

Features

- SMALL VOLTAGE OFFSET:
 - ◆ **TPA1295: $\pm 100\mu\text{V}$ (MAX)**
- WIDE COMMON MODE VOLTAGE: **-0.3V to +70V**
- WIDE CMRR THROUGH COMMON VOLTAGE: 130dB
- SUPPLY VOLTAGE: **3V to +18V**
- ACCURACY and ZERO-DRIFT PERFORMANCE
 - ◆ **$\pm 0.5\%$ Gain Error (Max, $-40^{\circ}\text{C} \sim 125^{\circ}\text{C}$)**
 - ◆ **$0.5\mu\text{V}/^{\circ}\text{C}$ Offset Drift (Max, $-40^{\circ}\text{C} \sim 125^{\circ}\text{C}$)**
 - ◆ **$5\text{ppm}/^{\circ}\text{C}$ Gain Drift (Max, $-40^{\circ}\text{C} \sim 125^{\circ}\text{C}$)**
- THREE GAIN OPTIONS for VOLTAGE OUTPUT
 - ◆ TPA1295T: 20V/V
 - ◆ TPA1295F: 50V/V
 - ◆ TPA1295H: 100V/V

Applications

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

Description

The TPA1295 family is of high voltage, Bi-directional current sense amplifier with voltage output. The TPA1295 can sense drops across shunts at common-mode voltages from -0.3V to 70V . The TPA1295 are available with three output voltage scales: 20V/V, 50V/V, 100V/V, with up to 500KHz bandwidth.

The TPA1295 operates from single 3V to 18V supply, offers breakthrough performance throughout the -40°C to $+125^{\circ}\text{C}$ temperature range. It features a zero-drift core, which leads to a typical offset drift of $0.4\mu\text{V}/^{\circ}\text{C}$ throughout the operating temperature range and the common-mode voltage range.

The TPA1295 family is offered in 8-pin SOP package.

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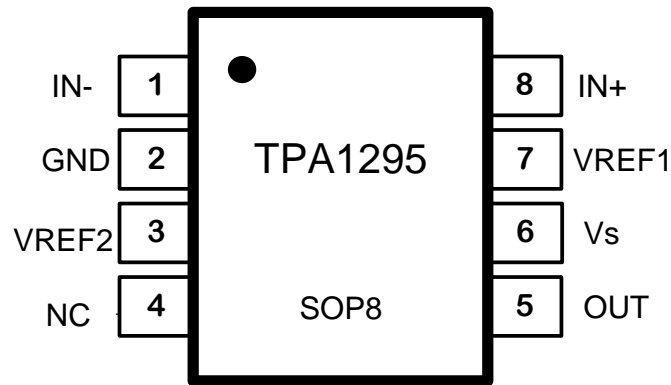
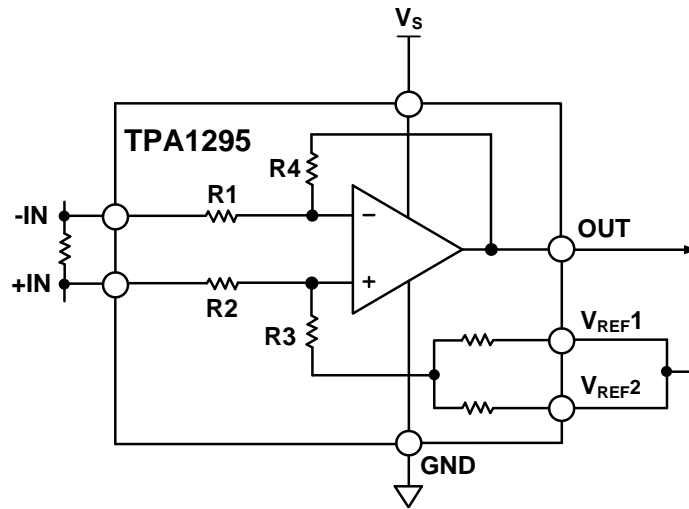
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Revision History

Date	Revision	Notes
2019/10/15	Rev.Pre	Initial Version
2020/12/11	Rev. A.0	Released Version
2022/5/1	Rev. A.1	Update order information and package outline dimensions

Functional Block Diagram & Pin Configuration



PIN No.	PIN NAME	TPA1295 DESCRIPTION
1	IN-	Negative Input
2	GND	Ground
3	VREF2	Reference Input 2
4	NC	Not connected
5	OUT	Output
6	Vs	Power supply
7	VREF1	Reference Input 1
8	IN+	Positive Input

Order Information

Model Name	Order Number	Gain	Package	Transport Media, Quantity	Package Marking
TPA1295	TPA1295T-SO1R-S ^{Note 1}	20V/V	8-Pin SOP	Tape and Reel, 4,000	295T
	TPA1295F-SO1R-S	50V/V	8-Pin SOP	Tape and Reel, 4,000	295F
	TPA1295H-SO1R-S ^{Note 1}	100V/V	8-Pin SOP	Tape and Reel, 4,000	295H

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 Current: +IN, -IN ^{Note 3}	±10mA	Storage Temperature Range.....	-65°C to 150°C

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 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
8-Pin SOP	158	43	°C/W

Electrical Characteristics

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

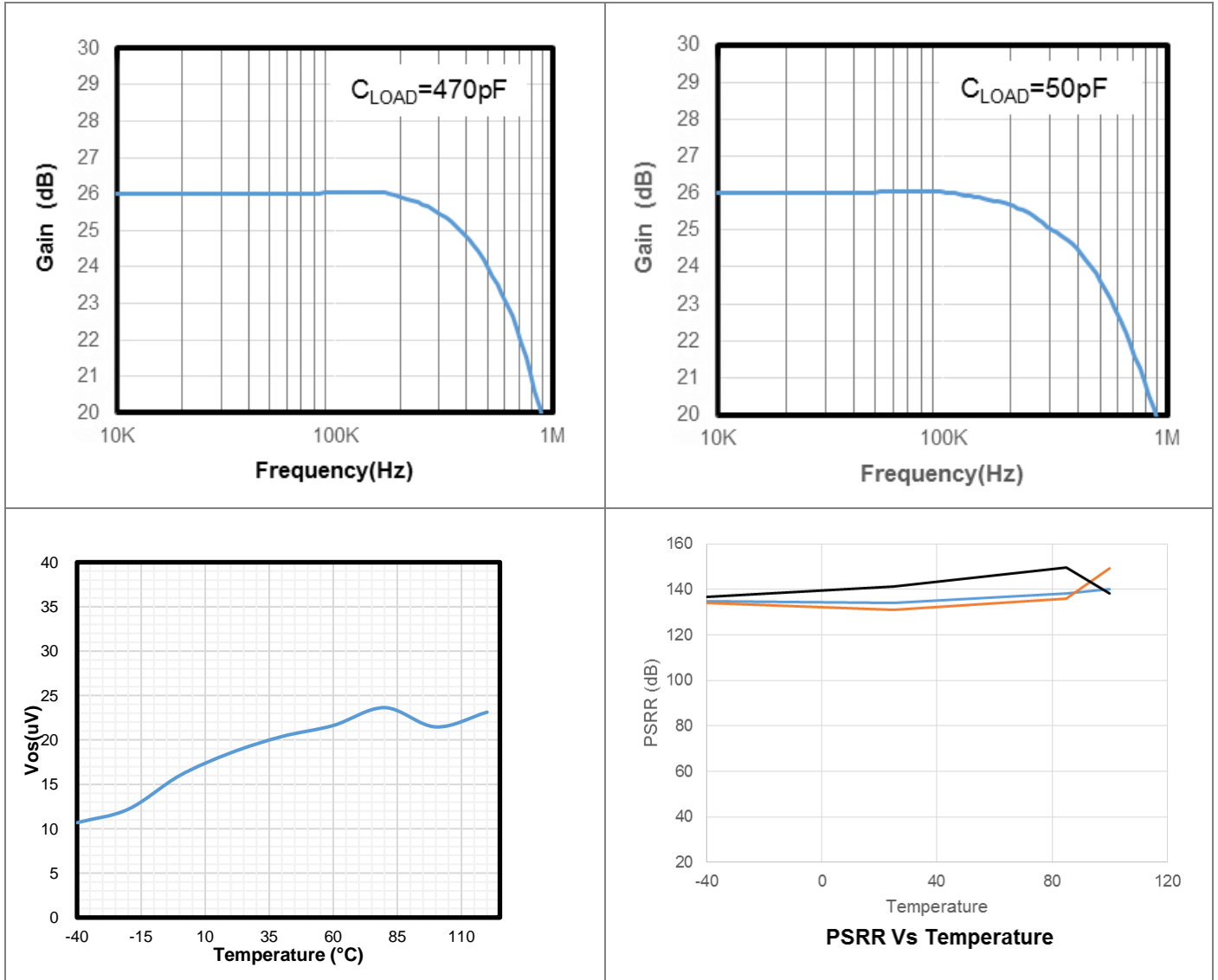
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
INPUT						
V _{OS}	Input Offset Voltage			±10	±100	μV
V _{OS} TC ^{Note 4}	Input Offset Voltage Drift	-40°C to 125°C			0.5	μV/°C
V _{CM}	Common-mode Input Range	-40°C to 125°C	-0.1		70	V
CMRR	Common Mode Rejection Ratio	-40°C to 125°C, -0.3V < V+ < 70V	110	130		dB
		DC to 50kHz		90		dB
I _B	Input Bias Current	-40°C to 125°C, V _{CM} =12V		12		μA
		-40°C to 125°C, V _{CM} =70V			210	μA
I _{OS}	Input Offset Current	-40°C to 125°C			1	μA
PSRR	Power Supply Rejection Ratio	3.0V < V+ < 5.5V		110		dB
NOISE RTI ^{Note 5}						
e _n	Input Voltage Noise Density	f = 1kHz		55		nV/√Hz
OUTPUT						
G	Gain	TPA1295T		20		V/V
		TPA1295F		50		V/V
		TPA1295H		100		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 500uA		0.10	0.31	V
V _{OL}	Output Swing from Supply Rail	-40°C to 125°C, Sink 500uA		0.01	0.02	V
FREQUENCY RESPONSE						
BW	Bandwidth	All Gain Configuration		500		kHz
SR	Slew Rate	VSENSE = VIN+ – VIN– = 500mV		20		V/μs
POWER SUPPLY						
V+	Supply Voltage		3		18	V
I _Q	Quiescent Current			600	1000	μA
TEMPERATURE RANGE						
	Specified range		-40		125	°C

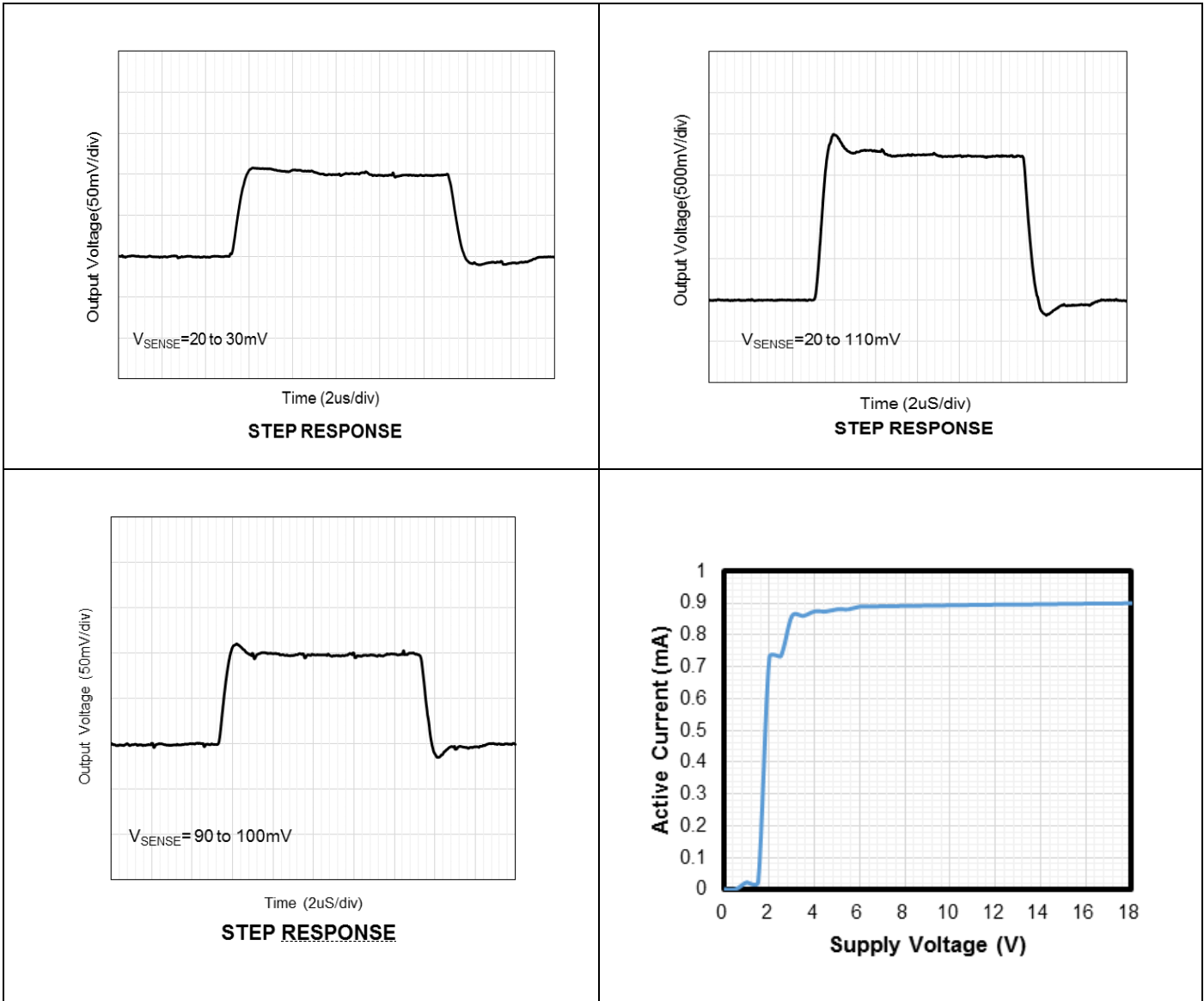
Note 4: Maxim specification is calculated with limited sample quantity in laboratory.

Note 5: RTI = referred to input.

Typical Performance Characteristics

The TPA1295T is used for characteristics at TA = 25°C, VSENSE = VIN+ – VIN– = 1mV, Vs = 12V, VIN+ =24V, unless otherwise noted



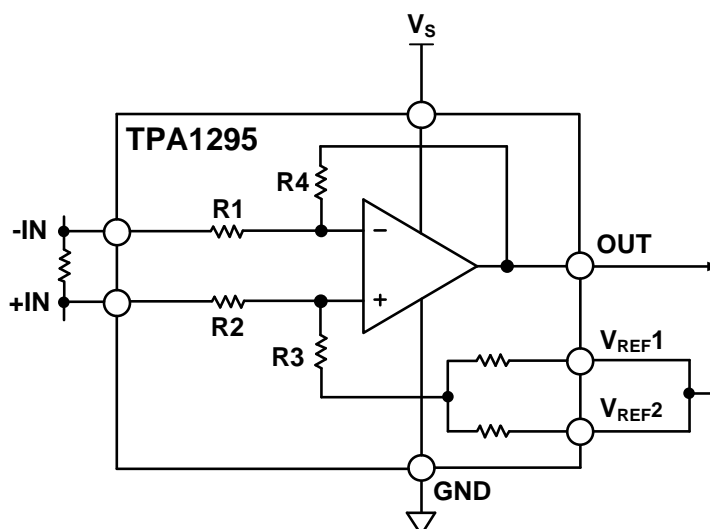


Operation Overview

The TPA1295 family is a high voltage power supply, zero drift, difference amplifier that uses a unique architecture to accurately amplify small differential current shunt voltages, especially for fast changing common-mode voltages. In typical applications, the TPA1295 family measures current by amplifying the voltage across a shunt resistor connected to its inputs by 3 gains of 20 V/V, 50V/V, 100V/V. The design provides excellent common-mode rejection, even with PWM common-mode inputs that can change at very fast rates. The TPA1295 features an input offset less than 100uV, and offset drift of less than 400 nV/° C.

Applications Information

TPA1295 Application block diagram



Reference pin connection for Bi-directional and Unidirectional Current Measurements

The output voltage is set by applying a voltage to the reference voltage inputs, REF1 and REF2. The output of the TPA1295 can be adjusted for unidirectional or bidirectional operation. In unidirectional operation, the output can be set at the negative rail (near ground) or at the positive rail (near Vs) when the differential input is 0 V, both reference inputs are connected to ground or positive supply. In bi-directional operation, the output is set within the output range. Adjusting the output is accomplished by applying voltage(s) to the referenced inputs, VREF1 and VREF2. The output when there is no differential input can be calculated by below equation.

$$V_{out} = (V_{REF1} + V_{REF2}) * 5/12$$

Selecting Rsense

The zero-drift offset performance of the TPA1295 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 TPA1295 family gives equivalent accuracy at a full-scale range on the order of 5~10 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 TPA1295 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:

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

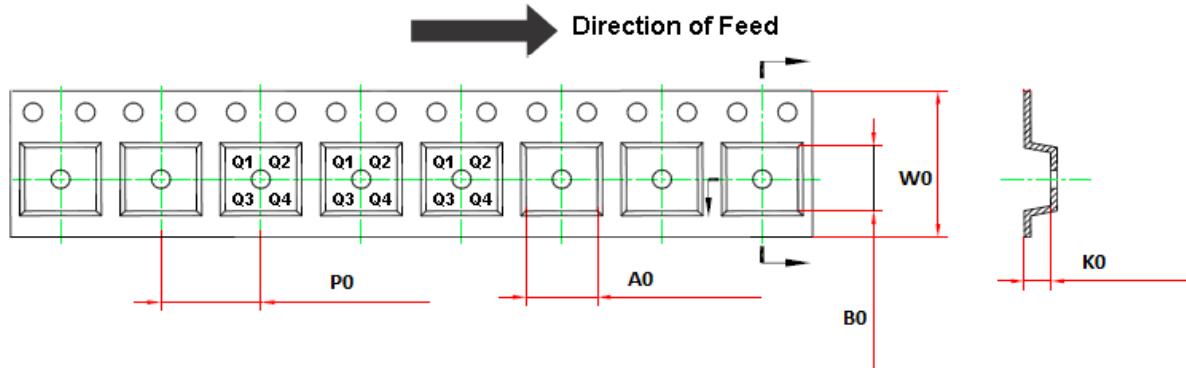
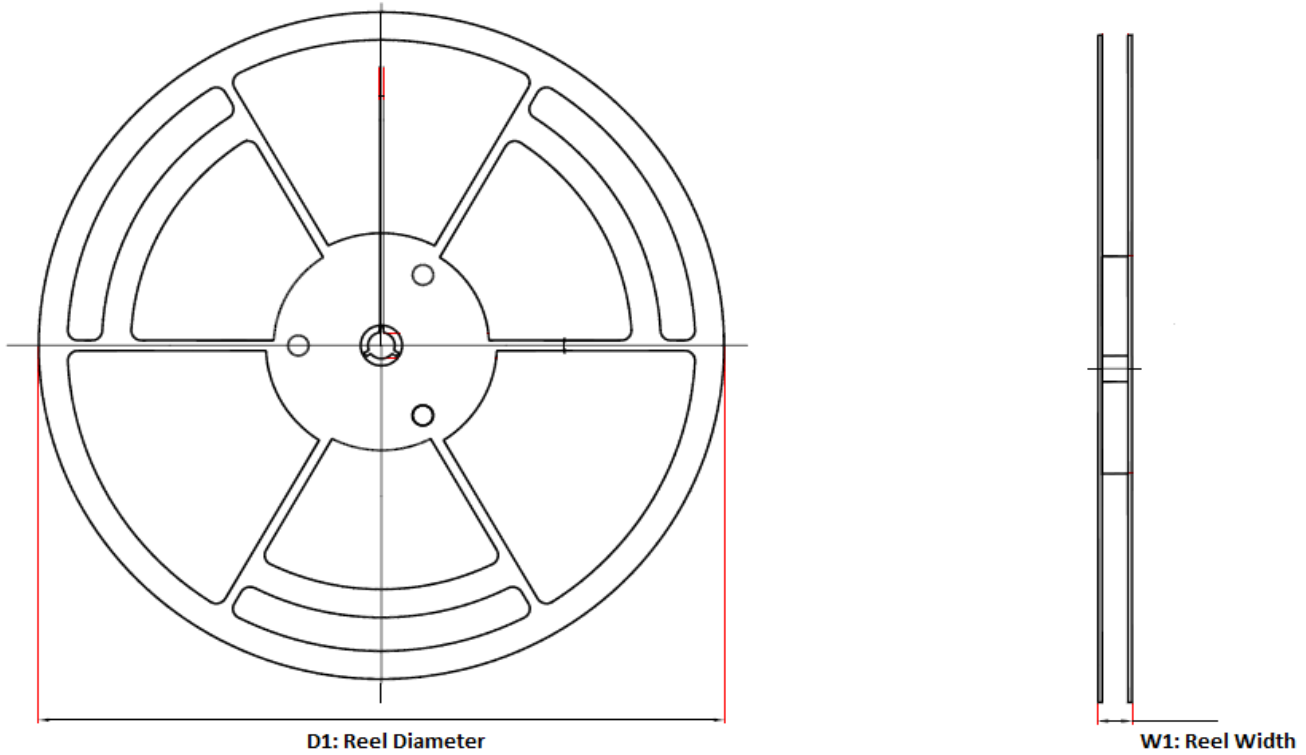
Where Vsense is the full-scale sense voltage, and Av is the gain of the TP1295.

In applications of monitoring a high current, ensure that Rsense is able to dissipate its own I²R power loss. If the resistor's power dissipation exceeds the nominal value, its value may drift, or it may fail altogether. The TP1295 senses a wide variety of currents with different sense-resistor values.

Power Supply Recommendation

The input circuitry of the TP1295 can accurately measure beyond its power-supply voltage, V+. For example, the V+ 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.

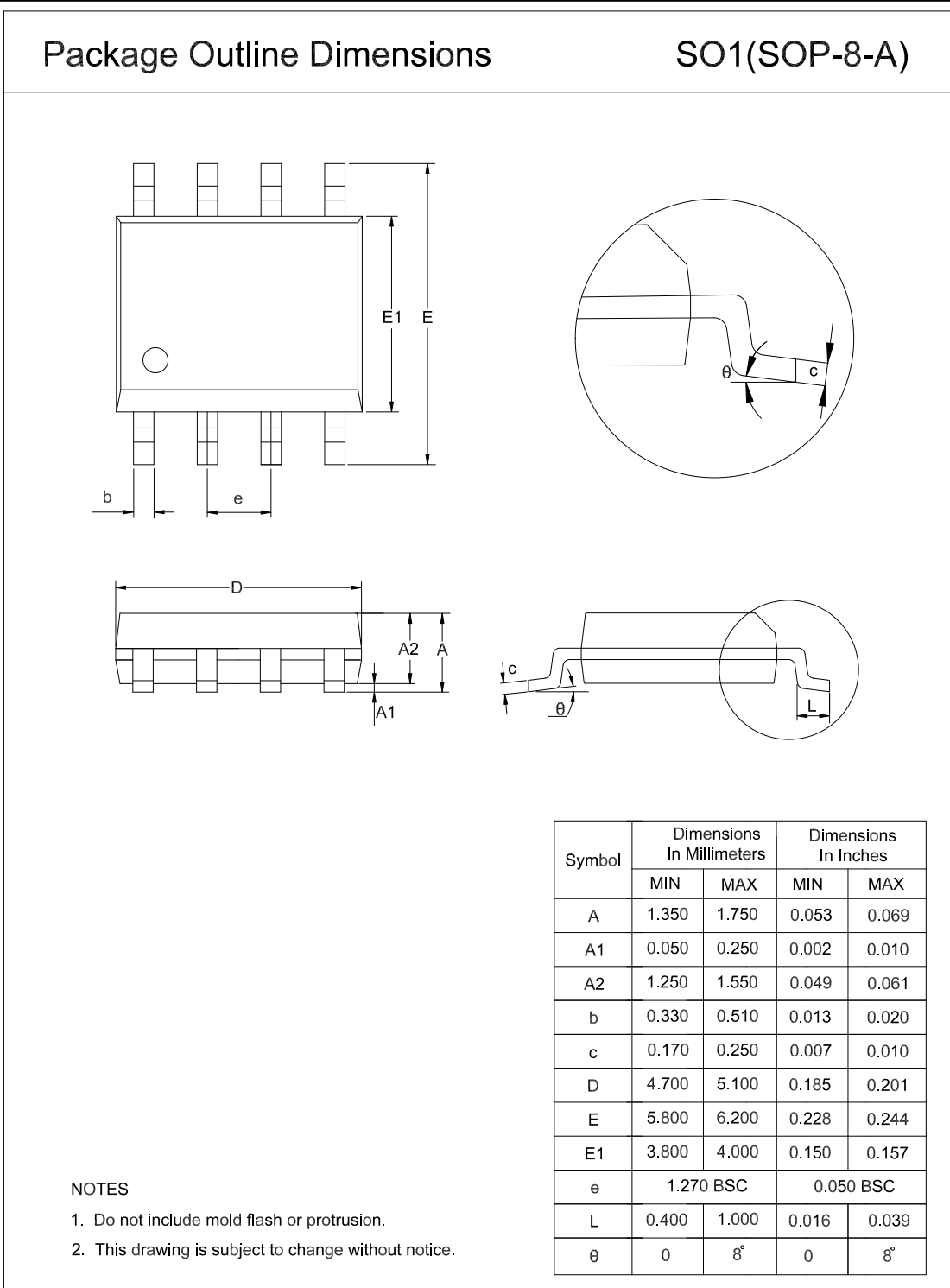
Tape and Reel Information



Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA1295T-SO1R-S	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TPA1295F-SO1R-S	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TPA1295H-SO1R-S	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1

Package Outline Dimensions

SOP8



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