Joulescope JS110 Datasheet

Jetperch LLC, revision 2.0

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The Joulescope™ JS110 is a precision DC energy analyzer. It measures current and voltage, then computes power and energy. It combines high-speed sampling and rapid dynamic current range switching to provide accurate and seamless current and energy measurements, even for devices with rapidly varying current consumption.

- -1V to 15V voltage range
- -1A to 3A current range, continuous
- Up to 10A current pulses (<10 ms, < 3A average per second)
- Down to 1.5 nA resolution, equivalent to 32-bits of dynamic range
- Synchronously measures voltage and current at 2 million samples per second, 14-bit
- 250 kHz bandwidth

- Rapid 1 µs switching between shunt resistors for seamless dynamic current measurement
- Computes power, total energy, and charge
- Operates with minimal voltage disturbance between IN and OUT ports
- Up to ±48V common-mode voltage between USB ground and IN-, IN+, OUT+, and OUT-
- 2 general-purpose inputs and 2 general-purpose outputs
- Programmable on/off for power cycling the target device and measuring inrush currents
- USB 2.0 high-speed host connectivity
- Host software support for Microsoft® Windows®, Apple® Mac® OS X®, and Linux®
- Host software provides real-time graphs of current, voltage, and power over time
- Host software is open source and available on GitHub
- Swappable front panel with open-source designs on GitHub
- Firmware upgradable

The Joulescope JS110 User's Guide describes how to use the instrument. The specification values are also available as js110_datasheet.yaml.

1 Absolute maximum ratings

	Min	Max	Unit
USB voltage	-0.3	6	V
Max voltage applied between IN+ to IN-	-20	20	V
Max voltage applied between OUT+ to OUT-	-20	20	V
Max voltage to USB ground (IN+, IN-, OUT+, OUT-)	-48	48	V
Input current (powered, burst)	-10	10	A
Input current (powered, sustained)	-3	3	A
Input current (unpowered)	-0.5	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

	Typical	Unit
Weight	217	grams
Width	81	mm
Length (including banana jack front panel)	150	mm
Height	33	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 to IN		-1.0		15	V
Input current	continuous	-1.5		3	A
Input current pulse	< 10 milliseconds, < 3A average			10[1]	A
Input current pulse	< 100 milliseconds, < 3A average			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 Joulescope is designed not to need re-calibration.

5 Current measurement specifications

Range	Accuracy	Resolution	Impedance	Bandwidth
10 A[1]	±0.3% ±7 mA	1 mA	0.01 Ω	250 kHz
2 A	±0.3% ±1.50 mA	175 µA	0.01 Ω	250 kHz
180 mA	±0.3% ±150 µA	15 µA	0.11 Ω	250 kHz
18 mA	±0.25% ±15 µA	1.5 µA	1.11 Ω	250 kHz
1.8 mA	±0.25% ±1.5 µA	150 nA	11.1 Ω	180 kHz
180 µA	±0.25% ±150 nA	15 nA	111 Ω	70 kHz
18 µA	±0.25% ±30 nA	1.5 nA	1111 Ω	15 kHz

1. Joulescope is designed for 3 A sustained. See the recommended operating conditions for maximum durations for higher currents.

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

6 Voltage measurement specifications

Range	Accuracy	Resolution	Impedance	Bandwidth
15 V	±0.1% ±11 mV	1.2 mV	-	250 kHz
5 V	±0.1% ±3.5 mV	400 µV	-	250 kHz

7 General specifications

	Test condition	Min	Typical	Max	Unit
Sampling frequency	25 °C		2000000		sps
Sampling frequency	25 °C	-20		20	ppm
Front panel insertions				100	

8 Parasitic effects specifications

	Test condition	Min	Typical	Max	Unit
Current leakage (IN+ to IN-)	25 °C, +3.3V		2		nA
Current leakage (IN+ to IN-)	25 °C, +5V		2		nA
Current leakage (IN+ to IN-)	25 °C, +15V		3		nA
Shunt resistor voltage, max	0 to 2 A, static		20	21	mV
Burden voltage (IN+ to OUT+)	< 1 A, banana jacks	0	25	30	mV
Burden voltage (OUT- to IN-)	< 1 A, banana jacks	0	3	8	mV
Shunt switching time	Over-range, < 100 ns rise time	0	0.8	1.2	µs
Over-range settling time		0	2	5	µs
Under-range settling time		0	2	5	µs

9 Software-controlled fuse specifications

	Test condition	Min	Typical	Max	Unit
Current leakage (IN+ to OUT+)	25 °C, 3.3V		5		nA
Current leakage (IN+ to OUT+)	25 °C, 5V		7		nA
Current leakage (IN+ to OUT+)	25 °C, 15V		28	5000	nA

10 General purpose inputs and outputs

	Test condition	Min	Typical	Max	Unit
Programmable logic level voltage		1.8		VUSB - 0.2	V
Input leakage per pin	25 °C			±1	µA
Input leakage per pin				±2	µA
Output voltage high	-100 µA	Vcco - 0.1			V
Output voltage high	-4 mA @ 1.65 V	1.2			V
Output voltage high	-8 mA @ 2.3 V	1.9			V
Output voltage high	-24 mA @ 3 V	2.4			V
Output voltage high	-32 mA @ 4.5 V	3.8			V
Output voltage low	100 µA			0.1	V
Output voltage low	4 mA @ 1.65 V			0.45	V
Output voltage low	8 mA @ 2.3 V			0.3	V
Output voltage low	24 mA @ 3 V			0.55	V
Output voltage low	32 mA @ 4.5 V			0.55	V
Output impedance	10 mA	90	100	110	Ω
GPI sample rate			2		MSPS
Continuous output current	Per pin			±50	mA
Total power dissipation	Over output impedance			0.25	W

The Joulescope uses the TI SN74LVC2T45 for both the GPIs and GPOs. See the SN74LVC2T45 datasheet[1] for more information. Both the GPIs and GPOs are protected with the Vishay VEMI45AA-HNH[2], which is an EMI filter with ESD protection. The VEMI45AA is a pi filter with 100 Ohm resistance and capacitance between 29 pF and 60 pF.

10.1 GPIO supply

	Min	Typical	Max	Unit
+5V output	4.4	VBUS - 0.1	5.5	V
Current			100	mA
Output impedance		1		Ω

[1] http://www.ti.com/lit/gpn/sn74lvc2t45
[2] https://www.vishay.com/docs/81385/vemi45aa.pdf