

GENERAL DESCRIPTION

The single SGM8040-1 and dual SGM8040-2 are nano-power, high precision operational amplifiers. These devices can operate from 1.4V to 5.5V single supply, and consume only 550nA quiescent current per amplifier. They are capable of rail-to-rail input and output. Therefore, the SGM8040-1/2 are suitable for use in portable instrumentation and battery-powered equipment.

The SGM8040-1/2 are unity-gain stable, and feature an 11kHz gain-bandwidth product. They are designed to provide optimal performance in low-frequency systems, when monitoring battery current and conditioning sensor signal.

The SGM8040-1 is available in Green SOT-23-5, SC70-5 and SOIC-8 packages. The SGM8040-2 is available in Green SOIC-8 and TDFN-2x2-8L packages. They operate over an ambient temperature range of -40°C to +85°C.

FEATURES

- **Low Quiescent Current: 550nA/Amplifier (TYP)**
- **Low Offset Voltage: 230µV (MAX)**
- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 11kHz (TYP)**
- **Supply Voltage Range: 1.4V to 5.5V**
- **Rail-to-Rail Input and Output**
- **-40°C to +85°C Operating Temperature Range**
- **Small Packages:**
 - SGM8040-1 Available in Green SOT-23-5, SC70-5 and SOIC-8 Packages**
 - SGM8040-2 Available in Green TDFN-2x2-8L and SOIC-8 Packages**

APPLICATIONS

- Battery-Powered Equipment
- Temperature Measurements
- Tollbooth Tags
- Wearable Devices

TYPICAL APPLICATION

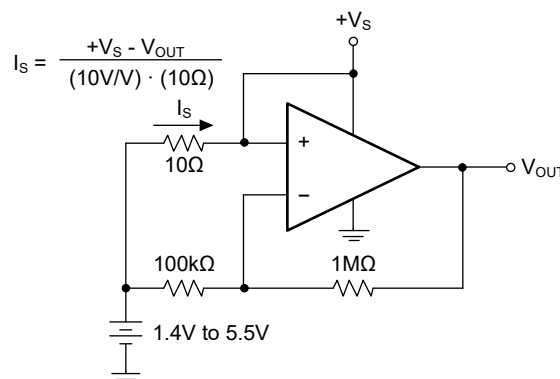


Figure 1. High-side Battery Current Sensor

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8040-1	SOT-23-5	-40°C to +85°C	SGM8040-1YN5G/TR	GP0XX	Tape and Reel, 3000
	SC70-5	-40°C to +85°C	SGM8040-1YC5G/TR	GY3XX	Tape and Reel, 3000
	SOIC-8	-40°C to +85°C	SGM8040-1YS8G/TR	SGM 80401YS8 XXXXX	Tape and Reel, 4000
SGM8040-2	SOIC-8	-40°C to +85°C	SGM8040-2YS8G/TR	SGM 80402YS8 XXXXX	Tape and Reel, 4000
	TDFN-2x2-8L	-40°C to +85°C	SGM8040-2YTDE8G/TR	GXF XXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XX = Date Code. XXXX = Date Code. XXXXX = Date Code and Vendor Code.

SOT-23-5/SC70-5

GYX X X

— Date Code - Month
— Date Code - Year
— Serial Number

SOIC-8

XXXXX

— Vendor Code
— Date Code - Week
— Date Code - Year

TDFN-2x2-8L

GXF — Serial Number

XX XX

— Date Code - Week
— Date Code - Year

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.

SGM8040-1 SGM8040-2

550nA, Rail-to-Rail I/O, High Precision Operational Amplifiers

ABSOLUTE MAXIMUM RATINGS

Supply Voltage.....	6V
Analog Inputs (V_{IN+} , V_{IN-}).....	$(-V_S) - 0.3V$ to $(+V_S) + 0.3V$
Differential Input Voltage.....	$ (-V_S) - (+V_S) $
Junction Temperature.....	+150°C
Storage Temperature Range.....	-65°C to +150°C
Lead Temperature (Soldering, 10s).....	+260°C
ESD Susceptibility	
HBM.....	8000V
MM.....	400V
CDM.....	1000V

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range.....	-40°C to +85°C
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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.

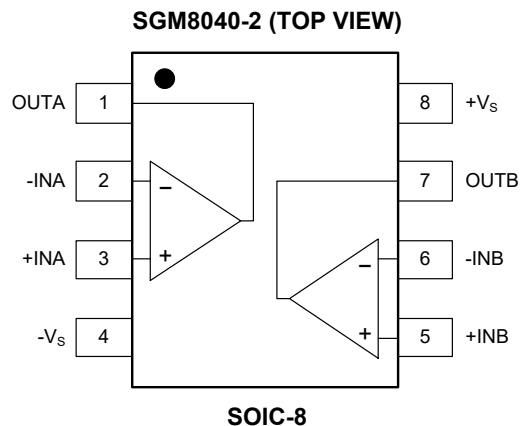
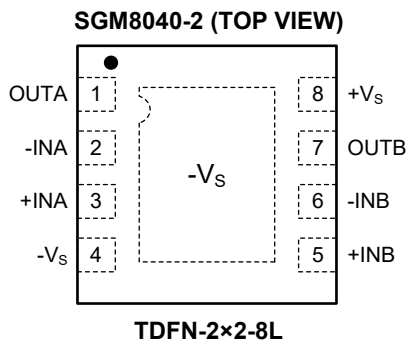
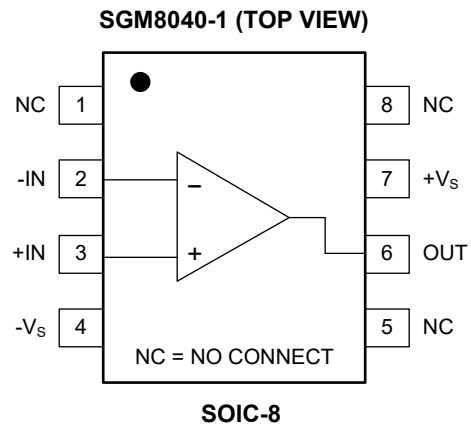
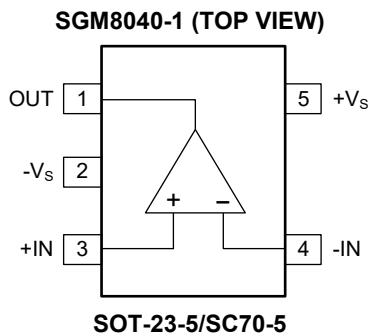
ESD SENSITIVITY CAUTION

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 CONFIGURATIONS



ELECTRICAL CHARACTERISTICS

(At $T_A = +25^\circ\text{C}$, Full = -40°C to $+85^\circ\text{C}$, $V_S = \pm 0.7\text{V}$ to $\pm 2.75\text{V}$ and $R_L = 1\text{M}\Omega$ ⁽¹⁾ connected to 0V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
DC Electrical Characteristics							
Input Offset Voltage	V_{OS}	$V_{CM} = 0\text{V}$	+25°C		80	230	μV
			Full			530	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		1		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	I_B	$V_{CM} = 0\text{V}$	+25°C		± 10	± 200	pA
Input Offset Current	I_{OS}	$V_{CM} = 0\text{V}$	+25°C		± 10	± 300	pA
Input Common Mode Voltage Range	V_{CM}		Full	$(-V_S) - 0.1$		$(+V_S) + 0.1$	V
Common Mode Rejection Ratio	CMRR	$V_S = \pm 2.5\text{V}, (-V_S) - 0.1\text{V} < V_{CM} < (+V_S) + 0.1\text{V}$	+25°C	82	92		dB
			Full	75			
		$V_S = \pm 2.5\text{V}, 0 < V_{CM} < (+V_S) + 0.1\text{V}$	+25°C	76	86		
			Full	70			
		$V_S = \pm 2.5\text{V}, (-V_S) - 0.1\text{V} < V_{CM} < 0$	+25°C	90	110		
			Full	86			
Open-Loop Voltage Gain	A_{OL}	$V_S = \pm 0.7\text{V}, (-V_S) + 0.1\text{V} < V_{OUT} < (+V_S) - 0.1\text{V}, R_L = 50\text{k}\Omega$	+25°C	88	110		dB
			Full	85			
		$V_S = \pm 2.5\text{V}, (-V_S) + 0.1\text{V} < V_{OUT} < (+V_S) - 0.1\text{V}, R_L = 50\text{k}\Omega$	+25°C	104	120		
			Full	94			
Output Voltage Swing from Rail		$R_L = 50\text{k}\Omega$	+25°C		3	9	mV
			Full			10	
Output Short-Circuit Current	I_{SC}	$V_S = \pm 0.7\text{V}$	+25°C		2		mA
		$V_S = \pm 2.5\text{V}$	+25°C	8	18		
Supply Voltage	V_S		Full	1.4		5.5	V
Quiescent Current/Amplifier	I_Q		+25°C		550	850	nA
			Full			900	
Power Supply Rejection Ratio	PSRR	$V_S = 1.4\text{V}$ to 5.5V	+25°C	86	104		dB
			Full	82			
AC Electrical Characteristics							
Gain-Bandwidth Product	GBP	$C_L = 60\text{pF}$	+25°C		11		kHz
Slew Rate	SR	$V_S = \pm 0.7\text{V}, V_{OUT} = 1V_{P-P}, G = +1$	+25°C		2		V/ms
		$V_S = \pm 1.25\text{V}, V_{OUT} = 1V_{P-P}, G = +1$	+25°C		3.5		
		$V_S = \pm 2.5\text{V}, V_{OUT} = 2V_{P-P}, G = +1$	+25°C		4		
Input Voltage Noise		$f = 0.1\text{Hz}$ to 10Hz	+25°C		5		μV_{P-P}
Input Voltage Noise Density	e_n	$f = 1\text{kHz}$	+25°C		180		$\text{nV}/\sqrt{\text{Hz}}$
Input Current Noise Density	i_n	$f = 1\text{kHz}$	+25°C		300		$\text{fA}/\sqrt{\text{Hz}}$

NOTE: 1. Refer to Figure 2 and Figure 3.

TEST CIRCUITS

Figure 2 and Figure 3 show the AC and DC test circuits.

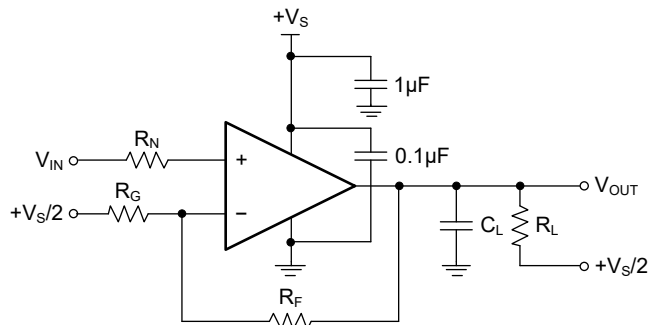


Figure 2. AC and DC Test Circuit for Most Non-Inverting Gain Configurations

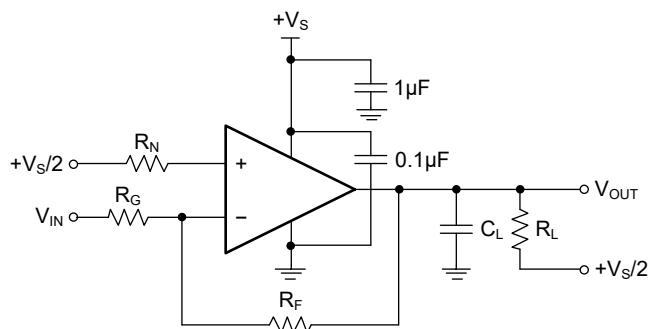
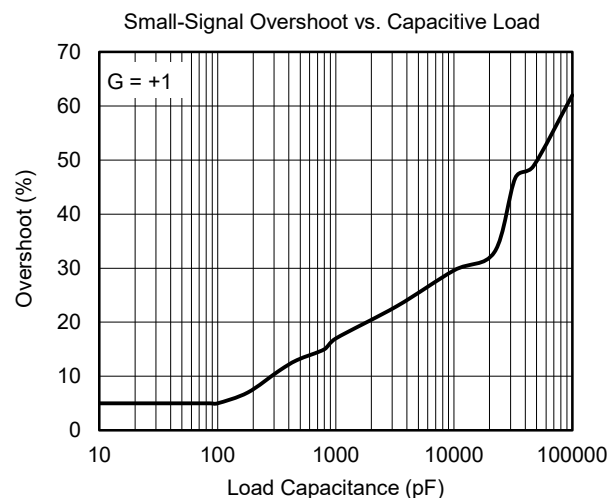
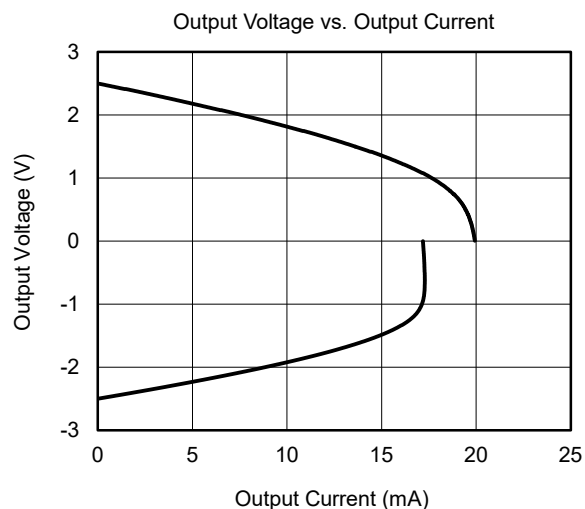
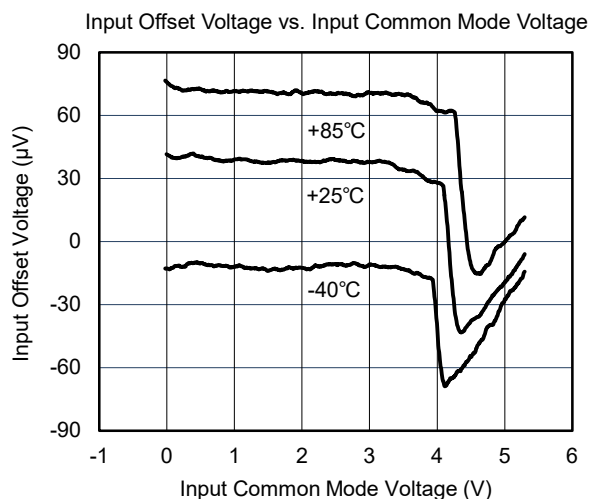
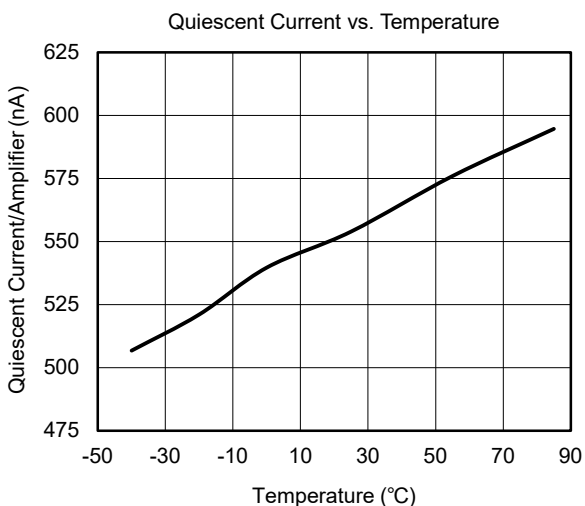
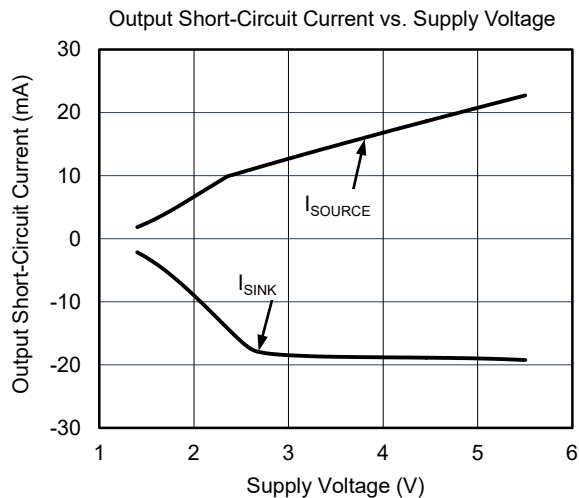
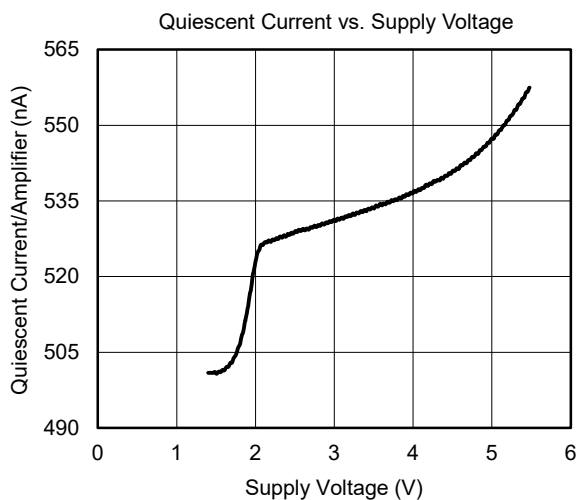


Figure 3. AC and DC Test Circuit for Most Inverting Gain Configurations

TYPICAL PERFORMANCE CHARACTERISTICS

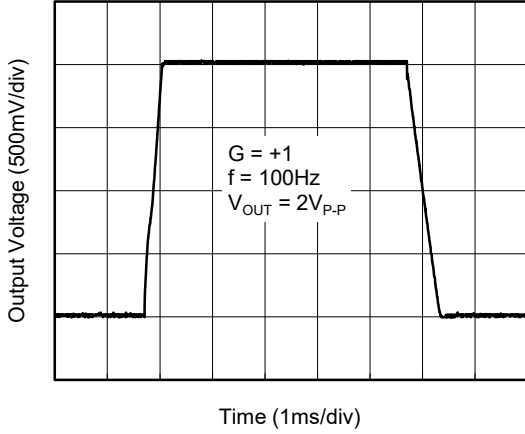
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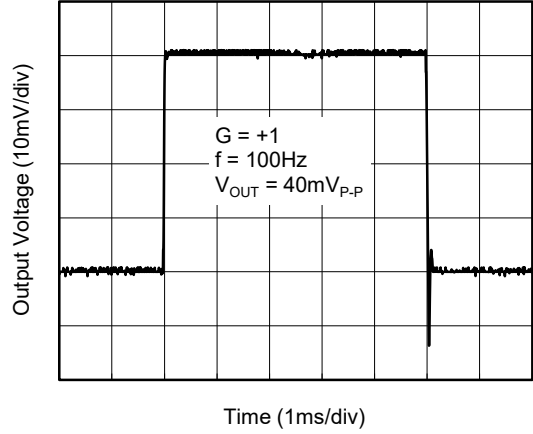
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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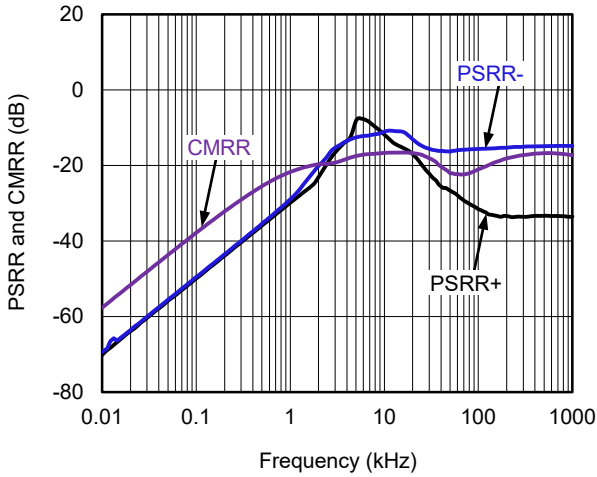
Large-Signal Step Response



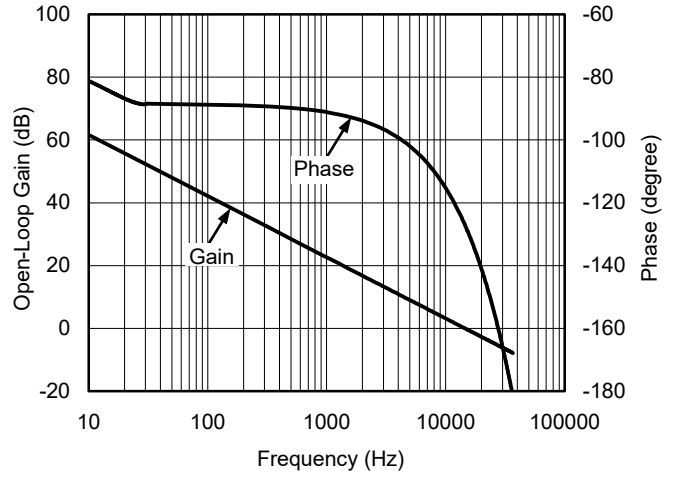
Small-Signal Step Response



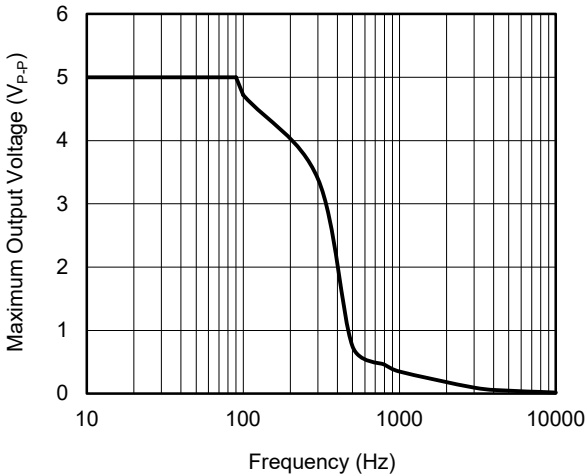
CMRR and PSRR vs. Frequency



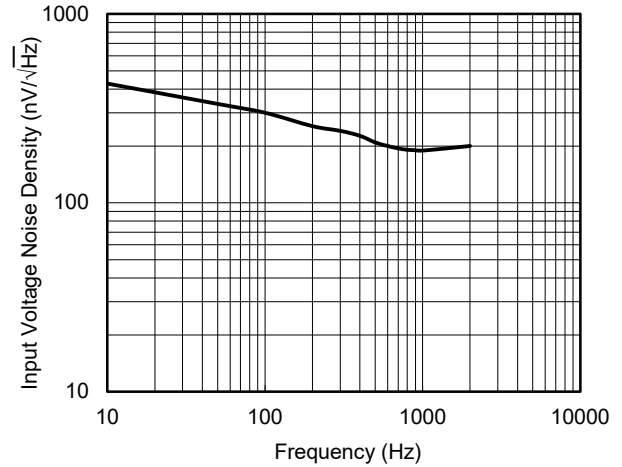
Open-Loop Gain and Phase vs. Frequency



Maximum Output Voltage vs. Frequency

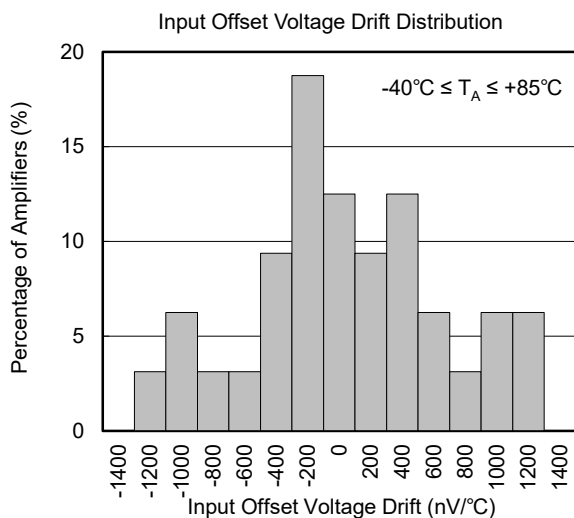
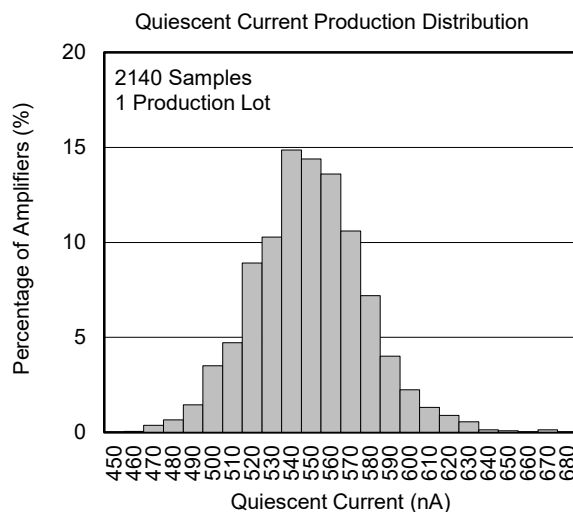
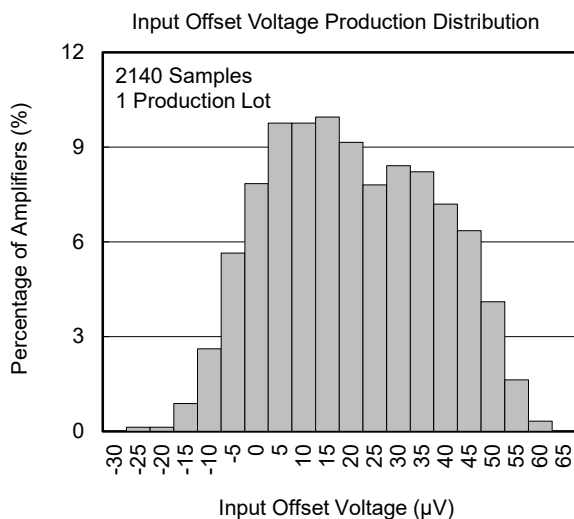
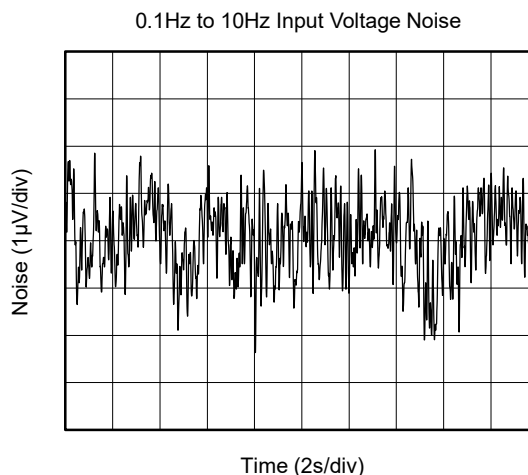
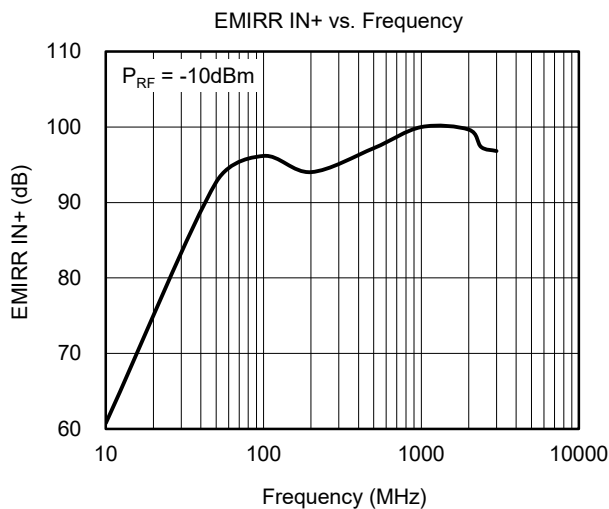


Input Voltage Noise Density vs. Frequency



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $R_L = 1\text{M}\Omega$, unless otherwise noted.



REVISION HISTORY

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

JULY 2023 – REV.A to REV.A.1

Page

Updated Package Outline Dimensions section 11

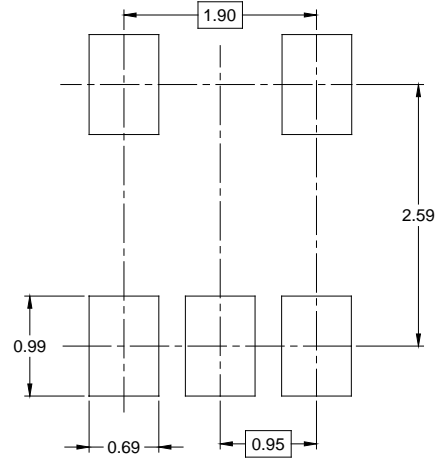
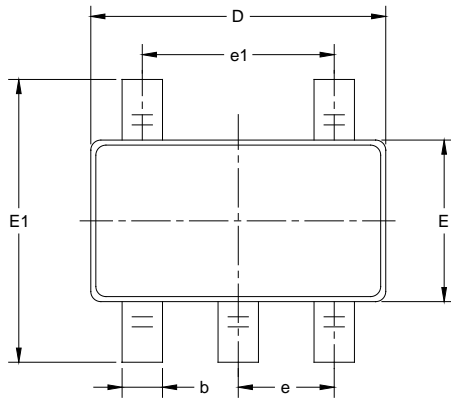
Changes from Original (SEPTEMBER 2018) to REV.A

Page

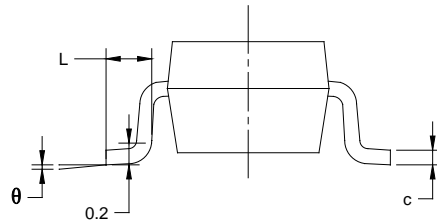
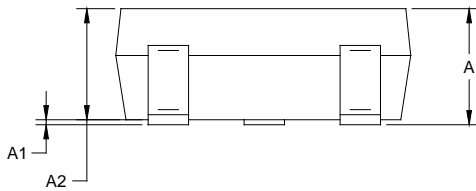
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PACKAGE OUTLINE DIMENSIONS

SOT-23-5



RECOMMENDED LAND PATTERN (Unit: mm)



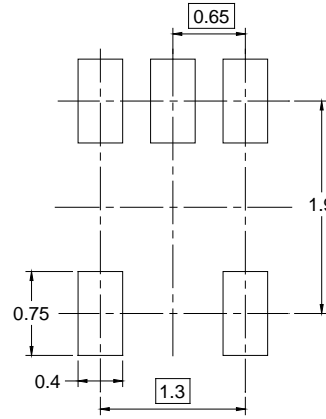
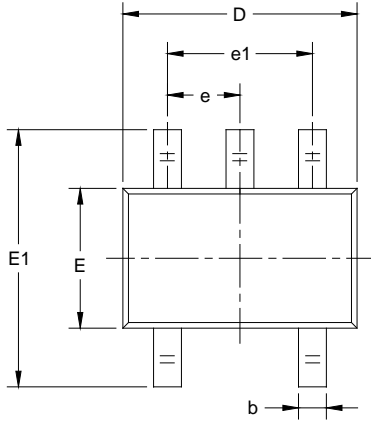
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

NOTES:

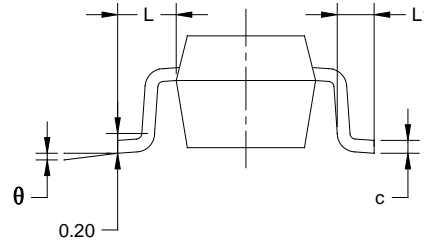
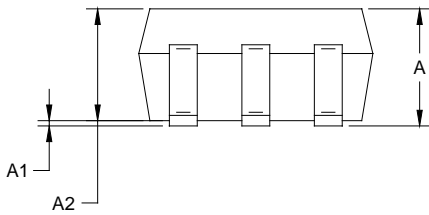
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2. This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

SC70-5



RECOMMENDED LAND PATTERN (Unit: mm)



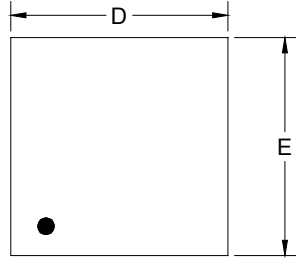
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	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.220	0.003	0.009
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 TYP	
e1	1.300 BSC		0.051 BSC	
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

NOTES:

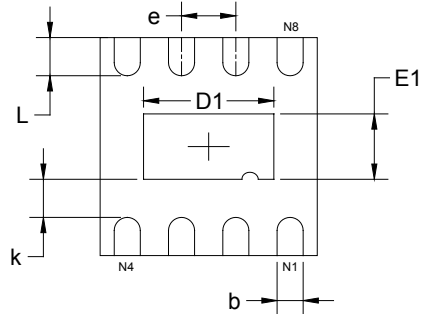
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2. This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

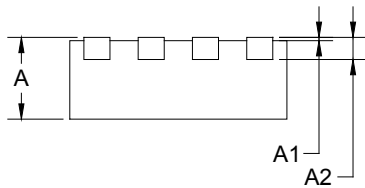
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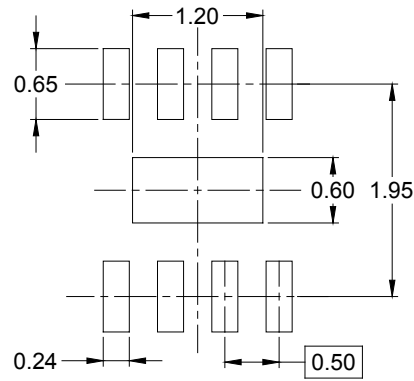
TOP VIEW



BOTTOM VIEW



SIDE VIEW

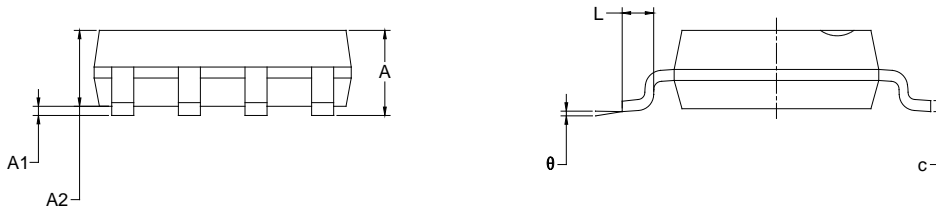
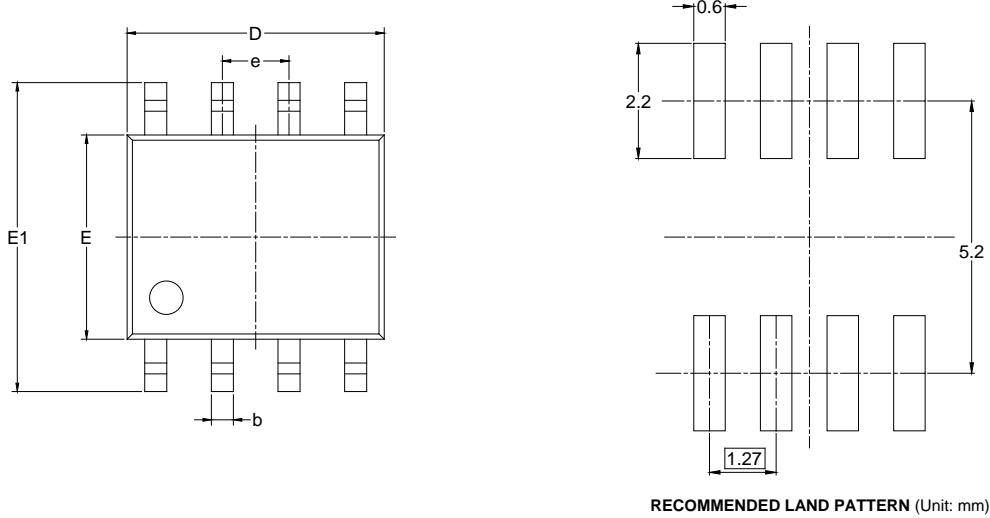


RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E	1.900	2.100	0.075	0.083
E1	0.500	0.700	0.020	0.028
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.250	0.450	0.010	0.018

PACKAGE OUTLINE DIMENSIONS

SOIC-8



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.

PACKAGE INFORMATION

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
SOT-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SC70-5	7"	9.5	2.40	2.50	1.20	4.0	4.0	2.0	8.0	Q3
TDFN-2×2-8L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
SOIC-8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1

D00001

PACKAGE INFORMATION

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
7" (Option)	368	227	224	8
7"	442	410	224	18
13"	386	280	370	5

DD0002