High Precision, High Voltage, 2ch Current Sense Amplifier

Features

- VOLTAGE OFFSET: **±100uV (MAX)**
- WIDE COMMON MODE VOLTAGE: **3.0V to +76V**
- SUPPLY VOLTAGE: **3.0V to +5.5V**
- ACCURACY and ZERO-DRIFT PERFORMANCE
  - **±0.5% Gain Error (Max over temperature)**
  - **0.4μV/°C Offset Drift (Max, -40°C ~125°C)**
  - **10ppm/°C Gain Drift (Max)**
- THREE GAIN OPTIONS for VOLTAGE OUTPUT
  - TPA1285T: 20V/V
  - TPA1285F: 50V/V
  - TPA1285H: 100V/V
- Rail-to-Rail Output
- Industrial –40°C to 125°C Operation Range
- ESD Rating: Robust 2.5kV – HBM, 1.5kV – CDM

Applications

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

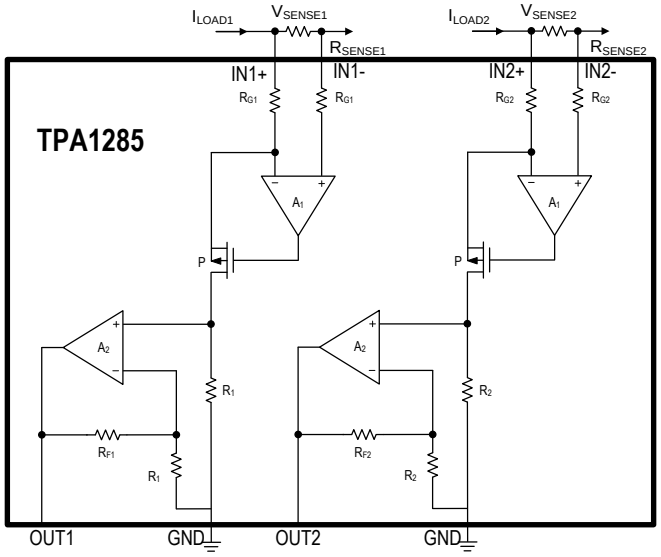
Description

The TPA1285, high precision, high common voltage, 2 channel high-side current sense amplifier has very high precision accuracy specifications of Vos less than 100μV (max) and gain error less than 0.5% (max). Three fixed gains are available: 20V/V, 50V/V, and 100V/V. The low offset of the zero-drift architecture enables current sensing with maximum drops across the shunt as low as 5mV full-scale.

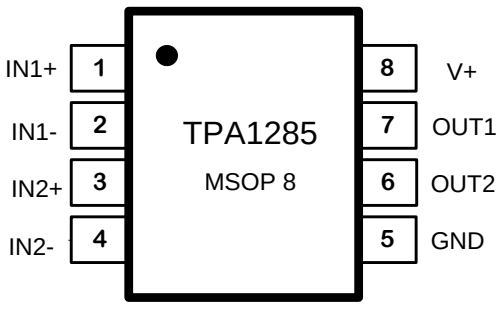
The TPA1285 features an input common-mode voltage range from 3.0V to 76V with 80kHz of small-signal bandwidth, which makes it ideal for small signal conditioning interfacing with a SAR ADC.

The TPA1285 offers breakthrough performance throughout the −40°C to +125°C temperature range. It features a zero-drift core, which leads to a maxim offset drift of 0.4μV/°C throughout the operating temperature range and the common-mode voltage range. The TPA1285 is offered 8-pin MSOP package

Functional Block Diagram



Pin Configuration



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Revision History

Date	Revision	Notes
2019/10/15	Rev.Pre	Initial Version
2020/12/11	Rev.A.0	Released Version
2021/9/22	Rev.A.1	Update format
2022/5/1	Rev.A.2	Update order information and package outline dimensions

2022/8/14	Rev.A.3	Modify absolute input common voltage and current information

Order Information

Model Name	Order Number	Gain	Package	Transport Media, Quantity	Package Marking
TPA1285	TPA1285T-VR-S	20V/V	8-Pin MSOP	Tape and Reel, 3,000	1285T
	TPA1285F-VR-S Note 1	50V/V	8-Pin MSOP	Tape and Reel, 3,000	1285F
	TPA1285H-VR-S Note 1	100V/V	8-Pin MSOP	Tape and Reel, 3,000	1285H

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

Absolute Maximum Ratings Note 2

Supply Voltage ……....6V
Input Common Voltage (Continuous)..... –0.5 to 80V
Input Common Voltage (Survival)……. –0.5 to 100V
Input Current: +IN, –IN Note 3.....±10mA
Current at Supply Pins……..... ±60mA
Operating Temperature Range.....–40°C to 125°C
Maximum Junction Temperature..... 150°C
Storage Temperature Range..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°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 each power supply. If the input extends more than 500mV beyond the power supply, the input current should be limited to less than 10mA.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	2.5	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 MSOP	210	45	°C/W

Electrical Characteristics

The specifications are at TA = 25°C, VSENSE = VIN+ – VIN– = 1mV, V+ = 3.3 V, VIN+ = 76V, unless otherwise noted

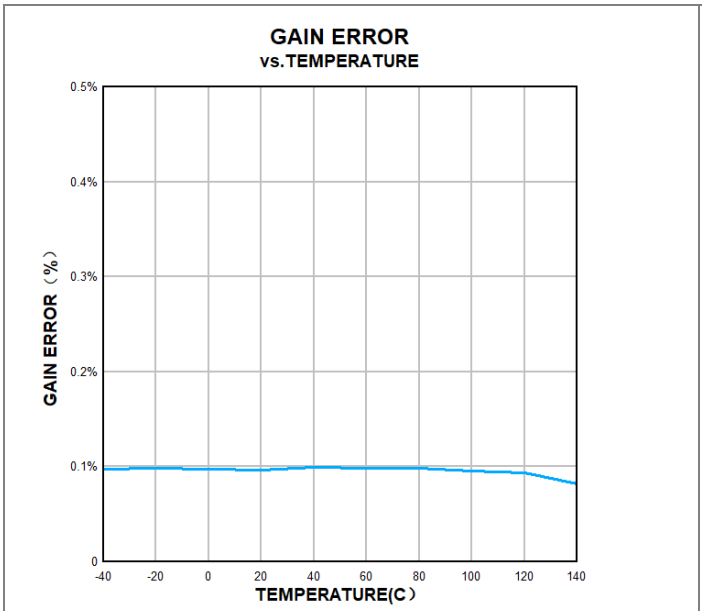
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
INPUT						
V_{OS}	Input Offset Voltage	-40°C to 125°C		±10	±100	uV
V_{OS} TC Note 4	Input Offset Voltage Drift	-40°C to 125°C			0.4	μV/°C
V_{CM}	Common-mode Input Range	-40°C to 125°C	3.0		76	V
CMRR	Common Mode Rejection Ratio	-40°C to 125°C, 3.0V < V+ < 76V	110	125		dB
I_B	Input Bias Current	-40°C to 125°C			65	uA
I_{OS}	Input Offset Current	-40°C to 125°C			1.1	uA
PSRR	Power Supply Rejection Ratio	3.0V < V+ < 5.5V		100		dB
NOISE RTI Note 5						
e_n	Input Voltage Noise Density	f = 1kHz		40		nV/√Hz
OUTPUT						
G	Gain	TPA1285T		20		V/V
		TPA1285F		50		V/V
		TPA1285H		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	10	ppm
C_{LOAD}	Maxim capacitive load	No oscillation		1		nF
V_{OH}	Output Swing from Supply Rail	-40°C to 125°C, Source 500uA		0.008	0.030	V
V_{OL}	Output Swing from Supply Rail	-40°C to 125°C, Sink 500uA		0.002	0.015	V
FREQUENCY RESPONSE						
BW	Bandwidth	All Gain Configuration		60		kHz
SR	Slew Rate			0.6		V/μs
POWER SUPPLY						
V+	Supply Voltage		3.0		5.5	V
I_Q	Quiescent Current			750	1000	μA
TEMPERATURE RANGE						
Specified range			-40		125	°C
Operating range			-55		150	°C

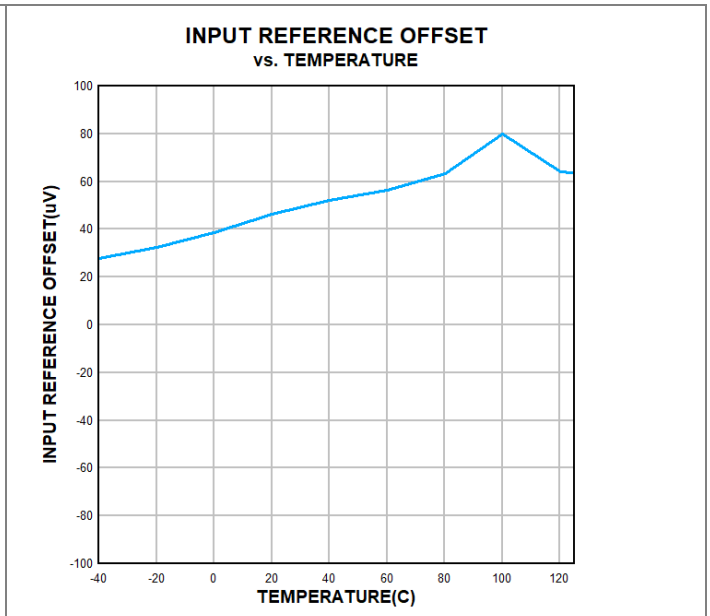
Note 4: Maxim specification is calculated with limited sample quantity in laboratory.

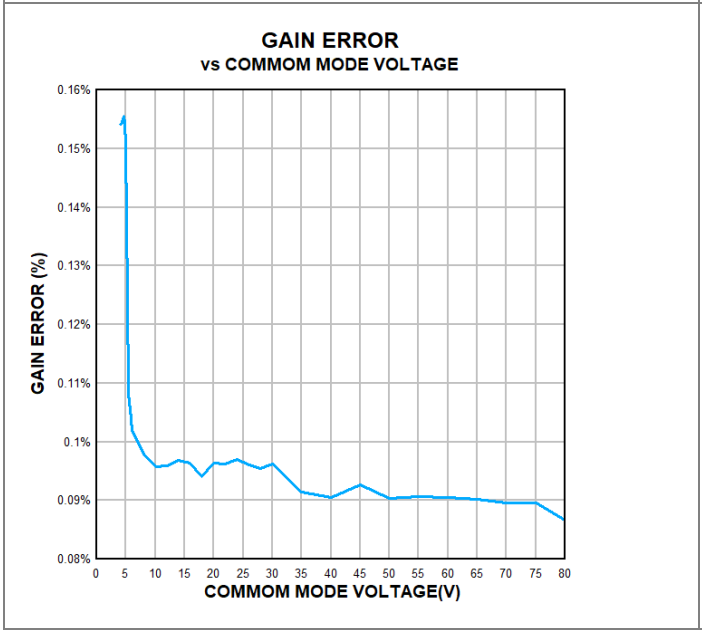
Note 5: RTI = referred to input.

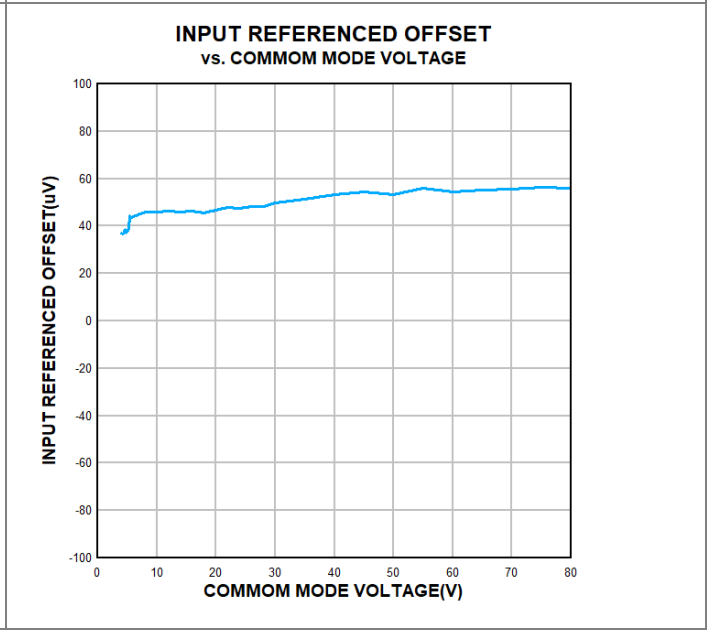
Typical Performance Characteristics

The TPA1285 is used for characteristics at TA = 25°C, VSENSE = VIN+ – VIN– = 1mV, V+ = 3.3V, VIN+ =76V, unless otherwise noted

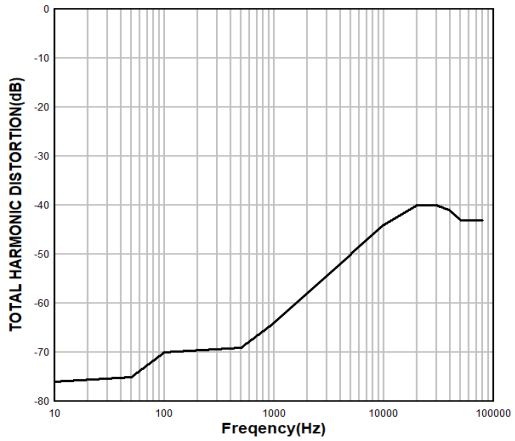




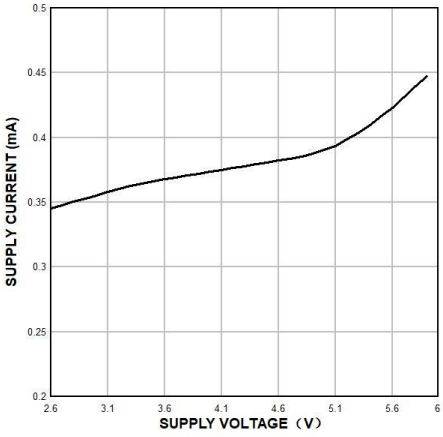




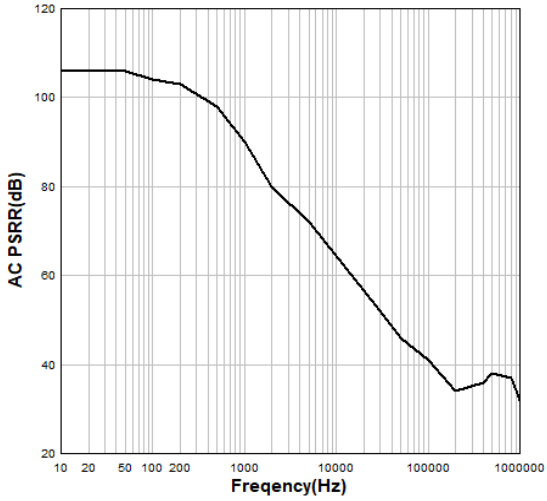
TOTAL HARMONIC DISTORTION
vs. FREQENCY



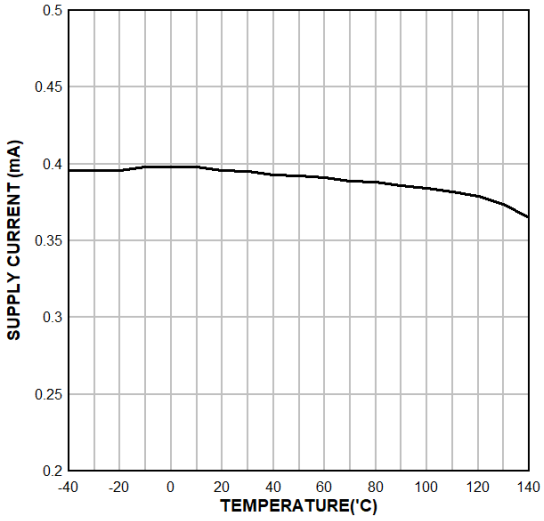
SUPPLY CURRENT
vs. SUPPLY VOLTAGE



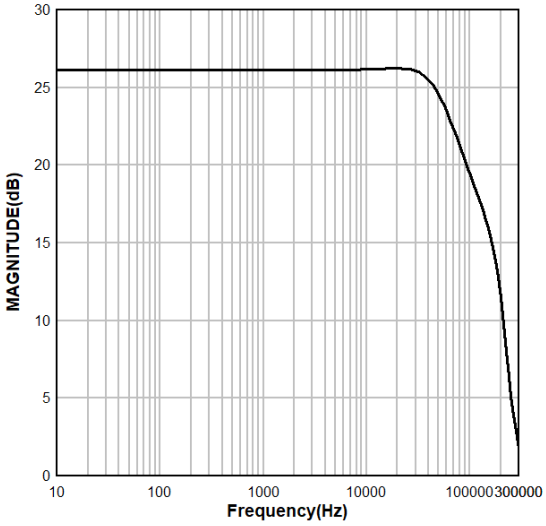
AC PSRR
vs. FREQENCY



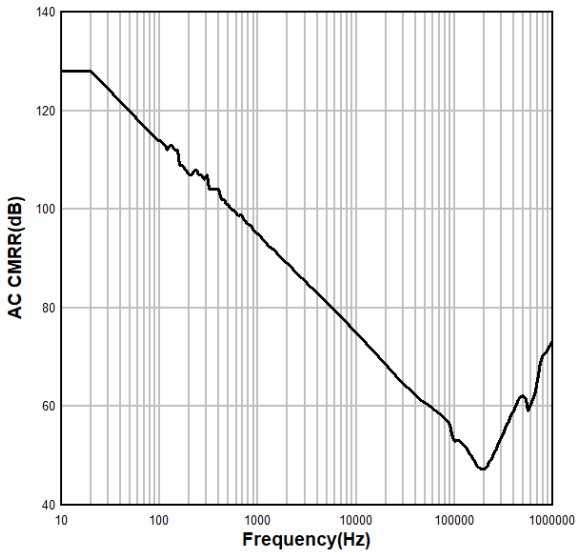
SUPPLY CURRENT
vs. TEMPERATURE

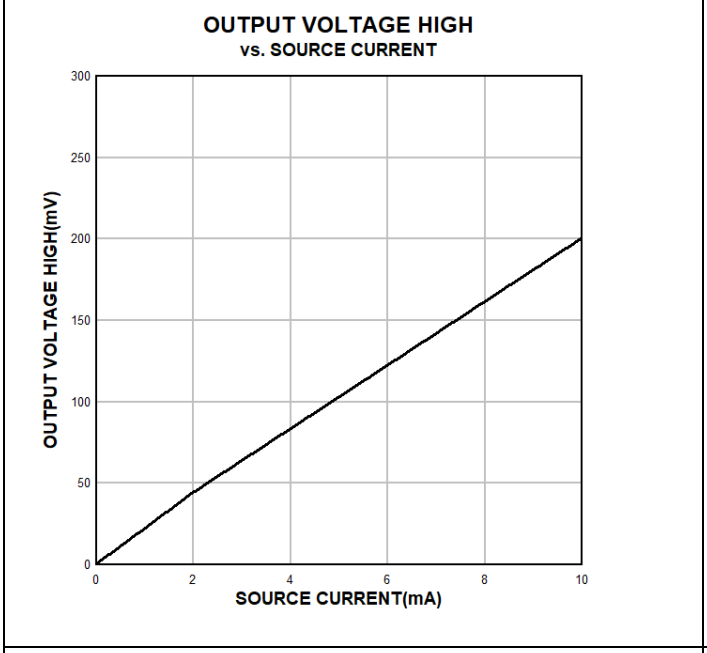


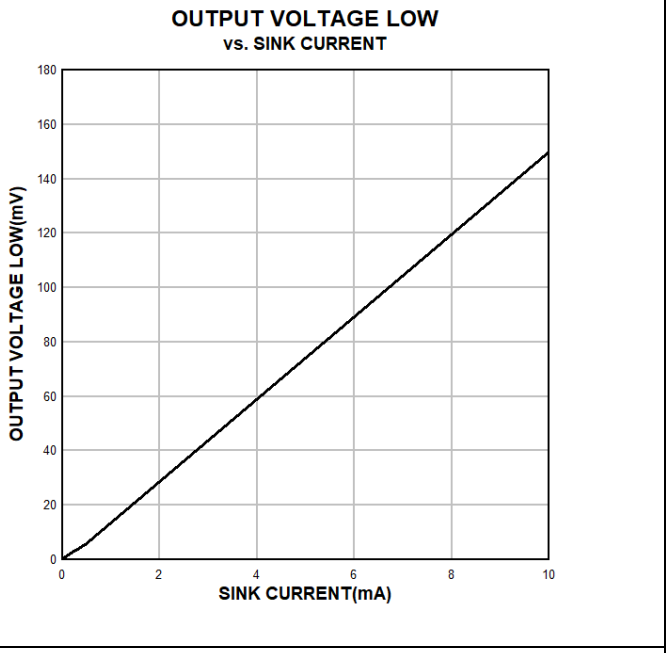
GAIN
vs. FREQENCY



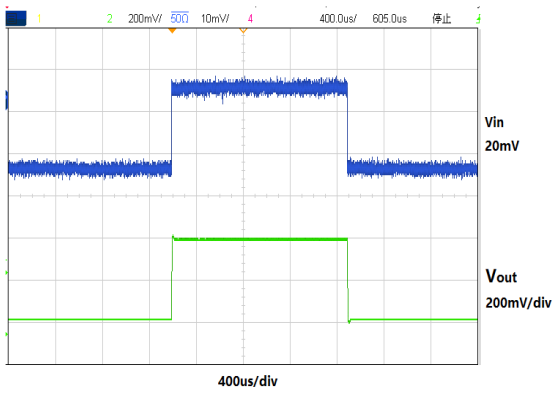
AC CMRR
vs. FREQENCY



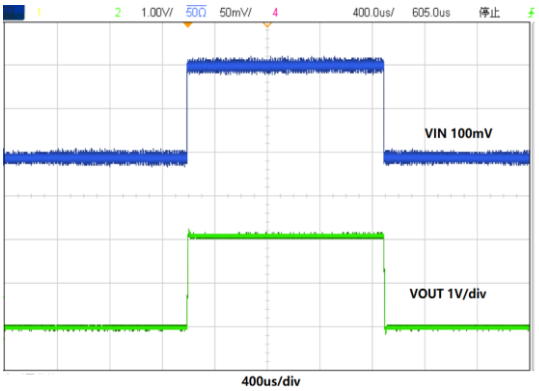




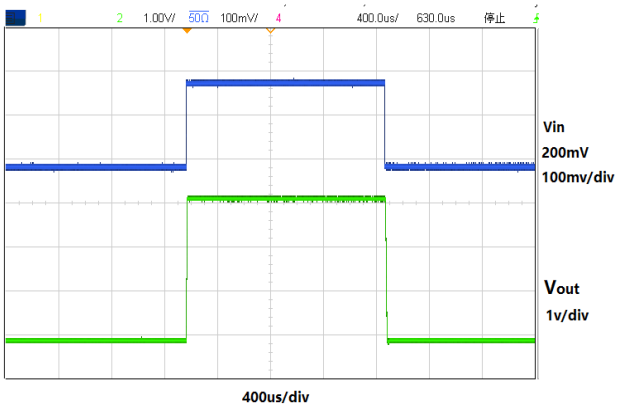
SMALL SIGNAL RESPONSE



LARGE-SIGNAL RESPONSE



SATURATIONRECOVERY RESPONSE



Pin Functions

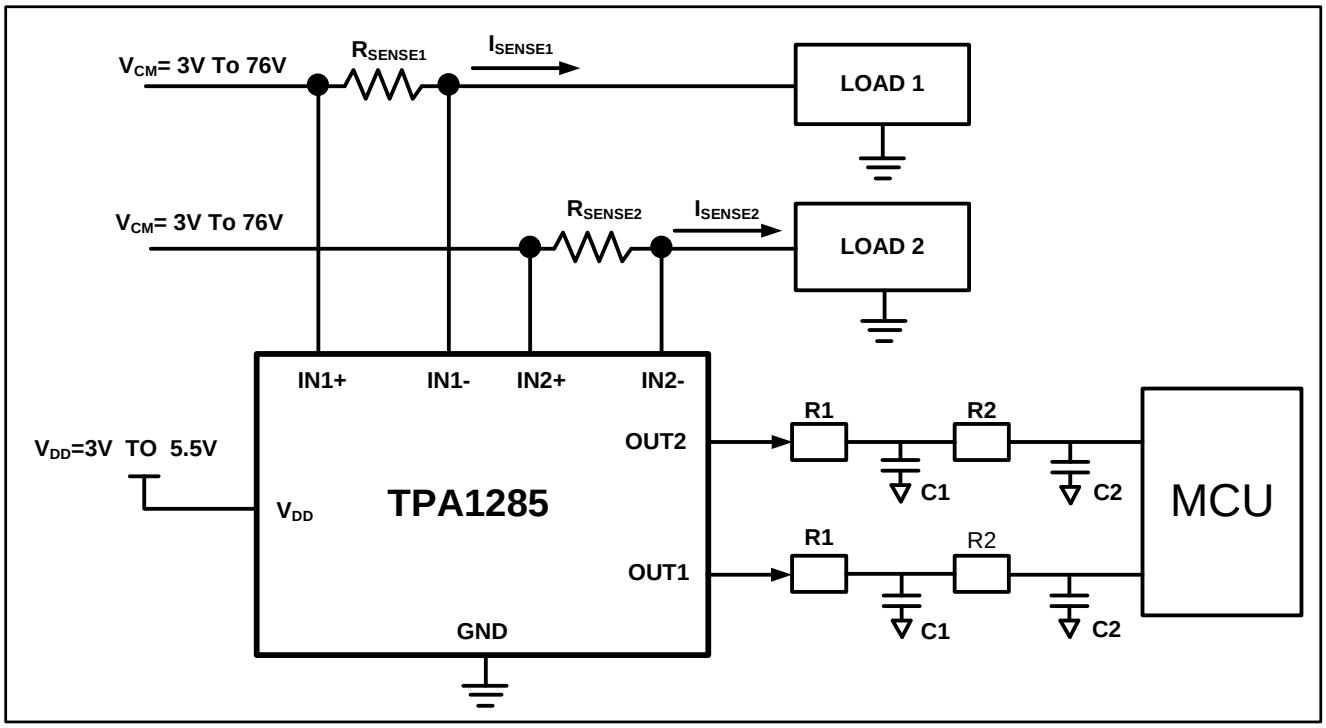
IN1-: Inverting Input of the Amplifier1.
IN1+: Non-Inverting Input of Amplifier1.
IN2-: Inverting Input of the Amplifier2.
IN2+: Non-Inverting Input of Amplifier2.
OUT1: Amplifier1 Output.
OUT2: Amplifier2 Output.
V+: Positive Power Supply. Typically, the voltage is from 3.0V to 5.5V. A bypass capacitor of 0.1μF as close to the part as possible should be used between power supply pin and ground pin.
GND: Negative Power Supply.

Operation Overview

The TPA1285 family is a high voltage power supply, zero drift, 2 channel difference amplifier that uses unique architecture to accurately amplify small differential current shunt voltages, especially for fast changing common-mode voltages. In typical applications, the TPA1285 family measures current by amplifying the voltage across a shunt resistor connected to its inputs by 3 gains of 20 V/V, 50V/V and 100V/V.

Applications Information

Application schematic



Selecting Rsense

The zero-drift offset performance of the TPA1285 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 TPA1285 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 TPA1285 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:

$$Vout = Vsense \times Av$$

Where Vsense is the full-scale sense voltage, and Av is the gain of the TPA1285.

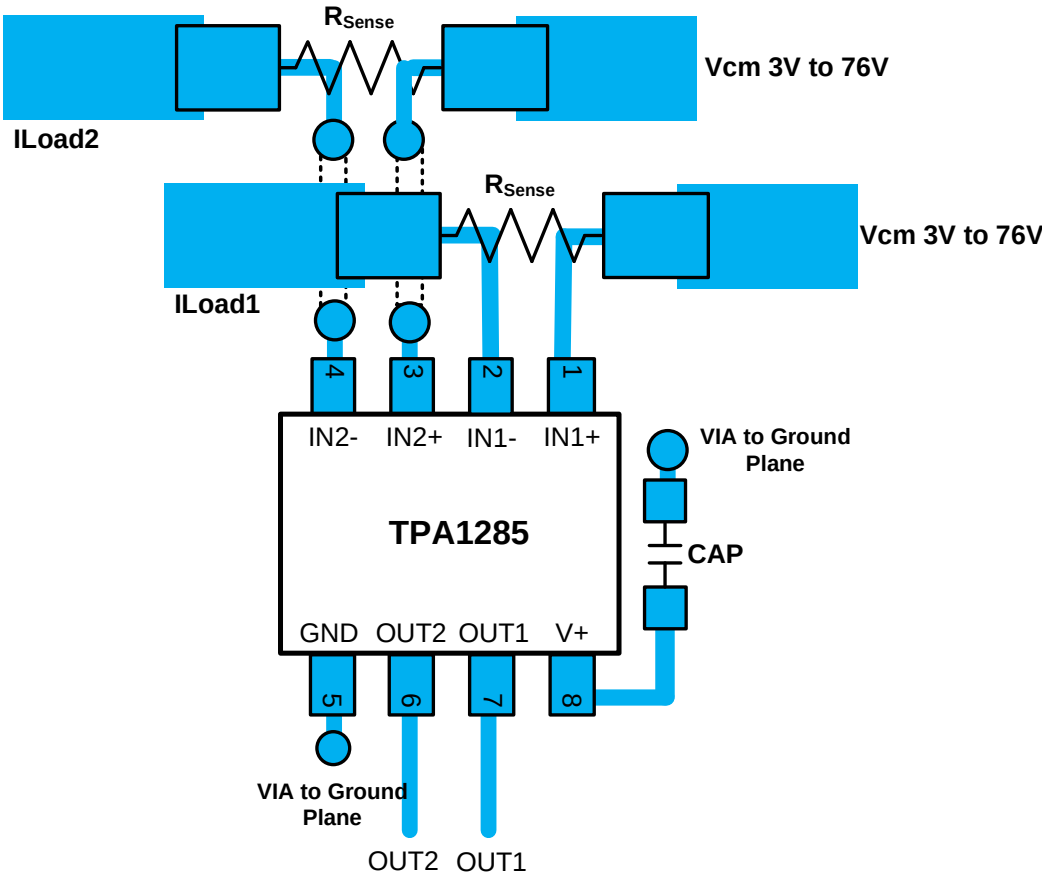
In applications of monitoring a high current, ensure that Rsense is able to dissipate its own I^2R power loss. If the resistor's power dissipation exceeds the nominal value, its value may drift, or it may fail altogether. The TPA1285 senses a wide variety of currents with different sense-resistor values.

Power Supply Recommendation

The input circuitry of the TPA1285 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 76V. However, the output voltage range of the OUT pin is limited by the voltages on the power-supply pin.

Proper Board Layout

To ensure optimum performance at the PCB level, care must be taken in the design of the board layout. Poor routing of the current sensing resistor can result in additional resistance between the input pins of the amplifier. Any additional high-current carrying impedance can cause significant measurement errors because the current resistor has a very low value. Below is recommended connection to connect to the device input pins. This connection ensures that only the current-sensing resistor impedance is detected between the input pins.

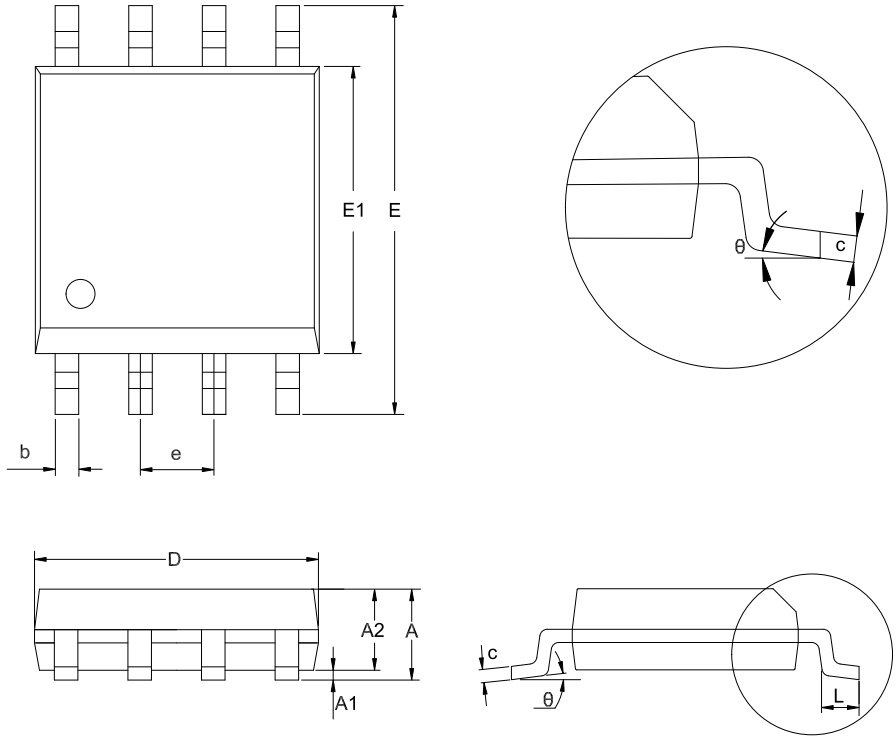


The use of a ground plane is highly recommended. A ground plane reduces EMI noise and also helps to maintain a constant temperature across the circuit board.

Package Outline Dimensions

MSOP-8

Package Outline Dimensions VS1(MSOP-8-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.050	0.150	0.002	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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