INA293-Q1 汽车类、110V 共模、高电压、高带宽、零漂移、单向电流检测放大器

1 特性

- 符合面向汽车 应用的 AEC-Q100：
  - 温度等级 1：–40°C 至 +125°C，T_A
- 宽共模电压：
  - 工作电压：−4V 至 +110V
  - 可承受电压：−20V 至 +116V
- 卓越的 CMRR
  - 160dB 直流 CMRR
  - 85dB 交流 CMRR（50kHz 时）
- 精度
  - 增益
    - 增益误差：0.2%（最大值）
    - 增益漂移：10ppm/°C（最大值）
  - 失调电压
    - 失调电压：±200µV（最大值）
    - 温漂：±1µV/°C（最大值）
- 可用增益：
  - INA293A1-Q1、INA293B1-Q1：20V/V
  - INA293A2-Q1、INA293B2-Q1：50V/V
  - INA293A3-Q1、INA293B3-Q1：100V/V
  - INA293A4-Q1、INA293B4-Q1：200V/V
  - INA293A5-Q1、INA293B5-Q1：500V/V
- 带宽：1MHz
- 压摆率：3V/µs
- 静态电流：1.5mA

2 应用

- 48V 汽车
- 电磁控制
- 48V 直流/直流转换器
- 阀门控制
- 电信设备
- 电源

3 说明

INA293-Q1 是适用于汽车的多功能、高电压、单向、电压输出电流检测放大器，能检测所有外部检测（分流）电阻在 –4V 至 110V 共模电压范围内的压降。负共模电压允许器件的工作电压低于接地电压，从而精确测量典型 H 桥 应用中的环流。INA293-Q1 放大器在增益为 20V/V 时的带宽为 1MHz。在 1MHz 带宽和低失调电压 <200uV（最大值）时，该器件能在共模开关瞬态较大的情况下提供快速稳定响应，进行精确测量。

INA293-Q1 由 2.7V 至 20V 的单电源供电，电源电流为 1.5mA。INA293-Q1 提供五个增益选项：20V/V、50V/V、100V/V、200V/V 和 500V/V。这些增益选项可以满足广泛的动态电流检测 应用。

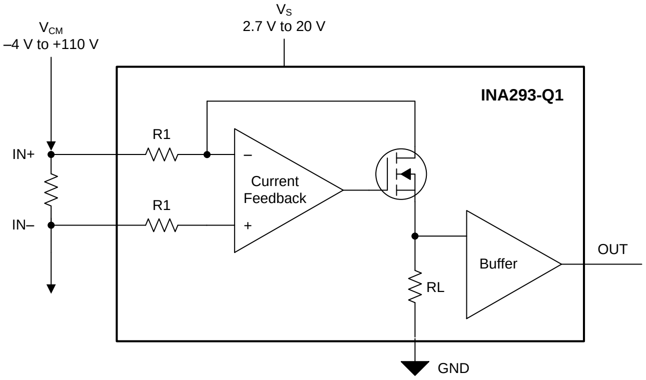
INA293-Q1 的额定工作温度范围为 −40°C 至 +125°C，并且采用节省空间的 SOT-23 封装。

器件信息[1]

器件型号	封装	封装尺寸（标称值）
INA293-Q1	SOT-23 (5)	2.90mm × 1.60mm

(1) 如需了解所有可用封装，请参阅数据表末尾的封装选项附录。

功能框图



English Data Sheet: SBOS870

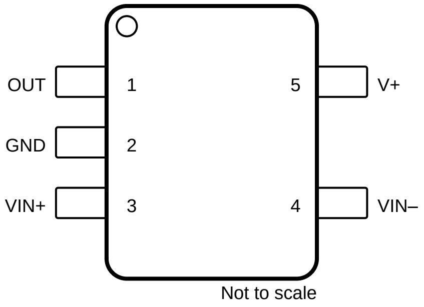
目录

4 修订历史记录

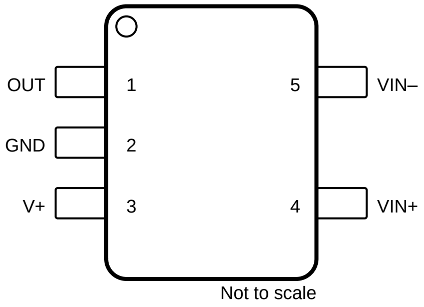
日期	修订版本	说明
2019 年 5 月	*	初始发行版

5 Pin Configuration and Functions

INA293A-Q1: DBV Package
5-Pin SOT-23
Top View



INA293B-Q1: DBV Package(1)
5-Pin SOT-23
Top View



(1) INA293B-Q1 is a preview device.

Pin Functions

PIN			TYPE	DESCRIPTION
NAME	INA293A-Q1	INA293B-Q1		
GND	2	2	Ground	Ground
OUT	1	1	Output	Output voltage
V+	5	3	Analog	Power supply, 2.7 V to 20 V
VIN+	3	4	Input	Connect to supply side of shunt resistor
VIN–	4	5	Input	Connect to load side of shunt resistor

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
V_S	Supply voltage		21	V
	Analog input, differential ($V_{IN+} – V_{IN–}$) (2)	–12	12	V
	Analog inputs, V_{IN+}, $V_{IN–}$ common-mode (2)	–20	116	V
	Output	GND – 0.3	V_S + 0.3	V
T_A	Operating temperature	–55	150	°C
T_J	Junction temperature		150	°C
T_{stg}	Storage temperature	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Rating* 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 under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) VIN+ and VIN– are the voltages at the IN+ and IN– pins, respectively.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 (1) HBM ESD Classification Level 2	±2000	V
		Charged device model (CDM), per AEC Q100-011 CDM ESD Classification Level C6	±1000	

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
V_{CM}	Common-mode input voltage range	–4	12	110	V
V_S	Operating supply voltage range	2.7	5	20	V
T_A	Ambient temperature	–40		125	°C

6.4 Thermal Information

THERMAL METRIC[1]		INA293-Q1	UNIT
		DBV (SOT-23)	
		5 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	221.7	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	144.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	49.7	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	26.1	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	49	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

6.5 Electrical Characteristics

at T_A = 25 °C, V_S = 5 V, $V_{SENSE} = V_{IN+} – V_{IN–}$, V_{SENSE} = 5 mV, and V_{CM} = 12 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT						
V_{CM}	Common-mode input voltage range	$V_{IN+} = V_{IN–}$ = –4 V to +110 V, T_A = –40°C to +125°C	–4		110	V
CMRR	Common-mode rejection ratio	$V_{IN+} = V_{IN–}$ = –4 V to +110 V, T_A = –40°C to +125°C	130	160		dB
		f = 50 kHz		85		dB
V_{OS}	Offset voltage, input referred	$V_{IN+} = V_{IN–}$ = 12 V		25	200	µV
dV_{OS}/dT	Offset voltage drift	$V_{IN+} = V_{IN–}$ = 12 V, T_A = –40℃ to +125℃			1	µV/C
PSRR	Power supply rejection ratio	V_S = 2.7 V to 20 V, T_A = –40°C to +125°C		1	5	µV/V
I_B	Input bias current	I_{B+}, $V_{IN+} = V_{IN–}$ = 12 V, V_{SENSE} = 0 mV		20		µA
		$I_{B–}$, $V_{IN+} = V_{IN–}$ = 12 V, V_{SENSE} = 0 mV		20		µA
OUTPUT						
G	Gain	INA293A1, INA293B1		20		V/V
		INA293A2, INA293B2		50		V/V
		INA293A3, INA293B3		100		V/V
		INA293A4, INA293B4		200		V/V
		INA293A5, INA293B5		500		V/V
	Gain error	GND + 50 mV ≤ V_{OUT} ≤ V_S – 200 mV		0.02	0.2	%
		T_A = –40°C to +125°C		2.5	10	ppm/°C
	Nonlinearity error			0.01		%
	THD + N	f = 1 kHz, V_{OUT} = 4 V_{PP}		65		dB
	Capacitance load	No sustained oscillations		1		nF
VOLTAGE OUTPUT						
	Swing to V_S power supply rail	R_{LOAD} = 10 kΩ to GND, T_A = –40°C to +125°C		V_S – 0.05	V_S – 0.2	V
	Swing to ground	R_{LOAD} = 10 kΩ to GND, V_{SENSE} = 0 mV, T_A = –40°C to +125°C		V_{GND} + 0.005	V_{GND} + 0.025	V

Electrical Characteristics (continued)

at T_A = 25 °C, V_S = 5 V, V_{SENSE} = V_{IN+} – $V_{IN–}$, V_{SENSE} = 5 mV, and V_{CM} = 12 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
FREQUENCY RESPONSE						
BW	Bandwidth	Gain = 20 V/V, C_{LOAD} = 5 pF, V_{SENSE} = 200 mV		1000		kHz
		Gain = 50 V/V, C_{LOAD} = 5 pF, V_{SENSE} = 80 mV		900		kHz
		Gain = 100 V/V, C_{LOAD} = 5 pF, V_{SENSE} = 40 mV		850		kHz
		Gain = 200 V/V, C_{LOAD} = 5 pF, V_{SENSE} = 20 mV		800		kHz
		Gain = 500 V/V, C_{LOAD} = 5 pF, V_{SENSE} = 8 mV		750		kHz
SR	Slew rate			3		V/µs
	Settling time	V_{IN+} = $V_{IN–}$ = 12 V, V_{SENSE} = 0 mV to 100 mV, output settles to 0.5%		10		µs
		V_{IN+} = $V_{IN–}$ = 12 V, V_{SENSE} = 0 mV to 100 mV, output settles to 1%		5		µs
NOISE						
	Voltage noise density			55		nV/√Hz
POWER SUPPLY						
I_Q	Quiescent current	V_{IN+} = $V_{IN–}$ = 12 V		1.5	2.0	mA
		T_A = –40°C to +125°C			2.5	mA

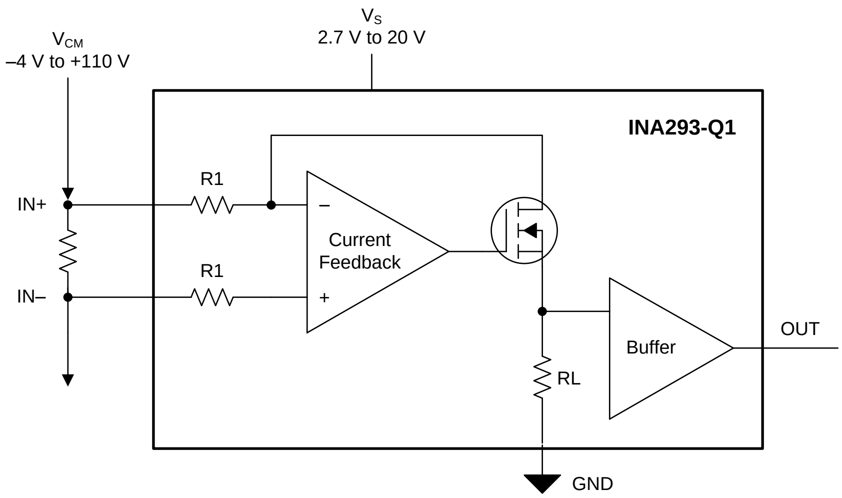
ADVANCE INFORMATION

7 Detailed Description

7.1 Overview

The INA293-Q1 is an automotive current-sense amplifier that offers a wide common-mode range, precision, zero-drift topology, excellent common-mode rejection ratio (CMRR), and a high bandwidth with fast slew rate. Different gain versions are available to optimize the output voltage based on the application. The INA293-Q1 is designed using a transconductance architecture with a current-feedback amplifier that enables low bias currents of 20 µA with a common-mode voltage of 110 V.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Amplifier Input Common-Mode Signal

The INA293-Q1 handles large common-mode voltages from –4 V to +110 V, and large common-mode signals on the IN+ and IN– pins beyond the supply voltage, V_S, operating from 2.7 V to 20 V. The INA293-Q1 works in pulse width modulation (PWM) applications with high common-mode transients. PWM applications have high dv/dt signals; however, the INA293-Q1 output stage settles faster, and thus enables accurate real time PWM measurements with the least blanking time. The INA293-Q1 input offset voltage of < 100 µV enables small-signal measurements accurately across a shunt resistor. The INA293-Q1 is designed with a high bandwidth of 1 MHz at the gain of 20 V/V with an output slew rate of < 3 V/µs. The combination of low offset and high bandwidth enables accurate current measurement with fast throughput for fast overcurrent detection.

7.3.1.1 Input-Signal Bandwidth

The INA293-Q1 –3-dB bandwidth is gain dependent, with several gain options of 20 V/V, 50 V/V, 100 V/V, 200 V/V and 500 V/V. The device is designed with a two-stage amplifier where the first stage is a transconductance amplifier measuring the voltage across the shunt. The differential voltage developed across the IN+ and IN– pins is converted to current output by the first-stage amplifier. The current output of the first-stage amplifier is internally converted to voltage output by connecting an internal precision resistor to ground. The second-stage amplifier, which is a voltage follower, buffers the voltage generated across the internal precision resistor to output pin VOUT. This unique multistage design enables the amplifier to achieve a high bandwidth of 1 MHz at a gain of 20 V/V. To maintain the stability of the amplifier as the gain increases, the amplifiers provide stable output by compensating for lower bandwidth. The INA293-Q1 with a gain of 500 V/V achieves a –3-dB bandwidth of 750 kHz. The device bandwidth provides the fast throughput and fast response that is required for the rapid detection and fast processing of overcurrent events. 图 1 shows the performance profile of the device over frequency. The full amplifier bandwidth is always available for fast overcurrent events at the same time that the lower frequency signals are amplified at a low distortion level. The output signal accuracy is reduced for frequencies closer to the maximum bandwidth. Individual requirements determine the acceptable limits of distortion for high-frequency, current-sensing applications. Testing and evaluation in the end application or circuit is required to determine the acceptance criteria, and to validate that the performance levels meet the system specifications.

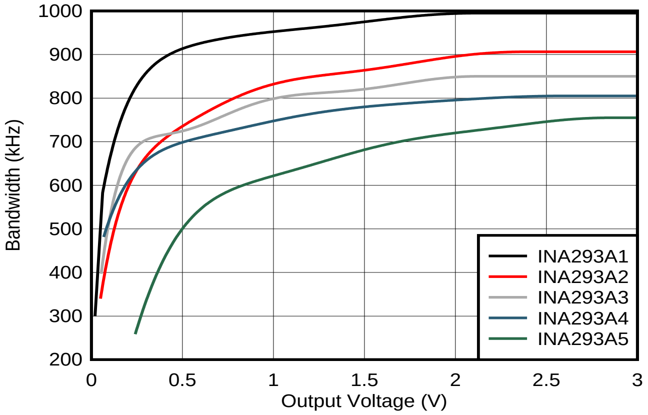


图 1. Bandwidth vs Output Voltage

Feature Description (接下页)

7.3.1.2 Low Input Bias Current

The INA293-Q1 measures currents on a common-mode voltage as high as 110 V. The INA293-Q1 can be configured as high side with direct connection to the battery to measure accurate currents. The INA293-Q1 input bias current draws < 20 µA at a common-mode voltage of 110 V. Bias currents of < 20 µA at a common-mode voltage of 110 V enable precision current sensing on applications that require lower leakage for high-side applications. The INA293-Q1 bias current consumption of < 20 µA enables precision current sensing for high-side only measurements.

7.3.1.3 Low V_{SENSE} Operation

The INA293-Q1 operates at a low V_{SENSE} signal. The output of the INA293-Q1 is linear with differential input signals across IN+ and IN– as low as 200 µV, and is limited by the input offset voltage of the amplifier. The INA293-Q1 is a chopped input architecture with zero-drift implementation to make sure that performance is consistent across the wide temperature range of –40°C to +125°C. Low offset voltage with low temperature offset drift enables the INA293-Q1 to measure low V_{SENSE} voltage consistently across temperature. Low V_{SENSE} operation is particularly beneficial when using low ohmic shunts that enable low current measurements, thus saving significant power loss across shunt.

7.3.1.4 Wide Fixed Gain Output

The INA293-Q1 gain error is < 0.25% at room temperature with a maximum drift of 10 ppm/°C over the full temperature range of – 40°C to +125°C. The INA293-Q1 is available in multiple gain options of 20 V/V, 50 V/V, 100 V/V, 200 V/V and 500 V/V. Depending on the system requirements and signal-to-noise ratio requirements desired, the INA293-Q1 with the desired gain can be selected. A gain of 20 V/V is often selected for applications that require accurately measuring low-level signals that are sensitive to noise. In applications where large signal content is more critical, select a higher gain amplifier, such as 500 V/V.

Internally, the amplifier gain is set with fixed resistors with a set ratio. The resistors are precision components with very low drift that are very unique and specific to the Texas Instruments manufacturing process. The gain resistors are set and described in 表 1.

表 1. Fixed Gain Resistor

GAIN	R1	RL
20 (V/V)	25 kΩ	500 kΩ
50 (V/V)	10 kΩ	500 kΩ
100 (V/V)	10 kΩ	1000 kΩ
200 (V/V)	5 kΩ	1000 kΩ
500 (V/V)	2 kΩ	1000 kΩ

7.3.1.5 Wide Supply Range

The INA293-Q1 operates with a wide supply range from a 2.7 V to 20 V. The output stage reaches a full-scale output to 20 V. Wide output range can enable very-wide dynamic current measurements. For a gain of 20 V/V, the maximum differential input acceptable is 1 V. The offset of the INA293-Q1 is ±200 µV, and is capable of measuring a wide dynamic range of current up to 74 dB.

7.4 Device Functional Modes

7.4.1 Unidirectional Operation

The INA293-Q1 measures the differential voltage developed across a resistor. This resistor is referred to as a current-sensing resistor or a current-shunt resistor. The INA293-Q1 operates in unidirectional mode only, and measures current in one direction only. The most common application of measuring unidirectional current is to measure current on a power supply to load, as shown in 图 2.

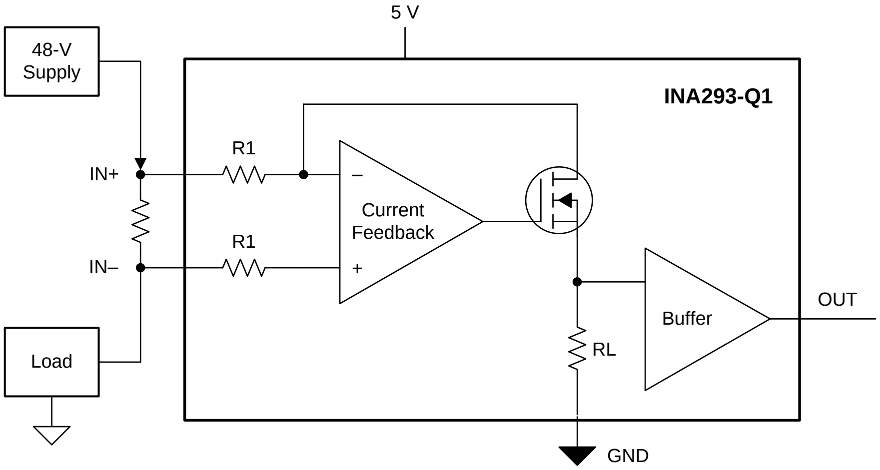


图 2. Unidirectional Application

The linear range of the output stage is limited to how close the output voltage can approach ground under zero-input conditions. The zero-current output voltage of the INA293-Q1 is very small; for most unidirectional applications, the output is limited by the input offset specification of 100 µV. When designing a system with the INA293-Q1, take care so that the minimum current measured across the shunt resistor is at a minimum of 100 µV. The INA293-Q1 lowest output voltage measurement capability is limited by the output stage of the amplifier.

7.4.2 High Signal Throughput

With a bandwidth of 1 MHz at the gain of 20 V/V and a rising slew rate of 3 V/µs, the INA293-Q1 is specifically designed for detecting and protecting applications from fast inrush currents in the system. In 表 2, the INA293-Q1 responds in less than 1 µs for a system measuring a 75-A threshold on a 2 mΩ shunt. The INA293-Q1 high bandwidth and high slew rate are used to trigger and detect overcurrent events in less than microseconds to indicate faults in the system.

表 2. Response Time

PARAMETER		EQUATION	INA293A1-Q1 AND INA293B1-Q1 AT V_S = 5 V
G	Gain		20 V/V
I_{MAX}	Maximum current		100 A
$I_{Threshold}$	Threshold current		75 A
R_{SENSE}	Current sense resistor value		2 mΩ
V_{OUT}	Output voltage		4 V
SR	Slew rate	$V_{OUT} = I_{MAX} \times R_{SENSE} \times G$	3 V/µs
	Output response time		< 1 µs

ADVANCE INFORMATION

8 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The INA293-Q1 measures the voltage developed across a current-sensing resistor when current passes through. The ability to have shunt common-mode voltages from −4 V to +110 V drive and control the output signal with V_S offers multiple configurations, as discussed throughout this section.

8.1.1 Selecting R_{Sense}

The INA293-Q1 determines the current magnitude by measuring the differential voltage developed across a resistor. This resistor is referred to as a current-sensing resistor or a current-shunt resistor. The flexible design of the device allows a wide input signal range across this current-sensing resistor.

Choose a current-sensing resistor that is based on the full-scale current to be measured, the full-scale input range of the circuitry following the device, and the device gain selected. The minimum current-sensing resistor is a design-based decision in order to maximize the input range of the signal-chain circuitry. Full-scale output signals that are not maximized to the full input range of the system circuitry limit the ability of the system to exercise the full dynamic range of system control.

Two important factors to consider when finalizing the current-sensing resistor value are the required current measurement accuracy and the maximum power dissipation across the resistor. A larger resistor voltage provides for a more accurate measurement, but increases the power dissipation in the resistor. The increased power dissipation generates heat, and reduces the sense resistor accuracy because of the temperature coefficient. The voltage signal measurement uncertainty is reduced when the input signal gets larger because any fixed errors become a smaller percentage of the measured signal. The design trade-off to improve measurement accuracy increases the current-sensing resistor value. The increased resistance value results in an increased power dissipation in the system that can additionally decrease the overall system accuracy. Based on these relationships, the measurement accuracy is inversely proportional to both the resistance value and power dissipation contributed by the current-shunt selection.

By increasing the current-shunt resistor, the differential voltage is increased across the resistor. Larger input differential voltages require a smaller amplifier gain to achieve a full-scale amplifier output voltage. Smaller current-shunt resistors are desired, but require large amplifier gain settings. The larger gain settings often have increased error and noise parameters, and are not attractive for precision designs. Historically, the design goals for high-performance measurements forced designers to accept selecting larger current-sense resistors and lower gain amplifier settings. The INA293-Q1 provides 200-V/V and 500-V/V gain options that offer the high gain setting and maintains high-performance levels with offset values below 100 µV. These devices allow for the use of lower shunt resistor values to achieve lower power dissipation and still meet high system performance specifications.

表 3 shows an example of the different results obtained from using five different gain versions of the INA293-Q1. From the table data, the highest gain device allows a smaller current-shunt resistor and decreased power dissipation in the element.

表 3. R_{SENSE} Selection and Power Dissipation(1)

PARAMETER		EQUATION	RESULTS AT V_S = 5 V				
			A1, B1 DEVICES	A2, B2 DEVICES	A3, B3 DEVICES	A4, B4 DEVICES	A5, B5 DEVICES
G	Gain		20 V/V	50 V/V	100 V/V	200 V/V	500 V/V
V_{DIFF}	Ideal differential input voltage	$V_{DIFF} = V_{OUT} / G$	0.25 V	0.1 V	0.05 V	0.025 V	0.01 V
R_{SENSE}	Current sense resistor value	$R_{SENSE} = V_{DIFF} / I_{MAX}$	25 mΩ	10 mΩ	5 mΩ	2.5 mΩ	1 mΩ
P_{SENSE}	Current-sense resistor power dissipation	R_{SENSE} x I_{MAX}2	2.5 W	1 W	0.5W	0.25 W	0.1 W

(1) Design example with 10-A full-scale current with maximum output voltage set to 5 V.

8.2 Typical Application

The INA293-Q1 is a unidirectional, current-sense amplifier capable of measuring currents through a resistive shunt with shunt common-mode voltages from −4 V to +110 V.

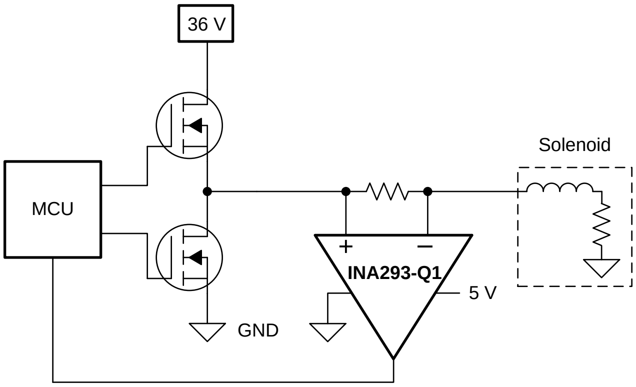


图 3. Current Sensing in a Solenoid Application

8.2.1 Design Requirements

V_{SUPPLY} is set to 12 V, Shunt resistor used is 50 mΩ, Common-mode voltage set to 36 V. 表 4 lists the design setup for this application

表 4. Design Parameters

DESIGN PARAMETERS	EXAMPLE VALUE
Power supply voltage	12 V
High-side current sensing	36 V
Maximum current sense	5 A
R_{SENSE} resistor	50 mΩ
Gain option	50 V/V

8.2.2 Detailed Design Procedure

The INA293-Q1 is designed to measure current in a typical solenoid application. The INA293-Q1 measures current across the 50-mΩ shunt that is placed directly across the h-bridge. The INA293-Q1 measures the differential voltage across the shunt resistor, and the signal is internally amplified with a gain of 50 V/V. The output of the INA293-Q1 is connected to the analog-to-digital converter (ADC) to digitize the current measurements.

Solenoid loads are highly inductive and are often prone to failure. Solenoids are often used for position control, precise fluid control, and fluid regulation. Measuring real-time current on the solenoid continuously can indicate the premature failure of solenoid, and can lead to a faulty control loop in the system. Measuring high-side current also indicates if there are any ground faults on the solenoid or the FETs that can be damaged in an application. The INA293-Q1, with high bandwidth and slew rate, is used to detect fast overcurrent conditions to prevent the solenoid damage from short-to-ground faults.

8.2.3 Application Curve

图 4 shows the output response of a solenoid.

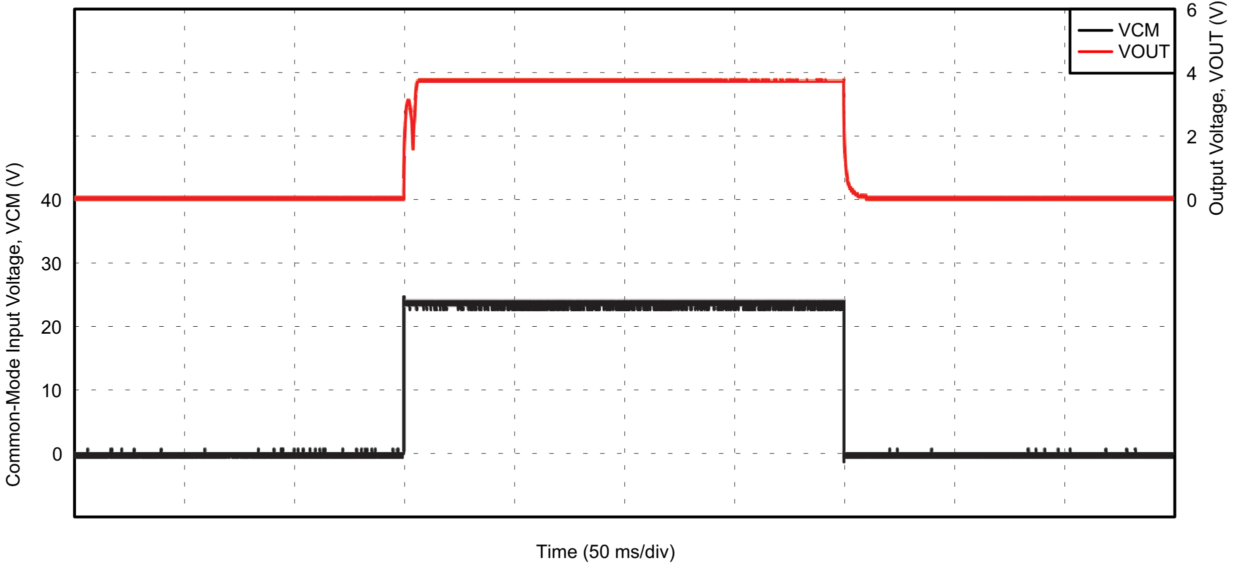


图 4. Solenoid Control Current Response

9 Power Supply Recommendations

The input circuitry of the INA293-Q1 device can accurately measure beyond the power-supply voltage, The power supply can be 5 V; whereas, the load power-supply voltage goes up to 110 V. The output voltage range of the OUT pin, however, is limited by the voltages on the power-supply pin.

10 Layout

10.1 Layout Guidelines

Attention to good layout practices is always recommended.

- Keep traces short, and when possible, use a printed circuit board (PCB) ground plane with surface-mount components placed as close as possible to the device pins.
- Place small ceramic capacitors directly across amplifier inputs to reduce RFI and EMI sensitivity.
- Place the amplifier as far away as possible from RFI sources on the PCB layout.
- Sources can include other components in the same system as the amplifier, such as inductors (particularly, switched inductors handling a lot of current and at high frequencies).
- RFI can generally be identified as a variation in offset voltage or dc signal levels with changes in the interfering RF signal. If the amplifier cannot be located away from sources of radiation, shielding may be needed.

10.2 Layout Example

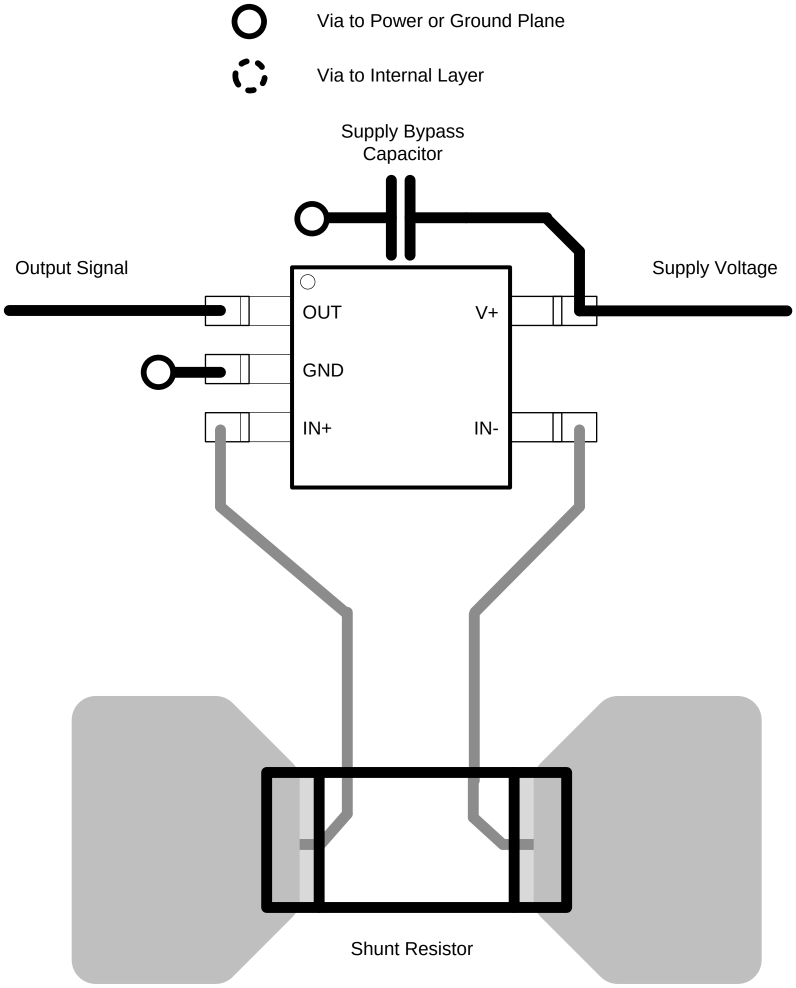


图 5. INA293A Recommended Layout

11 器件和文档支持

11.1 文档支持

11.1.1 相关文档

请参阅如下相关文档：德州仪器 (TI)，*INA293EVM 用户指南*

11.2 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的*通知我* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

11.3 社区资源

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.4 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.5 静电放电警告

ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

11.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PINA293A1QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		Samples
PINA293A2QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		Samples
PINA293A3QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		Samples
PINA293A4QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		Samples
PINA293A5QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125		Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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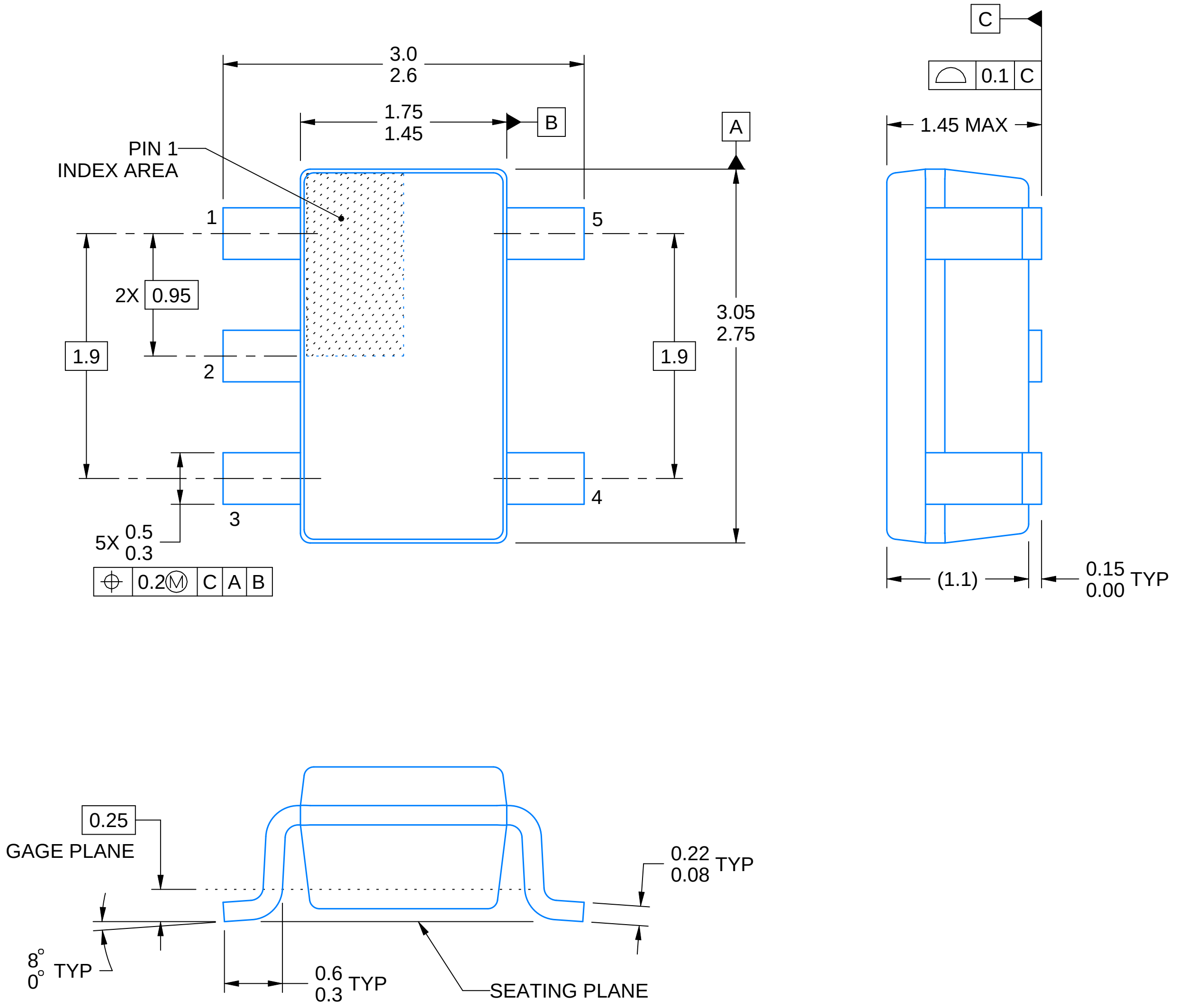

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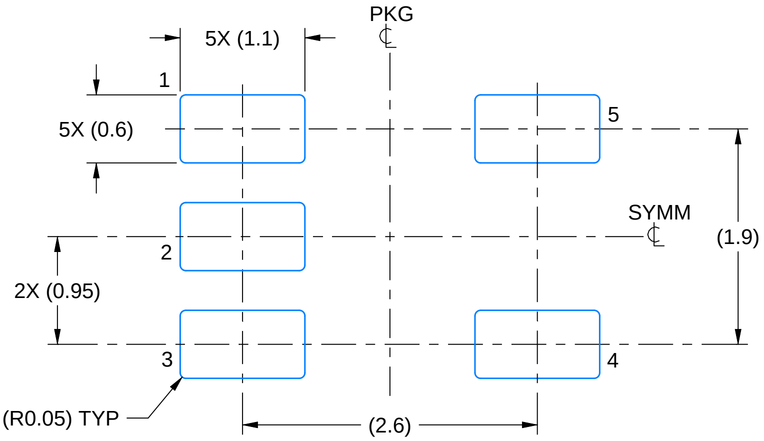
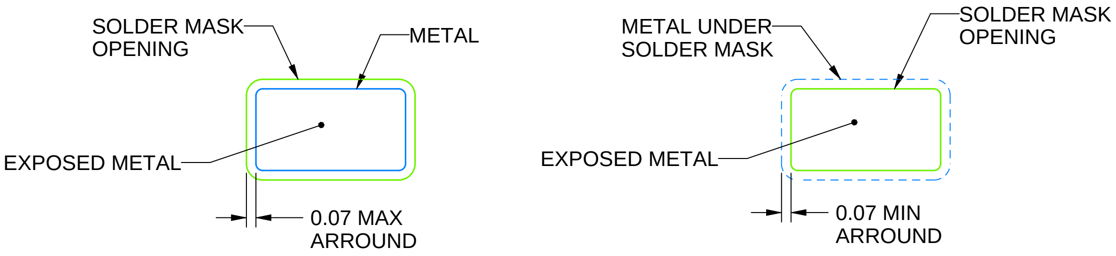
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



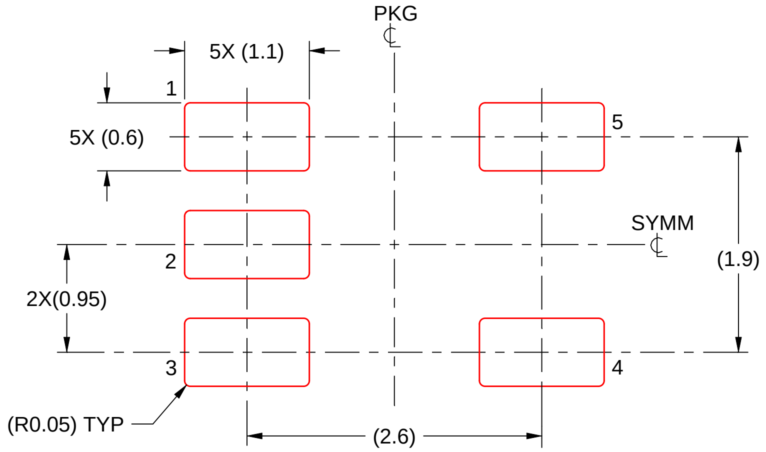
NON SOLDER MASK
DEFINED
(PREFERRED)

SOLDER MASK
DEFINED

SOLDER MASK DETAILS

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

重要声明和免责声明

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