1. 特性

- 宽共模电压范围：0V 至 76V
- 高精度：
  - Gain:
    - Gain error: 0.10% (max)
  - Offset:
    - Offset voltage: ±10μV (typ)
- 可供选择的增益：
  - G = 10V/V (CSA2302-10)
  - G = 20V/V (CSA2302-20)
  - G = 50V/V (CSA2302-50)
  - G = 100V/V (CSA2302-100)
- 8-pin MSOP 封装

2. 应用

- 通信设备
- 功率管理系统
- 服务器
- 电池电流检测

3. 说明

CSA2302 是一颗双通道高精度电流采样放大器。具有小于 10μV (typ)的失调电压，和小于 0.1% (max)的增益误差。

CSA2302 的 0V 至 76V 的宽输入共模范围，和 90kHz 的带宽使其非常适合驱动各种 ADC，在多通道数据采集系统中。

CSA2302 的温度工作范围是–40°C 到 125°C。有关订购信息，请参见 Table 1。

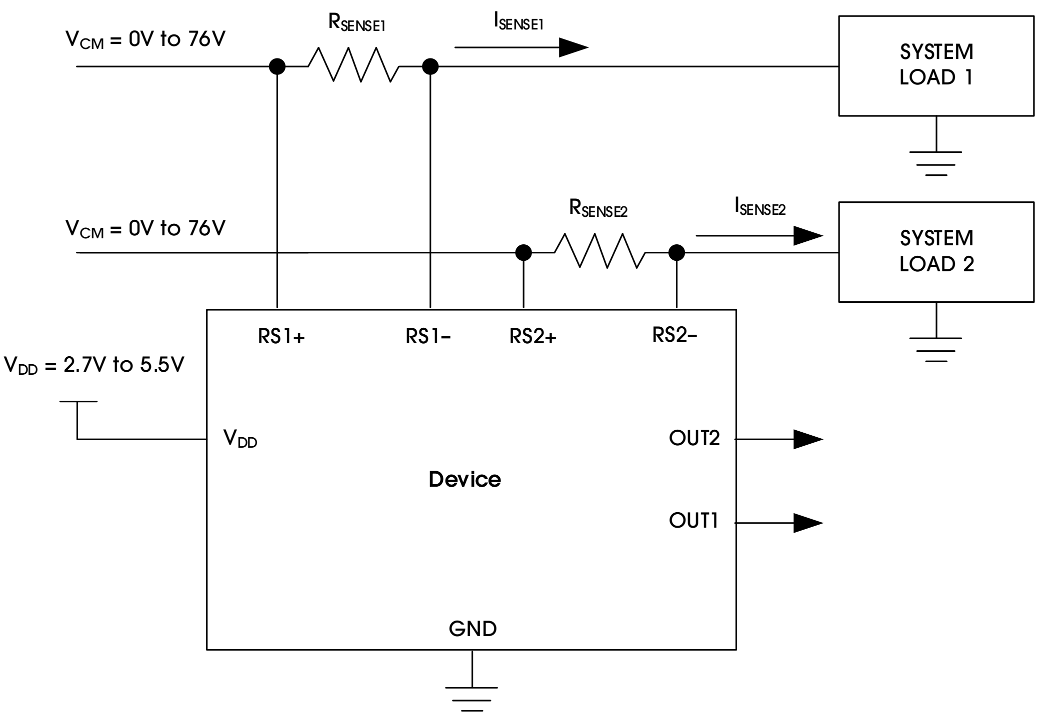


Table 1 lists the order information.

Table 1. Order Information

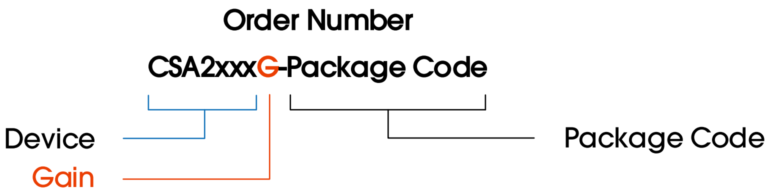
ORDER NUMBER(1)	PART NUMBER	CH (#)	PACKAGE	MARK	GAIN (TYP) (V/V)	BANDWITH (TYP) (kHz)	OPERATING TEMP (°C)	PACKAGE OPTION
CSA2302LAMSOP8	CSA2302-10	2	MSOP-8	CSA2302L	10	90	-40-125	T/R-4000
CSA2302MAMSOP8	CSA2302-20	2	MSOP-8	CSA2302M	20	90	-40-125	T/R-4000
CSA2302NAMSOP8	CSA2302-50	2	MSOP-8	CSA2302N	50	90	-40-125	T/R-4000
CSA2302PAMSOP8(2)	CSA2302-100	2	MSOP-8	CSA2302P	100	90	-40-125	T/R-4000

Table 2. Family Selection Guide

ORDER NUMBER(1)	PART NUMBER	CH (#)	PACKAGE	MARK	GAIN (TYP) (V/V)	BANDWITH (TYP) (kHz)	OPERATING TEMP (°C)	PACKAGE OPTION
CSA2202LAMSOP8(2)	CSA2202-10	2	MSOP-8	CSA2202L	10	50	-40-125	T/R-4000
CSA2202MAMSOP8	CSA2202-20	2	MSOP-8	CSA2202M	20	50	-40-125	T/R-4000
CSA2202NAMSOP8	CSA2202-50	2	MSOP-8	CSA2202N	50	50	-40-125	T/R-4000
CSA2202PAMSOP8(2)	CSA2202-100	2	MSOP-8	CSA2202P	100	50	-40-125	T/R-4000

Devices can be ordered via the following two ways:
1. Place orders directly on our website (www.analogysemi.com), or;
2. Contact our sales team by mailing to sales@analogysemi.com.

Note 1:



Note 2: Available in the future.

4. PIN CONFIGURATION AND FUNCTIONS

Figure 1 illustrates the pin configuration of the CSA2302.

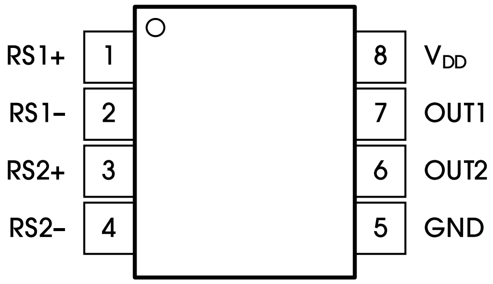


Figure 1. Pin Configuration

Table 3 lists the pin functions of the CSA2302.

Table 3. Pin Functions

POSITION	NAME	TYPE	DESCRIPTION
1	RS1+	Input	Channel 1 external resistor power-side connection
2	RS1−	Input	Channel 1 external resistor load-side connection
3	RS2+	Input	Channel 2 external resistor power-side connection
4	RS2−	Input	Channel 2 external resistor load-side connection
5	GND	Power	Ground
6	OUT2	Output	Output channel 2
7	OUT1	Output	Output channel 1
8	V_{DD}	Power	Supply voltage, connecting at least 100nF capacitor to GND.

5. SPECIFICATIONS

5.1 ABSOLUTE MAXIMUM RATINGS

Table 4 lists the absolute maximum ratings of the CSA2302.

Table 4. Absolute Maximum Ratings

PARAMETER	DESCRIPTION		MIN	MAX	UNITS
Voltage	V_{DD} to GND		-0.3	6.0	V
	RS+, RS- to GND		-0.3	80	
	RS+ to RS-	1s maximum duration due to package thermal dissipation	-80	80	
Current	Continuous input current (any pin)		-20	20	mA
Temperature	Operating, T_A		-40	125	°C
	Junction, T_J			150	
	Storage, T_{stg}		-65	150	
	Lead (soldering, 10s)			300	
	Soldering (reflow)			260	

Note: Stresses beyond those listed under Table 4 may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

5.2 ESD RATINGS

Table 5 lists the ESD ratings of the CSA2302.

Table 5. ESD Ratings

PARAMETER	SYMBOL	DESCRIPTION	VALUE	UNITS
Electrostatic Discharge	$V_{(ESD)}$	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[1]	±6000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101[2]	±1000	

Note 1: The JEDEC document JEP155 indicates that 500V HBM allows safe manufacturing with a standard ESD control process.
Note 2: The JEDEC document JEP157 indicates that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 THERMAL INFORMATION

Table 6 lists the thermal information for the CSA2302.

Table 6. Thermal Information

PARAMETER	SYMBOL	MSOP-8	UNITS
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	145	°C/W
Junction-to-Board Thermal Resistance	$R_{\theta JB}$	83.3	°C/W
Junction-to-Top Characterization Parameter	ψ_{JT}	1.7	°C/W
Junction-to-Board Characterization Parameter	ψ_{JB}	81.7	°C/W
Junction-to-Case (Top) Thermal Resistance	$R_{\theta JC(top)}$	48.3	°C/W
Junction-to-Case (Bottom) Thermal Resistance	$R_{\theta JC(bot)}$	85	°C/W

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5.4 ELECTRICAL CHARACTERISTICS

Table 7 lists the electrical characteristics of the CSA2302. 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.(1)

Table 7. Electrical Characteristics

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DC CHARACTERISTICS						
Supply Voltage	V_{DD}	Guaranteed by PSRR	2.7		5.5	V
Supply Current	I_{DD}	T_A = 25°C		1021	1350	μA
		−40°C < T_A < 125°C			1400	
Power-Supply Rejection Ratio	PSRR	2.7V ≤ V_{DD} ≤ 5.5V	105	123		dB
Input Common-Mode Voltage Range	V_{CM}	Guaranteed by CMRR	0		76	V
Input Bias Current at V_{RS+} and V_{RS-}(2)	I_{RS+}, I_{RS-}	V_{SENSE} = 0V		5	20	nA
Input Offset Current(2)	I_{RS+} − I_{RS-}	V_{SENSE} = 0V		5	20	nA
Input Leakage Current	I_{RS+}, I_{RS-}	V_{DD} = 0V, V_{RS+} = V_{RS-} = 76V		0.005	0.2	μA
Common-Mode Rejection Ratio	CMRR	0V < V_{RS+} < 76V	135	160		dB
Input Offset Voltage(2)(3)	V_{OS}	T_A = 25°C		±10	±60	μV
		−40°C ≤ T_A ≤ 125°C		±30	±100	
Input Offset Voltage Drift(2)	TCV_{OS}			200		nV/°C
Input Sense Voltage	V_{SENSE}			V_{OH} / G		mV
Gain(3)	G	CSA2302-10		10		V/V
		CSA2302-20		20		
		CSA2302-50		50		
		CSA2302-100		100		
Gain Error(2)	GE	T_A = 25°C		0.02	0.1	%
		−40°C ≤ T_A ≤ 125°C		0.08	0.3	
Output Low Voltage	V_{OL}	Sink 500μA			15	mV
		No load			4	
Output High Voltage	V_{OH}	Source 500μA	V_{DD} − 0.015			V
AC CHARACTERISTICS						
Signal Bandwidth	BW −3dB	All gain configurations V_{SENSE} > 5mV		90		kHz
AC Power-Supply Rejection Ratio	AC PSRR	f = 200kHz		43		dB
AC CMRR	AC CMRR	f = 200kHz		71		dB
Capacitive Load Stability	C_{LOAD}	With 250Ω isolation resistor		20		nF
		Without any isolation resistor		500		pF
Input Voltage-Noise Density	en	f = 1kHz		58		nV/√Hz
Power-Up Time(4)				80		μs
Saturation Recovery Time				5		μs

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

6. 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.

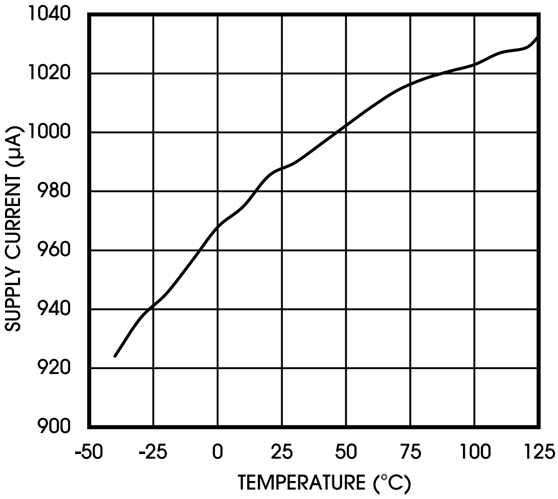

Figure 2. Supply Current vs Temperature

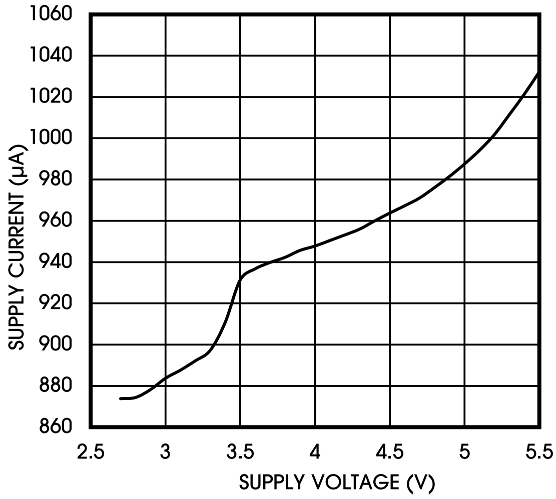

Figure 3. Supply Current vs Supply Voltage

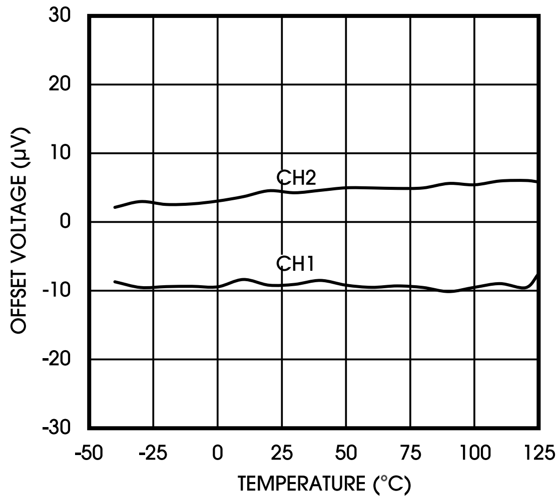

Figure 4. Input Offset Voltage vs. Temperature

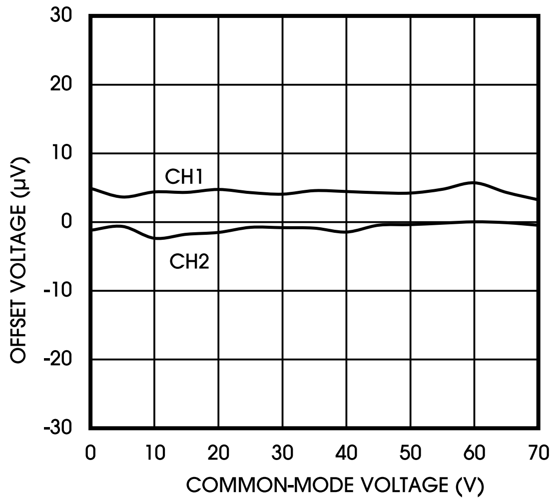

Figure 5. Input Offset Voltage vs. Input Common Mode Voltage

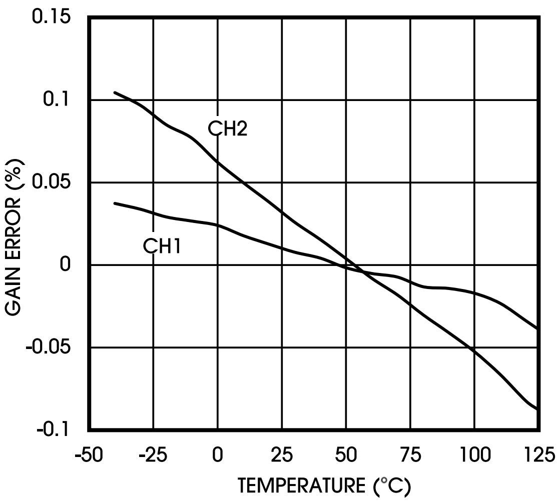

Figure 6. Gian Error vs. Temperature

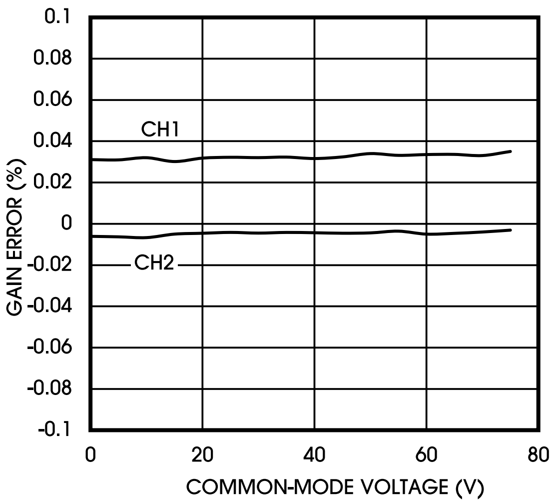

Figure 7. Gain Error vs. Common Mode Voltage

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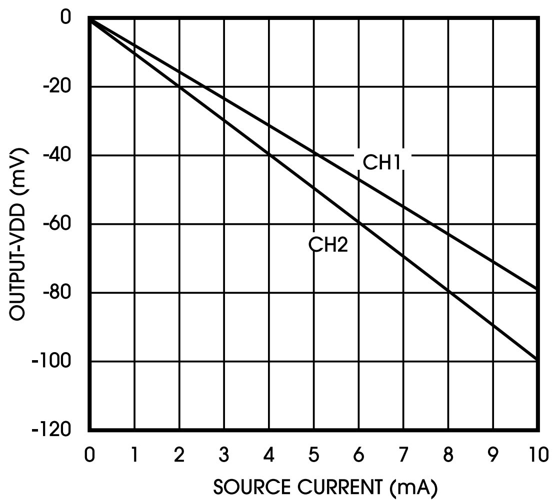

Figure 8. V_{OH} vs. Source Current

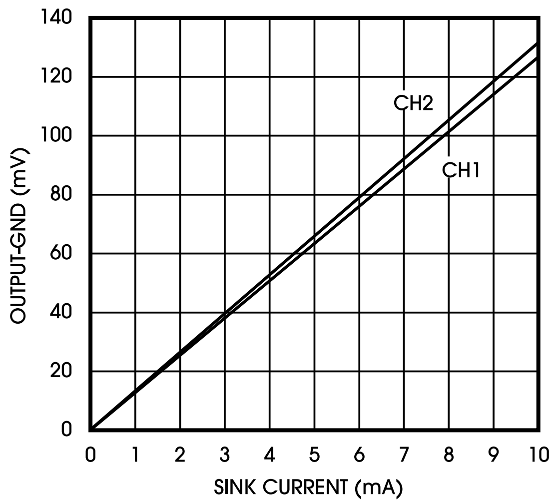

Figure 9. V_{OL} vs. Sink Current

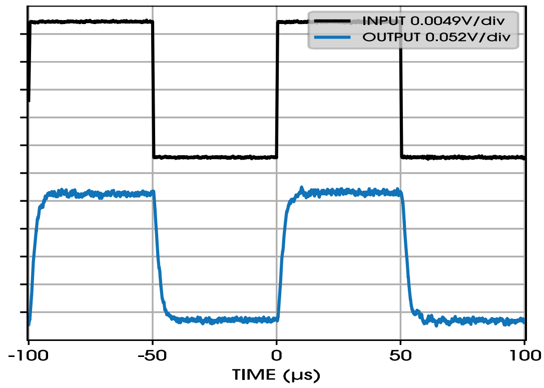

Figure 10. Small Signal Step Response (Gain = 10)

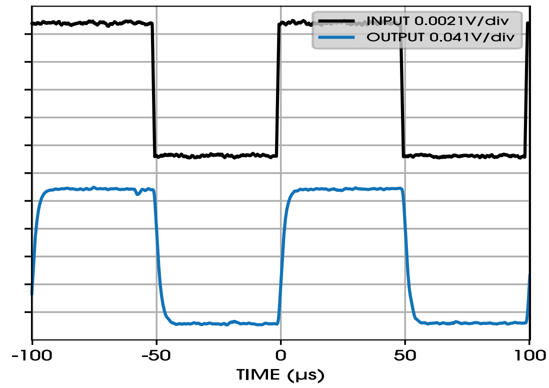

Figure 11. Small Signal Step Response (Gain = 20)

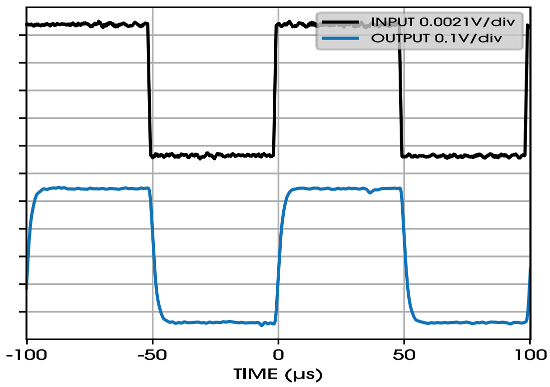

Figure 12. Small Signal Step Response (Gain = 50)

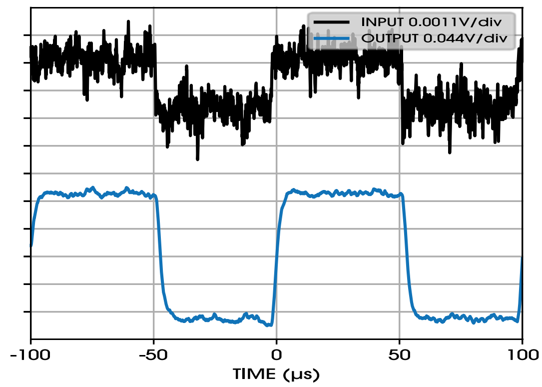

Figure 13. Small Signal Step Response (Gain = 100)

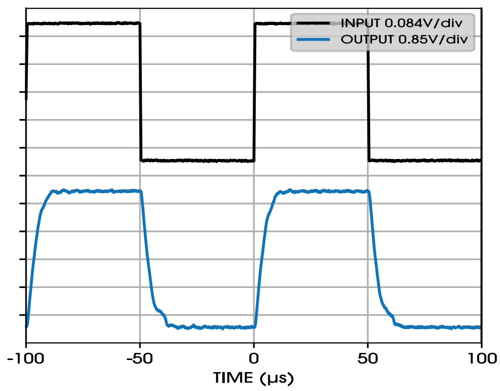

Figure 14. Large Signal Step Response (Gain = 10)

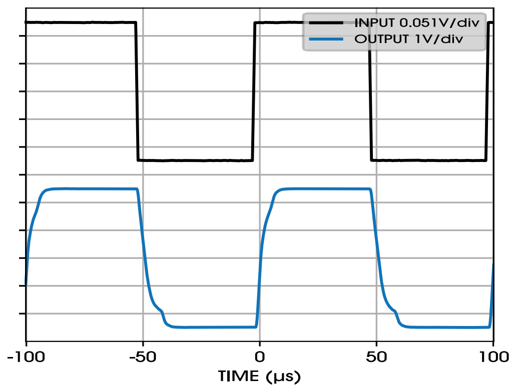

Figure 15. Large Signal Step Response (Gain = 20)

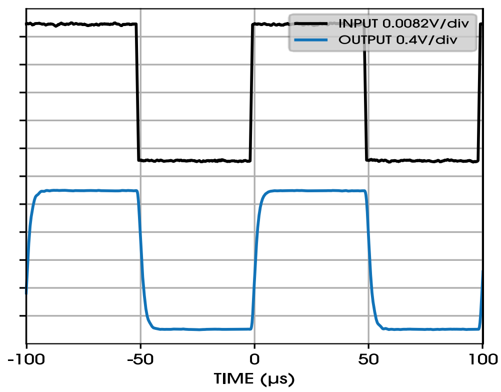

Figure 16. Large Signal Step Response (Gain = 50)

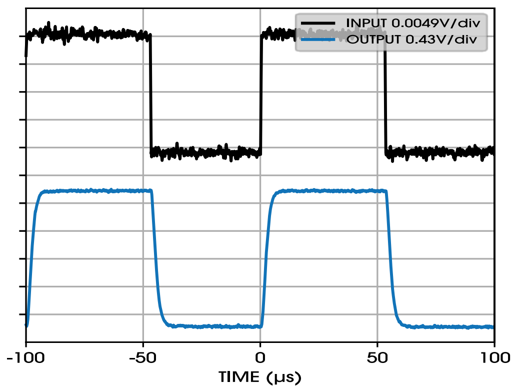

Figure 17. Large Signal Step Response (Gain = 100)

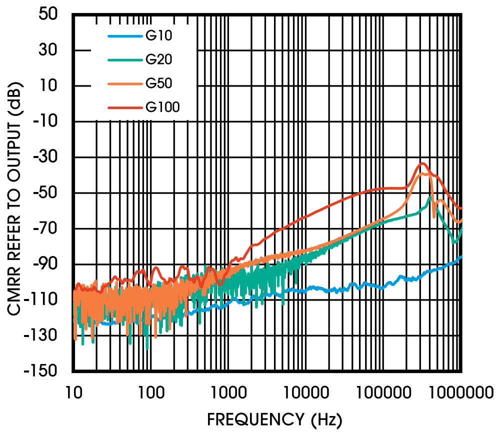

Figure 18. CMRR Referred to Output vs. Frequency

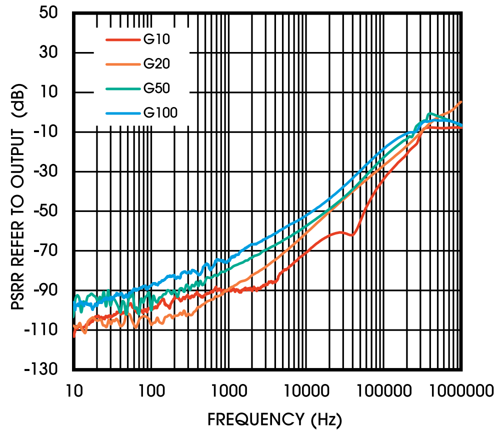

Figure 19. PSRR Referred to Output vs. Frequency

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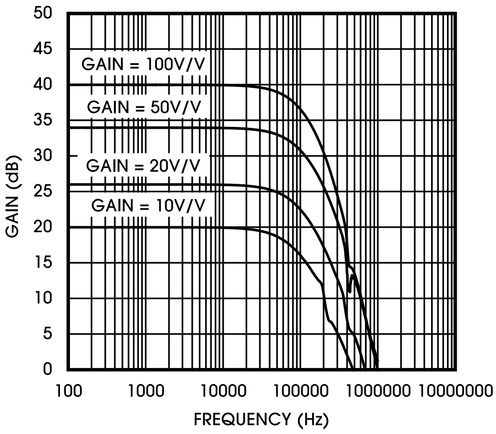

Figure 20. Gain vs. Frequency

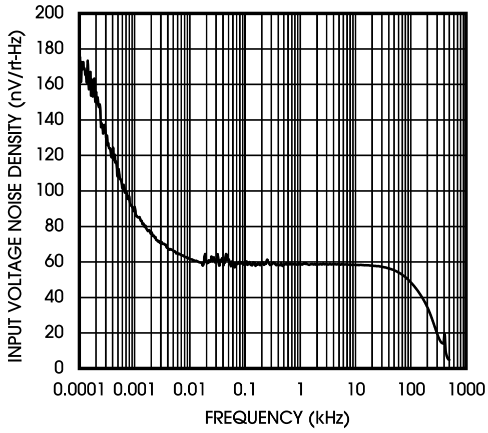

Figure 21. Input Voltage Noise Density vs. Frequency

7. 详细说明

7.1 概述

CSA2302 高侧电流检测放大器具有 0V 至 76V 输入共模范围，与电源电压无关。此功能允许监测低至 0V 的电池电流，并在高于电源电压(V_{DD})的电压下启用高侧电流检测。CSA2302 通过电流检测电阻器监控电流并放大电阻器两端的电压。

高侧电流监控不会干扰被测负载的接地路径，这使得 CSA2302 在范围广泛的高压系统中特别有用。

7.2 功能模块框图

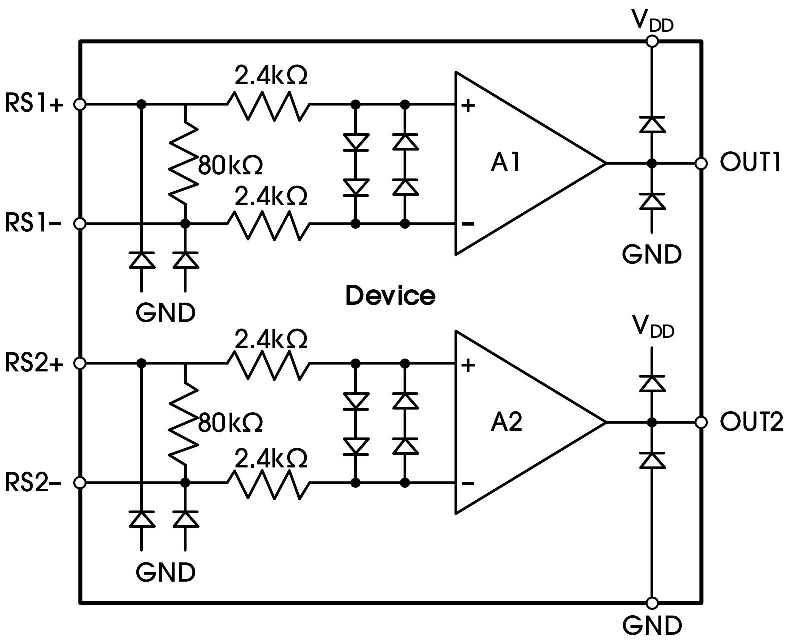

Figure 22. Functional Block Diagram

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8. 应用和实现

注
以下应用部分中的信息不是 AnalogySemi 组件规范的一部分，AnalogySemi 不保证其准确性或完整性。AnalogySemi 的客户有责任确定组件是否适合他们的用途。客户应验证和测试他们的设计实施以确认系统功能。

8.1 应用信息

8.1.1 推荐的元件值

理想情况下，最大负载电流会在电流检测电阻器上产生满量程检测电压。使用典型的 3.3V 为 V_{DD} 供电，并选择产生应用所需的最大输出电压所需的增益：

$$V_{OUT} = V_{SENSE} \times A_V \tag{1}$$

其中 V_{SENSE} 为满量程感应电压，增益 10V/V 时为 330mV，增益为 20V/V 时为 165mV，增益为 50V/V 时为 66mV，增益为 100V/V 时为 33mV，A_V 为器件增益。

在监测高电流的应用中，确保 R_{SENSE} 能够耗散其自身的 I^2R 损耗。如果电阻器的功耗超过标称值，则其值可能会漂移或完全失效。CSA2302 可通过不同的检测电阻值检测各种电流。

8.1.2 选择检测电阻

根据以下标准选择 R_{SENSE}：

- 电压损失：高 R_{SENSE} 值会导致电源电压因 IR 损失而降低。为使电压损失最小，请使用最低的 R_{SENSE} 值。
- 精度：较高的 R_{SENSE} 值允许更精确地测量较低的电流。这是因为当感测电压较大时偏移变得不那么重要。为获得最佳性能，在 V_{DD} 使用 3.3V 时，选择 R_{SENSE} 以提供大约 330mV (10V/V 增益)、165mV (20V/V 增益)或 66mV (50V/V 增益)、33mV (100V/V 增益)检测电压的满量程电流在每个应用程序。
- 效率和功耗：在高电流水平下，R_{SENSE} 中的 I^2R 损耗可能很大。选择电阻值及其额定功率耗散(瓦数)时请考虑这一点。此外，如果过热，检测电阻的值可能会漂移。
- 电感：如果 I_{SENSE} 具有较大的高频分量，则保持低电感。绕线电阻的电感量最大，而金属膜电阻稍好一些。也可提供低电感金属膜电阻器。它们不是像金属膜或线绕电阻器那样螺旋缠绕在磁芯上，而是一条直的金属带，可提供低于 1Ω 的值。

注意消除寄生走线电阻，避免因流过 R_{SENSE} 的大电流导致检测电压出现误差。使用四端电流检测电阻器或使用开尔文(强制和检测)PCB 布局技术。

8.2 电源旁路

建议使用电源旁路电容器以获得最佳性能，并且应尽可能靠近设备的电源和接地端子放置。该电源旁路电容器的典型值为靠近 V_{DD} / GND 引脚的 0.1µF (NP0 / C0G 型)。电容器的额定值应至少为最大预期施加电压的两倍。具有嘈杂或高阻抗电源的应用可能需要额外的去耦电容器来抑制电源噪声。

8.2.1 基站应用电路

这种高电压、高精度电流检测放大器的典型应用示例(Figure 23)是在需要监控功率放大器中流动的电流的基站系统中。根据技术的不同，此类放大器可以偏置高达 50V 或 60V，因此需要电流检测放大器，例如具有高压共模的 CSA2302。CSA2302 的输入失调电压非常低，可最大限度地减小外部检测电阻的值，从而实现系统节能。

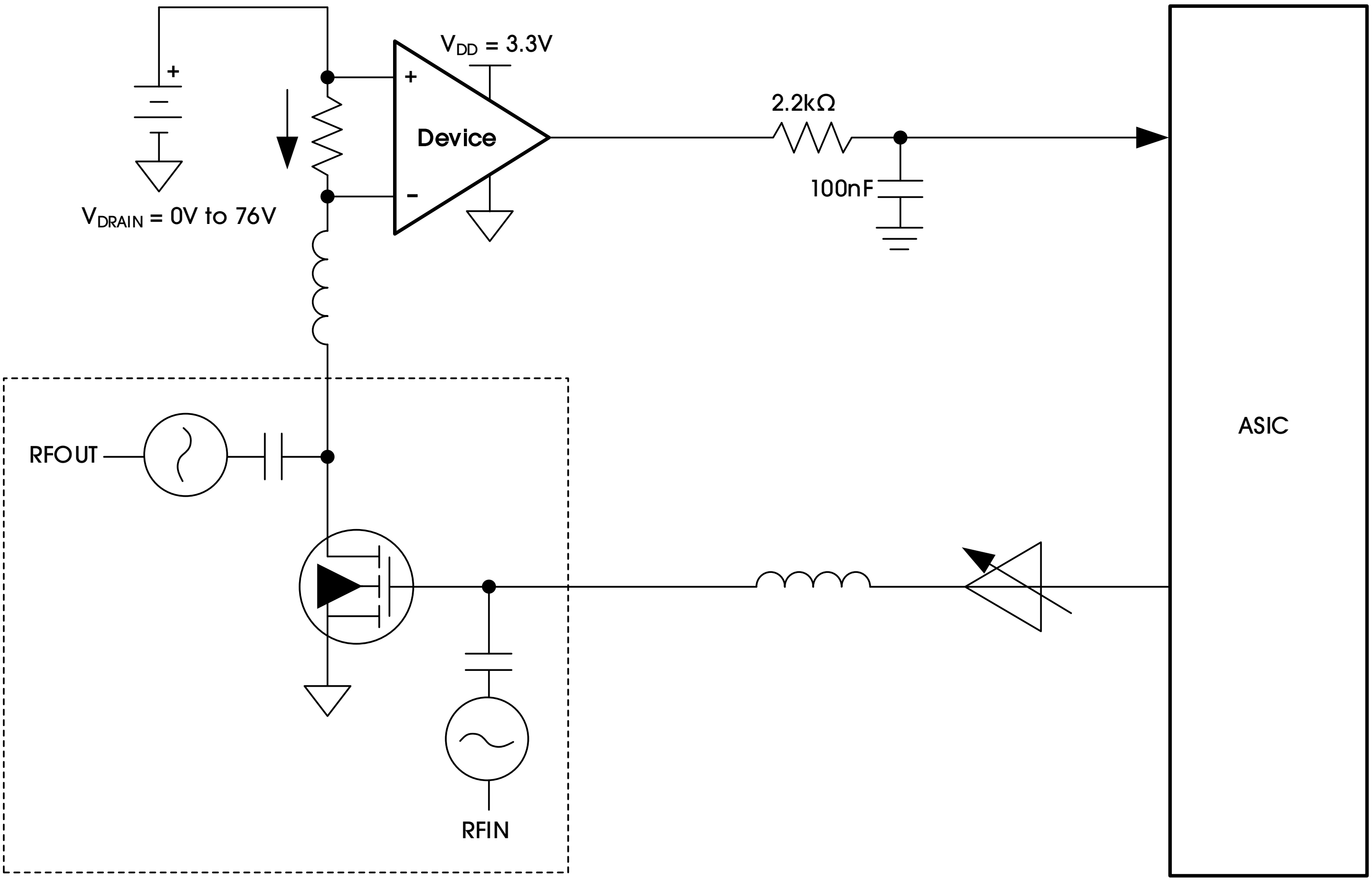

Figure 23. CSA2302 Used in Base-Station Application

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9. PACKAGE INFORMATION

The CSA2302 is available in the MSOP-8 packages. Figure 24 shows the package view.

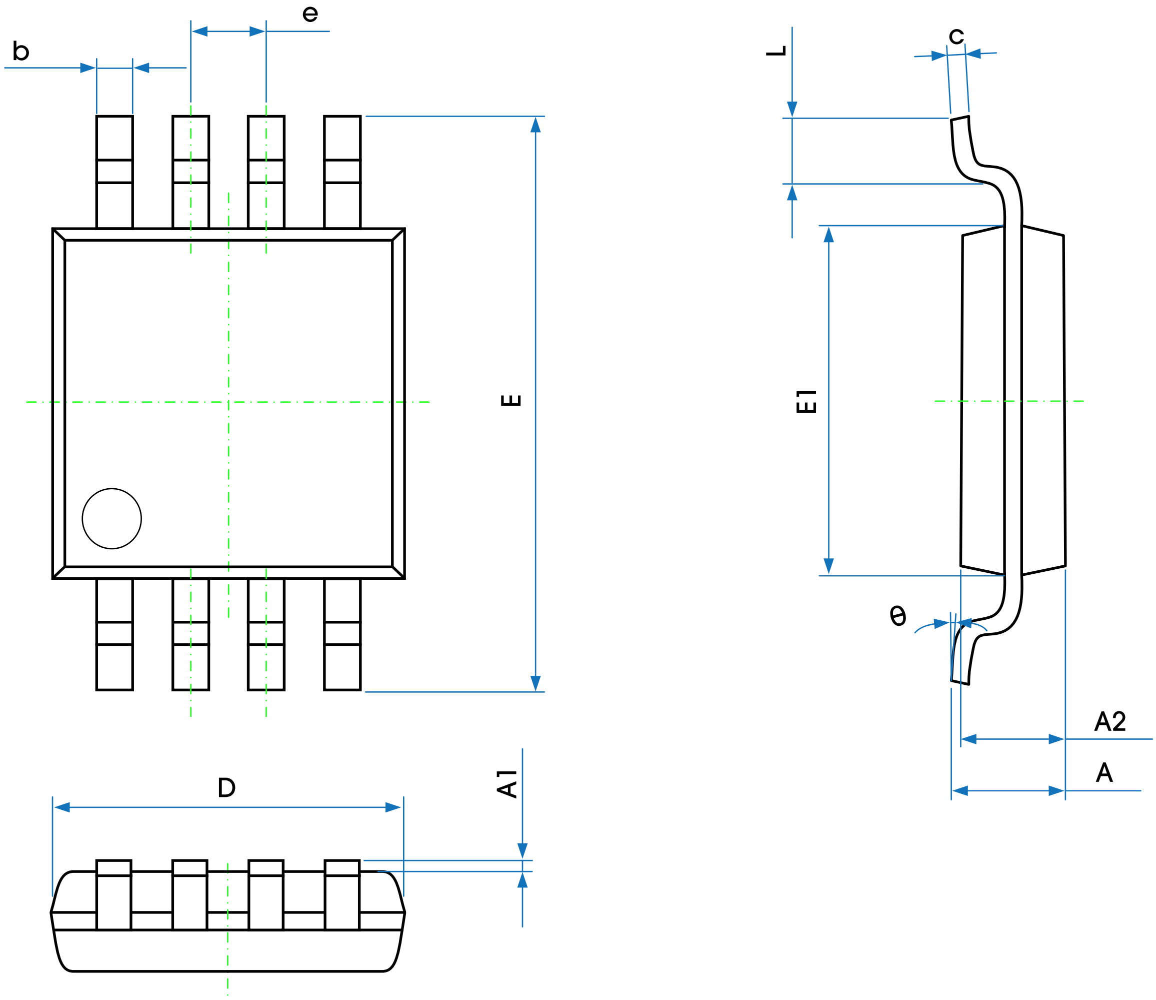


Figure 24. Package View

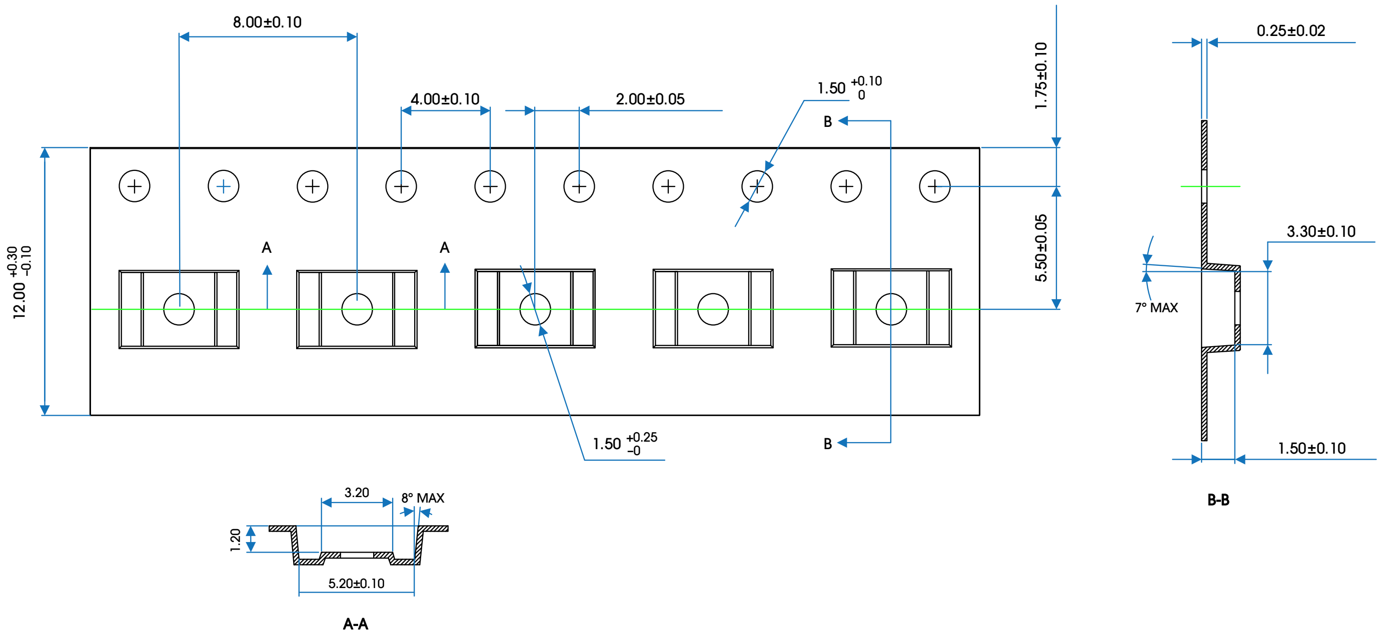
Table 8 provides detailed information about the dimensions.

Table 8. Dimensions

SYMBOL	DIMENSIONS IN MILLIMETERS		DIMENSIONS IN INCHES	
	MIN	MAX	MIN	MAX
A	—	1.100	—	0.043
A1	0.020	0.150	0.001	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	0.650 (BSC)		0.026 (BSC)	
E	4.750	5.050	0.187	0.199
E1	2.900	3.100	0.114	0.122
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

10. TAPE AND REEL INFORMATION

Figure 25 illustrates the carrier tape.



Notes:
1. Cover tape width: 9.5 ± 0.10.
2. Cumulative tolerance of 10 sprocket hole pitch: ±0.20 (max).
3. Camber: not to exceed 1mm in 100mm.
4. Mold#: MSOP-8.
5. All dimensions: mm.
6. Direction of view:

Figure 25. Carrier Tape Drawing

Table 9 provides information about tape and reel.

Table 9. Tape and Reel Information

PACKAGE TYPE	REEL	QTY/REEL	REEL/ INNER BOX	INNER BOX/ CARTON	QTY/CARTON	INNER BOX SIZE (MM)	CARTON SIZE (MM)
MSOP-8	13''	4000	1	8	32000	358*340*50	430*380*390

Figure 26 shows the product loading orientation—pin 1 is assigned on the upper left corner.

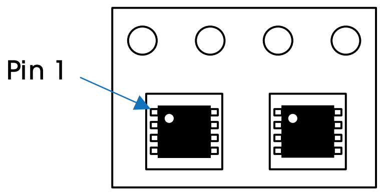


Figure 26. Product Loading Orientation

 Public

REVISION HISTORY

REVISION	DATE	DESCRIPTION
Rev A	23 February 2023	Rev A release.
Rev B	21 March 2023	1. Updated the header. 2. Updated the order information. 3. Updated Table 3 and Table 7. 4. Updated the TYPICAL CHARACTERISTICS information.