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System SourceMeter Instrument Specifications

SPECIFICATION CONDITIONS

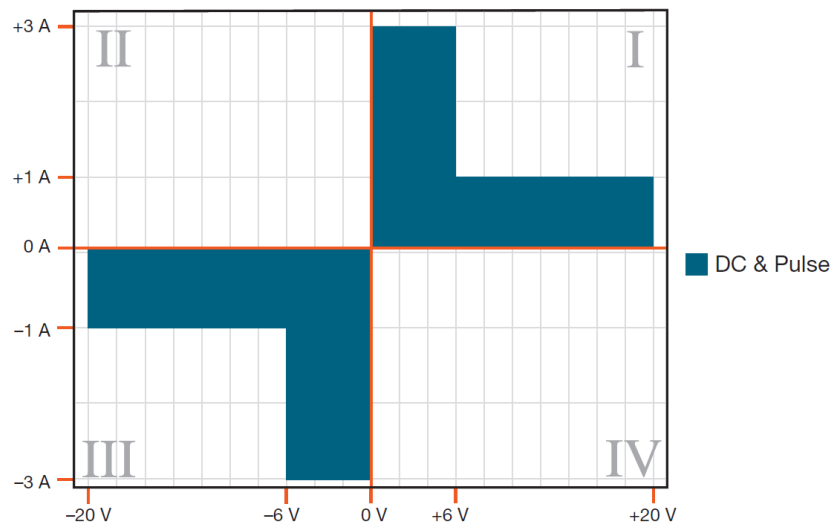
This document contains specifications and supplemental information for the Model 2606B System SourceMeter® instrument. Specifications are the standards against which the 2606B instruments are tested. Upon leaving the factory, the 2606B instruments meet these specifications. Supplemental and typical values are nonwarranted, apply at 23 °C, and are provided solely as useful information. Specifications are for individual modules.

Source and measurement accuracies are specified at the 2606B terminals under these conditions:

1. 23 °C ±5 °C, < 70 percent relative humidity
2. After a two-hour warm-up period
3. Speed normal (1 NPLC)
4. A/D autozero enabled
5. Remote sense operation or properly zeroed local operation
6. Calibration period: One year

DC POWER SPECIFICATIONS

	Voltage	Current
Maximum output power and source limits^{1,2}	20.2 W maximum ■ 20.2 V at 1.0A, -20.2 V at -1.0 A 6.06 V at 3.0 A, -6.06 V at -3.0A	20.2 W maximum ■ 1.01 A at 20 V, -1.01 A at -20 V 3.03 A at 6 V, -3.03 A at -6 V



¹ For additional power derating information for various load and temperature conditions, refer to “Operating Boundaries” in the *Series 2606B Reference Manual*.

² The System SourceMeter® will allow quadrant II and quadrant IV operation, however, it is intended for low power or short transient behavior. Operation in quadrant II and quadrant IV could result in an overtemperature error.



VOLTAGE ACCURACY SPECIFICATIONS^{3, 4}

Range	Source			Measure	
	Programming resolution	Accuracy ± (% reading + volts)	Typical noise (peak to peak) 0.1 Hz to 10 Hz	Display resolution	Accuracy ⁵ ± (% reading + volts)
100 mV	5 µV	0.02% + 250 µV	20 µV	100 nV	0.015% + 150 µV
1 V	50 µV	0.02% + 400 µV	50 µV	1 µV	0.015% + 200 µV
6 V	50 µV	0.02% + 1.8 mV	100 µV	1 µV	0.015% + 1 mV
20 V	500 µV	0.02% + 12 mV	500 µV	10 µV	0.015% + 8 mV

CURRENT ACCURACY SPECIFICATIONS³

Range	Source			Measure	
	Programming resolution	Accuracy ± (% reading + amperes)	Typical noise (peak to peak) 0.1 Hz to 10 Hz	Display resolution	Accuracy ⁵ ± (% reading + amperes)
100 nA	2 pA	0.06% + 100 pA	5 pA	100 fA	0.05% + 100 pA
1 µA	20 pA	0.03% + 800 pA	25 pA	1 pA	0.025% + 500 pA
10 µA	200 pA	0.03% + 5 nA	60 pA	10 pA	0.025% + 1.5 nA
100 µA	2 nA	0.03% + 60 nA	3 nA	100 pA	0.02% + 25 nA
1 mA	20 nA	0.03% + 300 nA	6 nA	1 nA	0.02% + 200 nA
10 mA	200 nA	0.03% + 6 µA	250 nA	10 nA	0.02% + 2.5 µA
100 mA	2 µA	0.03% + 30 µA	600 nA	100 nA	0.02% + 20 µA
1 A	20 µA	0.05% + 1.8 mA	70 µA	1 µA	0.03% + 1.5 mA
3 A	20 µA	0.06% + 4 mA	150 µA	1 µA	0.05% + 3.5 mA

³ For temperatures 0 °C to 18 °C and 28 °C to 50 °C, accuracy is degraded by $\pm(0.15 \times \text{accuracy specification})/^\circ\text{C}$.

⁴ Add 50 µV to source accuracy specifications per volt of HI lead drop.

⁵ Derate accuracy specification for NPLC setting < 1 by increasing the error term. Add appropriate typical percent of reading term for resistive loads using the table below.

NPLC setting	100 mV range	1 V and 40 V ranges	100 nA range	1 µA to 100 mA ranges	1 A to 3 A ranges
0.1	0.01%	0.01%	0.01%	0.01%	0.01%
0.01	0.08%	0.07%	0.1%	0.05%	0.05%
0.001	0.8%	0.6%	1%	0.5%	1.1%

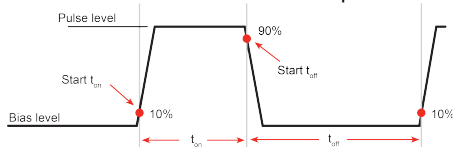
SUPPLEMENTAL CHARACTERISTICS

The following specifications are supplemental characteristics that provide additional information about instrument functions and performance. These characteristics are nonwarranted specifications; they describe the typical performance of the 2606B.

ADDITIONAL SOURCE CHARACTERISTICS

Noise 10 Hz to 20 MHz	< 20 mV peak-peak, < 3 mV _{RMS} <ul style="list-style-type: none"> 6 V range 			
Minimum programmable pulse width^{6,7}	100 µs Note: Minimum pulse width for settled source at a given I/V output and load can be longer than 100 ms.			
	Source value	Load	Source settling time (% of range)	Minimum pulse width
	6 V	2 Ω	0.2%	150 µs
	3 A	2 Ω	0.2%	150 µs
Pulse width programming resolution	1 µs			
Pulse width programming accuracy	±5 µs			
Pulse width jitter	2 µs			
Transient response time	< 70 µs for the output to recover to within 0.1% for a 10% to 90% step change in load.			
Overshoot	Voltage: <ul style="list-style-type: none"> < ±0.1% of range + 10 mV Step size = 10% to 90% of range, resistive load, maximum current limit/compliance Current: <ul style="list-style-type: none"> < ±0.1% of range Step size = 10% to 90% of range, resistive load See Current source output settling time for additional test conditions 			
Range change overshoot	Voltage: <ul style="list-style-type: none"> < 300 mV + 0.1% of larger range Overshoot into a 100 kΩ load, 20 MHz bandwidth Current: ⁷ <ul style="list-style-type: none"> < 300 mV/R_{LOAD} + 5% of larger range 			
Guard offset voltage	< 4 mV <ul style="list-style-type: none"> Current < 10 mA 			
Remote sense operating range⁸	Maximum voltage between HI and SENSE HI = 3 V Maximum voltage between LO and SENSE LO = 3 V			

⁶ Times measured from the start of pulse to the start off-time; see figure below.



⁷ With source settling set to SETTLE_SMOOTH_100NA

⁸ Add 50 µV to source accuracy specifications per volt of HI lead drop.

Voltage output headroom	<p>20 V range</p> <ul style="list-style-type: none"> Maximum output voltage = 22 V – (total voltage drop across source leads). Maximum 1 Ω source lead. <p>6 V range</p> <ul style="list-style-type: none"> Maximum output voltage = 8 V – (total voltage drop across source leads). Maximum 1 Ω source lead. 	
Overtemperature protection	Internally sensed temperature overload puts the instrument in standby mode	
Limit/compliance	<p>Bipolar limit (compliance) set with a single value</p> <p>Voltage:</p> <ul style="list-style-type: none"> Minimum value is 10 mV; accuracy is the same as voltage source <p>Current:</p> <ul style="list-style-type: none"> Minimum value is 10 nA; accuracy is the same as current source 	
Voltage source output settling time	Time required to reach within 0.1% of final value after source level command is processed on a fixed range.	
	Voltage range	Settling time
	100 mV	< 50 μs
	1 V	< 50 μs
	10 V	< 110 μs
20 V ⁹	< 150 μs	
Current source output settling time	Time required to reach within 0.1% of final value after source level command is processed on a fixed range	
	<ul style="list-style-type: none"> Values below for $I_{OUT} \times R_{LOAD} = 1 V$ 	
	Current range	Settling time
	3 A	< 80 μs (Current < 2.5 A, $R_{LOAD} > 2 \Omega$)
	1 A to 10 mA	< 80 μs ($R_{LOAD} > 6 \Omega$)
	1 mA	< 100 μs
	100 μA	< 150 μs
	10 μA	< 500 μs
	1 μA	< 2 ms
100 nA	< 20 ms	

ADDITIONAL MEASUREMENT CHARACTERISTICS

Current measure settling time¹⁰	Time required to reach within 0.1% of final value after source level command is processed on a fixed range	
	Values below for $V_{out} = 1 V$	
	Current range	Settling time
	1 mA	< 100 μs
Input impedance	> 10 GΩ	

⁹ Add 150 μs when measuring on the 1 A range.

¹⁰ Compliance equal to 100 mA

ADDITIONAL CHARACTERISTICS

Maximum load impedance	Normal mode 10 nF	High-capacitance mode 50 μ F
Common mode voltage	250 VDC	
Common mode isolation	> 1 G Ω < 4500 pF	
Sense high input impedance	> 10 G Ω	
Maximum sense lead resistance	1 k Ω for rated accuracy	
Overrange	101% of source range 102% of measure range	

MEASUREMENT SPEED CHARACTERISTICS^{11,12}

Maximum sweep operation rates (operations per second) for 60 Hz (50 Hz):

A/D converter speed (NPLC)	Trigger origin	Measure to memory <small>(using user scripts)</small>	Measure to USB <small>(using user scripts)</small>	Source measure to memory <small>(using user scripts)</small>	Source measure to USB <small>(using user scripts)</small>	Source measure to memory <small>(using sweep API)</small>	Source measure to USB <small>(using sweep API)</small>
0.001	Internal	20000 (20000)	9800 (9800)	7000 (7000)	6200 (6200)	12000 (12000)	5900 (5900)
0.001	Digital I/O	8100 (8100)	7100 (7100)	5500 (5500)	5100 (5100)	11200 (11200)	5700 (5700)
0.01	Internal	4900 (4000)	3900 (3400)	3400 (3000)	3200 (2900)	4200 (3700)	4000 (3500)
0.01	Digital I/O	3500 (3100)	3400 (3000)	3000 (2700)	2900 (2600)	4150 (3650)	3800 (3400)
0.1	Internal	580 (480)	560 (470)	550 (465)	550 (460)	560 (470)	545 (460)
0.1	Digital I/O	550 (460)	550 (460)	540 (450)	540 (450)	560 (470)	545 (460)
1.0	Internal	59 (49)	59 (49)	59 (49)	59 (49)	59 (49)	59 (49)
1.0	Digital I/O	59 (49)	59 (49)	59 (49)	59 (49)	59 (49)	59 (49)

¹¹ Tests performed using the following equipment: Computer hardware — Intel® Core™ i7 at 2.90 GHz, 8 GB RAM; software — Microsoft® Windows® 10 Enterprise 64-bit, Microsoft® Visual Studio® 2010, VISA™ version 5.8.

¹² Exclude current measurement ranges less than 1 mA.

Maximum single measurement rates (operations per second) for 60 Hz (50 Hz)

A/D converter speed (NPLC)	Trigger origin	Measure to USB	Source measure to USB	Source measure pass/fail to USB
0.001	Internal	1900 (1800)	1400 (1400)	1400 (1400)
0.01	Internal	1450 (1400)	1200 (1200)	1100 (1100)
0.1	Internal	450 (390)	425 (370)	425 (375)
1.0	Internal	58 (48)	57 (48)	57 (48)
Maximum measurement range change rate	> 7000 per second for > 10 μ A. When changing to or from a range \geq 1 A, maximum rate is > 2200 per second.			
Maximum source range change rate	> 400 per second > 10 μ A. When changing to or from a range \geq 1 A, maximum rate is > 190 per second.			
Maximum source function change rate	> 1000 per second			
Command processing time	< 1 ms <ul style="list-style-type: none"> ▪ Maximum time required for the output to begin to change after receiving the <code>smua.source.levelv</code> or <code>smua.source.leveli</code> command. 			

TRIGGERING AND SYNCHRONIZATION CHARACTERISTICS

Triggering

Trigger in to trigger out	0.5 μ s
Trigger in to source change¹³	10 μ s
Trigger timer accuracy	\pm 2 μ s
Source change¹³ after LXI trigger	280 μ s

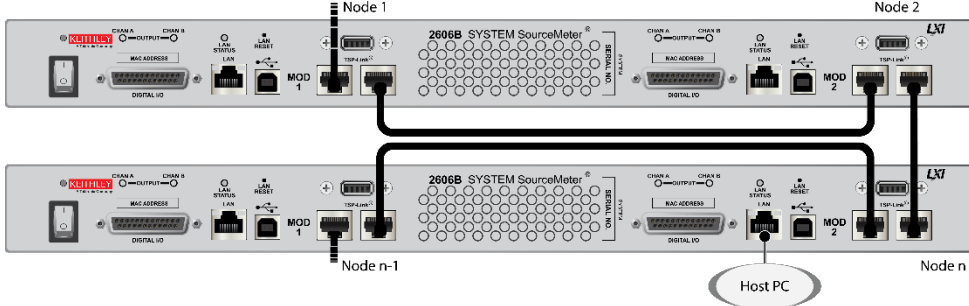
Synchronization

Multi-node synchronized source change¹³	< 0.5 μ s
Single-node synchronized source change¹³	< 0.5 μ s

¹³ Fixed source range with no polarity change.

SUPPLEMENTAL INFORMATION

Programming	<p>Embedded Test Script Processor (TSP®) scripting engine is accessible from any host interface:</p> <ul style="list-style-type: none"> ▪ Responds to individual instrument control commands ▪ Responds to high-speed test scripts comprised of remote commands and test script language (TSL) statements (for example, branching, looping, and math) ▪ Able to execute high-speed test scripts stored in memory without host intervention
Minimum user memory available	16 MB (approximately 250,000 lines of TSP code)
Test Script Builder	<p>Integrated development environment for building, running, and managing TSP scripts; includes an instrument console for interactive communication with any TSP-enabled instrument. For information on requirements, refer to the Test Script Builder documentation, available at tek.com/keithley.</p>
Software interface	<p>Read/write with tools such as Microsoft® Visual Basic®, Visual C/C++®, Visual C#®, LabVIEW™, CEC TestPoint™ Data Acquisition Software Package, and NI LabWindows™/CVI.</p>
Reading buffers	<p>Nonvolatile memory uses dedicated storage areas reserved for measurement data. Reading buffers are arrays of measurement elements. Each element can store the following items:</p> <ul style="list-style-type: none"> ▪ Measurement ▪ Source setting (at the time the measurement was taken) ▪ Measurement status ▪ Range information ▪ Timestamp <p>Reading buffers can be filled using the front-panel STORE key, and retrieved using the RECALL key or host interface.</p>
Buffer size, with timestamp and source setting	> 60,000 samples
Buffer size, without timestamp and source setting	> 140,000 samples

<p>System expansion</p>	<p>The TSP-Link expansion interface allows TSP-enabled instruments to trigger and communicate with each other. See the figure below.</p>  <p>The 2606B has four TSP-Link connectors (two on each module) to make it easier to connect instruments in a sequence.</p> <ul style="list-style-type: none"> Once source-measure instruments are interconnected through the TSP-Link expansion interface, a computer can access all of the resources of each source-measure instrument through the host interface of any System SourceMeter. A maximum of 32 TSP-Link nodes can be interconnected. Each source-measure module uses one TSP-Link node.
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TIMING

<p>Timer</p>	<p>Free-running 47-bit counter with 1 MHz clock input. Reset each time instrument power is turned on. If the instrument is not turned off, the timer is automatically reset to 0 every four years.</p>
<p>Timestamp</p>	<p>TIMER value is automatically saved when each measurement is triggered</p>
<p>Resolution</p>	<p>1 μs</p>
<p>Timestamp accuracy</p>	<p>\pm100 ppm</p>

GENERAL SPECIFICATIONS

Ethernet	RJ-45 connector, LXI version 1.4 Core 2011, 10/100BaseT, Auto-MDIX
LXI compliance	LXI version 1.4 Core 2011
Expansion interface	<ul style="list-style-type: none"> ▪ The TSP-Link® expansion interface allows TSP-enabled instruments to trigger and communicate with each other ▪ Cable type: Category 5e or higher LAN crossover cable ▪ 9.84 ft (3 m) maximum between each TSP-enabled instrument
USB control	USB 2.0 Device: USB-TMC488 protocol
USB file system	USB 2.0 Host: Mass storage class device
Power supply	100 VAC to 240 VAC, 50 Hz or 60 Hz (auto sensing), 425 VA maximum
Cooling	Forced air; front and side intakes and rear exhaust
Warranty	1 year
EMC	Conforms to European Union EMC Directive
Safety	NRTL listed to UL 61010-1 and CSA C22.2 No 61010-1 Conforms with European Union EMC Low Voltage Directive
Environment	For indoor use only Altitude: Maximum 6562 ft (2000 m) above sea level Operating: 0 °C to 50 °C, 70% relative humidity up to 35 °C. Derate 3% relative humidity/°C, 35 °C to 50 °C Storage: -25 °C to 65 °C
Dimensions	Rack mount: 1.7 in. high x 19 in. wide x 26.8 in. deep (44 mm x 483 mm x 680 mm)
Weight	13.6 kg (30 lb)

<p>Digital I/O interface</p>	<p>Connector: 25-pin female D</p> <p>Input/output pins: 14 open drain I/O bits</p> <p>Absolute maximum input voltage: 5.25 V</p> <p>Absolute minimum input voltage: -0.25 V</p> <p>Maximum logic low input voltage: 0.7V, +850 μA max</p> <p>Minimum logic high input voltage: 2.1 V, +570 μA</p> <p>Maximum source current (flowing out of digital I/O bit): +960 μA</p> <p>Maximum sink current at maximum logic low voltage (0.7): -5.0 mA</p> <p>Absolute maximum sink current (flowing into digital I/O pin): -11 mA</p> <p>5 V power supply pin: Limited to 250 mA, solid-state fuse protected</p> <p>Output enable: Active high input pulled down internally to ground with a 10 kΩ resistor; when the output enable input function has been activated, each SourceMeter channel will not turn on unless the output enable pin is driven to > 2.1 V (nominal current = 2.1 V / 10 kΩ = 210 μA).</p>
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