-5V to 100V, Bidirectional, Ultra-Precision Current-Sense Amplifier with High PWM Rejection

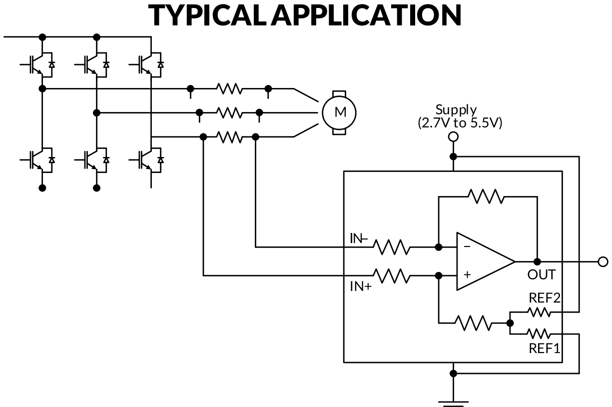
1 FEATURES

- **High PWM Rejection**
- **Excellent CMRR:**
  - 150dB (TYP) DC CMRR
- **Wide Common-Mode Range: -5V to 100V**
- **Gain Error:**
  - 25°C: ±0.1% (MAX)
  - -40°C to 125°C: ±0.5% (MAX)
- **Offset:**
  - 25°C: ±30µV (MAX)
  - -40°C to 125°C: ±200µV (MAX)
- **Available Gains:**
  - RSA240A: 20V/V
  - RSA240B: 50V/V
  - RSA240C: 100V/V
- **Quiescent Current: 1.55mA (TYP)**
- **Micro Size Packages: SOP8, TSSOP8**

2 APPLICATIONS

- **Motor Controls**
- **Solenoid and Valve Controls**
- **Power Management**
- **Actuator Controls**
- **Pressure Regulators**
- **Telecom Equipment**

TYPICAL APPLICATION



3 DESCRIPTIONS

The RSA240 device is a bidirectional, fixed gain, voltage-output, current-sense amplifier which features high PWM rejection and wide common-mode voltage range from -5V to 100V.

The high PWM rejection suppresses large common-mode transients ($\Delta V/\Delta t$) on the output signal, which is particularly relevant for applications utilizing pulse width modulation (PWM), such as motor driver and solenoid control systems. The negative common-mode voltage capability allows the device to function even when the voltage is below ground, which is useful in typical applications like the flyback period of a solenoid.

These characteristics make accurate current measurement without large transients and related recovery disturbances on the output voltage.

The device is powered from a single 2.7V to 5.5V supply, and draws 1.55mA (TYP) supply current. There are three fixed gain options: 20V/V, 50V/V and 100V/V. The low offset in the zero-drift architecture enables highly accurate current sensing, even with very small voltage drops across the shunt as low as 10mV full-scale.

The RSA240 is available in Green SOP8 and TSSOP8 packages. It operates over an ambient temperature range of -40°C to 125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RSA240	SOP8	4.90mm x 3.90mm
	TSSOP8	3.00mm × 4.40mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Table of Contents

4 REVISION HISTORY

Note: Page numbers for previous revisions may different from page numbers in the current version.

Version	Change Date	Change Item
A.0	2025/01/09	Preliminary version completed
A.0.1	2025/02/20	1. Update Gain Error PARAMETER value 2. Update Typical Characteristics Figure 5
A.1	2025/06/26	Initial version completed

5 PACKAGE/ORDERING INFORMATION [1]

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking [2]	MSL [3]	Package Qty
RSA240AXK	SOP8	8	1	-40°C ~125°C	RSA240A	MSL1	Tape and Reel,4000
RSA240BXK	SOP8	8	1	-40°C ~125°C	RSA240B	MSL1	Tape and Reel,4000
RSA240CXK	SOP8	8	1	-40°C ~125°C	RSA240C	MSL1	Tape and Reel,4000
RSA240AXQ	TSSOP8	8	1	-40°C ~125°C	RSA240A	MSL1	Tape and Reel,4000
RSA240BXQ	TSSOP8	8	1	-40°C ~125°C	RSA240B	MSL1	Tape and Reel,4000
RSA240CXQ	TSSOP8	8	1	-40°C ~125°C	RSA240C	MSL1	Tape and Reel,4000

NOTE:

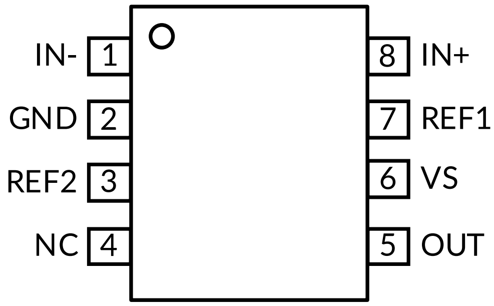
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

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

(3) RUNIC classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F, Please align with RUNIC if your end application is quite critical to the preconditioning setting or if you have special requirement.

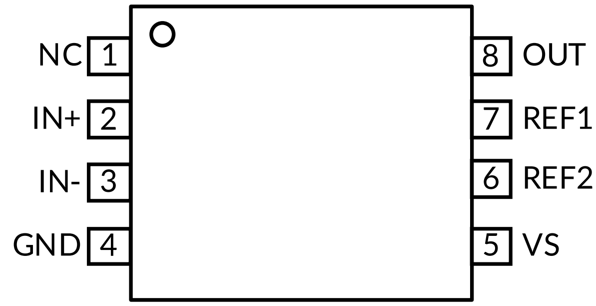
6 PIN CONFIGURATION AND FUNCTIONS

TOP VIEW



SOP8

TOP VIEW



TSSOP8

Pin Description

PIN		NAME	TYPE	DESCRIPTION
SOP8	TSSOP8			
4	1	NC	-	Reserved. Connect to ground or leave floating.
8	2	IN+	Analog input	Connect to supply side of shunt resistor.
1	3	IN-	Analog input	Connect to load side of shunt resistor.
2	4	GND	Analog	Ground
6	5	VS	-	Power supply, 2.7V to 5.5V
3	6	REF2	Analog input	Reference 2 voltage. Connect to 0V to VS.
7	7	REF1	Analog input	Reference 1 voltage. Connect to 0V to VS.
5	8	OUT	Analog output	Output voltage

7 SPECIFICATIONS

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) [1]

PARAMETER	DESCRIPTION		MIN	MAX	UNITS
Voltage	Supply			6	V
	Analog inputs, V_{IN+} , V_{IN-} [2]	Differential (V_{IN+}) – (V_{IN-}), 1s maximum duration due to package thermal dissipation	-30	30	V
		Common-mode	-10	105	
	REF1, REF2, NC inputs		GND – 0.3	V_S + 0.3	V
	Output		GND – 0.3	V_S + 0.3	V
θ_{JA}	Package thermal impedance [3]	SOP8		110	°C/W
		TSSOP8		240	
Temperature	Operating free-air, T_A		-40	125	°C
	Junction, T_J [4]			150	
	Storage, T_{stg}		-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) V_{IN+} and V_{IN-} are the voltages at the IN+ and IN− pins, respectively.
(3) The package thermal impedance is calculated in accordance with JESD-51.
(4) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-Body Model (HBM)	±2000	V
		Charged-Device Model (CDM)	±1000	

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Electrical Characteristics

(V_S = 5V, V_{SENSE} = V_{IN+} - V_{IN-}, V_{CM} = 12V, V_{REF1} = V_{REF2} = V_S/2 and T_A = -40°C to +125°C, typical values are measured at T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN(1)	TYP(2)	MAX(1)	UNITS
Input						
Input Common-Mode Voltage	V_{CM}	V_{IN+} = -5V to 100V, V_{SENSE} = 0mV	-5		100	V
Common-Mode Rejection Ratio	CMRR	V_{IN+} = -5V to 100V, V_{SENSE} = 0mV	135	150		dB
Offset Voltage, Input-Referred	V_{OS}	V_{SENSE} = 0mV, T_A = +25°C		±6	±30	µV
		V_{SENSE} = 0mV, T_A = -40°C to +125°C			±200	µV
Power Supply Rejection Ratio	PSRR	V_S = 2.7V to 5.5V, V_{SENSE} = 0mV		±1.5	±12	µV/V
Input Bias Current	I_B	I_{B+} , I_{B-}, V_{SENSE} = 0mV		10		nA
Reference Input Range			0		V_S	V
Output						
Gain	G	RSA240A		20		V/V
		RSA240B		50		
		RSA240C		100		
Gain Error		GND + 50mV ≤ V_{OUT} ≤ V_S - 200mV, T_A = +25°C		±0.03	±0.1	%
		T_A = -40°C to +125°C			±0.5	%
Nonlinearity Error		GND + 10mV ≤ V_{OUT} ≤ V_S - 200mV		±0.01		%
Reference Divider Accuracy		V_{OUT} = |(V_{REF1} - V_{REF2})|/2 at V_{SENSE} = 0mV		±0.02	±0.5	%
Reference Voltage Rejection Ratio (Input-Referred)	RVRR	RSA240A		20		µV/V
		RSA240B		10		
		RSA240C		5		
Maximum Capacitive Load		No sustained oscillation		1		nF
Voltage Output						
Swing to VS Power Supply Rail		R_L = 10kΩ to GND		V_S-0.005	V_S-0.015	V
Swing to GND		R_L = 10kΩ to GND, V_{SENSE} = 0mV, V_{REF1} = V_{REF2} = 0V		V_{GND}+3	V_{GND}+10	mV
Frequency Response						
Bandwidth	BW	All gains, -3dB bandwidth		500		kHz
Settling Time		Output settles to 0.5% of final value		5		µs
Slew Rate	SR	OUT=2V_{PP}		2.3		V/µs
Noise (Input-Referred)						
Voltage Noise Density				150		$nV/\sqrt{Hz}$
Power Supply						
Operating Voltage Range	V_S		2.7		5.5	V
Quiescent Current	I_Q	V_{SENSE} = 0mV, T_A = +25°C		1.55	1.8	mA
		vs temperature, T_A = -40°C to +125°C			2	

NOTE:
(1) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

7.4 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

V_S = 5V, V_{CM} = 12V, V_{REF1} = V_{REF2} = V_S/2 and T_A = +25°C, unless otherwise noted.

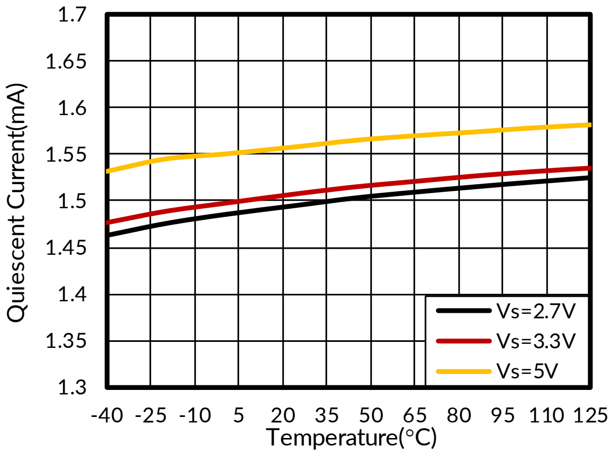


Figure 1. Quiescent Current vs Temperature

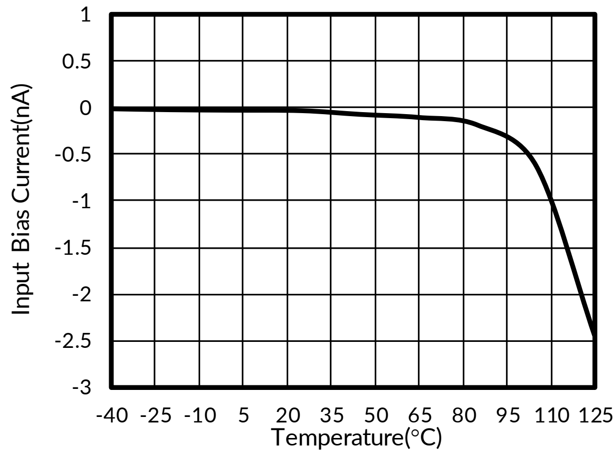


Figure 2. Input Bias Current vs Temperature

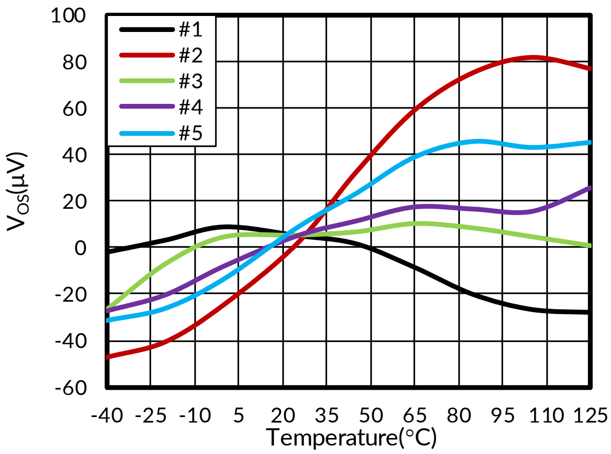


Figure 3. Offset Voltage vs Temperature

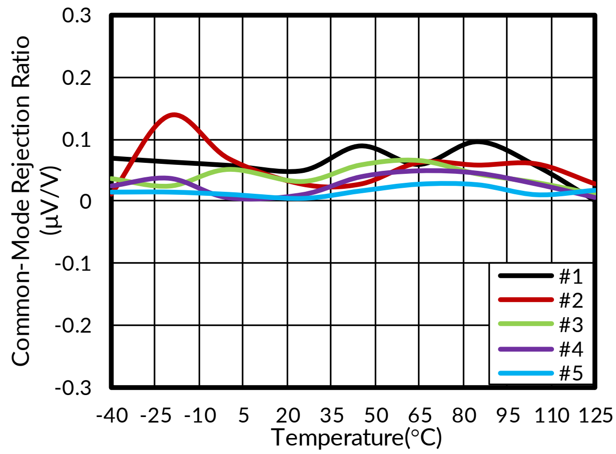


Figure 4. Common-Mode Rejection Ratio vs Temperature

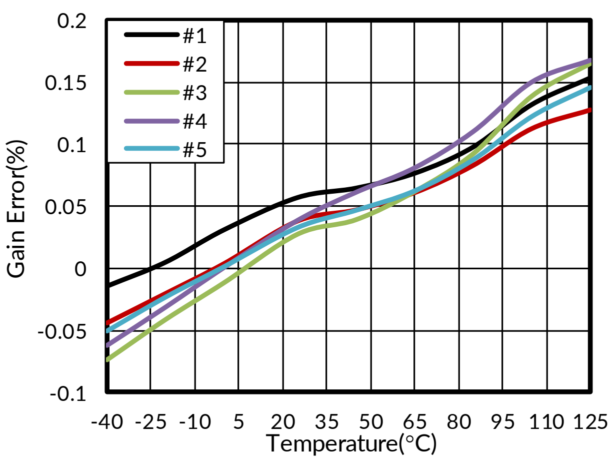


Figure 5. Gain Error vs Temperature

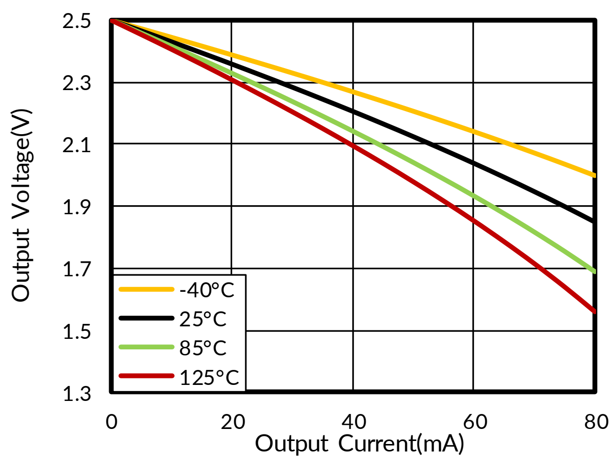


Figure 6. Output Voltage vs Output Current (Sourcing)

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

V_S = 5V, V_{CM} = 12V, V_{REF1} = V_{REF2} = V_S/2 and T_A = +25°C, unless otherwise noted.

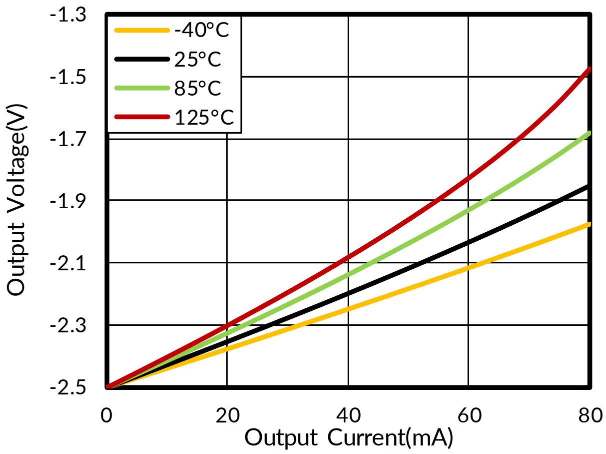


Figure 7. Output Voltage vs Output Current (Sinking)

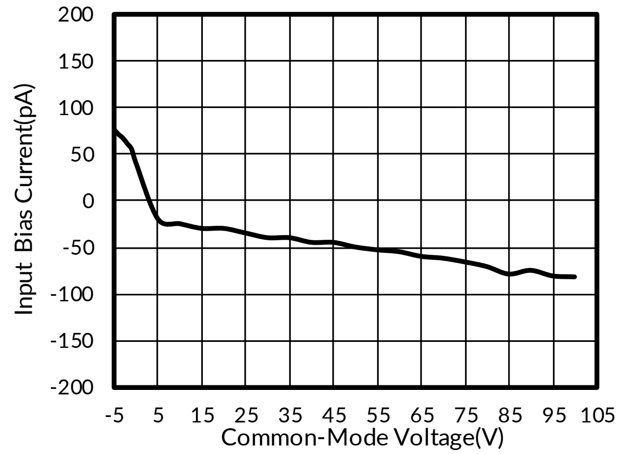


Figure 8. Input Bias Current vs Common-Mode Voltage

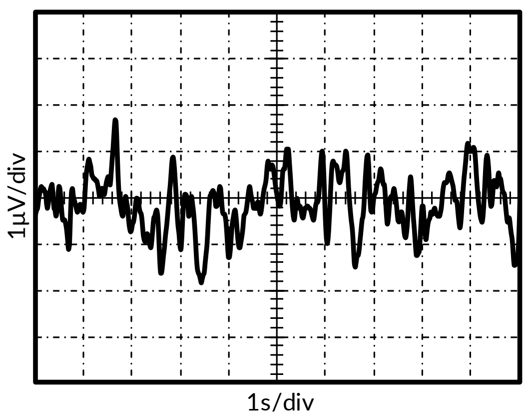


Figure 9. 0.1Hz to 10Hz Voltage Noise

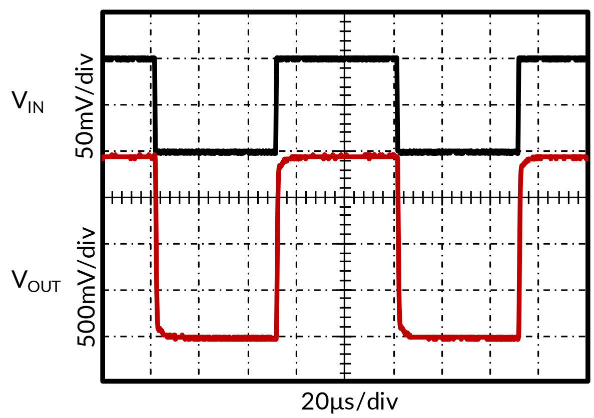


Figure 10. Large-Single Step Response

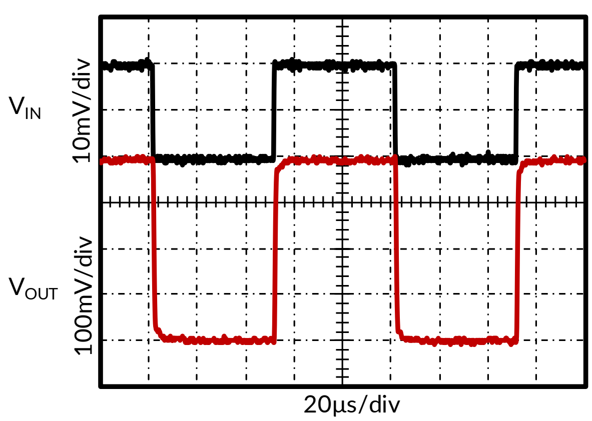


Figure 11. Small-Single Step Response

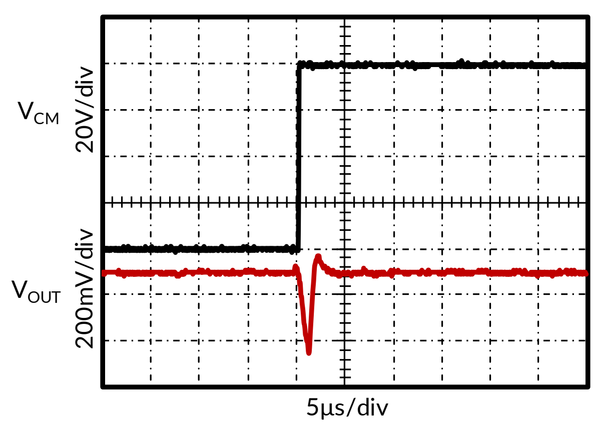


Figure 12. Common-Mode Voltage Transient Response

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

V_S = 5V, V_{CM} = 12V, V_{REF1} = V_{REF2} = V_S/2 and T_A = +25°C, unless otherwise noted.

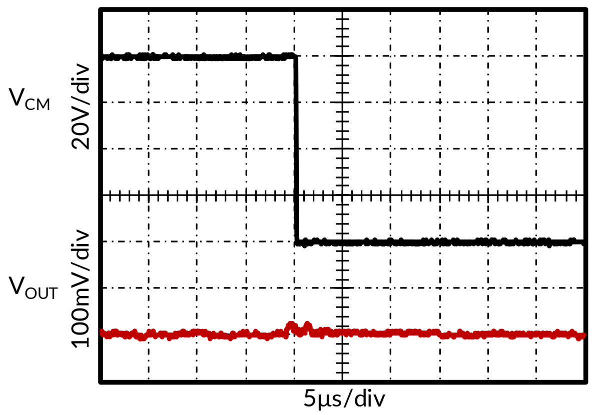


Figure 13. Common-Mode Voltage Transient Response

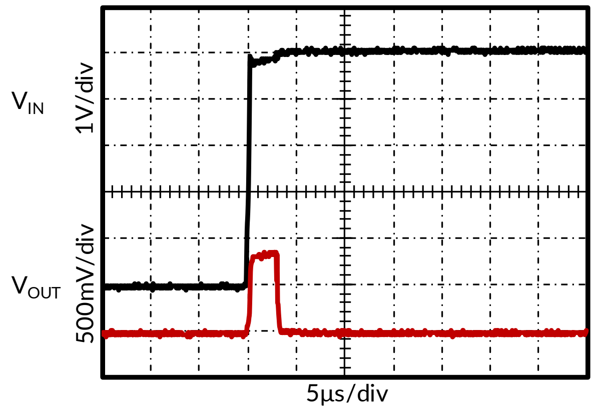


Figure 14. Start-Up

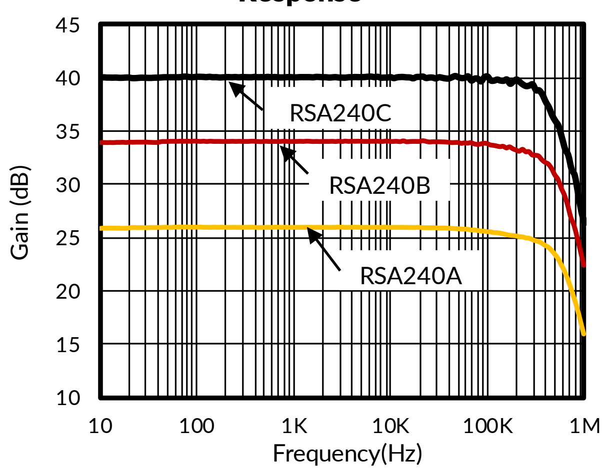


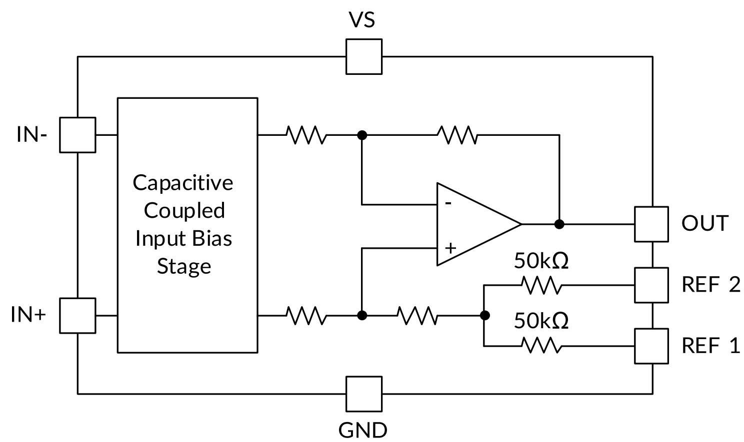
Figure 15. Gain vs Frequency

8 DETAILED DESCRIPTION

8.1 Overview

The RSA240 is a current-sense amplifier that offers a wide common-mode range, precision, zero-drift topology, excellent common-mode rejection ratio (CMRR), and features enhanced pulse width modulation (PWM) rejection. Enhanced PWM rejection reduces the effect of common-mode transients on the output signal that are associated with PWM signals. Multiple gain versions are available to allow for the optimization of the desired full-scale output voltage based on the target current range expected in the application.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Amplifier Input Signal

The RSA240 is designed to handle large common-mode transients over a wide voltage range. Input signals from current measurement applications for linear and PWM applications can be connected to the amplifier to provide a highly accurate output, with minimal common-mode transient artifacts.

8.3.1.1 Enhanced PWM Rejection Operation

The enhanced PWM rejection feature of the RSA240 provides increased attenuation of large common-mode ΔV/Δt transients. Large ΔV/Δt common-mode transients associated with PWM signals are employed in applications such as motor or solenoid drive and switching power supplies. Traditionally, large ΔV/Δt common-mode transitions are handled strictly by increasing the amplifier signal bandwidth, which can increase chip size, complexity and ultimately cost. The RSA240 is designed with high common-mode rejection techniques to reduce large ΔV/Δt transients before the system is disturbed as a result of these large signals. The high AC CMRR, in conjunction with signal bandwidth, allows the RSA240 to provide minimal output transients and ringing compared with standard circuit approaches.

8.3.2 Selecting the Sense Resistor (R_{SENSE})

The RSA240 determines the current magnitude from 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.

The current-sensing resistor is ideally chosen solely 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, which 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 which 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, which are not attractive for precision designs. Historically, the design goals for high-performance measurements forced designers to accept selecting larger current-sense resistors and the lower gain amplifier settings. The RSA240 provides 100V/V gain option that offer the high-gain setting and maintains high-performance levels with offset values below 25 µV. These devices allow for the use of lower shunt resistor values to achieve lower power dissipation and still meet high system performance specifications.

Table 1 shows an example of the different results obtained from using two different gain versions of the RSA240. From the table data, the higher gain device allows a smaller current-shunt resistor and decreased power dissipation in the element.

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

PARAMETER		EQUATION	RESULTS	
			RSA240A	RSA240C
Gain		-	20 V/V	100 V/V
V_{DIFF}	Ideal maximum differential input voltage	$V_{DIFF} = V_{OUT}$ / Gain	150mV	30mV
R_{SENSE}	Current-sense resistor value	$R_{SENSE} = V_{DIFF} / I_{MAX}$	15mΩ	3mΩ
P_{RSENSE}	Current-sense resistor power dissipation	$R_{SENSE} \times I_{MAX}{}^2$	1.5W	0.3W

(1) Full-scale current = 10 A, and full-scale output voltage = 3 V.

8.4 Device Functional Modes

8.4.1 Adjusting the Output Midpoint With the Reference Pins

Figure 16 shows a test circuit for reference-divider accuracy. The RSA240 output is configurable to allow for unidirectional or bidirectional operation.

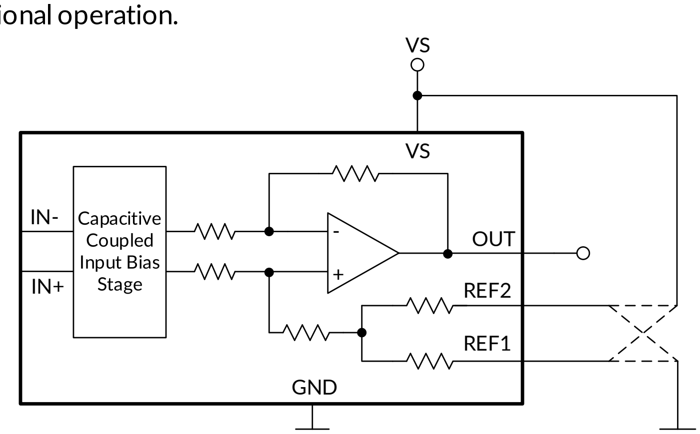


Figure 16. Test Circuit For Reference Divider Accuracy

Note: Do not connect the REF1 pin or the REF2 pin to any voltage source lower than GND or higher than V_S.

The output voltage is set by applying a voltage or voltages to the reference voltage inputs, REF1 and REF2. The reference inputs are connected to an internal gain network. There is no operational difference between the two reference pins.

8.4.2 Reference Pin Connections for Unidirectional Current Measurements

Unidirectional operation allows current measurements through a resistive shunt in one direction. For unidirectional operation, connect the device reference pins together and then to the negative rail (see the Ground Referenced Output section) or the positive rail (see the VS Referenced Output section). The required differential input polarity depends on the output voltage setting. The amplifier output moves away from the referenced rail proportional to the current passing through the external shunt resistor. If the amplifier reference pins are connected to the positive rail, then the input polarity must be negative to move the amplifier output down (towards ground). If the amplifier reference pins are connected at ground, then the input polarity must be positive to move the amplifier output up (towards supply).

The following sections describe how to configure the output for unidirectional operation cases.

8.4.2.1 Ground Referenced Output

When using the RSA240 in a unidirectional mode with a ground referenced output, both reference inputs are connected to ground; this configuration takes the output to ground when there is a 0V differential at the input (as Figure 17 shows).

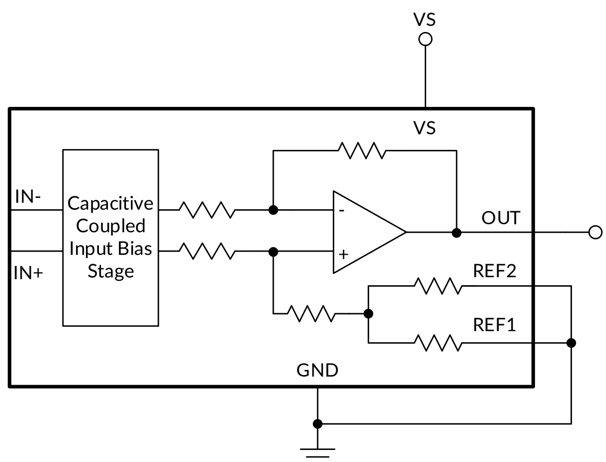


Figure 17. Ground Referenced Output

8.4.2.2 V_S Referenced Output

Unidirectional mode with a VS referenced output is configured by connecting both reference pins to the positive supply. Use this configuration for circuits that require power-up and stabilization of the amplifier output signal and other control circuitry before power is applied to the load (as shown in Figure 18).

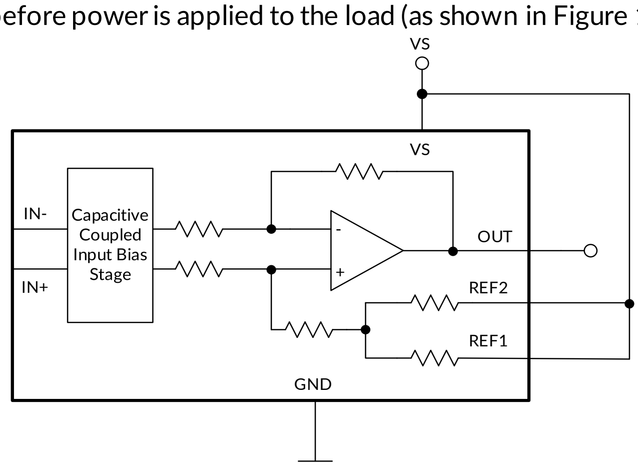


Figure 18. VS Referenced Output

8.4.3 Reference Pin Connections for Bidirectional Current Measurements

Bidirectional operation allows the RSA240 to measure currents through a resistive shunt in two directions. For this operation case, the output voltage can be set anywhere within the reference input limits. A common configuration is to set the reference inputs at half-scale for equal range in both directions. However, the reference inputs can be set to a voltage other than half-scale when the bidirectional current is non-symmetrical.

8.4.3.1 Output Set to External Reference Voltage

Connecting both pins together and then to a reference voltage results in an output voltage equal to the reference voltage for the condition of shorted input pins or a 0-V differential input; this configuration is shown in Figure 19. The output voltage decreases below the reference voltage when the IN+ pin is negative relative to the IN– pin and increases when the IN+ pin is positive relative to the IN– pin. This technique is the most accurate way to bias the output to a precise voltage.

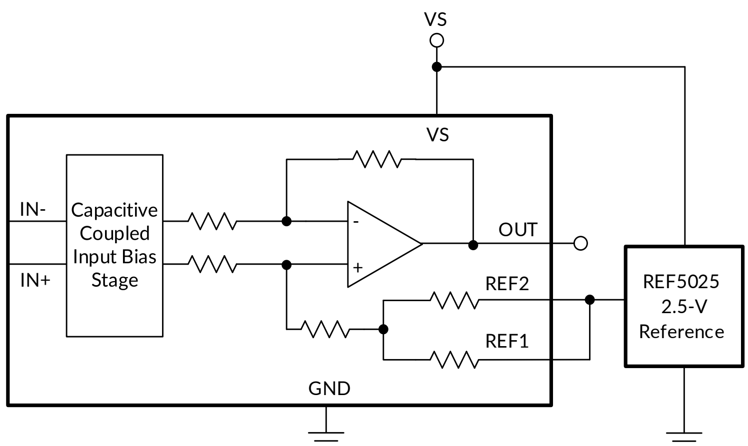


Figure 19. External Reference Output

8.4.3.2 Output Set to Midsupply Voltage

By connecting one reference pin to VS and the other to the GND pin, the output is set at half of the supply when there is no differential input, as shown in Figure 20. This method creates a ratiometric offset to the supply voltage, where the output voltage remains at $V_S/2$ for 0V applied to the inputs.

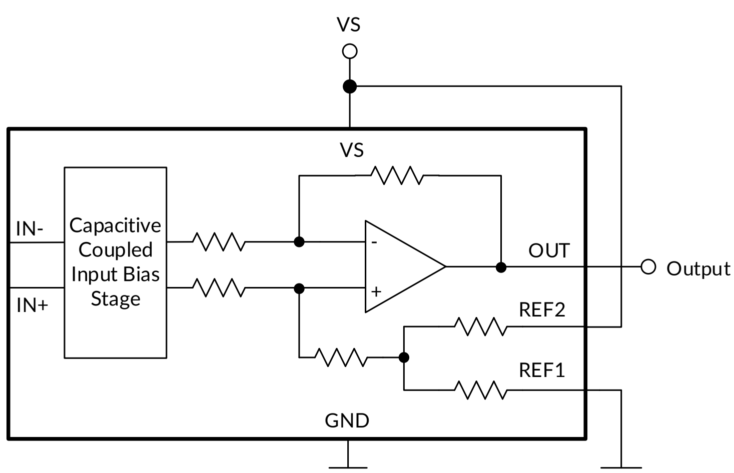


Figure 20. Midsupply Voltage Output

8.4.3.3 Output Set to Mid-External Reference

In this case, an external reference is divided by two by connecting one REF pin to ground and the other REF pin to the reference, as shown in Figure 21.

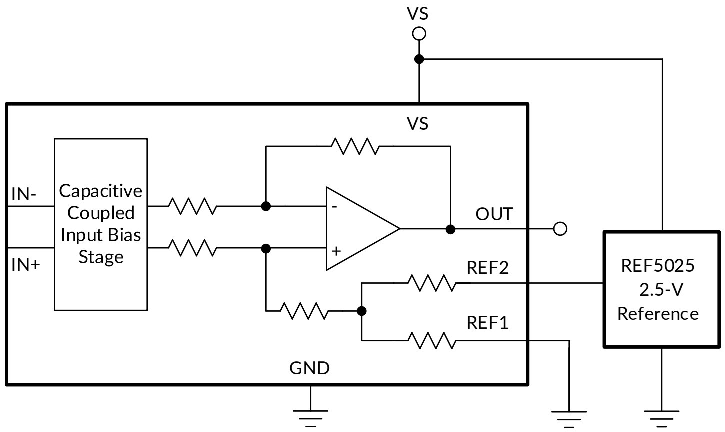


Figure 21. Mid-External Reference Output

8.4.3.4 Output Set Using Resistor Divider

The RSA240 REF1 and REF2 pins allow for the midpoint of the output voltage to be adjusted for system circuitry connections to analog to digital converters (ADCs) or other amplifiers. The REF pins are designed to be connected directly to supply, ground, or a low-impedance reference voltage. The REF pins can be connected together and biased using a resistor divider to achieve a custom output voltage. If the amplifier is used in this configuration, as shown in Figure 22, use the output as a differential signal with respect to the resistor divider voltage. Use of the amplifier output as a single-ended signal in this configuration is not recommended because the internal impedance shifts can adversely affect device performance specifications.

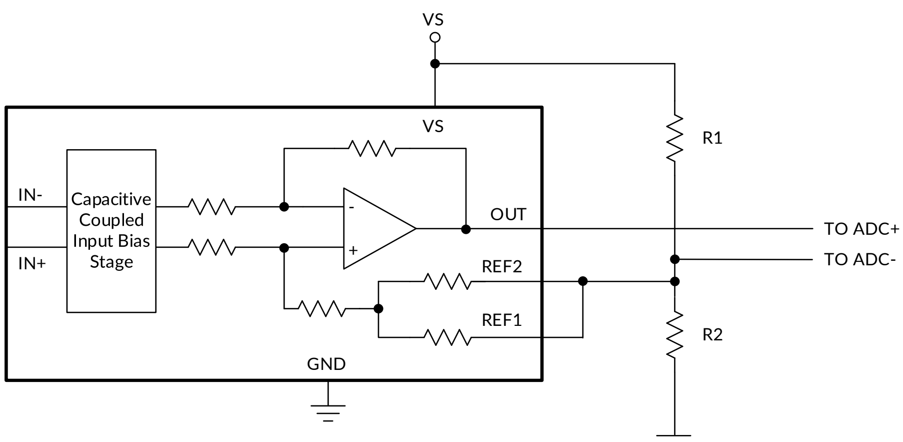


Figure 22. Setting the Reference Using a Resistor Divider

9 APPLICATION AND IMPLEMENTATION

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

9.1 Application Information

The RSA240 measures the voltage developed as current flows across the current-sensing resistor. The device provides reference pins to configure operation as either unidirectional or bidirectional output swing. When using the RSA240 for inline motor current sense, the device is commonly configured for bidirectional operation.

9.1.1 Input Filtering

When measuring current in noisy environments, filters are required for accurate measurements. The RSA240 features low input bias current that makes it possible to add a filter at the input end without sacrificing the current-sense accuracy. The filter at the input position can attenuate differential noise before the input signal is amplified. Figure 23 shows the filter at the input pins.

The series resistance of filter results in additional gain error. The gain error introduced can be calculated by the Equation 1.

$$\text{Gain Error}(\%)=1-\frac{R_{DIFF}}{R_{SENSE}+2\times R_F+R_{DIFF}} \quad (1)$$

where:
R_{DIFF} is the differential input impedance about 55kΩ.
R_F is the added value of the series filter resistance.

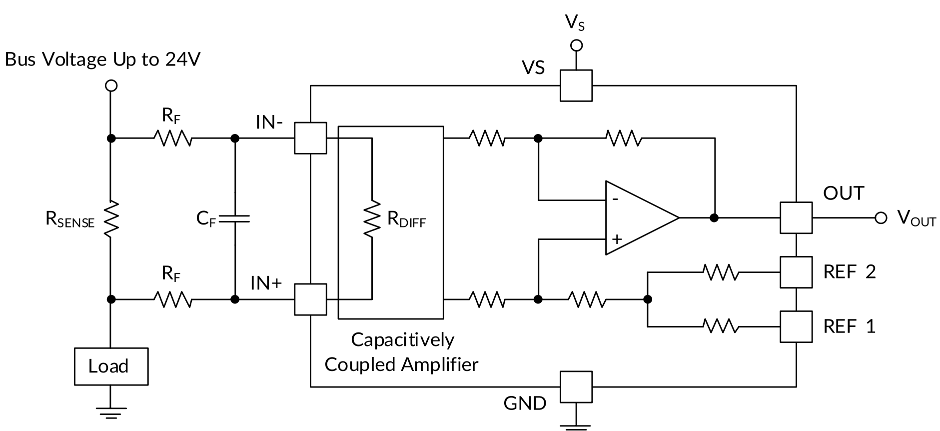


Figure 23. Filter at Input Pins

The high input impedance and low bias current of the RSA240 make the design of input filters easy and flexible without impacting the accuracy of current measurement. External series resistance adds to the measurement error, so limit the value of these series resistors to 22Ω or less. For example, set R_F = 22Ω and C_F = 2.2nF to achieve a low-pass filter corner frequency of 1.64MHz without severely impacting the current-sensing bandwidth or precision. Table 2 illustrates the gain error introduced by R_F where R_{SENSE} has been neglected.

Table 2. Gain Error Introduced by the External Filter Resistance at Input Pins

External Filter Resistance R_F (Ω)	Gain Error (%)
4.7	0.012
10	0.025
22	0.055

9.2 Typical Applications

The RSA240 offers advantages for multiple applications including the following:

- High common-mode range and excellent CMRR enables direct inline sensing
- Ultra-low offset and drift eliminates the necessity of calibration
- Wide supply range enables a direct interface with most microprocessors

Two specific applications are provided and include more detailed information.

9.2.1 Inline Motor Current-Sense Application

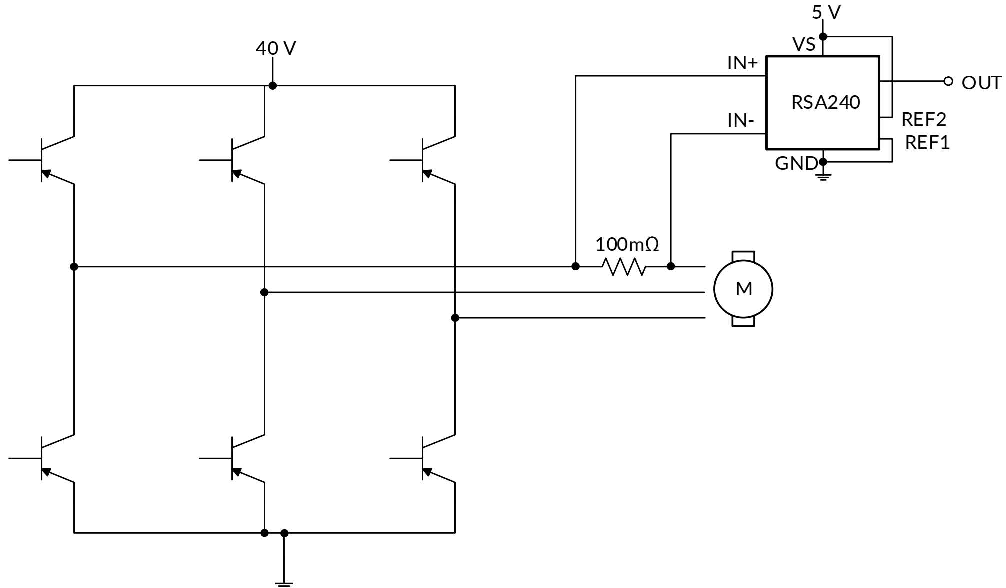


Figure 24. Inline Motor Application Circuit

9.2.1.1 Design Requirements

Inline current sensing has many advantages in motor control, from torque ripple reduction to real-time motor health monitoring. However, the full-scale PWM voltage requirements for inline current measurements provide challenges to accurately measure the current. Switching frequencies in the 50kHz to 100kHz range create higher $\Delta V/\Delta t$ signal transitions that must be addressed to obtain accurate inline current measurements.

With a superior common-mode rejection capability, high precision, and a high common-mode specification, the RSA240 provides performance for a wide range of common-mode voltages.

9.2.1.2 Detailed Design Procedure

For this application, the RSA240 measures current in the drive circuitry of a 36V, 4000RPM motor.

To demonstrate the performance of the device, the RSA240A with a gain of 20 V/V was selected for this design and powered from a 5V supply.

Using the information in the Adjusting the Output Midpoint With the Reference Pins section, the reference point is set to midscale by splitting the supply with REF1 connected to ground and REF2 connected to supply. This configuration allows for bipolar current measurements. Alternatively, the reference pins can be tied together and driven with an external precision reference.

The current-sensing resistor is sized so that the output of the RSA240 is not saturated. A value of 100mΩ was selected to maintain the analog input within the device limits.

9.2.2 Solenoid Drive Current-Sense Application

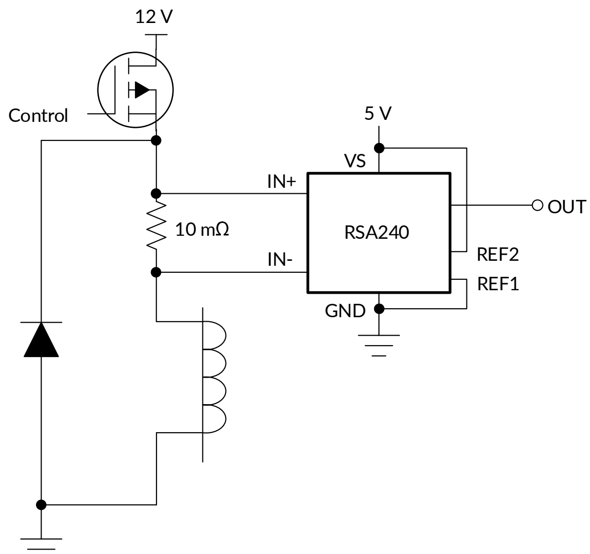


Figure 25. Solenoid Drive Application Circuit

9.2.2.1 Design Requirements

Challenges exist in solenoid drive current sensing that are similar to those in motor inline current sensing. In certain topologies, the current-sensing amplifier is exposed to the full-scale PWM voltage between ground and supply. The RSA240 is well suited for this type of application.

9.2.2.2 Detailed Design Procedure

For this application, the RSA240 measures current in the driver circuit of a 24V, 500mA water valve.

To demonstrate the performance of the device, the RSA240A with a gain of 100 V/V was selected for this design and powered from a 5V supply.

Using the information in the Adjusting the Output Midpoint With the Reference Pins section, the reference point is set to midscale by splitting the supply with REF1 connected to ground and REF2 connected to supply. Alternatively, the reference pins can be tied together and driven with an external precision reference.

A value of 10 mΩ was selected to maintain the analog input within the device limits.

10 POWER SUPPLY RECOMMENDATIONS

The RSA240 series makes accurate measurements beyond the connected power-supply voltage (V_S) because the inputs (IN+ and IN–) operate anywhere between –5V and 100V independent of V_S. For example, the V_S power supply equals 5V and the common-mode voltage of the measured shunt can be as high as 100 V.

Although the common-mode voltage of the input can be beyond the supply voltage, the output voltage range of the RSA240 series is constrained to the supply voltage.

10.1 Power Supply Decoupling

Place the power-supply bypass capacitor as close as possible to the supply and ground pins. RUNIC recommends a bypass capacitor value of 0.1µF. Additional decoupling capacitance can be added to compensate for noisy or high-impedance power supplies.

11 LAYOUT

11.1 Layout Guidelines

11.1.1 Connection to the Current-Sense Resistor

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-ohmic value. Use a Kelvin or 4-wire connection to connect to the device input pins. This connection technique ensures that only the current-sensing resistor impedance is detected between the input pins.

11.2 Layout Example

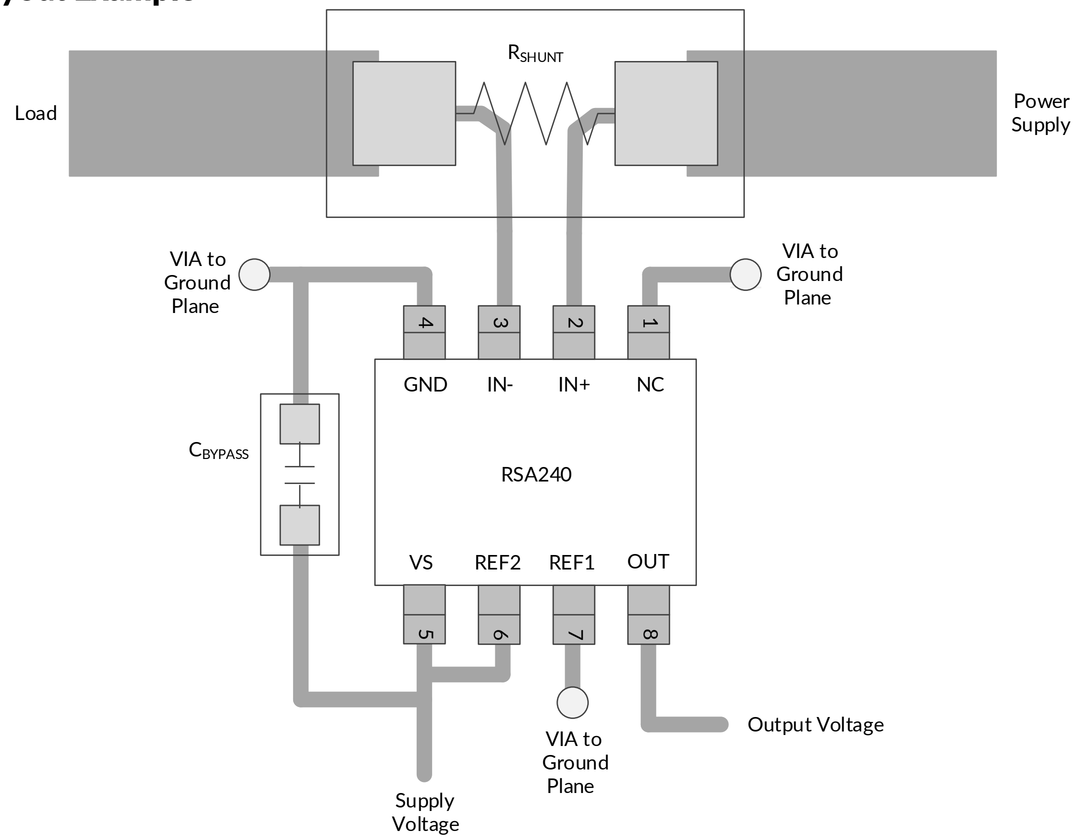


Figure 26. Recommended TSSOP Package Layout

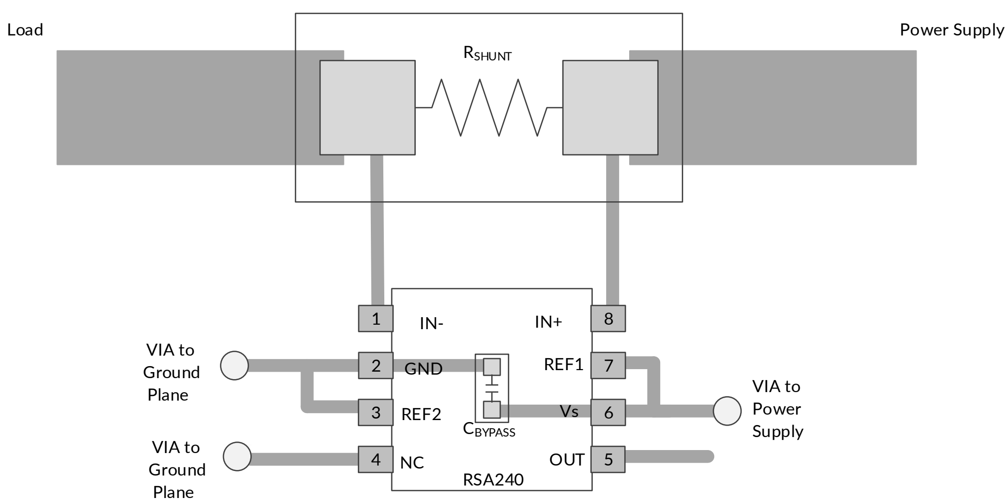
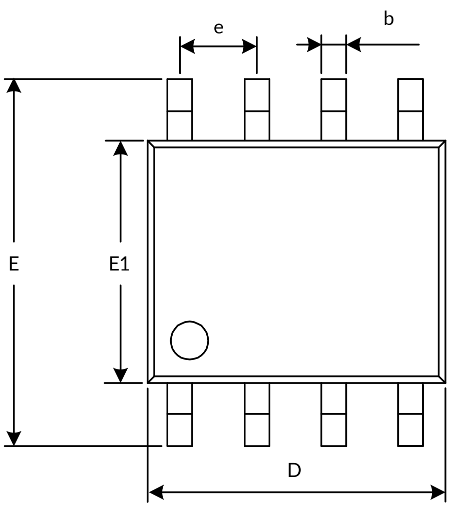
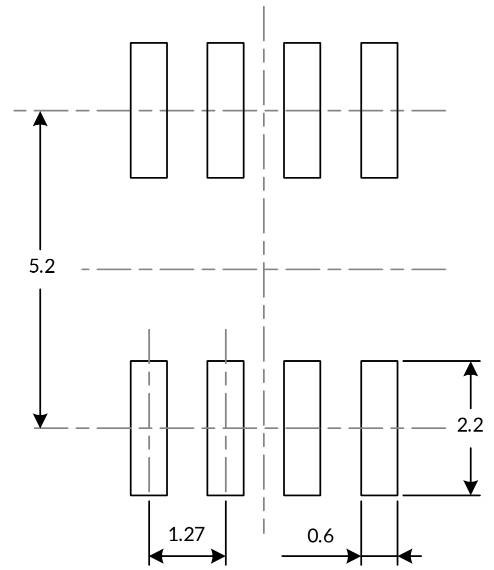


Figure 27. Recommended SOP Package Layout

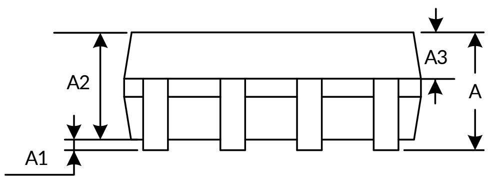
12 PACKAGE OUTLINE DIMENSIONS

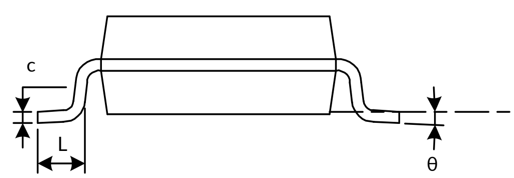
SOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)



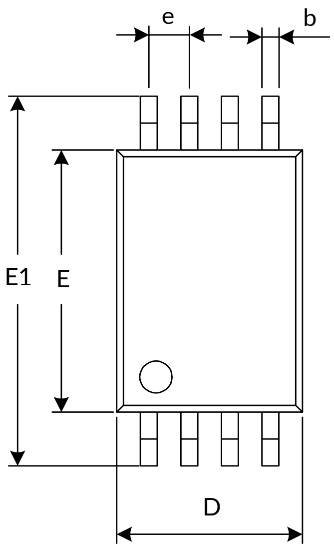


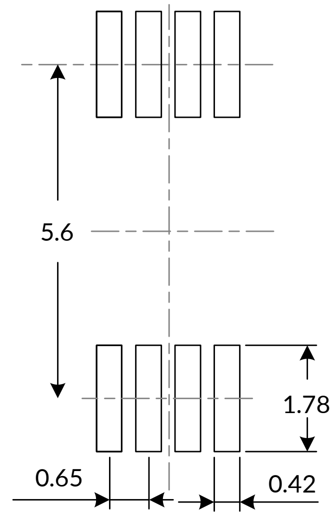
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)		1.750		0.069
A1	0.100	0.225	0.004	0.009
A2	1.300	1.500	0.051	0.059
A3	0.600	0.700	0.024	0.028
b	0.390	0.470	0.015	0.019
c	0.200	0.240	0.008	0.009
D (1)	4.800	5.000	0.189	0.197
e	1.270 (BSC) (2)		0.050 (BSC) (2)	
E	5.800	6.200	0.228	0.244
E1 (1)	3.800	4.000	0.150	0.157
L	0.500	0.800	0.020	0.031
θ	0°	8°	0°	8°

NOTE:

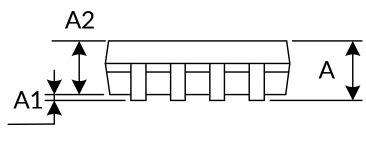
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

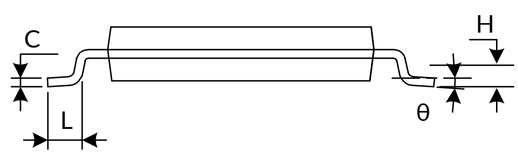
TSSOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D (1)	2.900	3.100	0.114	0.122
E (1)	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) (2)		0.026(BSC) (2)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

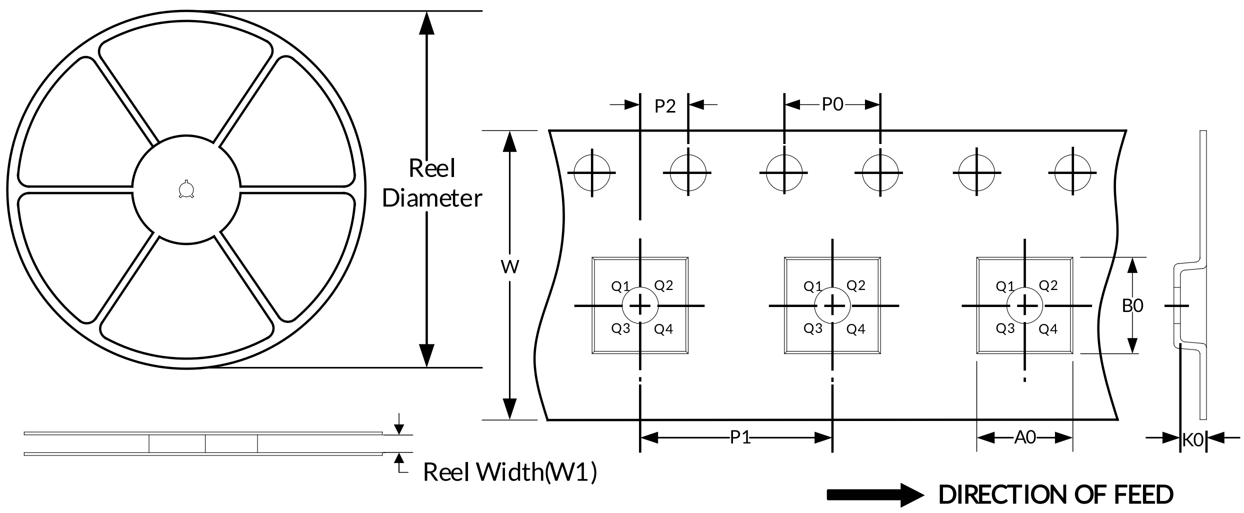
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

13 TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOP8	13”	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
TSSOP8	13”	12.4	6.90	3.45	1.65	4.0	8.0	2.0	12.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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