

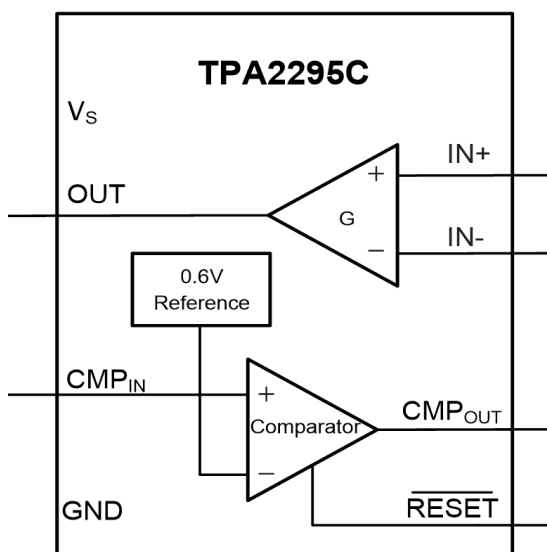
Features

- SMALL VOLTAGE OFFSET:
 - ◆ TPA2295C: $\pm 0.5\text{mV}$ (MAX)
- WIDE COMMON MODE VOLTAGE: -0.1V to $+70\text{V}$
- WIDE CMRR THROUGH COMMON VOLTAGE: **130dB**
- SUPPLY VOLTAGE: **3.0V** to **+18V**
- ACCURACY and ZERO-DRIFT PERFORMANCE
 - ◆ $\pm 0.5\%$ Gain Error (Max, -40°C ~ 125°C)
 - ◆ $0.5\mu\text{V}/^\circ\text{C}$ Offset Drift (Max, -40°C ~ 125°C)
 - ◆ $5\text{ppm}/^\circ\text{C}$ Gain Drift (Max, -40°C ~ 125°C)
- FIVE GAIN OPTIONS for VOLTAGE OUTPUT
 - ◆ TPA2295CT: 20V/V
 - ◆ TPA2295CF: 50V/V
 - ◆ TPA2295CS: 60V/V
 - ◆ TPA2295CH: 100V/V
 - ◆ TPA2295CW: 200V/V
- Comparator :
 - ◆ 0.6-V Internal Voltage Reference
 - ◆ Open-Drain Output with Latch control

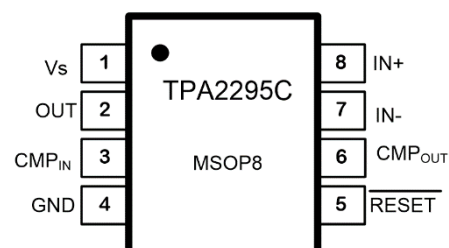
Applications

- CURRENT SENSING (High-Side/Low-Side)
- BATTERY CHARGERS & POWER MANAGEMENT
- AUTOMOTIVE & INDUSTRIAL CONTROL
- BASE STATIONS & TELECOM EQUIPMENT

Functional Block Diagram



Pin Configuration



PIN No.	PIN NAME	TPA2295C DESCRIPTION
1	Vs	Power supply
2	OUT	Output
3	CMPIN	Comparator input
4	GND	Ground
5	RESET	Comparator reset pin, active low
6	CMPOUT	Comparator output
7	IN-	Negative Input
8	IN+	Positive Input.

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Revision History

Date	Revision	Notes
2019/03/15	Rev.Pre	Initial Version
2019/10/24	Rev.A.0	Released version
2020/8/24	Rev.A.1	Improve HBM ESD to 2kV

2022/5/1	Rev.A.2	Update order information and package outline dimensions
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Order Information

Model Name	Order Number	Gain	Internal Comparators	Package	Transport Media, Quantity	Package Marking
TPA2295C	TPA2295CT-VS1R-S	20V/V	1	MSOP8	Tape and Reel, 3,000	295CT
	TPA2295CF-VS1R-S	50V/V	1	MSOP8	Tape and Reel, 3,000	295CF
	TPA2295CS-VS1R-S ^{Note 1}	60V/V	1	MSOP8	Tape and Reel, 3,000	295CS
	TPA2295CH-VS1R-S	100V/V	1	MSOP8	Tape and Reel, 3,000	295CH
	TPA2295CW-VS1R-S ^{Note 1}	200V/V	1	MSOP8	Tape and Reel, 3,000	295CW

Note 1: Future product, contact 3PEAK factory for more information and sample.

Absolute Maximum Ratings ^{Note 2}

Supply Voltage	18V	Operating Temperature Range.....	-40°C to 125°C
Input Common Voltage (Continuous).....	-0.3 to 75V	Maximum Junction Temperature.....	150°C
Input Common Voltage (Survival).....	-0.3 to 80V	Storage Temperature Range.....	-65°C to 150°C
Input Current: +IN, -IN ^{Note 3}	±10mA		

Note 2: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 3: The inputs are protected by ESD protection diodes to each power supply.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	1.5	kV

Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
MSOP8	210	45	°C/W

Electrical Characteristics

The specifications are at T = 25°C, VSENSE = VIN+ – VIN– = 1mV, Vs = 12V, VIN+ = 70V, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
INPUT						
V _{OS}	Input Offset Voltage	-40°C to 125°C, TPA2295C		±50	±500	μV
V _{OS} TC ^{Note4}	Input Offset Voltage Drift	-40°C to 125°C			0.5	μV/°C
V _{CM}	Common-mode Input Range	-40°C to 125°C	-0.1		70	V
CMRR	Common Mode Rejection Ratio	-40°C to 125°C, -0.3V < V+ < 70V	110	130		dB
		DC to 50kHz		90		dB
I _b	Input Bias Current	-40°C to 125°C			210	μA
I _{OS}	Input Offset Current	-40°C to 125°C			1	μA
PSRR	Power Supply Rejection Ratio	-40°C to 125°C		110		dB
NOISE RTI ^{Note 5}						
e _n	Input Voltage Noise Density	f = 1kHz		55		nV/√Hz
OUTPUT						
G	Gain	TPA2295CT		20		V/V
		TPA2295CF		50		V/V
		TPA2295CS		60		V/V
		TPA2295CH		100		V/V
		TPA2295CW		200		V/V
GE	Gain Error	-40°C to 125°C		±0.1%	±0.5%	
GE TC	Gain Error Vs Temperature	-40°C to 125°C		3	5	ppm
C _{LOAD}	Maxim capacitive load	No oscillation		0.5		nF
V _{OH}	Output Swing from Supply Rail	-40°C to 125°C, Source 1.2mA		0.15	0.310	V
V _{OL}	Output Swing from GND	-40°C to 125°C		0.01	0.02	V
FREQUENCY RESPONSE						
BW	Bandwidth	All Gain Configuration		500		kHz
SR	Slew Rate	VSENSE = VIN+ – VIN– = 500mV		20		V/μs
Comparator						
VR	Internal voltage reference	-40°C to 125°C	586	600	630	mV
Hysteresis	Comparator Hysteresis			-8		mV
IBC	Comparator input current	-40°C to 125°C		5		nA
VINC	Input voltage range		0		Vs-1.5V	V
VOLC	Low level Open Drain output			100	150	mV
TR	Response time			1		μs
	RESET threshold			1.1		V
	Logic input impedance			2		MΩ
	Minimum RESET pulse width			0.2		μs

HV, High side Current Sense Amplifier with Internal Comparator

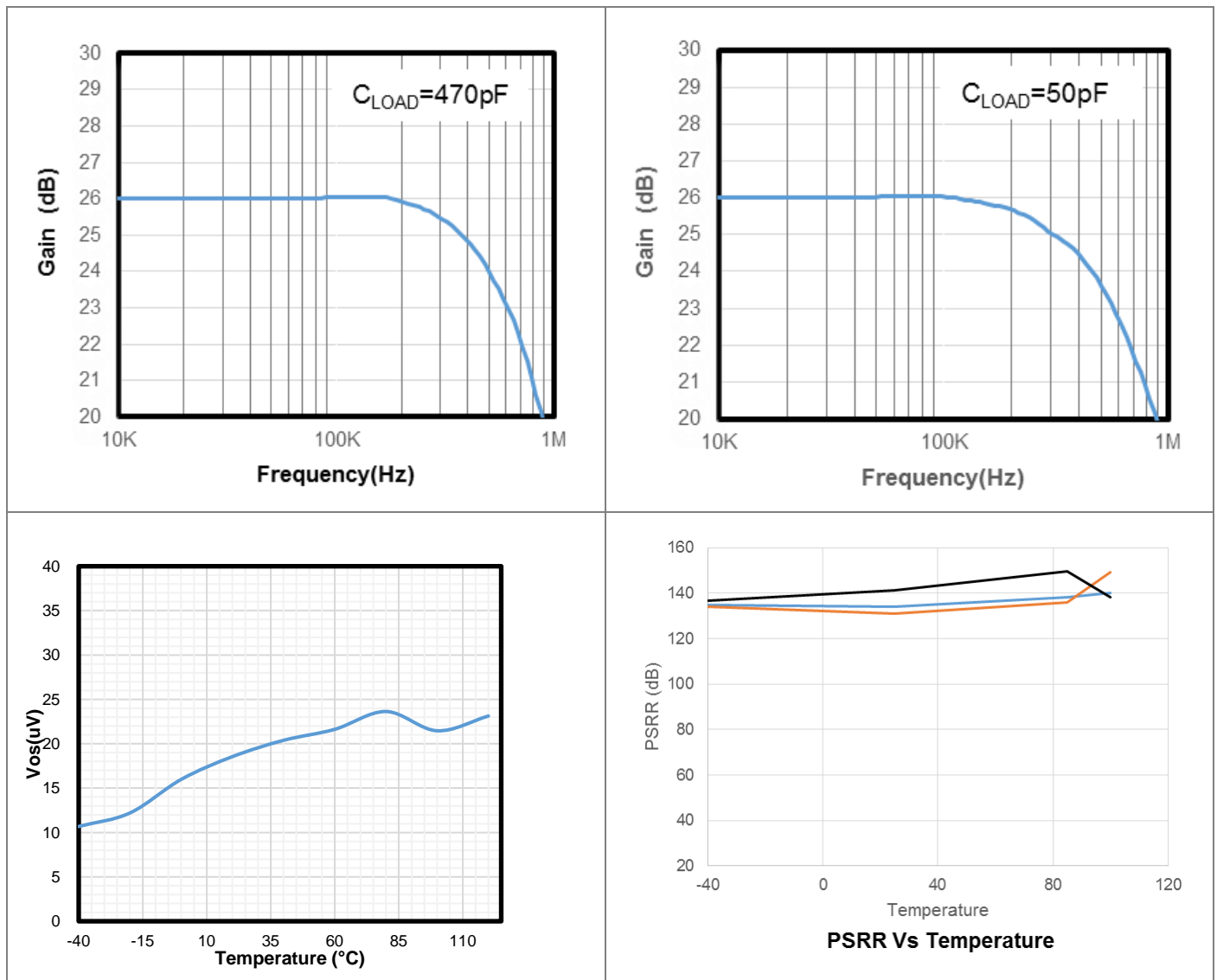
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
	RESET propagation delay			0.5		μs
POWER SUPPLY						
V _s	Supply Voltage		3.0		18	V
I _q	Quiescent Current	-40°C to 125°C		600	1000	μA
TEMPERATURE RANGE						
	Specified range		-40		125	°C

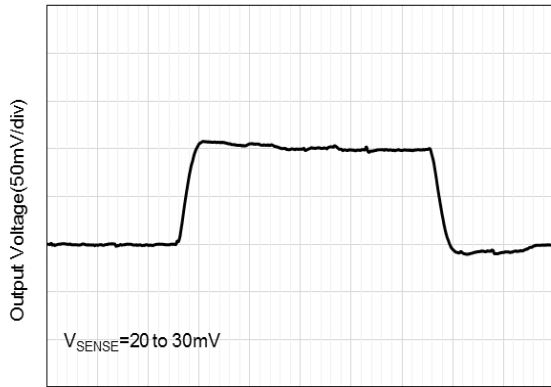
Note 4: Maxim specification is calculated with limited sample quantity in laboratory.

Note 5: RTI = referred to input.

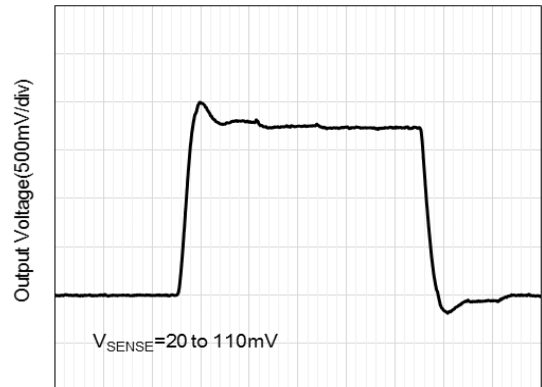
Typical Performance Characteristics

The TPA2295C is used for characteristics at TA = 25°C, V_{SENSE} = V_{IN+} – V_{IN-} = 1mV, V_s = 12V, V_{IN+} = 24V, unless otherwise noted

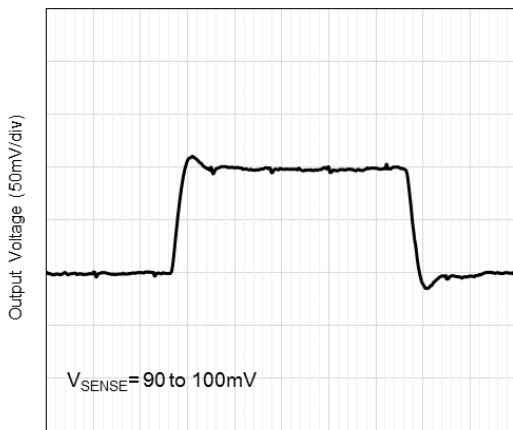




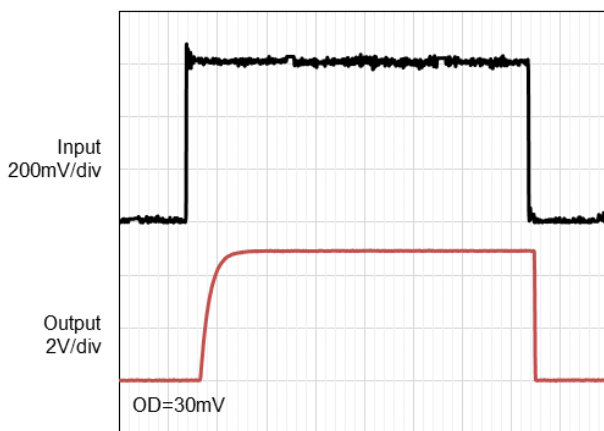
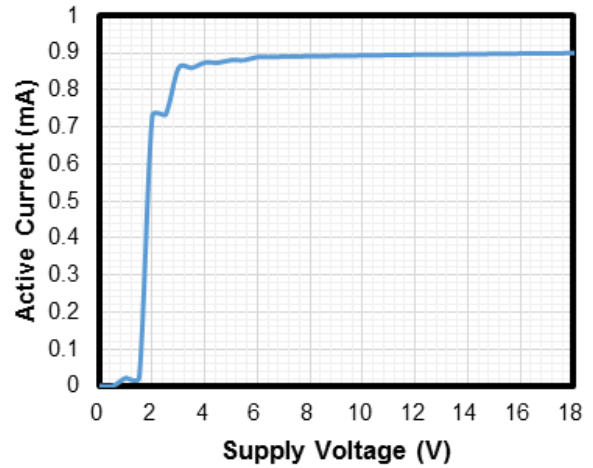
Time (2us/div)
STEP RESPONSE



Time (2us/div)
STEP RESPONSE



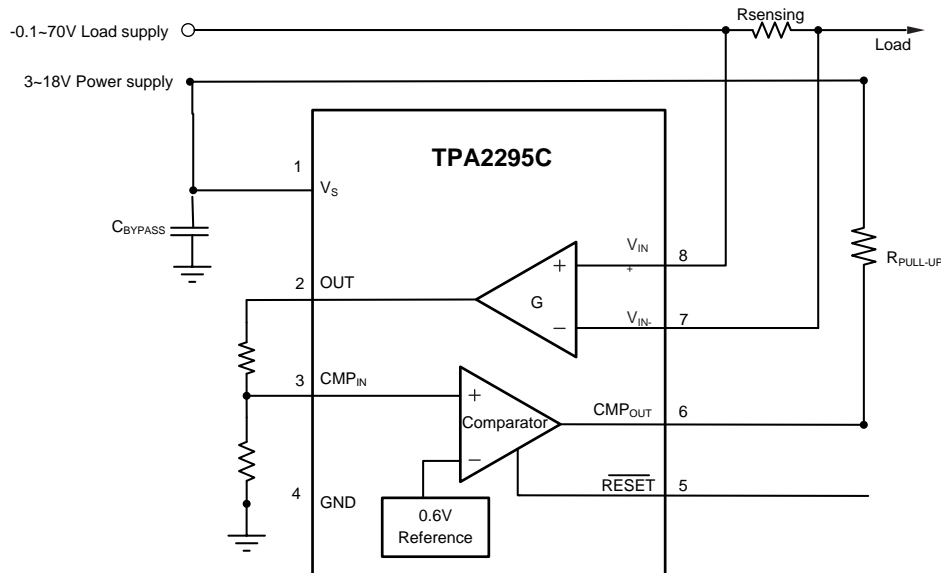
Time (2uS/div)
STEP RESPONSE



Time (2us/div)
Comparator Propagation Delay

Applications Information

Application schematic



Selecting Rsense

The zero-drift offset performance of the TPA2295C offers several benefits. Most often, the primary advantage of the low offset characteristic enables lower full-scale drops across the Rsense. For example, non-zero-drift current sense monitors typically require a full-scale range of 100 mV. The TPA2295C family gives equivalent accuracy at a full-scale range on the order of 10 mV. This accuracy reduces Rsense dissipation by an order of magnitude with many additional benefits.

Alternatively, there are applications that must measure current over a wide dynamic range that can take advantage of the low offset on the low end of the measurement. Most often, these applications can use the lower gains of the TPA2295C to accommodate larger Rsense drops on the upper end of the scale.

Recommended Component Values

Ideally, the maximum load current develops the full-scale sense voltage across the current-sense resistor. Choose the gain needed to match the maximum output voltage required for the application:

$$V_{out} = V_{sense} \times A_v$$

Where V_{sense} is the full-scale sense voltage, and A_v is the gain of the TPA2295C.

In applications of monitoring a high current, ensure that Rsense is able to dissipate its own I^2R power loss. If the resistor's power dissipation exceeds the nominal value, its value may drift or it may fail altogether. The TPA2295C senses a wide variety of currents with different sense-resistor values.

Internal Comparator

The TPA2295C family has an internal open-drain comparator, which has typically 2mV voltage offset and a 1 μ s response time. The RESET pin reset the comparator output, and the output latches.

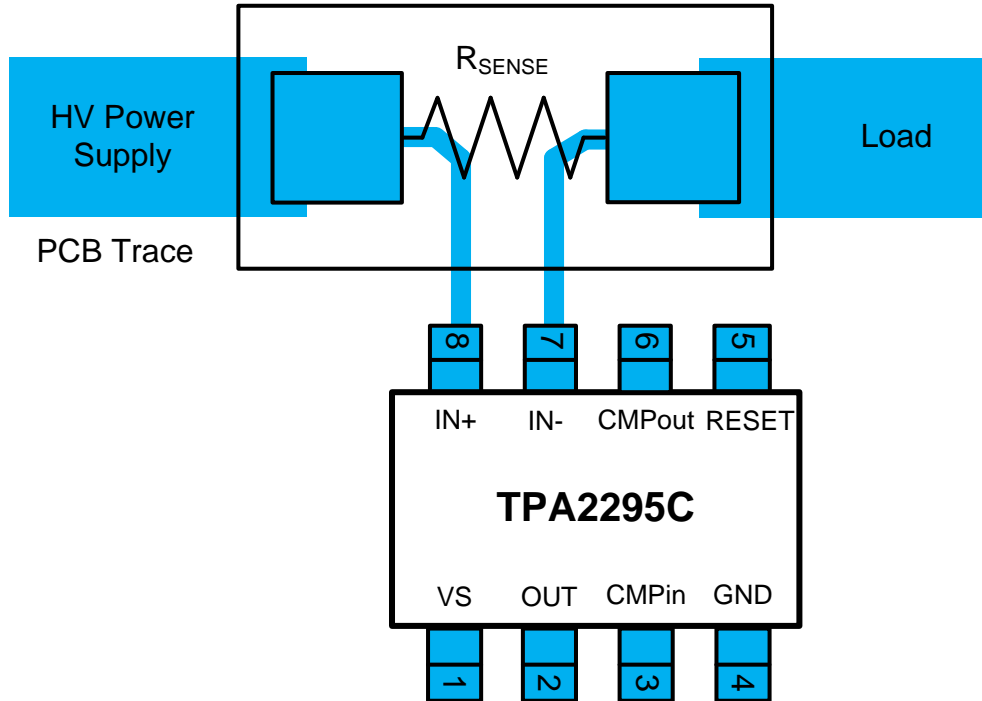
Power Supply Recommendation

The input circuitry of the TPA2295C can accurately measure beyond its power-supply voltage, V_s . For example, the V_s power supply can be 5V, whereas the load power-supply voltage can be as high as 70V. However, the output voltage range of the OUT pin is limited by the voltages on the power-supply pin.

HV, High side Current Sense Amplifier with Internal Comparator

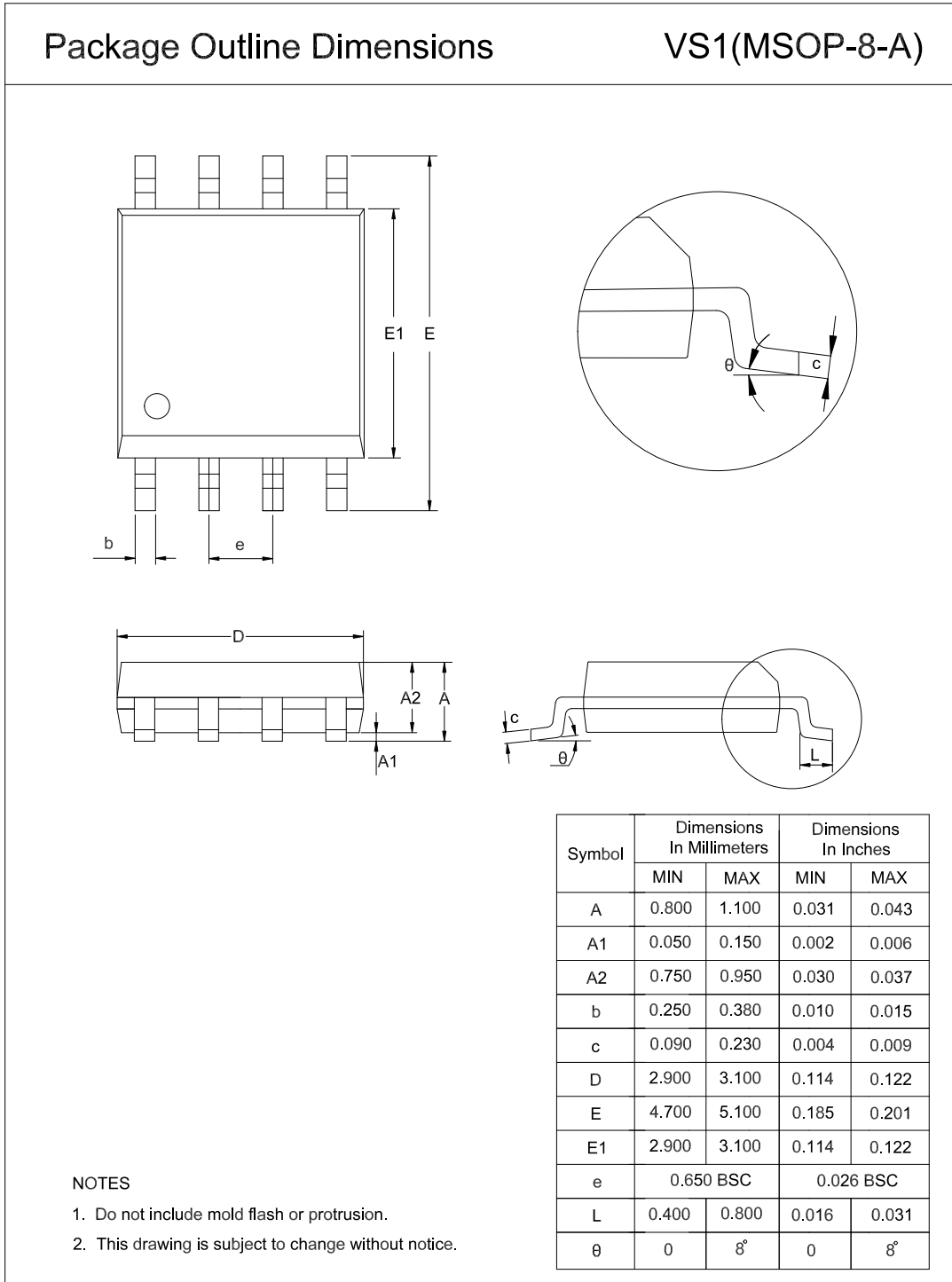
Layout: Kelvin connection

Below figure shows a typical routing of Kelvin-sensed traces to the inputs of the TPA2295C. The Kelvin-sense traces should be as close as possible to the current-sense resistor's solder contact pads. Any additional high-current carrying impedance can cause significant measurement errors because the current resistor has a very low value.



Package Outline Dimensions

MSOP-8



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