# SGM840xQ
# -4V to 80V, Automotive Bidirectional, Ultra-Precision Current-Sense Amplifier with High PWM Rejection

## GENERAL DESCRIPTION

The SGM840xQ device is an automotive-qualified, bidirectional, fixed gain, voltage-output, current-sense amplifier which features high PWM rejection and wide common-mode voltage range from -4V to 80V.

The high PWM rejection suppresses large common-mode transients (ΔV/Δt) 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 1mA (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 device is AEC-Q100 qualified (Automotive Electronics Council (AEC) standard Q100 Grade 1) and it is suitable for automotive applications.

The SGM840xQ is available in a Green SOIC-8 package. It operates in the temperature range of -40℃ to +125℃.

## FEATURES

- **AEC-Q100 Qualified for Automotive Applications**
  **Device Temperature Grade 1**
  **$T_A$ = -40℃ to +125℃**
- **Functional Safety-Capable**
  - **Documentation Available to Aid Functional Safety System Design**
- **High PWM Rejection**
- **Excellent CMRR:**
  - **130dB (TYP) DC CMRR**
  - **80dB (TYP) AC CMRR at 50kHz**
- **Wide Common-Mode Range: -4V to 80V**
- **Gain Error:**
  - **+25℃: ±0.35% (MAX)**
  - **-40℃ to +125℃: ±1.5% (MAX)**
- **Offset:**
  - **+25℃: ±90μV (MAX)**
  - **-40℃ to +125℃: ±150μV (MAX)**
- **Available Gains:**
  - **SGM840AQ: 20V/V**
  - **SGM840BQ: 50V/V**
  - **SGM840CQ: 100V/V**
- **Available in a Green SOIC-8 Package**

## APPLICATIONS

Automotive Applications
Motor Controls
Solenoid and Valve Controls
Power Management
Actuator Controls
Pressure Regulators
Telecom Equipment

## TYPICAL APPLICATION

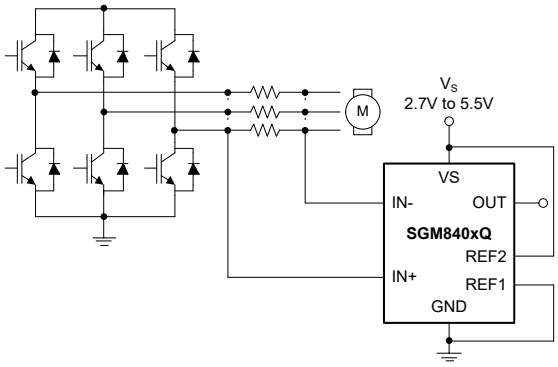



**Figure 1. Typical Application Circuit**

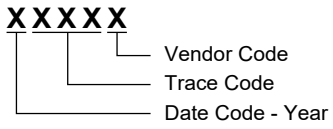
代理商 威尔逊 www.wisvie.com 联系电话 138 2526 5270

# PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM840AQ (Gain = 20V/V) | SOIC-8 | -40℃ to +125℃ | SGM840AQS8G/TR | 0YJS8<br>XXXXX | Tape and Reel, 4000 |
| SGM840BQ (Gain = 50V/V) | SOIC-8 | -40℃ to +125℃ | SGM840BQS8G/TR | 1AJS8<br>XXXXX | Tape and Reel, 4000 |
| SGM840CQ (Gain = 100V/V) | SOIC-8 | -40℃ to +125℃ | SGM840CQS8G/TR | 1AKS8<br>XXXXX | Tape and Reel, 4000 |

## MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.




Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_S$ ..... 6V
Analog Inputs, $V_{IN+}$, $V_{IN-}$
Differential $V_{IN+}$ - $V_{IN-}$ ..... -36V to 36V
Common-Mode ..... -6V to 85V
REF1, REF2, NC Inputs ..... GND - 0.3V to $V_S$ + 0.3V
Output ..... GND - 0.3V to $V_S$ + 0.3V
Package Thermal Resistance
SOIC-8, $\theta_{JA}$ ..... 114.3℃/W
SOIC-8, $\theta_{JB}$ ..... 63.9℃/W
SOIC-8, $\theta_{JC}$ ..... 54.5℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility (1) (2)
HBM ..... ±8000V
CDM ..... ±2000V

NOTES:

1. For human body model (HBM), all pins comply with AEC-Q100-002 specification.

2. For charged device model (CDM), all pins comply with AEC-Q100-011 specification.

## RECOMMENDED OPERATING CONDITIONS

Input Common-Mode Voltage, $V_{CM}$ ..... -4V to 80V
Supply Voltage Range, $V_S$ ..... 2.7V to 5.5V
Operating Ambient Temperature Range ..... -40℃ to +125℃
Operating Junction Temperature Range ..... -40℃ to +125℃

## OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

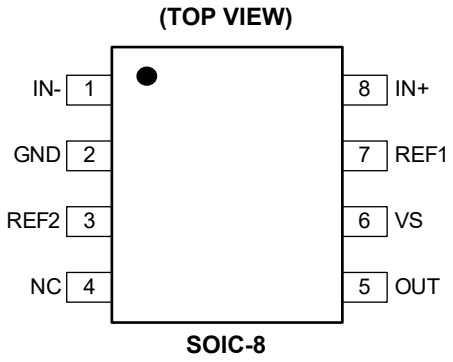
## ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

## DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

## PIN CONFIGURATION




## PIN DESCRIPTION

| PIN | NAME | TYPE | FUNCTION |
|---|---|---|---|
| 1 | IN- | A/I | Connect it to load side of shunt resistor. |
| 2 | GND | G | Ground. |
| 3 | REF2 | A/I | Voltage Reference 2. Connect it to any voltage source between GND and $V_S$. |
| 4 | NC | — | Connect it to GND or leave it floating. |
| 5 | OUT | A/O | Output Voltage. |
| 6 | VS | P | 2.7V to 5.5V Power Supply. |
| 7 | REF1 | A/I | Voltage Reference 1. Connect it to any voltage source between GND and $V_S$. |
| 8 | IN+ | A/I | Connect it to supply side of shunt resistor. |

NOTE: I = input, O = output, A = analog, P = power, G = ground.

# ELECTRICAL CHARACTERISTICS

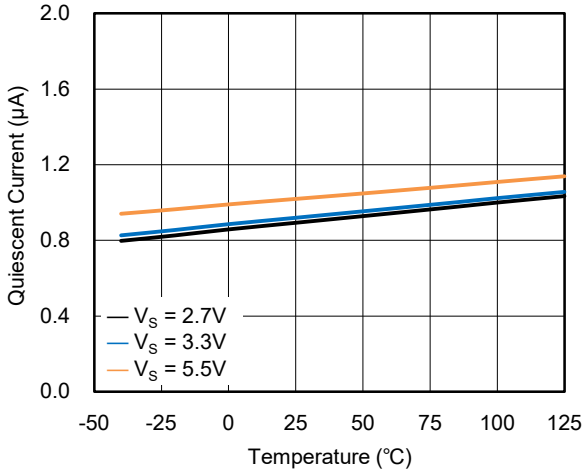
($V_S$ = 5V, $V_{SENSE}$ = $V_{IN+}$ - $V_{IN-}$, $V_{CM}$ = 12V, $V_{REF1}$ = $V_{REF2}$ = $V_S$/2 and $T_A$ = -40℃ to +125℃, typical values are measured at $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **Input** | | | | | | |
| Input Common-Mode Voltage | $V_{CM}$ | $V_{IN+}$ = -4V to 80V, $V_{SENSE}$ = 0mV | -4 | | 80 | V |
| Common-Mode Rejection Ratio | CMRR | $V_{IN+}$ = -4V to 80V, $V_{SENSE}$ = 0mV | 120 | 130 | | dB |
| | | f = 50kHz | | 80 | | |
| Offset Voltage, Input-Referred | $V_{OS}$ | $V_{SENSE}$ = 0mV, $T_A$ = +25℃ | | ±5 | ±90 | μV |
| | | $V_{SENSE}$ = 0mV, $T_A$ = -40℃ to +125℃ | | | ±150 | |
| Power Supply Rejection Ratio | PSRR | $V_S$ = 2.7V to 5.5V, $V_{SENSE}$ = 0mV | | ±1 | ±20 | μV/V |
| Input Bias Current | $I_B$ | $I_{B+}$, $I_{B-}$, $V_{SENSE}$ = 0mV | | 0.05 | | μA |
| Reference Input Range | | | 0 | | $V_S$ | V |
| **Output** | | | | | | |
| Gain | G | SGM840AQ | | 20 | | V/V |
| | | SGM840BQ | | 50 | | |
| | | SGM840CQ | | 100 | | |
| Gain Error | | GND + 50mV ≤ $V_{OUT}$ ≤ $V_S$ - 200mV, $T_A$ = +25℃ | | ±0.05 | ±0.35 | % |
| | | $T_A$ = -40℃ to +125℃ | | | ±1.5 | |
| Nonlinearity Error | | GND + 10mV ≤ $V_{OUT}$ ≤ $V_S$ - 200mV | | ±0.02 | | % |
| Reference Divider Accuracy | | $V_{OUT}$ = \|($V_{REF1}$ - $V_{REF2}$)\|/2 at $V_{SENSE}$ = 0mV | | ±0.02 | ±0.45 | % |
| Reference Voltage Rejection Ratio (Input-Referred) | RVRR | SGM840AQ | | 45 | | μV/V |
| | | SGM840BQ | | 25 | | |
| | | SGM840CQ | | 15 | | |
| Maximum Capacitive Load | | No sustained oscillation | | 1 | | nF |
| **Voltage Output** | | | | | | |
| Swing to VS Power Supply Rail | | $R_L$ = 10kΩ to GND | | $V_S$ - 0.02 | $V_S$ - 0.05 | 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 | | 400 | | kHz |
| | | All gains, 1% THD+N | | 100 | | |
| Settling Time | | Output settles to 0.5% of final value | | 6 | | μs |
| Slew Rate | SR | | | 2.5 | | V/μs |
| **Noise (Input-Referred)** | | | | | | |
| Voltage Noise Density | | | | 100 | | 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℃ | | 1.0 | 1.5 | mA |
| | | vs. temperature, $T_A$ = -40℃ to +125℃ | | | 1.7 | |

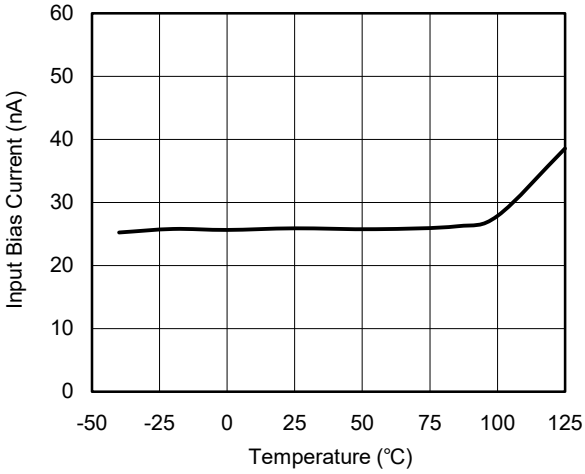
## TYPICAL PERFORMANCE CHARACTERISTICS

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

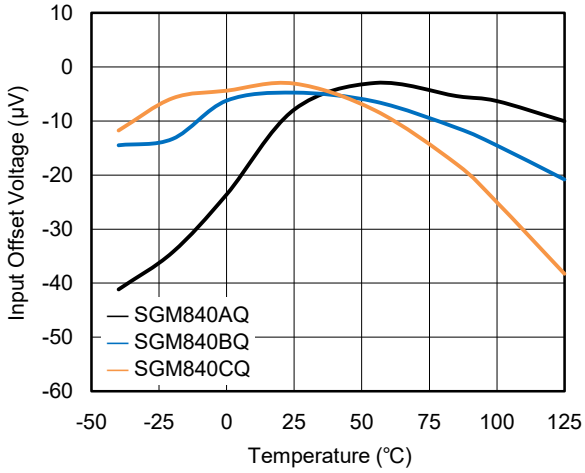
Quiescent Current vs. Temperature



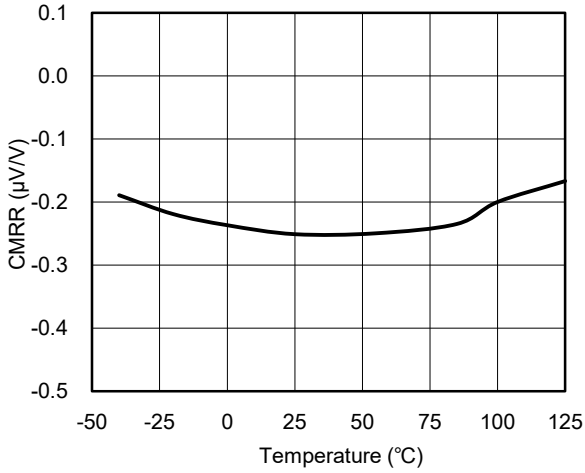

Input Bias Current vs. Temperature



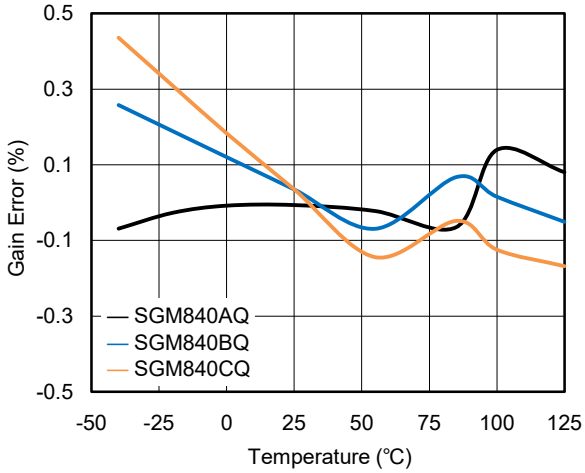

Input Offset Voltage vs. Temperature



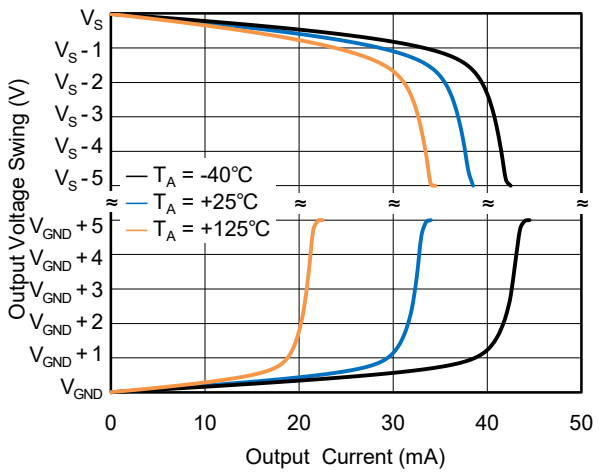

CMRR vs. Temperature




Gain Error vs. Temperature



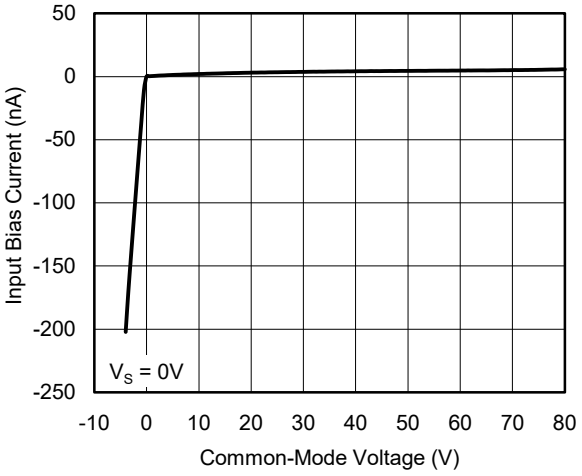

Output Voltage Swing vs. Output Current



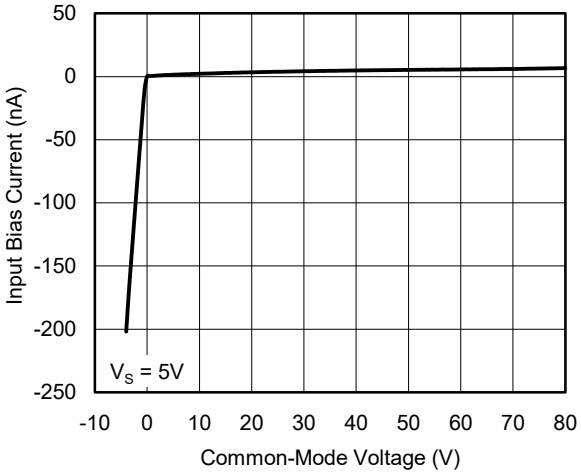
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

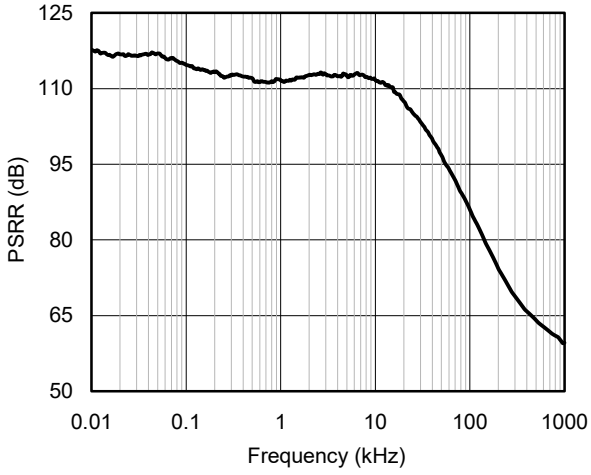
Input Bias Current vs. Common-Mode Voltage



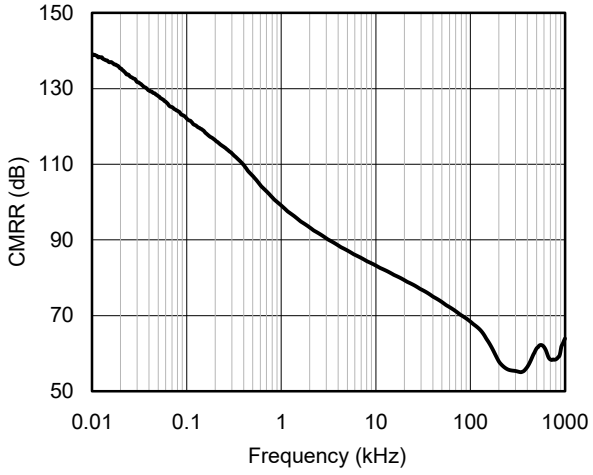

Input Bias Current vs. Common-Mode Voltage



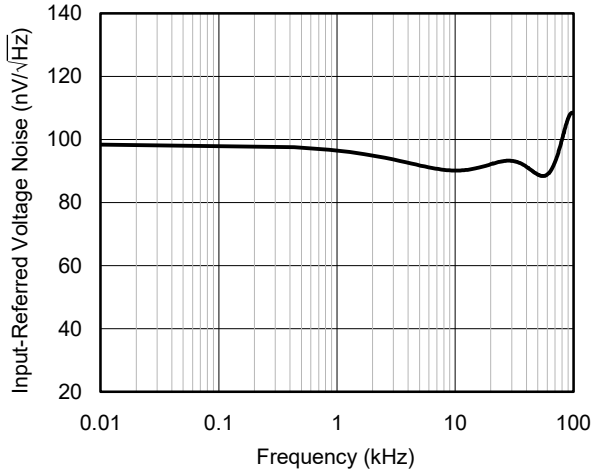

PSRR vs. Frequency



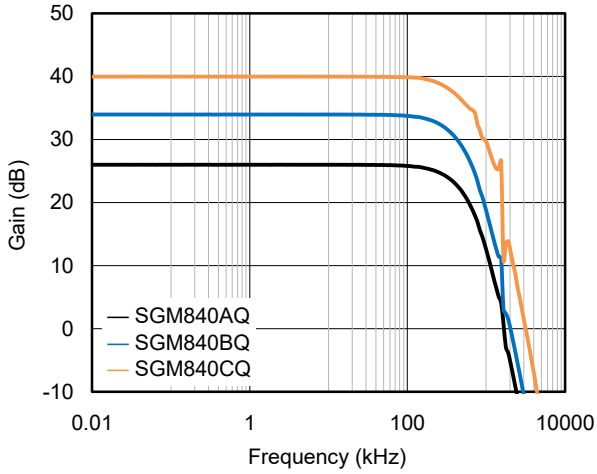

CMRR vs. Frequency




Input-Referred Voltage Noise vs. Frequency



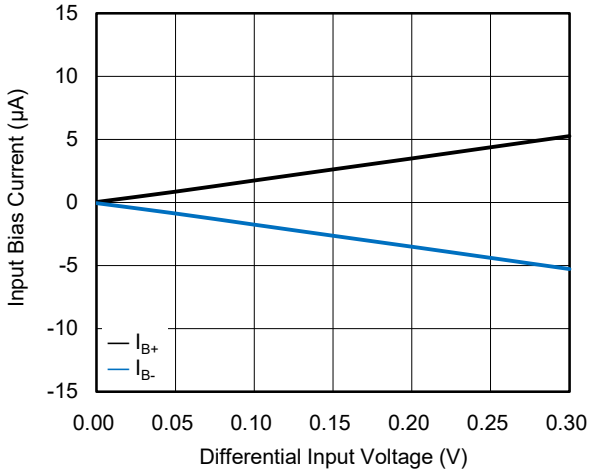

Gain vs. Frequency



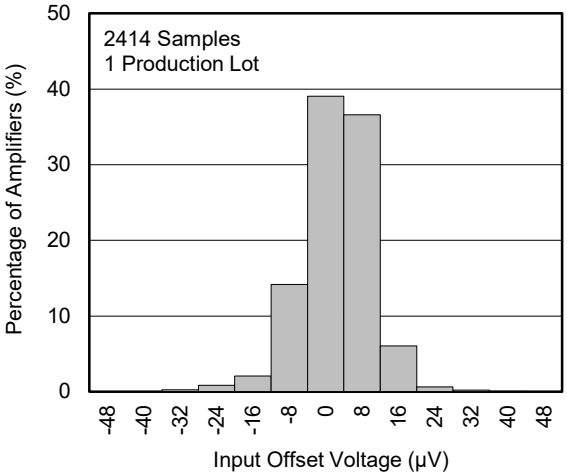
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

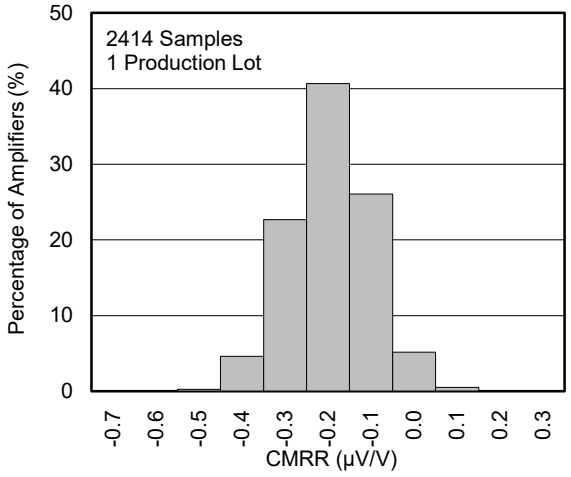
Input Bias Current vs. Differential Input Voltage



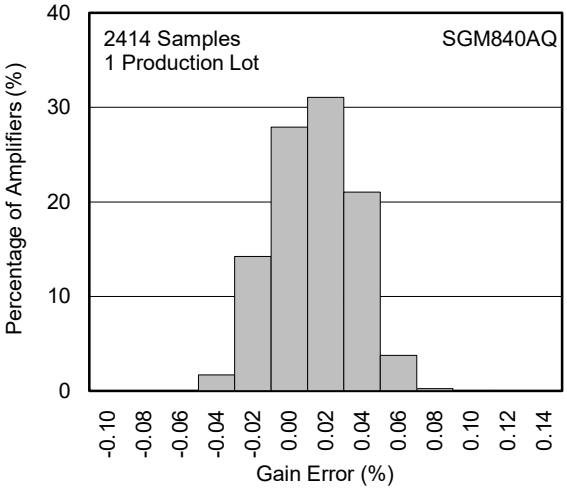

Input Offset Voltage Production Distribution



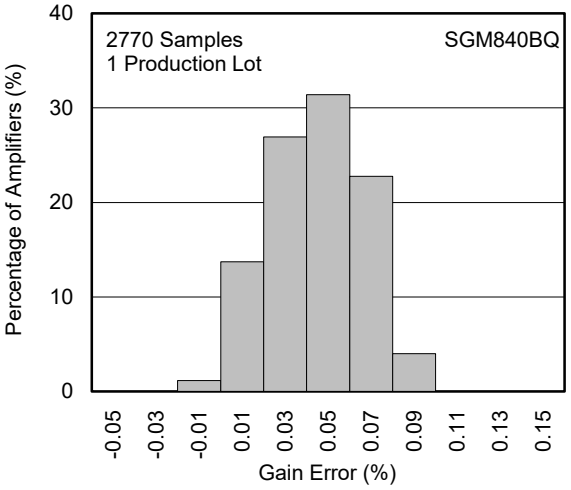

CMRR Production Distribution



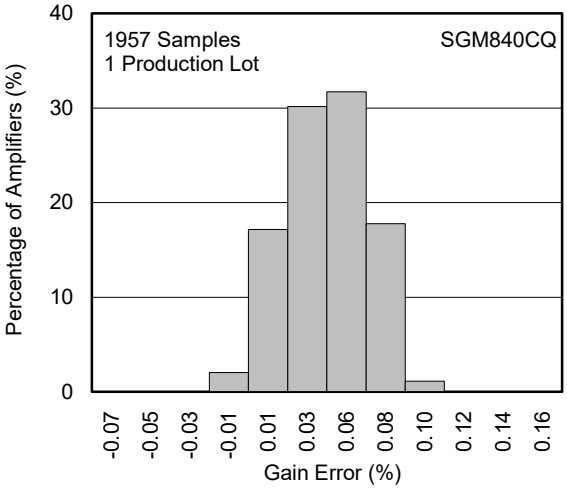

Gain Error Production Distribution




Gain Error Production Distribution



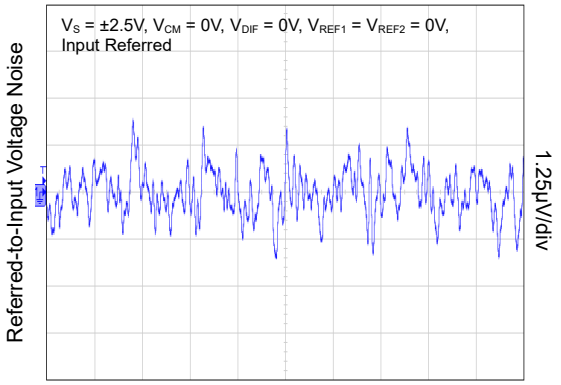

Gain Error Production Distribution



## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

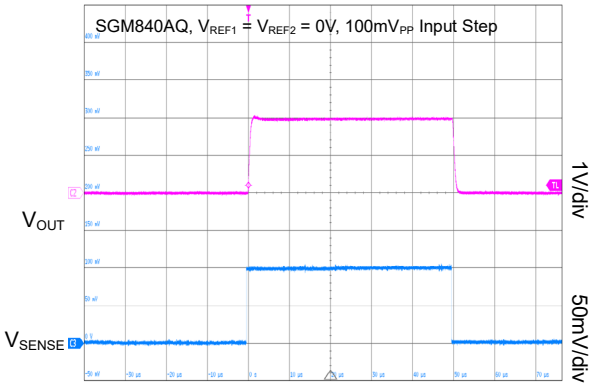
$V_S$ = 5V, $V_{CM}$ = 12V, $V_{REF1}$ = $V_{REF2}$ = $V_S$/2 and $T_A$ = +25°C, unless otherwise noted.

0.1Hz to 10Hz Voltage Noise



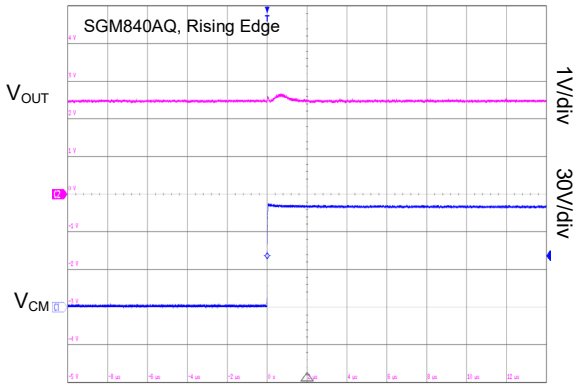

Time (1s/div)

Step Response



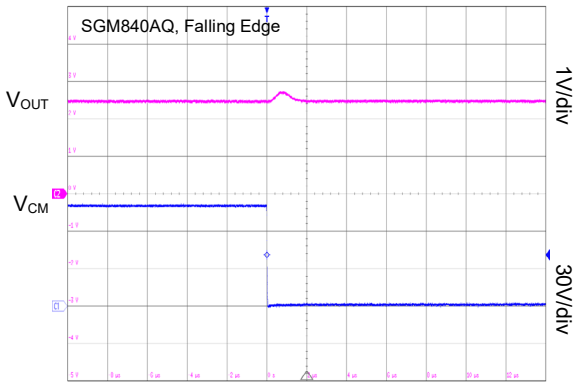

Time (10μs/div)

Common-Mode Voltage Transient Response



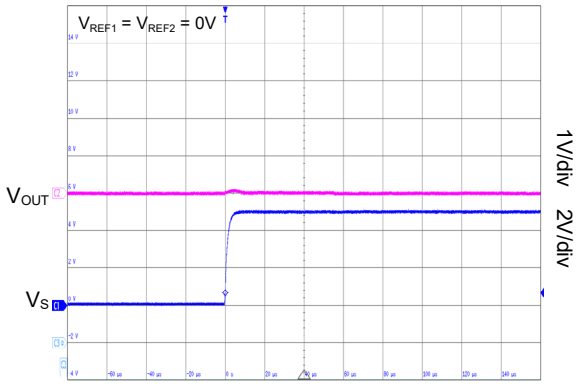

Time (2μs/div)

Common-Mode Voltage Transient Response




Time (2μs/div)

Startup Response




Time (20μs/div)

## FUNCTIONAL BLOCK DIAGRAM

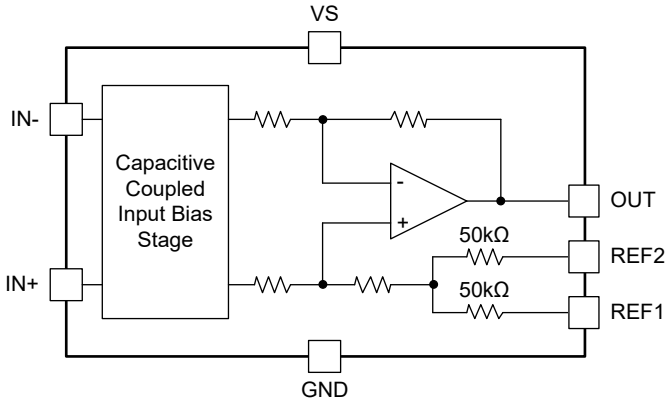



**Figure 2. Block Diagram**

## DETAILED DESCRIPTION

### Overview

The SGM840xQ is a bidirectional analog voltage output current-sense amplifier with a wide common-mode range, high accuracy, zero-drift topology, and high common-mode rejection. High common-mode rejection can suppress the effect of fast common-mode transients on the output. Multiple gain versions can be used to optimize the required full-scale output voltage according to the expected target current range in the application.

### Feature Description

#### Precision Current Measurement

The SGM840xQ uses the zero-drift input architecture which provides the low offset voltage and low offset drift. The offset voltage of SGM840xQ is less than ±150μV from -40℃ to +125℃. The internal gain resistor has excellent temperature stability, ensuring that the gain error remains within ±1.5%. All of these features improve the accuracy, especially at smaller current-sense voltage, and allow for lower-value shunt resistor.

#### Large Input Common-Mode Voltages

The SGM840xQ uses a capacitive feedback amplifier on the input front end which makes the input common-mode voltage range no longer restricted by the power supply voltage ($V_S$). DC common-mode voltages are blocked from downstream circuits, resulting in very high common-mode rejection. The SGM840xQ can support wide common-mode voltages from -4V to 80V. This allows for the SGM840xQ to be used for both low-side and high-side current-sensing applications.

#### Low Input Bias Current

The SGM840xQ has low input bias current which draws a 0.05μA (TYP) at a common-mode voltage up to 80V. This feature achieves precision current sensing in applications where lower current leakage is required.

#### High Input-Signal Bandwidth

The SGM840xQ has 400kHz (TYP) input signal bandwidth and 2.5V/μs slew rate which provide the rapid throughput and response needed to quickly detect and handle over-current events. Without higher bandwidth, the protection circuit has not fast response time and may cause damage to the monitored application or circuit.

#### Bidirectional Current Monitoring

The SGM840xQ can sense current flow through a sense resistor in both directions. The output voltage ($V_{OUT}$) can be calculated according to the formula below.

$$V_{OUT} = (I_{SENSE} \times R_{SENSE} \times G) + V_{BIAS} \quad (1)$$

where:

$I_{SENSE}$ is the load current that flows through a sense resistor.

$R_{SENSE}$ is the current-sense resistor.

G is the available gain option of the selected device.

$V_{BIAS}$ is the biased voltage of output set by REF1 and REF2 pins.

# DETAILED DESCRIPTION (continued)

### High PWM Rejection

The SGM840xQ uses a capacitive coupled amplifier which has high PWM rejection. The high PWM rejection allows the output to recover quickly after a rapid input PWM common-mode transient. The settling time after PWM common-mode transient events is about 2μs typically. This feature makes it possible to support higher PWM frequencies and lower duty cycles in applications like motor, solenoid control and switching power supplies.

### Low THD+Noise Output

Figure 3 displays the device's performance across different frequencies. The SGM840xQ has less harmonic distortion which is beneficial for use in the audio.

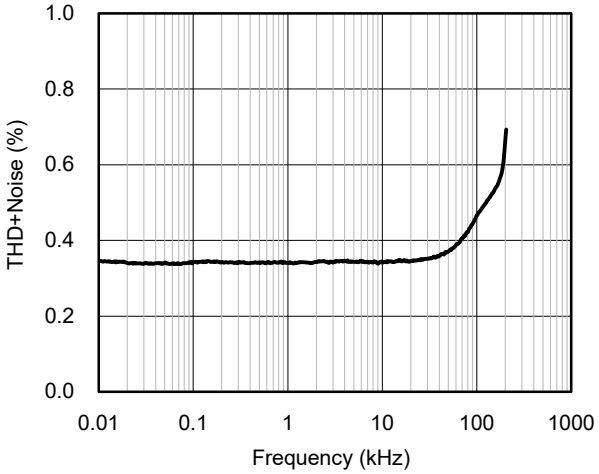



**Figure 3. Performance over Frequency**

## Device Functional Modes

### Adjusting the Output Midpoint with REFx Pins

Figure 4 shows a reference test circuit for the accuracy of the internal resistor divider. The SGM840xQ output can be configured to allow unidirectional or bidirectional operation.

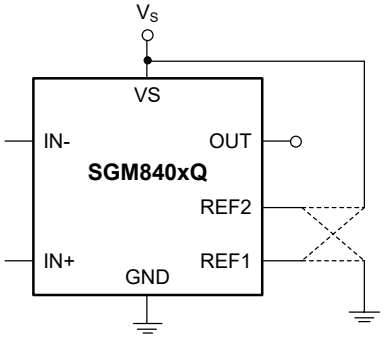



**Figure 4. Test Circuit for Reference Divider Accuracy**

Note that the input voltage of the REF1 pin or the REF2 pin must be between VS or GND.

The REF1 and REF2 are connected to the internal gain resistor divider network inside the chip. The output biased voltage can be set by connecting REF1 and REF2 to different voltage source such as VS, GND, or a low-impedance reference voltage.

### Unidirectional Current Measurements with REFx Pins

Unidirectional operation allows the SGM840xQ to measure the current through a resistive shunt in a single direction. There is ground referenced output or VS referenced output. The following sections describe the two different configurations.

#### *GND Referenced Output*

Connect both reference pins of SGM840xQ together to GND. The current direction in this configuration is from IN+ to IN-.

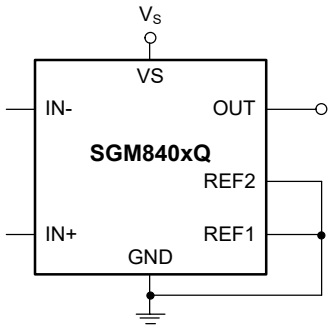



**Figure 5. GND Referenced Output**

#### *VS Referenced Output*

Connect both reference pins of SGM840xQ together to VS. The current direction is from IN- to IN+. This configuration is suitable for applications that require a stable power supply to the amplifier output and other control circuits before there is a current flowing through the current-sense resistor.

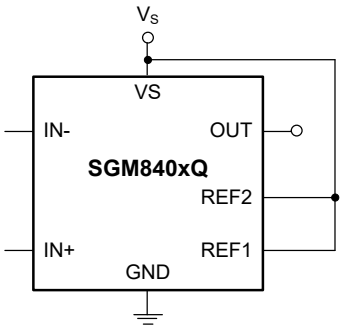



**Figure 6. VS Referenced Output**

# DETAILED DESCRIPTION (continued)

## Bidirectional Current Measurements with the Reference Pins

Bidirectional operation allows the SGM840xQ to measure the current through the resistor shunt in both directions. The common configuration is to set the reference input at half of the output full-scale which allows for an equal range in both directions. In asymmetrical bidirectional current sense application, the reference input can be set to others according to the application.

## Setting Output to External Reference Voltage

Connect both reference pins together to an external reference voltage. The output biased voltage is equal to the reference voltage in this configuration. This is the most accurate method to bias the output to the reference voltage.

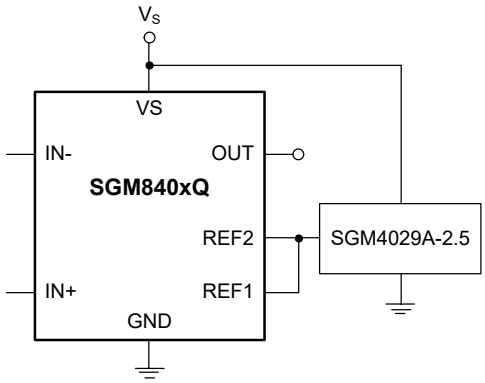



**Figure 7. External Reference Output**

## Setting Output to a Half of $V_S$

Connect one reference pin to VS and the other reference pin to GND. The output biased voltage is equal to a half of $V_S$ in this configuration. The output bias voltage keeps at a half if $V_S$ varies.

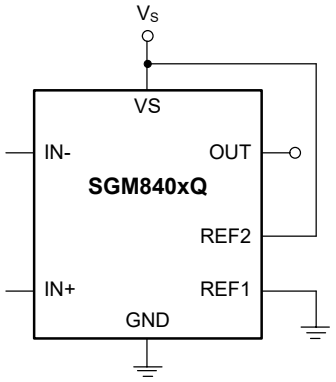



**Figure 8. A Half of VS Output**

## Setting Output to a Half of External Reference

Connect one REF pin to an external reference and the other REF to the GND. The output biased voltage is equal to a half of external reference in this configuration. The output bias voltage keeps at a half of external reference if the external reference varies.

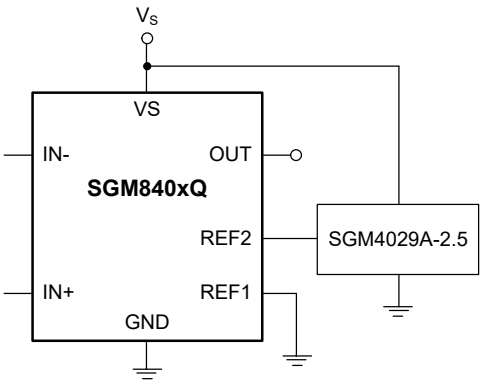



**Figure 9. A Half of External Reference Output**

## Setting a Differential Output

As described above, the reference pins are usually configured to connect to supply, ground, or a low-impedance reference voltage. However, in some application, a differential output voltage is needed. Connecting the two reference pins together can get a differential output voltage between the reference and OUT pins. Figure 10 shows the configuration circuit.

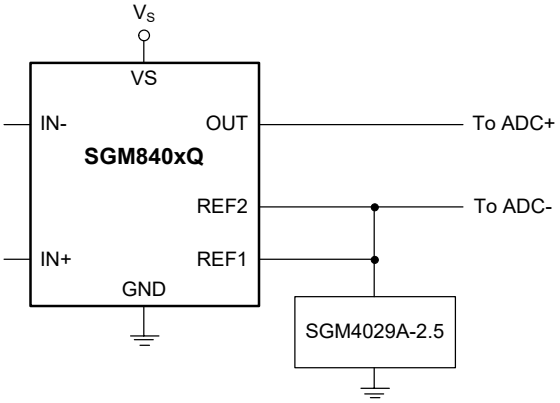



**Figure 10. Reference Different Output**

# APPLICATION INFORMATION

The SGM840xQ can operate in unidirectional or bidirectional current-sensing operation by the different reference pins connection. In the in-line motor current sense applications, SGM840xQ is usually configured to bidirectional mode operation.

## $R_{SENSE}$ and Device Gain Selection

The proper resistance value selection is very critical to the current sensing system. Choose $R_{SENSE}$ based on these criteria: the measured current range, the available gain device, the input range of the backend receiving circuit, and the measurement accuracy.

Within the range of the backend receiving circuit, the resistance of current-sensing resistor should be as large as possible. A larger current-sensing resistance develops a higher sensed voltage across the resistor. The higher the sensed voltage decreases, the smaller the error proportion caused by the input offset of the measured signal, and the higher the accuracy. However, higher resistance also leads to more power dissipation additionally, which makes the resistance drift and affects the precision of any measurement system due to the temperature coefficient. To limit the power loss, it is preferred to minimize the shunt resistance.

Still, the resistance of current-sensing resistor should not be too small. A smaller current-sensing resistance needs a higher amplifier gain to achieve the full-scale output voltage. A higher-gain amplifier has more error proportion caused by the input offset and noise, making it less suitable for precision designs.

Therefore, for the best performance, the selected current-sensing resistor should provide approximately the maximum input differential sense voltage with full-scale output voltage, while having lower power dissipation and higher accuracy. Note that the tolerance and temperature coefficient of the chosen resistors directly affect the precision of any measurement system.

Packaging of the current-sensing resistor is also an important aspect to consider. Small package size is good for space savings and improved integration, but may have poor thermal performance. Larger package size has better heat dissipation, but can be costly.

Therefore, the choice of current-sensing resistor is based on the trade-off between measurement accuracy, power consumption and cost. Generally, sense resistors of 5mΩ to 100mΩ are available with 1% accuracy or better.

The SGM840xQ provides 20V/V, 50V/V and 100V/V gain as available options for use. Table 1 gives the different results from 20V/V, 50V/V and 100V/V gain. The higher gain allows a smaller current-sensing resistor resistance and achieves lower power dissipation.

## Input Filtering

When measuring current in noisy environments, filters are required for accurate measurements. The SGM840xQ 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 11 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 2.

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

where:

$R_{DIFF}$ is the differential input impedance about 55kΩ.

$R_F$ is the added value of the series filter resistance.

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

| Parameter | Symbol | Equation | Results | | |
|---|---|---|---|---|---|
| | | | SGM840AQ | SGM840BQ | SGM840CQ |
| Gain | G | — | 20V/V | 50V/V | 100V/V |
| Ideal Maximum Differential Input Voltage | $V_{DIFF}$ | $V_{DIFF} = V_{OUT}/Gain$ | 125mV | 50mV | 25mV |
| Current-Sense Resistor Value | $R_{SENSE}$ | $R_{SENSE} = V_{DIFF}/I_{MAX}$ | 12.5mΩ | 5mΩ | 2.5mΩ |
| Current-Sense Resistor Power Dissipation | $P_{RSENSE}$ | $R_{SENSE} \times I_{MAX}^2$ | 1.25W | 0.5W | 0.25W |

NOTE: Full-scale current = 10A, and full-scale output voltage = 2.5V.

## APPLICATION INFORMATION (continued)

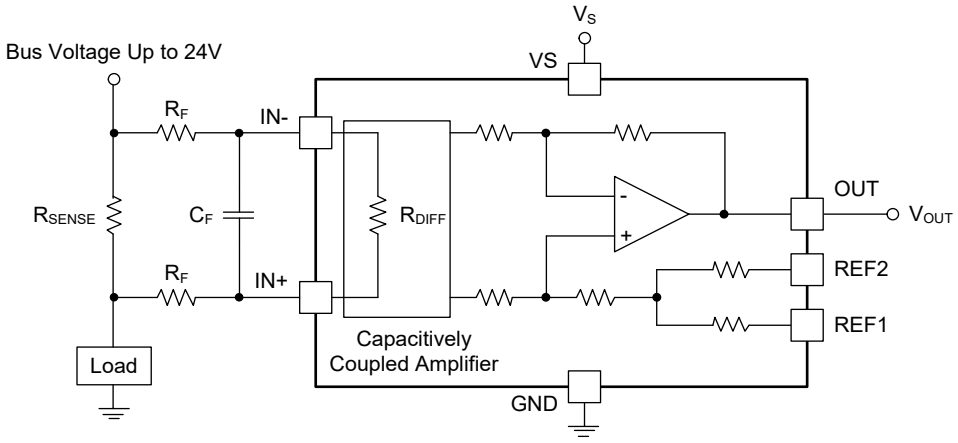



**Figure 11. Filter at Input Pins**

The high input impedance and low bias current of the SGM840xQ 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 |

## Typical Applications

The SGM840xQ features the following advantages in applications:

1. Wide common-mode range and excellent CMRR allows for in-line current sense.

2. Ultra-low offset and drift make calibration unnecessary

3. Ultra-low input bias current is benefit for accuracy of small current measurement and input filtering.

4. The high PWM rejection allows the output to recover quickly after a rapid input PWM common-mode transient.

5. The power supply range can be interfaced and compatible with most microprocessors. The power supply of most microprocessors is 3.3V or 5V.

## In-Line Motor Current Measurement

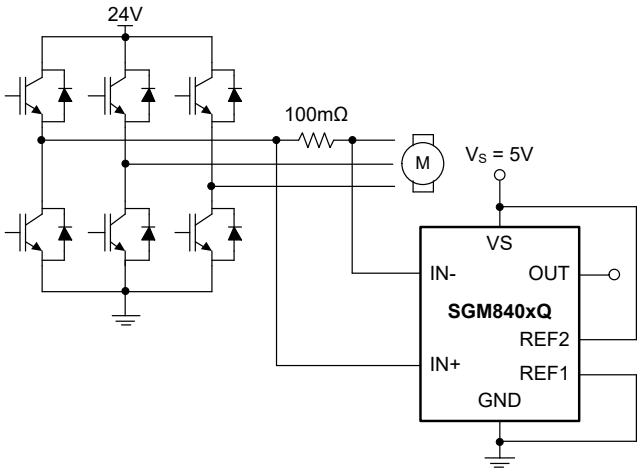



**Figure 12. In-Line Motor Current Measurement**

### *Design Requirements*

In-line current sensing is necessary in motor control applications. However, the presence of rapid and large common-mode voltage transients of source voltage cause the in-line current measurement to inaccurate, which must be overcome.

The SGM840xQ features good common-mode rejection capability, high precision, up to 400kHz bandwidth and high common-mode specifications which fit this application well.

### *Detailed Design Procedure*

For this application, SGM840xQ is used to measure the phase current of a 24V, 4000RPM motor.

Select the device with a gain of 20V/V and is powered by a 5V power supply.

## APPLICATION INFORMATION (continued)

Configure the device for bidirectional current measurements. Output biased voltage is set to half of $V_S$ by connecting REF1 to GND and REF2 to VS to split the supply. Surely, output biased voltage can be tied together and connected to an external reference voltage.

Select a 100mΩ resistor to keep the analog input within the device limits.

***Application Curve***

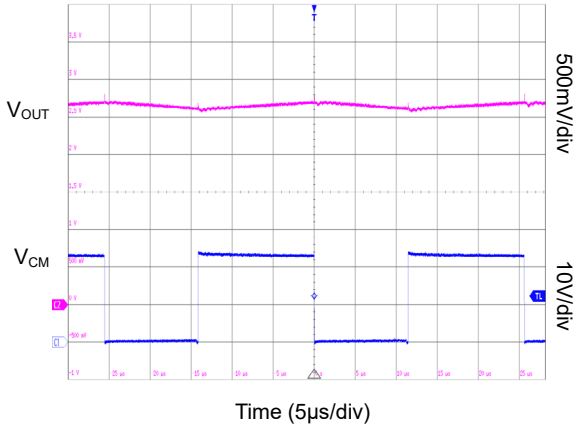



**Figure 13. In-Line Motor Current-Sense Input and Output Signals**

### Solenoid Drive Current Measurement

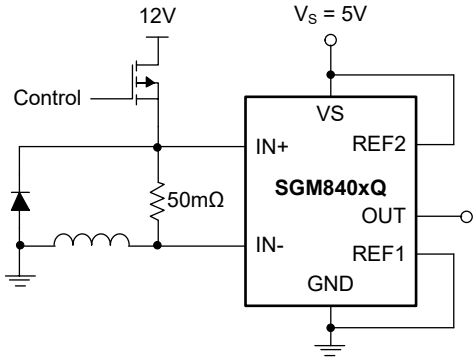



**Figure 14. Solenoid Drive Current Measurement**

***Design Requirements***

In solenoid drive current sensing application, the high PWM rejection of current-sensing amplifier is also needed. The SGM840xQ is a choice for these kind of applications.

***Detailed Design Procedure***

For this application, the SGM840xQ is used to measure the current of 12V, 0.5A water value.

Select the device with a gain of 100V/V and use a 5V power supply.

Configure the device for bidirectional current measurements. Output biased voltage is set to half of $V_S$ by connecting REF1 to GND and REF2 to VS to split the supply. Surely, output biased voltage can be tied together and connected to an external reference voltage.

Select a 50mΩ resistor to keep the analog input within the device limits.

***Application Curve***

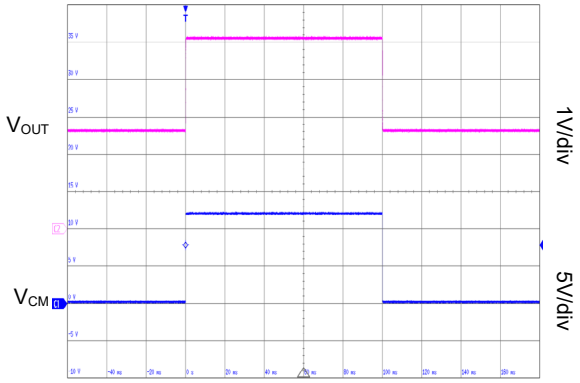



**Figure 15. Solenoid Drive Current Sense Input and Output Signals**

### Special Precautions

For high-precision measurement, the following items need to be check first.

1. Choose a precision current-sense resistor.
2. Provide a precision reference voltage for REF1 and REF2.
3. Optimize the layout and routing between the input pins and the sensing resistor.
4. Place adequate decoupling capacitor between VS and GND pin.

### Power Supply Recommendations

The SGM840xQ series can accurately measure signals over a wide range of common-mode voltages, from -4V to 80V, independent of the power supply voltage (VS). For instance, even if the SGM840xQ is powered by a 5V supply, it can handle common-mode voltages as low as -4V and as high as 80V. The output voltage range is subjected to the power supply.

# LAYOUT

## Layout Guidelines

Current sense connections must be made using Kelvin or 4-wire connection between the input pins and the sensing resistor. This connection method eliminates the extra induced impedance, ensuring that only the current-sensing resistor impedance can be detected between the input pins. Figure 16 shows the good and bad connections.

Place a decoupling capacitor as close as possible to the VS and GND pins. A 0.1μF bypass capacitor for this supply is recommended.

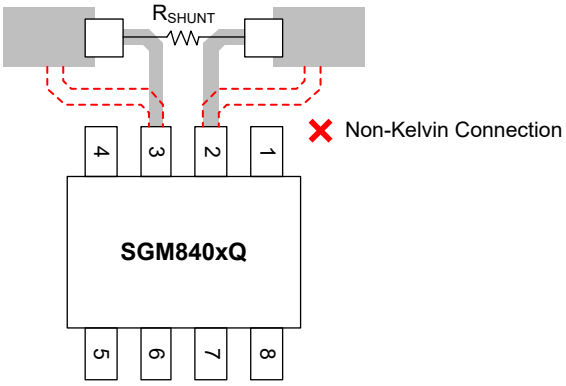



**Figure 16. Shunt Connections to the SGM840xQ**

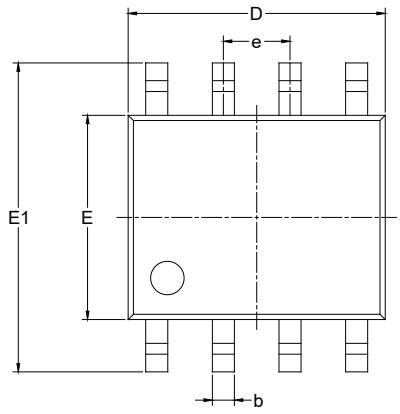
# REVISION HISTORY

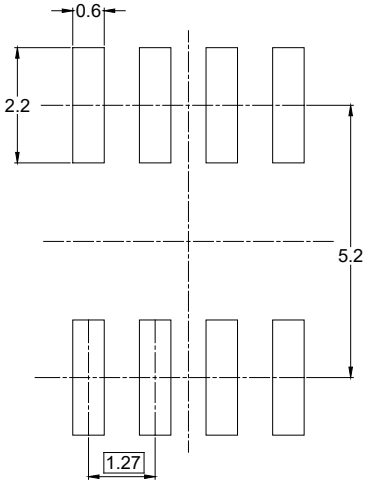
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (OCTOBER 2024) to REV.A | Page |
|---|---|
| Changed from product preview to production data | All |

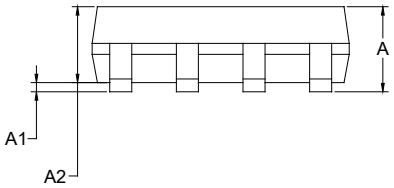
# PACKAGE OUTLINE DIMENSIONS

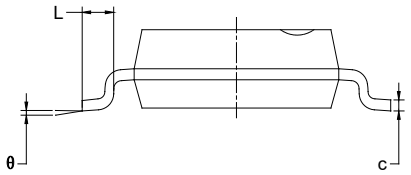
## SOIC-8




**RECOMMENDED LAND PATTERN** (Unit: mm)



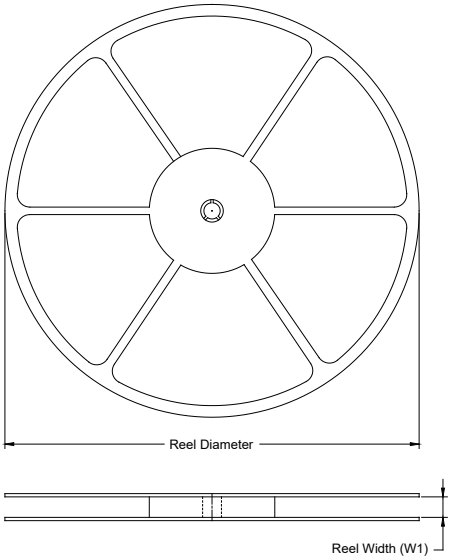




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.006 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.200 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 1.27 BSC | | 0.050 BSC | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

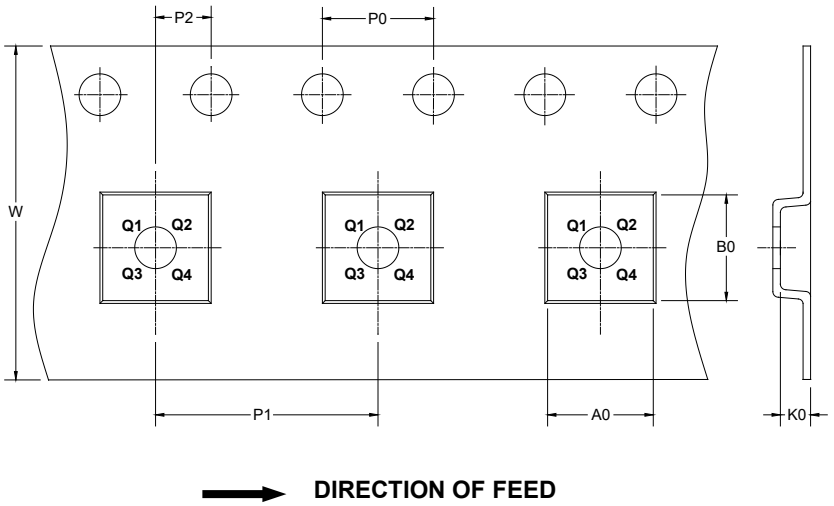
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

### REEL DIMENSIONS




### TAPE DIMENSIONS



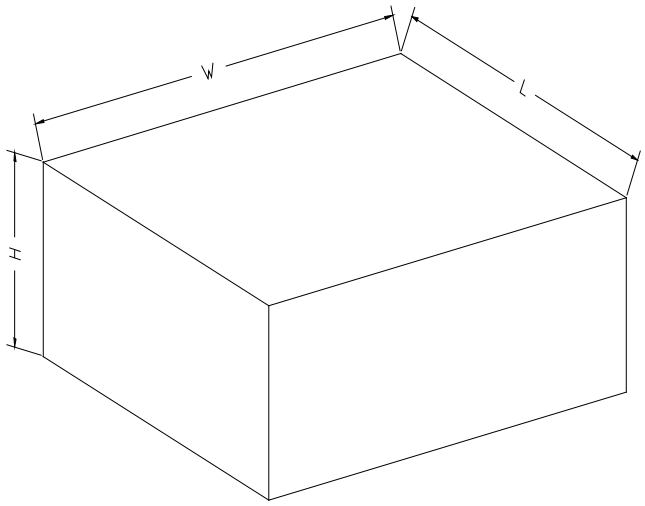

NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|
| SOIC-8 | 13" | 12.4 | 6.40 | 5.40 | 2.10 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |

DD0001

## CARTON BOX DIMENSIONS




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

## KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|---|---|---|---|---|
| 13″ | 386 | 280 | 370 | 5 |

DD0002