 Digits	Resolution	24 hours 23°C $\pm$ 5°C	90 Days 23°C $\pm$ 5°C	One Year 23°C $\pm$ 5°C
240 nA	240.0000 nA	0.1 pA	0.15 + 50pA	0.2 + 65pA	0.17 + 100pA
2.4 μ A	2.400000 μ A	1 pA	0.1 + 350pA	0.15 + 500pA	0.2 + 600pA
24 μ A	24.00000 μ A	10 pA	0.08 + 3nA	0.12 + 4nA	0.18 + 2nA

[1] With Aperture set to $\geq$ 0.5 Sec, and within one hour from Zero (Relative control).

1.7 RTD Temperature Measurement (SM2064)

- **Ro:** Variable from 10 Ω to 10 k Ω
- **Measurement Method:** 4-Wire
- **Temperature units:** Selectable $^{\circ}\text{C}$ or $^{\circ}\text{F}$

RTD Type	Ro (Ω)	Resolution	Temperature range	Temperature Accuracy 23 $^{\circ}\text{C} \pm 5^{\circ}\text{C}$ [1] One Year
pt385, pt3911, pt3916, pt3926	100, 200 Ω	0.01 $^{\circ}\text{C}$	-150 to 650 $^{\circ}\text{C}$	$\pm 0.06^{\circ}\text{C}$
pt385, pt3911, pt3916, pt3926	500, 1 k Ω	0.01 $^{\circ}\text{C}$	-150 to 650 $^{\circ}\text{C}$	$\pm 0.03^{\circ}\text{C}$
Cu (Copper)	Less than 12 Ω	0.01 $^{\circ}\text{C}$	-100 to 200 $^{\circ}\text{C}$	$\pm 0.18^{\circ}\text{C}$ for temperatures $\leq 20^{\circ}\text{C}$, $\pm 0.05^{\circ}\text{C}$ otherwise
Cu (Copper)	Higher than 90 Ω	0.01 $^{\circ}\text{C}$	-100 to 200 $^{\circ}\text{C}$	$\pm 0.10^{\circ}\text{C}$ for temperatures $\leq 20^{\circ}\text{C}$, $\pm 0.05^{\circ}\text{C}$ otherwise

[1] With Aperture of 0.5s and higher, using a 4-wire RTD. Measurement accuracy does not include RTD probe error.

1.8 Thermocouple Temperature Measurement (SM2064)

- **Cold Junction Compensation:** By Sensor measurement or S/W setting.
- **Cold Junction Temperature range:** 0 $^{\circ}\text{C}$ to 50 $^{\circ}\text{C}$
- **Cold Junction Sensor:** Use SMX40T or SM40T Isothermal unit, or define sensor equation
- **Isothermal Block compatibility:** SM4022, SM4042, SMX4032, SM40T, SMX40T
- **Temperature units:** Selectable $^{\circ}\text{C}$ or $^{\circ}\text{F}$

TC Type	Resolution	Maximum Temperature [2]	Temperature Accuracy 23 $^{\circ}\text{C} \pm 5^{\circ}\text{C}$ [1] One Year
B	0.01 $^{\circ}\text{C}$	2200 $^{\circ}\text{C}$	$\pm 0.38^{\circ}\text{C}$
E	0.01 $^{\circ}\text{C}$	1200 $^{\circ}\text{C}$	$\pm 0.035^{\circ}\text{C}$
J	0.01 $^{\circ}\text{C}$	2000 $^{\circ}\text{C}$	$\pm 0.06^{\circ}\text{C}$
K	0.01 $^{\circ}\text{C}$	3000 $^{\circ}\text{C}$	$\pm 0.07^{\circ}\text{C}$
N	0.01 $^{\circ}\text{C}$	3000 $^{\circ}\text{C}$	$\pm 0.10^{\circ}\text{C}$
R	0.01 $^{\circ}\text{C}$	2700 $^{\circ}\text{C}$	$\pm 0.25^{\circ}\text{C}$
S	0.01 $^{\circ}\text{C}$	3500 $^{\circ}\text{C}$	$\pm 0.35^{\circ}\text{C}$
T	0.01 $^{\circ}\text{C}$	550 $^{\circ}\text{C}$	$\pm 0.06^{\circ}\text{C}$

[1] With Aperture of 0.5s and higher. Measurement accuracy does not include Thermocouple error.

[2] DMM Linearization temperature range may be greater than that of the Thermocouple device.

1.9 Additional Component Measurement Capability

1.9.1 Diode Characterization

- **Available DC current values** 100 nA, 1 μA , 10 μA , 100 μA and 1 mA.
- **SM2064 add variable current** of 10 nA to 12.5 mA
- **Typical Current Value Uncertainty** 1%
- **Typical Voltage Value Uncertainty** 0.02%
- **Maximum diode voltage compliance** 4 V

1.9.2 Capacitance, Ramp Method (SM2064)

Accuracy $\pm$ (% of reading + Farads) [1]

Range	Full Scale Reading	Resolution	One Year 23°C ± 5°C
1,200 pF	1,199.9 pF	0.1 pF	1.5 ± 0.25 pF
12 nF	11.999 nF	1 pF	1.2 ± 5 pF
120 nF	119.99 nF	10 pF	1.0
1.2 µF	1.1999 µF	100 pF	1.0
12 µF	11.999 µF	1 nF	1.0
120 µF	119.99 µF	10 nF	1.0
1.2 mF	1.1999 mF	100 nF	1.2
12 mF	50.000 mF	1 µF	2

[1] Within one hour of zero, using Relative control. Accuracy is specified for values higher than 5% of the selected range with the exception of the 1,200 pF range.

This Measurement is independent of set Aperture and Read Interval. If desired, the DMMSetCapsAveSamp() function may be used to control measurement parameters. It is provided means to fine tune the measurement timing for the application, trading off accuracy for speed.

Measurement time will vary as function of the set parameters, selected range and measured capacitance. The following are measurement times associated with the default parameters, as range is selected.

Range	Input	Measurement Time	Measurement Rate (rps)
1,200 pF	5% of Scale	19.5 ms	51.3
1,200 pF	Full Scale	52.3 ms	19.1
12 nF	5% of Scale	70.0 ms	14.3
12 nF	Full Scale	118ms	8.5
120 nF	5% of Scale	8.9 ms	112.4
120 nF	Full Scale	127 ms	7.9
1.2 µF	5% of Scale	15.6 ms	64.1
1.2 µF	Full Scale	175 ms	5.7
12 µF	5% of Scale	14.1 ms	70.9
12 µF	Full Scale	480 ms	2.1
120 µF	5% of Scale	17.3 ms	57.8
120 µF	Full Scale	50.3 ms	19.9
1.2 mF	5% of Scale	52.6 ms	19.0
1.2 mF	Full Scale	151.5 ms	6.6
12 mF	5% of Scale	52.8 ms	18.9
12 mF	Full Scale	170 ms	5.9

1.9.3 Capacitance, In-Circuit Method (SM2064)

- Adjustable Peak Voltages Stimulus 100mV to 1.3V
- Minimum Parallel Load Resistance 100Ω

Accuracy ± (% of reading + Farads) [1]

Range	Full Scale 3-½ Digits	Resolution	One Year 23°C ± 5°C [2]
24 nF	23.99 nF	10 pF	2.7 ± 100 pF
240 nF	239.9 nF	100 pF	2.5 ± 500 pF
2.4 μF	2.399 μF	1000 pF	2.5 ± 5 nF
24 μF	23.99 μF	10 nF	
240 μF	239.9 μF	100 nF	
2.4 mF	2.399 mF	1 μF	
24 mF	23.99 mF	10 μF	

[1] Within one hour of zero, using Relative control, and Caps Open-Cal operation

[2] Accuracy is specified for values higher than 5% of the selected range with the exception of the 2.4 nF range.

Capacitance Measurement time is independent of set Aperture and Read Interval. It depends on range, and capacitance.

1.9.4 Inductance Measurement (SM2064)

Range	Test frequency	Full Scale 4 ½ Digits	Resolution	Accuracy 23°C ± 5°C One Year [2]
24 μH	75 kHz	33.000 μH	1 nH	3.0% + 500 nH
240 μH	50 kHz	330.00 μH	10 nH	2.0% + 3 μH
2.4 mH	4 kHz	3.3000 mH	100 nH	1.5% + 25 μH
24 mH	1.5 kHz	33.000 mH	1 μH	1.5% + 200 μH
240 mH	1 kHz	330.00 mH	10 μH	2.5 + 3 mH
2.4 H	100 Hz	3.3000 H	100 μH	3 + 35 mH

[1] Within one hour of zero, and Open Terminal Calibration.

[2] Accuracy is specified for values greater than 5% of the selected range.

1.10 Time Measurements

1.10.1 Threshold DAC

- The Threshold DAC is used for selecting a detection level, providing optimal frequency and timing measurements even at extreme duty cycle values.

± (% of setting + volts)

Selected VAC range [1]	Threshold range (DC level)	Threshold DAC resolution	Highest allowed input Vp-p	Typical one year setting uncertainty
240 mV	-1.0 V to +1.0 V	0.5 mV	1.900 V	0.2% + 4 mV
2.4 V	-10.0 V to +10.0 V	5.0 mV	19.00 V	0.2% + 40 mV
24 V	-100.0 V to 100.0 V	50 mV	190.0 V	0.2% + 0.4 V
240 V	-400 V to 400 V	500 V	850.0 V	0.2% + 4 V

[1] This table should be used in conjunction with the AC volts section above.

1.10.2 Frequency and Period Measurement

ACV Mode

- **Input Impedance** 1 M Ω with < 300 pF

Frequency Range	2 Hz - 100 Hz	100 Hz-1 kHz	1 kHz-10 kHz	10 kHz-100 kHz	100 kHz-300 kHz
Resolution	1 mHz	10 mHz	100 mHz	1 Hz	1 Hz
Uncertainty is $\pm 0.002\%$ of reading $\pm$ adder shown	4 mHz	20 mHz	200 mHz	2 Hz	5 Hz
Input Signal Range [1]	10% - 200% of range	10% - 200% of range	10% - 200% of range	10% - 200% of range	45% - 200% of range

[1] Input RMS voltage required for a valid reading. Do not exceed 250 V RMS input. For example, 10% - 200% of range indicates that in the 240 mVAC range, the input voltage should be 24 mV to 660 mV RMS.

ACI Mode

- **Input Impedance** 10 Ω in the 3 mA and 30 mA ranges, 0.1 Ω in the 330 mA and 2.5 A ranges.

Frequency Range	2 Hz - 100 Hz	100 Hz-1 kHz	1 kHz-10 kHz	10 kHz-500 kHz
Resolution	1 mHz	10 mHz	100 mHz	1 Hz
Uncertainty	0.01% ± 4 mHz	0.01% ± 20 mHz	0.01% ± 200 mHz	0.01% ± 2 Hz
Input Signal Range, 2.4 mA, 240mA Ranges [1]	10% - 500% of range	10% - 500% of range	10% - 500% of range	10% - 500% of range
Input Signal Range, 24 mA, 2.4 A ranges	50% - 100% of range	50% - 100% of range	50% - 100% of range	50% - 100% of range

[1] Input current required to give a valid reading. For example, 10% - 500% of range indicates that in the 3.3 mA range, the input current should be 0.33 mA to 16.5 mA.

1.10.3 Duty Cycle Measurement

Frequency Range	2 Hz to 100 Hz	100 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 100 kHz
Resolution	0.02%	0.2%	2%	20%
Typical Uncertainty is $\pm 0.03\%$ of reading $\pm$ adder shown	0.03%	0.3%	3%	20%
Full scale reading	100.00 %	100.00 %	100.00 %	100.00 %

1.10.4 Pulse Width

$\pm$ (% of reading + sec)

Polarity	Frequency range	Resolution	Width range	Typical Uncertainty
Positive or negative pulse widths	2 Hz to 100 kHz	1 μ s	2 μ s to 1 s	0.01 +/- 4 μ s

1.10.5 Totalizer

- Active edge polarity: Positive or negative transition
- Maximum count: 10^9
- Allowed rate: 1 to 30,000 events per second
- Uses Threshold DAC

1.11 Trigger Functions

1.11.1 External Hardware Trigger (at DIN-7 connector)

Trigger Input voltage level range	+3 V to +15 V activates the trigger.
Trigger Pulse Width	Minimum = $1/\text{Aperture} + 50\mu\text{S}$
Minimum trigger input current	1 mA
Internal Reading Buffer	Circular; 80 or 120 readings depending on resolution.
Isolation of trigger input	± 50 V from analog DMM inputs, and from chassis earth ground.

1.11.2 Analog Threshold Trigger

- Trigger point: Selectable positive or negative transition of set threshold.
- Buffer type: Circular
- Captures up to 120 post-trigger readings for apertures $\leq 625\mu\text{Sec}$.
- Captures up to 80 post-trigger readings for apertures $> 625\mu\text{Sec}$.
- Aperture range: 160ms to $625\mu\text{S}$ (to $2.5\mu\text{S}$ with SM2064)
- Read Interval range: $1/\text{Aperture}$ to 65ms
- User selects number of post-trigger readings.
- The number of pre-trigger readings: buffer size – post-trigger count.
- The number of cycles the circular filled, and the trigger point are retrievable.

1.11.3 Delayed Hardware Trigger

This function allows time for the signal to settle after a trigger has occurred.

It allows readings to be delayed up to 65mSec with $1\mu\text{Sec}$ resolution.

It allows readings to be delayed up to 1s with $2\mu\text{s}$ resolutions.

1.12 Measurement Aperture and Read Interval

Both Aperture and The Read Interval may be set. The range of values depend on the DMM model and its mode of operation. For example, when using the internal buffer such as in External Trigger mode, the Read Interval can be set smaller than in Command/Response operation. The time involved in processing the measurement command and the post processing and transmission of the measurement results constitute an overhead, which limits the minimum Read Interval to a value that is greater than the Aperture. Setting it to zero (default) results in the fastest measurement rates at the selected Aperture. The faster SM2064 has lower overhead and therefore a shorter minimum Read Interval than the SM2060. For instance, with Aperture set to $625\mu\text{s}$ and Read Interval set to zero, in command/response operation the SM2060 measurement rate is about 1,090/s while that of the SM2064 is 1,370/s. This indicates overhead of about $300\mu\text{s}$ for the SM2060 and $100\mu\text{s}$ for the SM2064.

The SM2064 has 31 A/D apertures available, ranging from 5 Seconds to $2.5\mu\text{S}$. The following table contains all available measurement apertures and the corresponding minimum read intervals and measurement rates.

Power Line Rejection	Command/Response mode min. Read	H/W Trigger mode min. Read Interval(s) / max meas. Rate
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	Interval(s) / max meas. rate(Hz)			(Hz)
Aperture	60Hz	50Hz	400Hz	
5.1200s [1]	√	√	√	5.121s / 0.2
5.0666s [1]	√			5.0677s / 0.2
2.08s [1]		√	√	2.081s / 0.5
2.0s [1]	√	√	√	2.001s / 0.5
1.06666s [1]	√			1.067s / 1
960ms [1]		√	√	0.9605s / 1
533.33ms [1]	√			533.6ms / 2
480ms [1]		√	√	480.2ms / 2
266.666ms [1]	√			268ms / 4
160.0ms	√	√	√	166ms / 6
133.33ms	√			134ms / 8
80.00ms		√	√	80.4ms / 13
66.6667ms	√			67.2ms / 15
40.00ms		√	√	40.4ms / 25
33.333ms	√			33.643ms / 29.72
20.00ms		√	√	20.098ms / 49.76
16.6667ms	√			16.77ms / 59.6
10ms				10.094ms / 99
8.333ms				8.422ms / 119
5ms				5.109ms / 195
4.16667ms				4.265ms / 234
2.5ms				2.598ms / 385
2.0833ms				2.177ms / 458
1.25ms				1.344ms / 744
1.0417ms				1.133ms / 880
625μS				719μs / 1,390
520.83μS				617μs / 1,625
312.5μS				410μs / 2,445
260.42μS				355μs / 2,825
130.21μS				223μs / 4,475
2.5μS				47μs / 21,600

[1] Not available with any of the Triggered modes.

The SM2060 has 26 A/D apertures available, ranging from 5 Seconds to 625uSec. The following table contains all available measurement apertures corresponding minimum read intervals and measurement rates.

	Power Line Rejection			Command/Response mode min. Read Interval(s) / max meas. rate(Hz)	H/W Trigger mode min. Read Interval(s) / max meas. Rate (Hz)
Aperture	60Hz	50Hz	400Hz		
5.1200s [1]	√	√	√	5.121s / 0.2	N/A
5.0666s [1]	√			5.0677s / 0.2	N/A
2.08s [1]		√	√	2.081s / 0.5	N/A
2.0s [1]	√	√	√	2.001s / 0.5	N/A
1.06666s [1]	√			1.067s / 1	N/A
960ms [1]		√	√	0.9605s / 1	N/A
533.33ms [1]	√			533.6ms / 2	N/A
480ms [1]		√	√	480.2ms / 2	N/A
266.666ms [1]	√			268ms / 4	N/A
160.0ms	√	√	√	166ms / 6	160.3 ms / 6
133.33ms	√			134ms / 8	133.5 ms / 8
80.00ms		√	√	80.4ms / 13	80.2 ms / 13
66.6667ms	√			67.2ms / 15	66.713 ms / 15
40.00ms		√	√	40.4ms / 25	40.32 ms / 24.8
33.333ms	√			33.7ms / 30	33.38 ms / 30
20.00ms		√	√	20.35ms / 50	20.33 ms / 50
16.6667ms	√			16.9ms / 59	16.89 ms / 59
10ms				10.36ms / 97	10.25 ms / 97
8.333ms				8.68ms / 115	8.503 ms / 115
5ms				5.36ms / 185	5.187 ms / 185
4.16667ms				4.52ms / 220	4.274 ms / 220
2.5ms				2.86ms / 350	2.614 ms / 350
2.0833ms				2.44ms / 410	2.216 ms / 410
1.25ms				1.6ms / 625	1.380 ms / 625
1.0417ms				1.39ms / 719	1.158 ms / 864
625μS				917μs / 1,090	728 μs / 1,370

[1] Not available with any of the Triggered modes.

Precise control of the measurement timing and line frequency rejection can be accomplished by controlling the Read Interval and Aperture. Line rejection is dictated by the Aperture, and the duration of measurement is controlled with Read Interval.

Read Interval can be programmed in μs increments for values up to 65ms, and in 20μs increments to 1 second.

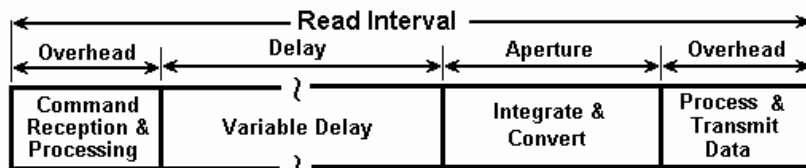


Figure 2-1: Time frame of a single measurement.

1.13 Source Functions (SMX2064)

- Isolated to 300 V DC from the Chassis
- Current can be paralleled with multiple SMX2064s
- Voltage can be put in series with multiple SMX2064s

1.13.1 DC Voltage Source

Parameter	Closed Loop [1]	Open Loop
Output Voltage range	-10.000 V to +10.000 V	
Typical Current source/sink at 5V output	5 mA	5 mA
DAC resolution	18 bits	12 bits
Accuracy 23°C ± 10°C One Year	0.015% ± 350 µV	1.0% ± 35 mV
Typical settling time	3 S (rate set to 2/s)	1 ms
Typical source resistance	250 Ω	

[1] An Aperture set to 133ms or higher is required for the closed loop mode.

1.13.2 AC Voltage Source

The AC Voltage source has two ranges. 900 mV range and 8V range. The lower range is capable of generating 50mV to 9.3V while the higher range can generate 300mV to 7.2V RMS.

Parameter	Specification
Ranges	900mV and 8V
Output Voltage, sine wave	30mV to 7.2 V RMS (0.14 to 20.0V peak-to-peak)
DAC resolution	12 bits
Typical Current Drive at 3.5V RMS	3 mA RMS
Accuracy 18 °C to 28 °C One Year	ACV spec + 0.8% ± 20 mV
Typical settling time (f-out > 40 Hz)	0.5 s
Typical source resistance	250 Ω
Frequency range / resolution	10 Hz to 100 kHz / 10 mHz
SFDR (spurious free dynamic range)	60dBc
THD (total harmonic distortion)	59dBc
Frequency stability	100 ppm ± 10 mHz

[1] 166ms or higher Aperture is required for proper closed loop mode.

1.13.3 DC Current Source

Range	Compliance Voltage	Resolution [1]	Minimum level	Accuracy 23°C ± 10°C One Year
1.25 µA	4.2 V	500 pA	1 nA	1% + 10 nA
12.5 µA	4.2 V	5 nA	10 nA	1% + 100 nA
125 µA	4.2 V	50 nA	100 nA	1% + 500 nA
1.25 mA	4.2 V	500 nA	1 µA	1% + 5 µA
12.5 mA	1.5 V	5 µA	10 µA	1% + 50 µA

[1] Resolution without Trim DAC. The use of the Trim DAC can improve the resolution by a factor of 10, but it has to be set separately since it is not calibrated.

1.14 Accuracy Notes

Important: all accuracy specifications for DCV, Resistance, DCI, ACV, and ACI apply for the time periods shown in the respective specification tables. To meet these specifications, Self Calibration must be performed once a day or as indicated in the specification table. This is a simple software operation that takes a few seconds. It can be performed by calling Windows command DMMCal(), or selecting S-Cal in the control panel.

These products are capable of continuous measurement as well as data transfer rates of up to 20,000 readings per second (rps). In general, to achieve 7-1/2 Digits of resolution, the Aperture should be set to 0.5s or a higher value. 6-1/2 digit resolution requires at least 10ms Aperture. For 5-1/2 use at least 625us Aperture.

1.15 Other Specifications

Temperature Coefficient over 0°C to 50°C Range

- Less than 0.1 x accuracy specification per °C At 23C ± 5°C

Aperture (user selectable)

- 625 μs to 2s in 26 discrete values, SM2060 (approx. 0.5 to 1,400 readings per second)
- 2.5μs to 2s in 31 discrete values, SM2064 (approx. 0.5 to 20,000 readings per second)
- In Triggered modes Aperture is limited to 160ms or shorter.

Read Interval (user selectable)

- 47μs to 65ms, 1μs steps in Trigger modes, SM2064
- 730μs to 65ms, 1us steps in Trigger modes, SM2060
- 47μs to 1s, 1μs steps below 65ms, in command/response modes, SM2064
- 916μs to 1s, 1μs steps below 65ms, in command/response modes, SM2060

Hardware Interface	Single PCI slot
Overload Protection (voltage inputs)	330 VDC, 250 VAC
Isolation	330 VDC, 250 VAC from Earth Ground
Maximum Input (Volt x Hertz)	8x10 ⁶ Volt x Hz normal mode input (across Voltage HI & LO). 1x10 ⁶ Volt x Hz Common Mode input (from Voltage HI or LO relative to Earth Ground).
Safety	Designed to IEC 1010-1, Installation Category II.
Calibration	Calibrations are performed by Signametrics in a computer at 23°C internal temperature rise. All calibration constants are stored in a text file.
Temperature Range Operating	-10°C to 65°C
Temperature Range Storage	-40°C to 85°C
Size	SM2060, SM2064: 4.5" X 8.5" (PCI format) SMX2060, SMX2064: Single 3U PXI or CompactPCI slot
DMM Internal Temperature sensor accuracy	±1°C (SM2064)
Power	+5 volts, 300 mA maximum

Note: Signametrics reserves the right to make changes in materials, specifications, product functionality, or accessories without notice.

Accessories

Several accessories are available for the SM2060 series DMM's, which can be purchased directly from Signametrics, or one of its approved distributors or representatives. These are some of the accessories available:

- DMM probes SM-PRB (\$15.70)
- DMM probe kit SM-PRK (\$38.50)
- Deluxe probe kit SM-PRD (\$95.00).
- Shielded SMT Tweezers Probes SM-PRSMT (\$24.90).
- Multi Stacking Double Banana shielded cable 36" SM-CBL36 (\$39.00).
- Multi Stacking Double Banana shielded cable 48" SM-CBL48 (\$43.00).
- Mini DIN Trigger, 6-Wire Ohms connector SM2060-CON7 (\$14.00).
- Lab View VI's library SM204x.llb (free).
- Extended 3 Year warrantee (does not include calibration) \$150.00 for SM2060 and SMX2060, \$240 for the SM2064 and SMX2064.

