
Joulescope JS320 Datasheet

Jetperch LLC, revision 2.0

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The Joulescope™ JS320 is a precision DC energy analyzer. It measures current and voltage, then computes power, energy and charge. It measures current over ten orders of magnitude, from amps down to nanoamps, with fast autoranging and minimal voltage drop.

- $\pm 15\text{V}$ voltage range
- $\pm 3\text{A}$ current range, continuous
- $\pm 10\text{A}$ current pulses ($< 10\text{ ms}$, $< 3\text{A}$ average per second)
- Down to 0.1 nA resolution, equivalent to 36-bits of dynamic range
- Synchronously measures voltage and current at 1 million samples per second, 24-bit
- 200 kHz linear phase bandwidth

- 300 kHz compensated bandwidth with optional digital filter
- Rapid 1 μ s switching between shunt resistors
- Enwavify™ technology for consistent, accurate measurements through current range changes
- Computes power, energy, and charge
- Operates with minimal voltage disturbance between Current + and Current – ports
- Up to ± 48 V common-mode voltage between USB ground and sensing ports
- 4 general-purpose inputs and 2 general-purpose outputs
- 1 BNC trigger configurable for either digital input, digital output, or analog output
- Programmable on/off for power cycling the target device and measuring inrush currents
- USB 2.0 high-speed host connectivity with USB C connector
- Host software support for Microsoft® Windows®, Apple® macOS®, and Linux®
- Host software user interface provides real-time graphs of current, voltage, and power over time
- Python library and scripting provided
- Host software is open source and available on GitHub
- Swappable front panel with open-source designs on GitHub
- Firmware upgradable

The Joulescope JS320 User's Guide describes how to use the instrument. The specification values are also available as [js320_datasheet.yaml](#).

1 Absolute maximum ratings

	Min	Max	Unit
USB voltage	-0.3	6	V
Max voltage applied between any port (Current +, Current -, Voltage +, Voltage -)	-20	20	V
Max voltage to USB ground from any port (Current +, Current -, Voltage +, Voltage -)	-48	48	V
Input current (powered, burst)	-10	10	A
Input current (powered, sustained)	-3	3	A
Input current (unpowered)	N/A (off)	N/A (off)	A
Storage temperature	-40	80	°C
Operating temperature	0	50	°C
Relative humidity (non-condensing)	0	95	%
Altitude from sea level	-100	2500	m
Max voltage applied to GPI relative to USB ground	-10	10	V

2 Mechanical

2.1 Instrument only

	Typical	Unit
Weight	190	grams
Width	99	mm
Length (including binding posts and BNC connector)	126	mm
Height	28	mm

2.2 Complete product kit

	Typical	Unit
Weight	510	grams
Width	190	mm
Length	200	mm
Height	60	mm

3 Recommended operating conditions

	Test condition	Min	Typical	Max	Unit
Operating temperature		10		40	°C
USB supply voltage		4.5	5.0	5.5	V
USB supply current				500	mA
Voltage applied across Voltage + and Voltage -		-15		15	V
Voltage applied across Current + and Current -	Current range off	-15		15	V
Input current	continuous	-3		3	A
Input current pulse	< 50 milliseconds, < 3A average	-10 ¹		10 ¹	A
Input current pulse	< 250 milliseconds, < 3A average	-5 ¹		5 ¹	A

1. Suitable for handling inrush currents when connecting capacitive loads.

4 Specification conditions

Temperature	23 °C ± 10 °C
Humidity	20% to 80% RH, non-condensing
Calibration interval	1 year ¹

1. Recommended to comply with industry-standard practices, but the Joulescope JS320 is designed not to need recalibration.

5 Current measurement specifications

Range	Accuracy ¹	Impedance	Guaranteed ²
10 A ³	±0.25% ±500 µA	0.01 Ω	±10.4 A
180 mA	±0.25% ±50 µA	0.11 Ω	±188 mA
18 mA	±0.25% ±5 µA	1.11 Ω	±18.8 mA
1.8 mA	±0.25% ±500 nA	11.1 Ω	±1.88 mA
180 µA	±0.25% ±50 nA	111 Ω	±188 µA
18 µA	±0.25% ±10 nA ⁴	1111 Ω	±18.8 µA

1. Accuracy is specified as a percentage of measurement plus a fixed offset. Some instruments specify offset as a percentage of the full-scale range.
2. The highest current that this range is guaranteed to measure without saturation. Higher currents may saturate the range and potentially trip the soft fuse for that current range.
3. Max 3 A sustained. See the recommended operating conditions for higher current durations.
4. ±1.0 nA for ±5 °C over 24 hours with trim offset calibration.

The resolution depends on the noise. Noise depends on both the current range and signal bandwidth, which is limited by the sample frequency. The following table shows the typical (not guaranteed) resolution given only the JS320 self-noise with no additional external noise pickup.

Range	1 Msps resolution (typical)	10 ksps resolution (typical)	10 sps resolution (typical)	Units
10 A	1000	100	10	µA
180 mA	100	10	1	µA
18 mA	10	1	0.1	µA
1.8 mA	1000	100	10	nA
180 µA	100	10	1	nA
18 µA	10	1	0.1	nA

Test current measurement bandwidth by varying the effective load impedance. Due to load capacitance, altering the source voltage is often not a valid method of testing current bandwidth.

The JS320 is sensitive to RF radiation, which induces real current in test setups. When tested with EN61326-1 and 3 V RMS/m, the JS320 measured up to 10 μ A (observed, not guaranteed) of current at several frequencies. The exact frequency susceptibility varies with cable length and configuration.

6 Voltage measurement specifications

Range	Accuracy ¹	Guaranteed
15 V	$\pm 0.1\% \pm 500 \mu\text{V}$	$\pm 15.5 \text{ V}$
2 V	$\pm 0.1\% \pm 200 \mu\text{V}$	$\pm 2.05 \text{ V}$

1. At $V+ == I+$. See the CMRR specification for extended voltage.

The resolution depends on the noise. Noise depends on both the current range and signal bandwidth, which is limited by the sample frequency. The following table shows the typical (not guaranteed) resolution given only the JS320 self-noise with no additional external noise pickup.

Range	1 Msps resolution (typical)	10 ksps resolution (typical)	10 sps resolution (typical)	Units
15 V	500	50	10	μV
2 V	100	10	2	μV

The JS320 is sensitive to RF radiation, which induces real voltages in test setups. When tested with EN61326-1 and 3 V RMS/m, the JS320 error increased by 10 mV (observed, not guaranteed) at several frequencies. The exact frequency susceptibility varies with cable length and configuration.

7 General specifications

	Test condition	Min	Typical	Max	Unit
Sampling frequency	25 °C		1000000		sps
Sampling frequency accuracy	25 °C	-5		5	ppm
Measurement bandwidth	-3 dB	185	195	225	kHz
Compensated bandwidth	-3 dB	280	300	350	kHz
Front panel insertions				100	

8 Parasitic effects specifications

	Test condition	Min	Typical	Max	Unit
Current leakage (Voltage + to -)	25 °C, $\pm 3.3V$		100		pA
Current leakage (Voltage + to -)	25 °C, $\pm 5V$		100		pA
Current leakage (Voltage + to -)	25 °C, $\pm 15V$		100		pA
Shunt resistor voltage, max	-2 to 2 A, static		20	21	mV
Burden voltage (Current + to -)	1 A, banana jacks	0	25	35	mV
Burden voltage (Current + to -)	Shunt resistor, $< \pm 2$ A			± 20	mV
Shunt switching time	Over-range, < 200 ns rise time	0	0.8	1.2	μs
Measurement gap following a current range switch				0	μs
CMRR on voltage input (common mode rejection ratio)	25 °C, $\pm 15V$		-70		dB

9 Software-controlled fuse specifications

	Test condition	Min	Typical	Max	Unit
Current leakage (Current + to -)	25 °C, 3.3V	± 5			nA
Current leakage (Current + to -)	25 °C, 5V	± 7			nA
Current leakage (Current + to -)	25 °C, 15V	± 28		± 5000	nA
Fuse engage time	5 A		0.293		s
Fuse engage time	10 A		0.050		s

10 General purpose inputs and outputs

	Test condition	Min	Typical	Max	Unit
Internal 3.3V reference		3.135	3.3	3.465	V
External reference	$V_{ref} < (V_{USB} - 0.5 V)$	$V_{ref} - 0.1$	V_{ref}	$V_{ref} + 0.1$	V
Input leakage per pin	25 °C			± 10	nA
Input leakage per pin				± 100	nA
Output voltage high	-100 μA	$V_{cco} - 0.1$			V
Output impedance	10 mA	45	50	80	Ω
GPI sample rate			1		MSPS
Continuous output current	Per pin			± 50	mA
Total power dissipation	Over output impedance			0.25	W

The Joulescope uses the TI [TLV9034](https://www.ti.com/product/TLV9034)¹ for GPIs and the TI [SN74LVC2T45](https://www.ti.com/product/SN74LVC2T45)² to drive the GPOs. Both the GPIs and GPOs are protected with the TI [TPD4E1U06](https://www.ti.com/product/TPD4E1U06)³ for ESD protection.

Both gates of the TI SN74LVC2G125 drive the trigger in parallel, each through a 100 Ω resistor for 50 Ω drive.

¹ <https://www.ti.com/product/TLV9034>

² <https://www.ti.com/product/SN74LVC2T45>

³ <https://www.ti.com/product/TPD4E1U06>