WS74285

Dual-Channel High-Precision High-Voltage Current-Sense Amplifier

Descriptions

The WS74285 dual-channel high-side current-sense amplifier has precision accuracy specifications of V_{OS} less than 70μV (max) and gain error less than 0.1%(max).

The WS74285 features an input common-mode voltage range from 2.7V to 76V with 400kHz of small-signal bandwidth, which makes it ideal for interfacing with a SARADC for multichannel multiplexed data acquisition systems.

The WS74285 operates over the -40°C to +125°C temperature range. The WS74285 is offered in 8-pin MSOP and CSP package.

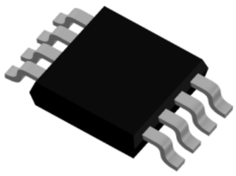
Applications

- Base Stations and Communication Equipment
- Power Management Systems
- Server Backplanes
- Industrial Control and Automation

Features

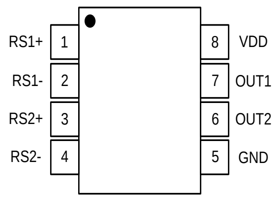
- 2.7V to 76V Input Common Mode
- Low 70μV (max) Input Offset Voltage
- Low 0.1% (max) Gain Error
- Gain Options
  G = 12.5V/V (WS74285x1)
  G = 20V/V (WS74285)
  G = 50V/V (WS74285x3)
  G = 100V/V (WS74285x4)
- 8-Pin MSOP Package
- 8-Pin CSP Package

Http://www.omnivision-group.com

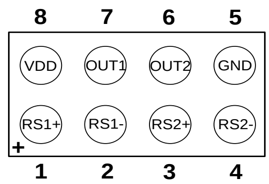


MSOP-8L

CSP-8L



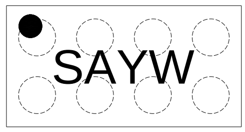
MSOP-8L
(Top view)



CSP-8L
(Bottom view)

Pin configuration

MSOP-8L



CSP-8L

Marking

4285 = Device code
GM, SA = Special code
Y = Year code
W = Week code

Order Information

Device	Package	Shipping
WS74285M-8/TR	MSOP-8L	4000/Reel &Tape
WS74285C-8/TR	CSP-8L	3000/Reel &Tape

Pin Descriptions

Pin Number	Symbol	Descriptions
1	RS1+	Channel 1 External Resistor Power-Side Connection
2	RS1-	Channel 1 External Resistor Load-Side Connection
3	RS2+	Channel 2 External Resistor Power-Side Connection
4	RS2-	Channel 2 External Resistor Load-Side Connection
5	GND	Ground
6	OUT2	Output Channel2
7	OUT1	Output Channel1
8	VDD	Supply Voltage

Absolute Maximum Ratings[1]

Parameter	Symbol	Value	Unit
Supply Voltage, ([V+] – [V-])	V_S[2]	6	V
RS+, RS- to GND		80	V
RS+ to RS-		±10	V
Continuous Input Current (Any Pin)		±10	mA
Output Short-Circuit Duration	t_{SO}	Unlimited	/
Operating Fee-Air Temperature Range	T_A	-40 to 125	°C
Storage Temperature Range	T_{STG}	-65 to 150	°C
Junction Temperature Range	T_J	206	°C
Lead Temperature Range	T_L	300	°C
Soldering Temperature		260	°C

Note:

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are only stress ratings, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. All voltage values, except differential voltage are with respect to network terminal.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum level	Unit
HBM	Human Body Model ESD	MIL-STD-883H Method 3015.8 JEDEC-EIA/JESD22-A114A	±2000	V
MM	Machine Model ESD	JEDEC-EIA/JESD22-A115	±400	V
CDM	Charged Device Model ESD	JEDEC-EIA/JESD22-C101E	±2000	V

Electronics Characteristics

$V_{RS+} = V_{RS-} = +76V$, $V_{DD} = +3.3V$, $V_{SENSE} = V_{RS+} - V_{RS-} = 1mV$, $T_A = -40°C$ to $+125°C$, unless otherwise noted. Typical values are at $T_A = +25°C$.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC Characteristics						
V_{DD}	Supply Voltage	Guaranteed by PSRR	2.7		5.5	V
I_{DD}	Supply Current	$T_A = +25°C$		200	680	μA
		$-40°C < T_A < +125°C$				μA
PSRR	Power-Supply Rejection Ratio	$2.7V \le V_{DD} \le 5.5V$	100	130		dB
V_{CM}	Input Common-Mode Voltage Range	Guaranteed by CMRR	2.7		76	V
I_{RS+}, I_{RS-}	Input Bias Current at V_{RS+} and V_{RS-} (Note 3)			45	70	μA
I_{RS+}, I_{RS-}	Input Offset Current (Note 3)			100		nA
I_{RS+}, I_{RS-}	Input Leakage Current (Note 3)	$V_{DD} = 0V$, $V_{RS+} = 76V$		50		nA
CMRR	Common-Mode Rejection Ratio	$2.7V < V_{RS+} < 76V$	120	150		dB
V_{OS}	Input Offset Voltage (Note 3)	$T_A = +25°C$		±10	±70	μV
		$-40°C \le T_A \le +125°C$		±20		μV
TCV_{OS}	Input Offset Voltage Drift (Note 3)			100		nV/°C
V_{SENSE}	Input Sense Voltage	G = 12.5 V/V		200		mV
		G = 20 V/V		125		
		G = 50 V/V		50		
		G = 100 V/V		25		
G	Gain	Full-scale V_{SENSE} = 125mV		20		V/V
GE	Gain Error (Note 3)	$T_A = +25°C$		0.01		%
		$-40°C \le T_A \le +85°C$				
		$-40°C \le T_A \le +125°C$				
V_{OL}	Output Low Voltage	Sink 500μA		8		mV
		No load		3		mV
V_{OH}	Output High Voltage to rail	Source 500μA		7		mV
AC Characteristics						
BW -3dB	Signal Bandwidth	All gain configurations V_{SENSE} > 5mV		400		kHz
AC PSRR	AC Power-Supply Rejection Ratio	f = 200kHz		68		dB

Electronics Characteristics (continued)

$V_{RS+} = V_{RS-} = +76V$, $V_{DD} = +3.3V$, $V_{SENSE} = V_{RS+} - V_{RS-} = 1mV$, $T_A = -40°C$ to $+125°C$, unless otherwise noted. Typical values are at $T_A = +25°C$.

AC CMRR	AC CMRR	f = 200kHz	1mV sine wave		87		dB
			20mV sine wave		80		
	Output Transient Recovery Time	∆VOUT = 2VP-P			1.5		µs
C_{LOAD}	Capacitive Load Stability	With 250Ω isolation resistor			20		nF
		Without any isolation resistor			200		pF
e_n	Input Voltage-Noise Density	f = 1kHz			20		nV/√Hz
THD	Total Harmonic Distortion (Up to 7th Harmonics)	f = 1kHz, $V_{OUT} = 1V_{P-P}$			60		dB
	Power-Up Time (Note 5)				50		µs
	Saturation Recovery Time				20		µs

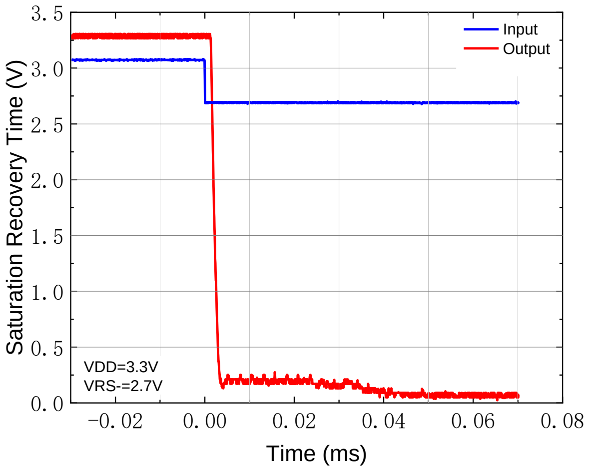
Note:

1. 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.
2. All devices are 100% production tested at $T_A = +25°C$. All temperature limits are guaranteed by design.
3. Specifications are guaranteed by design, not production tested.
4. Gain and offset voltage are calculated based on two point measurements: V_{SENSE1} and V_{SENSE2}. V_{SENSE1} = 20% x Full Scale V_{SENSE}. V_{SENSE2} = 80% x Full Scale V_{SENSE}.
5. Output is high-Z during power-up.

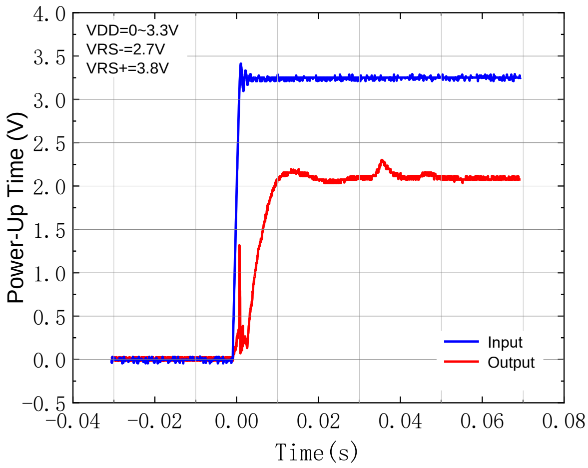
Typical Characteristics

V_{RS+} = V_{RS-} = 76V, V_{DD} = 3.3V, V_{SENSE} = V_{RS+} - V_{RS-} = 1mV, T_A = +25°C, unless otherwise noted.

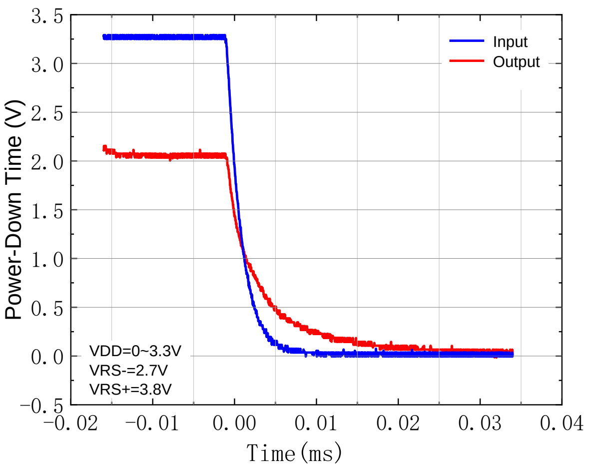
Saturation Recovery Time



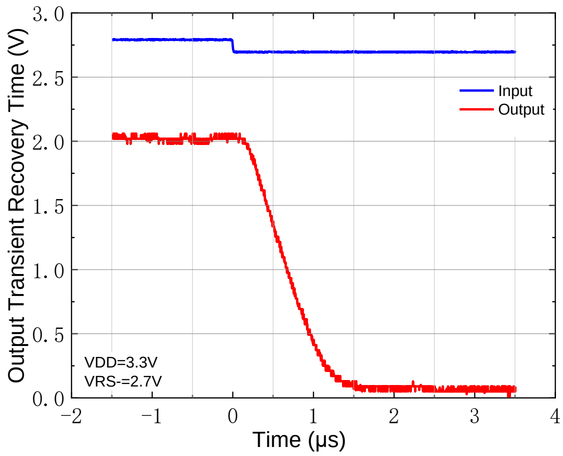
Power-Up Time



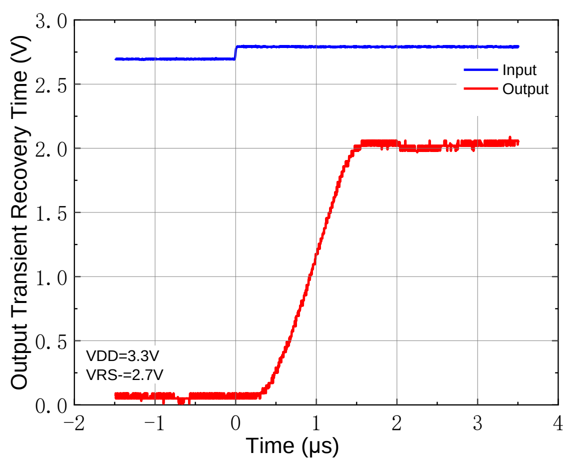
Power- down Time



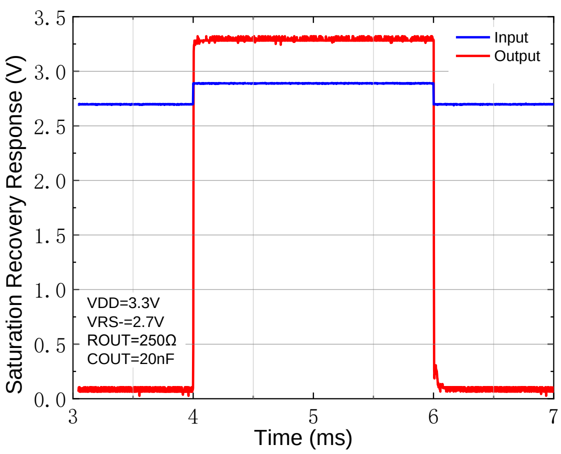
Output Transient Recovery Time Down



Output Transient Recovery Time Up



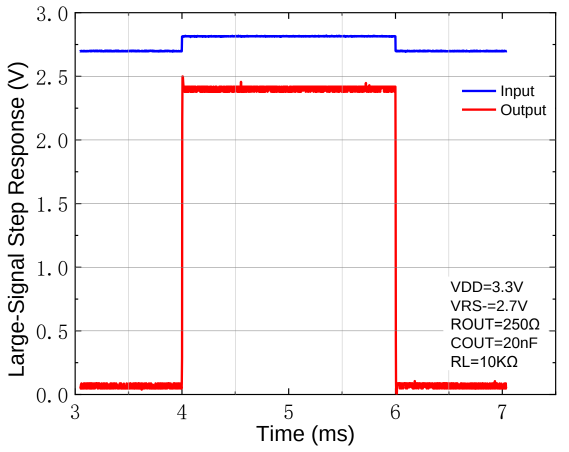
Saturation Recovery Response



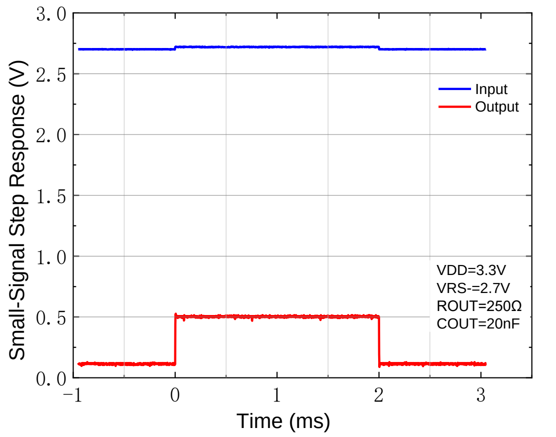
Typical Characteristics (continued)

$V_{RS+} = V_{RS-} = 76V$, $V_{DD} = 3.3V$, $V_{SENSE} = V_{RS+} - V_{RS-} = 1mV$, $T_A = +25°C$, unless otherwise noted.

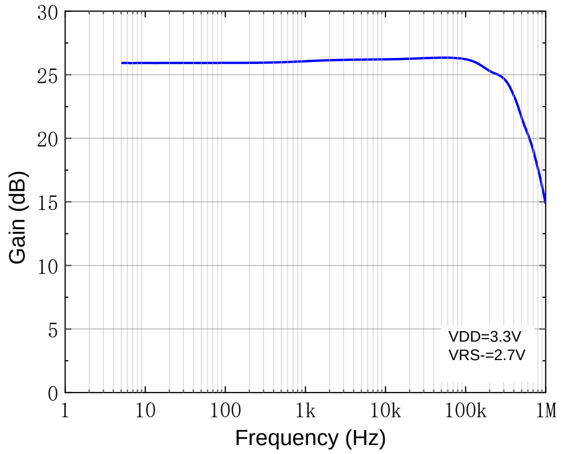
Large-Signal Step Response



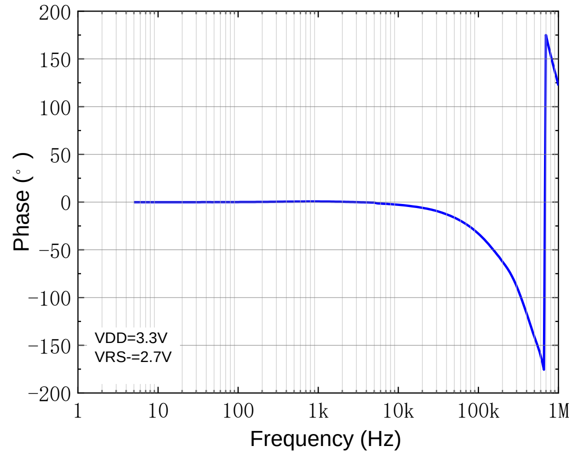
Small-Signal Step Response



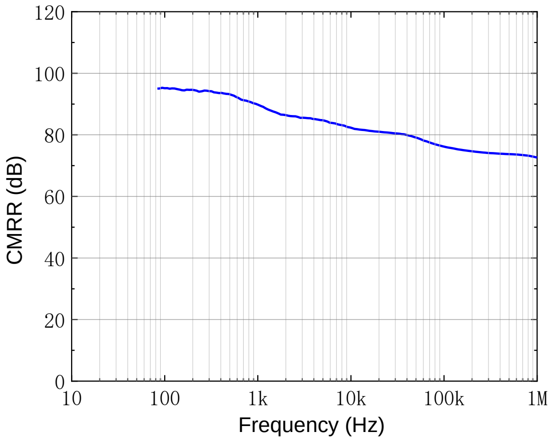
Gain vs. Frequency



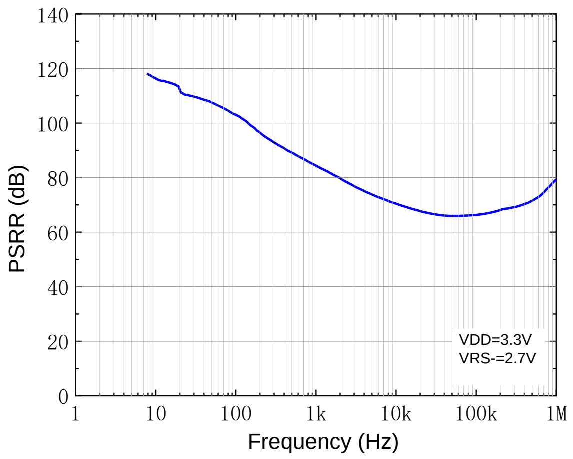
Phase vs. Frequency



CMRR



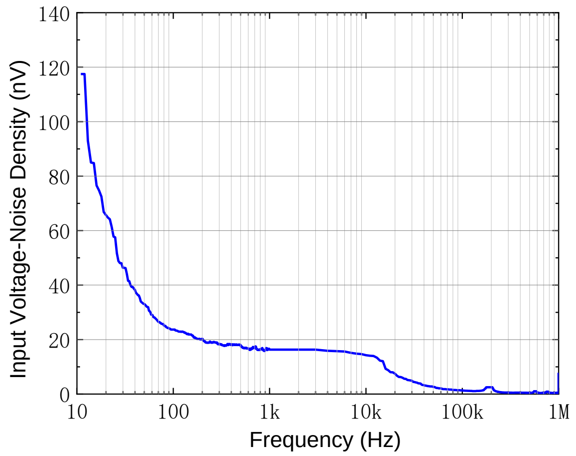
Power-Supply Rejection Ratio



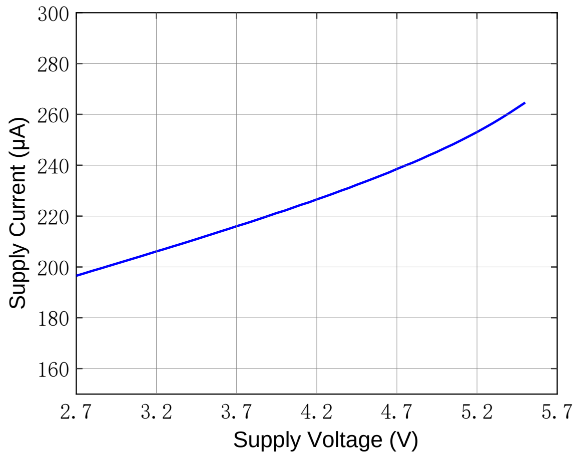
Typical Characteristics (continued)

$V_{RS+} = V_{RS-}$ = 76V, V_{DD} = 3.3V, $V_{SENSE} = V_{RS+} - V_{RS-}$ = 1mV, T_A = +25°C, unless otherwise noted.

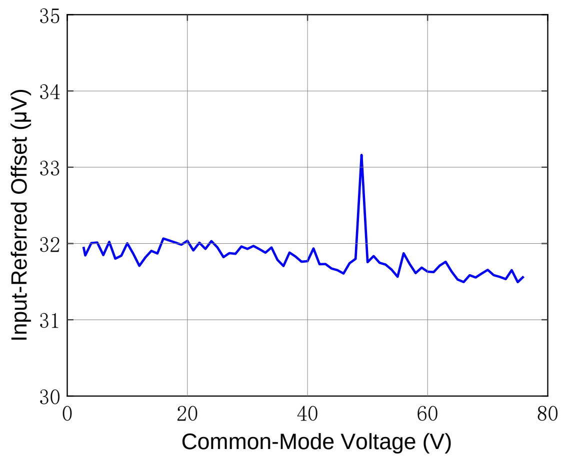
Input Voltage-Noise Density



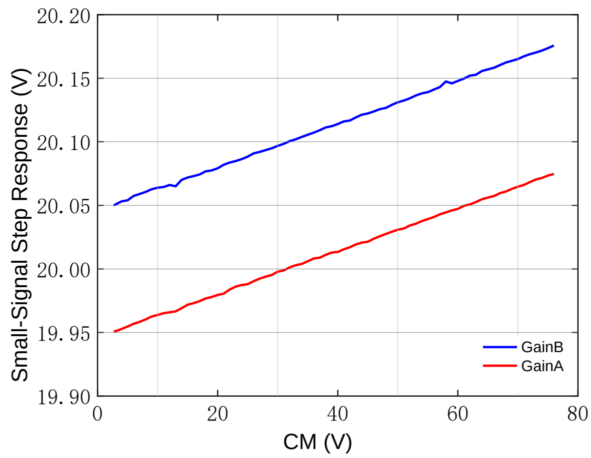
Supply Current vs. Supply Voltage



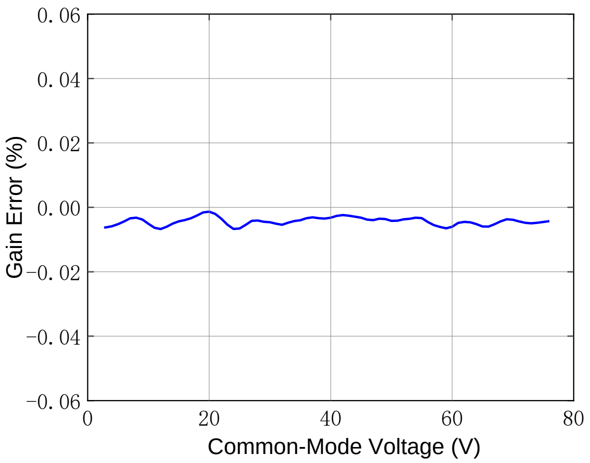
Input-Referred Offset vs. Common-Mode Voltage



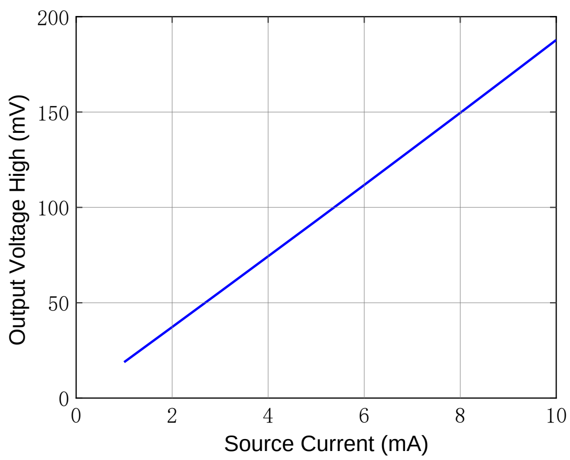
Gain vs. CM



Gain Error vs. Common-Mode Voltage



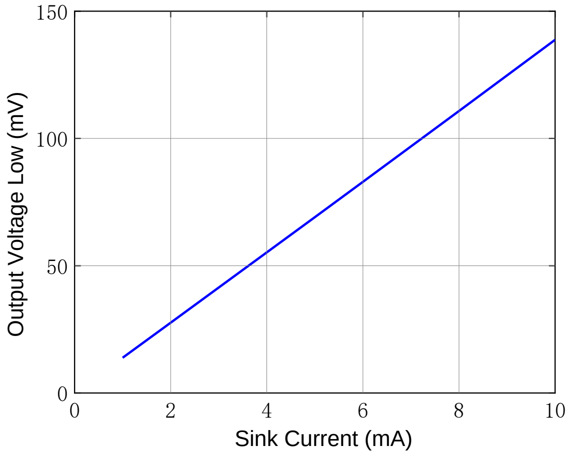
Output Voltage High vs. Source Current



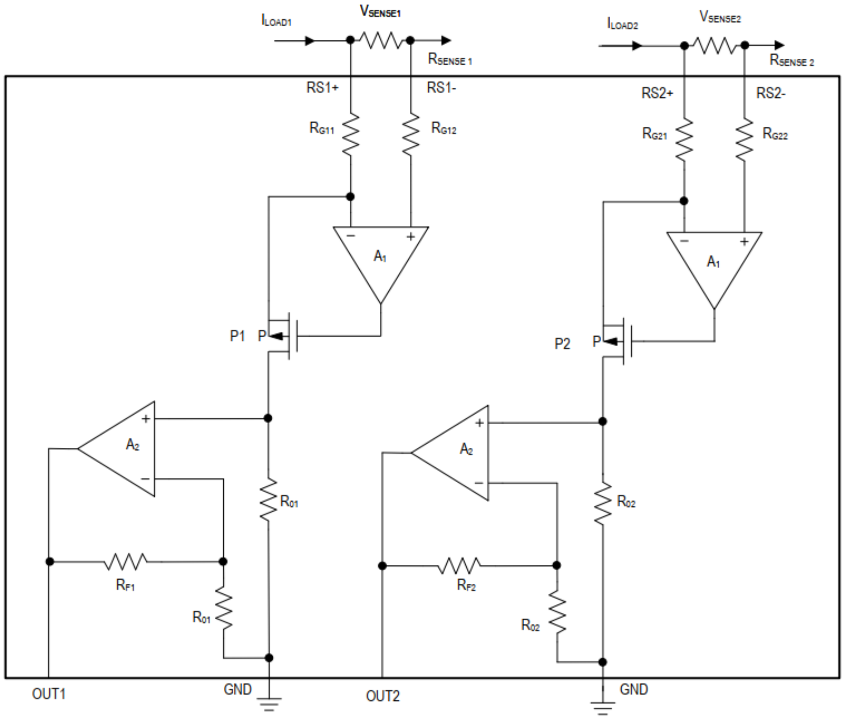
Typical Characteristics (continued)

$V_{RS+} = V_{RS-} = 76V$, $V_{DD} = 3.3V$, $V_{SENSE} = V_{RS+} - V_{RS-} = 1mV$, $T_A = +25°C$, unless otherwise noted.

Output Voltage Low vs. Sink Current



Functional Diagram



Detailed Description

The WS74285 high-side, current-sense amplifier features a 2.7V to 76V input common-mode range that is independent of supply voltage. This feature allows the monitoring of supply voltage. This feature allows the monitoring of current out of a battery as low as 2.7V and enables high-side current sensing at voltages greater than the supply voltage (V_{DD}). The WS74285 monitors current through a current-sense resistor and amplifies the voltage across the resistor.

High-side current monitoring does not interfere with the ground path of the load being measured, making the WS74285 particularly useful in a wide range of high-voltage systems.

The WS74285 operates as follows: current from the source flows through R_{SENSE} to the load (see Functional Diagram), creating a sense voltage, V_{SENSE}. The internal op amp A1 is used to force the current through an internal gain resistor R_{G11} at RS1+ pin, such that its voltage drop equals the voltage drop (V_{SENSE}) across the external sense resistor (R_{SENSE}). The internal resistor at RS1- pin (R_{G12}) has the same value as R_{G11} to minimize error. The 2) has the same value as R_{G11} to minimize error p-channel FET. Its source current is the same as the drain current which flows through a second gain resistor, R_{01} producing a voltage $V_{R01} = V_{SENSE}$ x R_{01}/R_{G11}.

The output voltage V_{OUT1} is produced from a second op amp A2 with the gain (1+ RF1/R01). Hence, the $V_{OUT1}= I_{LOAD1}$ x R_{SENSE1} (R_{01}/R_{G11}) x (1+ R_{F1}/ R_{01}) for channel 1 and Vout2=I_{LOAD2} x R_{SENSE2} (R_{02}/R_{G21}) x (1+R_{F2}/ R_{02}) for channel 2. Internal resistor R_{01} = R_{02}, R_{G11}=R_{G12}=R_{G21}=R_{G22}, R_{F1}=R_{F2}.The gain-setting resistors R_{01}, R_{02}, R_{G11}, R_{G12}, R_{G21}, R_{G22}, R_{F1} and R_{F2} are available in Table1).

Total gain = 12.5V/V for WS74285x1, 20V/V for the WS74285T, 50V/V for the WS74285x3, and 100V/V for the WS74285x4.

Applications Information

Recommended Component Values

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

$$V_{OUT} = V_{SENSE} \times A_V$$

Where V_{SENSE} is the full-scale sense voltage, 200mV for gain of 12.5V/V, 125mV for gain of 20V/V, 50mV for gain of 50V/V, 25mV for gain of 100V/V, and A_V is the gain of the device.

In applications monitoring a high current, ensure that R_{SENSE} is able to dissipate its own I^2R loss. If the resistor's power dissipation exceeds the nominal value, its value may drift or it may fail altogether. The WS74285 senses a wide variety of currents with different sense-resistor values.

Choosing the Sense Resistor

Choose R_{SENSE} based on the following criteria:

Voltage Loss : A high R_{SENSE} value causes the power- source voltage to degrade through IR loss. For minimal voltage loss, use the lowest R_{SENSE}.

Accuracy: A high R_{SENSE} value allows lower currents measured more accurately. This is due to offsets becoming less significant when the sense voltage is larger. For best performance select R_{SENSE} to provide approximately 200mV (gain of 12.5V/V), 125mV (gain of 20V/V), or 50mV (gain of 50V/V), 25mV (gain of 100V/V) of sense voltage for the full-scale current in each application.

Efficiency and Power Dissipation: At high current levels the I^2R losses in R_{SENSE} can be significant. Consider this when choosing the resistor value and its power dissipation (wattage) rating. In addition, the sense resistor's value might drift if it heats up excessively.

Inductance: Keep inductance low if I_{SENSE} has a large high-frequency component. Wire-wound resistors have the highest inductance, while metal film is somewhat better. Low-inductance, metal-film resistors are also available. Instead of being spiral wrapped around a core, as in metal-film or wire wound resistors, they are a straight band of metal and are available in values under 1Ω.

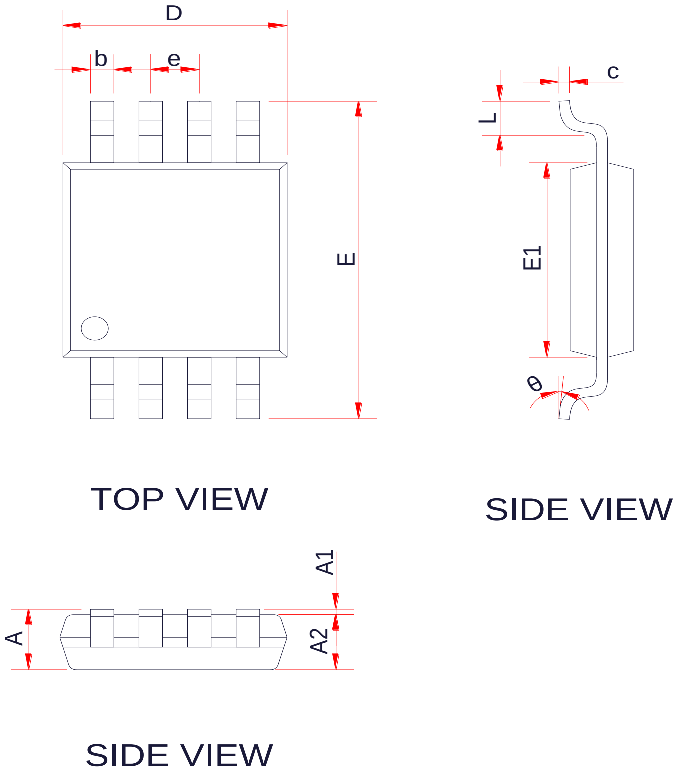
Take care to eliminate parasitic trace resistance from causing errors in the sense voltage because of the high currents that flow through R_{SENSE}. Either use a four terminal current-sense resistor or use Kelvin (force and sense) PCB layout techniques.

Base Station Application Circuit

An example of a typical application (Figure 1) of this high-voltage, high-precision current-sense amplifier is in base-station systems where there is a need to monitor the current flowing in the power amplifier. Such amplifiers, depending on the technology, can be biased up to 50V or 60V thus requiring a current-sense amplifier like the WS74285 with high-voltage common mode. The very low input offset voltage of the WS74285 minimizes the value of the external sense resistor thus resulting in system power-saving.

PACKAGE OUTLINE DIMENSIONS

MSOP-8L

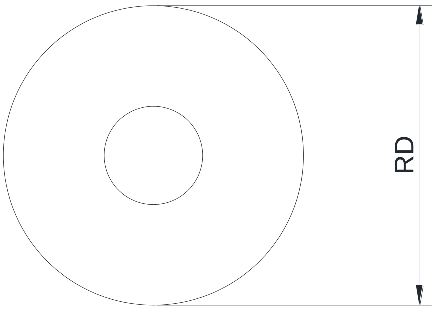


Symbol	Dimensions In Millimeters (mm)		
	Min.	**Typ.**	**Max.**
A	-	-	1.10
A1	0.02	-	0.15
A2	0.75	0.80	0.95
b	0.25	-	0.38
c	0.09	-	0.23
D	2.90	3.00	3.10
E	4.75	4.90	5.05
E1	2.90	3.00	3.10
e	0.65 BSC		
L	0.40	-	0.80
θ	0°	-	6°

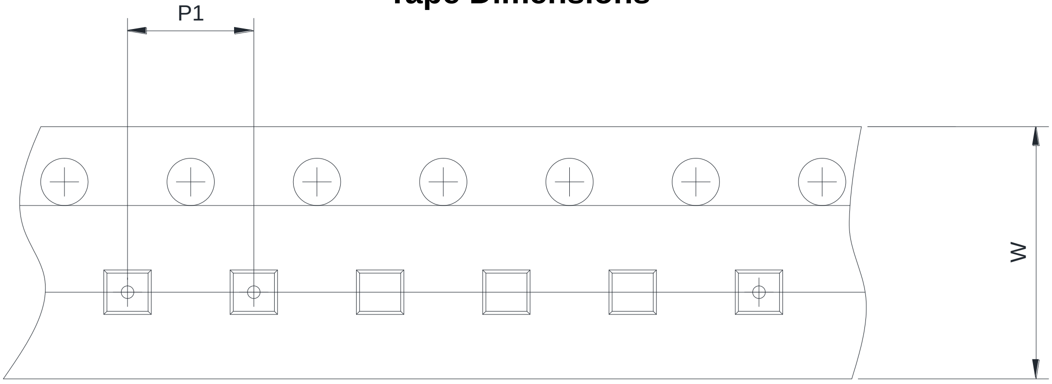
TAPE AND REEL INFORMATION

MSOP-8L

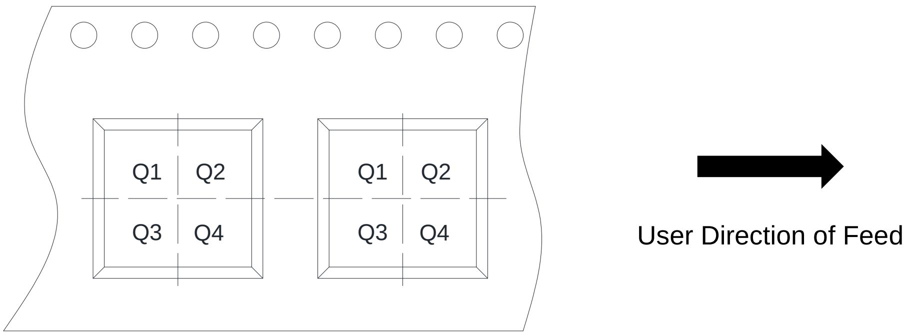
Reel Dimensions



Tape Dimensions



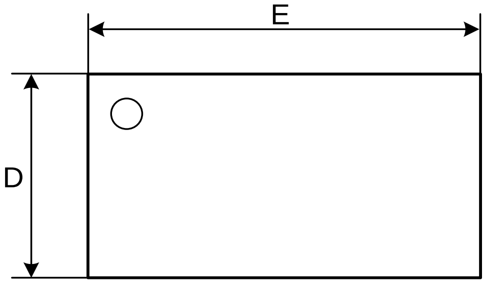
Quadrant Assignments For PIN1 Orientation In Tape



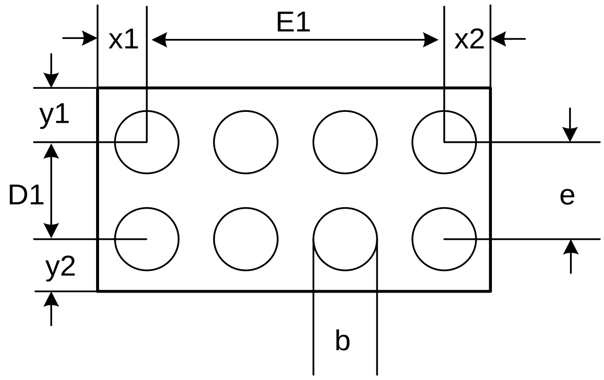
RD	Reel Dimension	☐ 7inch ☑ 13inch
W	Overall width of the carrier tape	☐ 8mm ☑ 12mm
P1	Pitch between successive cavity centers	☐ 2mm ☐ 4mm ☑ 8mm
Pin1	Pin1 Quadrant	☑ Q1 ☐ Q2 ☐ Q3 ☐ Q4

PACKAGE OUTLINE DIMENSIONS

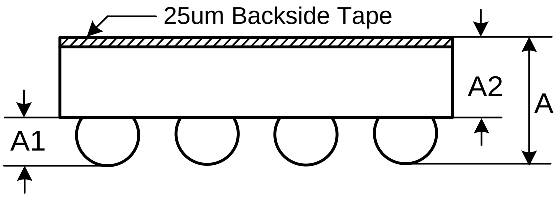
CSP-8L



TOP VIEW
(MARK SIDE)



BOTTOM VIEW
(BALL SIDE)



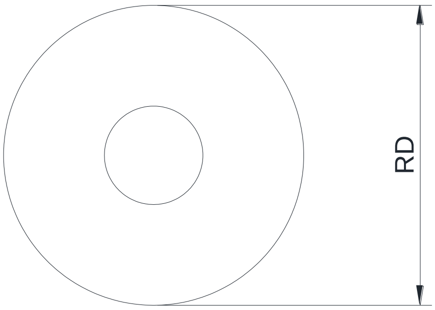
SIDE VIEW

Symbol	**Dimensions In Millimeters (mm)**		
	Min.	**Typ.**	**Max.**
A	0.595	0.640	0.685
A1	0.220	0.240	0.260
A2	0.375	0.400	0.425
D	1.020	1.050	1.080
D1	0.500BSC		
E	1.940	1.970	2.000
E1	1.500 BSC		
b	0.300	0.320	0.340
e	0.500 BSC		
x1	0.235 REF		
x2	0.235 REF		
y1	0.275 REF		
y2	0.275 REF		

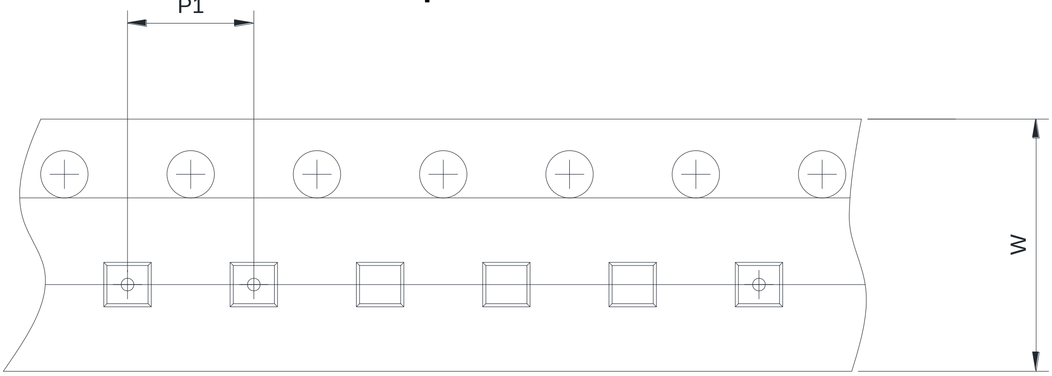
TAPE AND REEL INFORMATION

CSP-8L

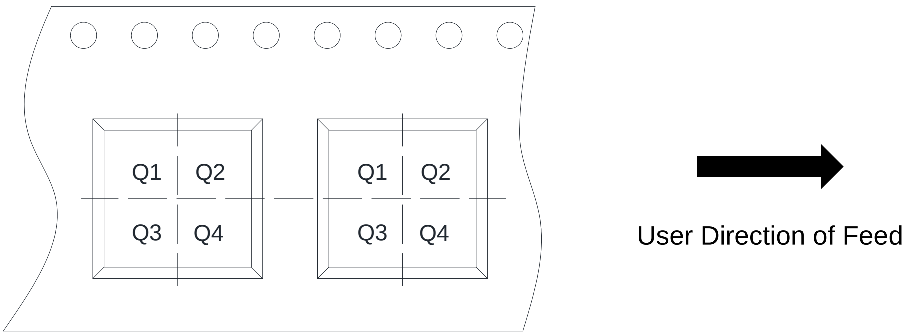
Reel Dimensions



Tape Dimensions



Quadrant Assignments For PIN1 Orientation In Tape



RD	Reel Dimension	☑ 7inch ☐ 13inch
W	Overall width of the carrier tape	☑ 8mm ☐ 12mm
P1	Pitch between successive cavity centers	☐ 2mm ☑ 4mm ☐ 8mm
Pin1	Pin1 Quadrant	☐ Q1 ☑ Q2 ☐ Q3 ☐ Q4