SGM8535/6/7/8
1.5MHz, Rail-to-Rail Output Operational Amplifiers

PRODUCT DESCRIPTION

The SGM8535 (single), SGM8536 (dual), SGM8537 (single with shutdown) and SGM8538 (quad) are rail-to-rail output voltage feedback amplifiers. They have a wide input common-mode voltage range and output voltage swing, and take the minimum operating supply voltage down to 1.8V. The maximum recommended supply voltage is 5.5V.

The SGM8535/6/7/8 provide 1.5MHz bandwidth at a low current consumption of 80μA per amplifier. Very low input bias currents enable SGM8535/6/7/8 to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail outputs are useful to designers for buffering ASIC in single-supply systems.

Applications for these amplifiers include safety monitoring, portable equipment, battery and power supply control, signal conditioning and interfacing for transducers in very low power systems.

The SGM8535/6/7/8 are specified over the extended -40℃ to +85℃ temperature range. The SGM8535 single is available in Green SOT-23-5, SC70-5, MSOP-8 and SOIC-8 packages. The SGM8536 dual is available in Green SOIC-8 and MSOP-8 packages. The SGM8537 single with shutdown is available in Green SOT-23-6, MSOP-8 and SOIC-8 packages. The SGM8538 quad is available in Green SOIC-14 and TSSOP-14 packages.

FEATURES

- **Rail-to-Rail Output**
- **Low Input Offset Voltage: 0.6mV (TYP)**
- **Unity Gain Stable**
- **Gain Bandwidth Product: 1.5MHz**
- **Supply Voltage Range: 1.8V to 5.5V**
- **Low Supply Current**
  - **80μA/Amplifier (TYP)**
  - **0.1μA Shutdown Current for SGM8537**
- **Small Packaging:**
  - **SGM8535 Available in SOT-23-5, SC70-5, SOIC-8 and MSOP-8**
  - **SGM8536 Available in MSOP-8 and SOIC-8**
  - **SGM8537 Available in SOT-23-6, SOIC-8 and MSOP-8**
  - **SGM8538 Available in SOIC-14 and TSSOP-14**

APPLICATIONS

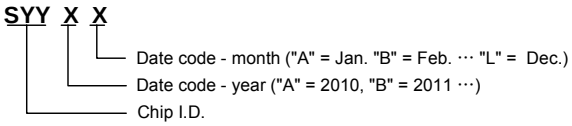
ASIC Input or Output Amplifier
Sensor Interface
Piezoelectric Transducer Amplifier
Medical Instrumentation
Mobile Communication
Audio Output
Portable Systems
Smoke Detectors
Mobile Telephone
Notebook PC
PCMCIA Cards
Battery-Powered Equipment

PACKAGE/ORDERING INFORMATION

MODEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
SGM8535	SGM8535AYN5G/TR	SOT-23-5	Tape and Reel, 3000	SB2XX
	SGM8535BYN5G/TR	SOT-23-5	Tape and Reel, 3000	SB3XX
	SGM8535YC5G/TR	SC70-5	Tape and Reel, 3000	SB4XX
	SGM8535YS8G/TR	SOIC-8	Tape and Reel, 2500	SGM8535YS8
	SGM8535YMS8G/TR	MSOP-8	Tape and Reel, 3000	SGM8535YMS8
SGM8536	SGM8536YMS8G/TR	MSOP-8	Tape and Reel, 3000	SGM8536YMS8
	SGM8536YS8G/TR	SOIC-8	Tape and Reel, 2500	SGM8536YS8
SGM8537	SGM8537YN6G/TR	SOT-23-6	Tape and Reel, 3000	SB5XX
	SGM8537YS8G/TR	SOIC-8	Tape and Reel, 2500	SGM8537YS8
	SGM8537YMS8G/TR	MSOP-8	Tape and Reel, 3000	SGM8537YMS8
SGM8538	SGM8538YS14G/TR	SOIC-14	Tape and Reel, 2500	SGM8538YS14
	SGM8538YTS14G/TR	TSSOP-14	Tape and Reel, 3000	SGM8538YTS14

NOTE: Package marking is defined as the follow:

MARKING INFORMATION



For example: SB2BA (2011, January)

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$.....6V
Common-Mode Input Voltage.....-0.1V to $+V_S$ - 1.3V
Storage Temperature Range.....-65℃ to +150℃
Junction Temperature .....150℃
Operating Temperature Range..... -40℃ to +85℃
Lead Temperature Range (Soldering 10 sec)
.....260℃
ESD Susceptibility
HBM (SGM8535/6/8).....8000V
HBM (SGM8537).....3000V
MM 400V

NOTE:
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

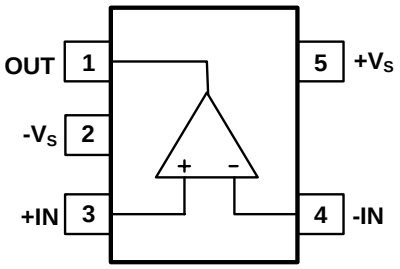
CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. 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 very small parametric changes could cause the device not to meet its published specifications.

SGMICRO reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact SGMICRO sales office to get the latest datasheet.

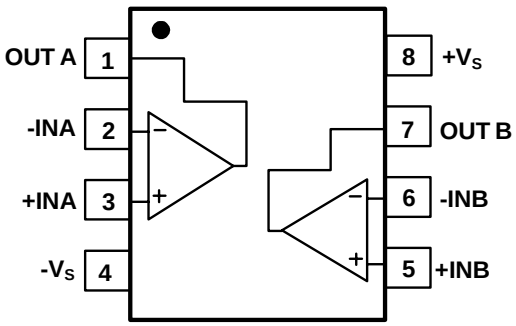
PIN CONFIGURATIONS (Top View)

SGM8535YC5G
SGM8535AYN5G



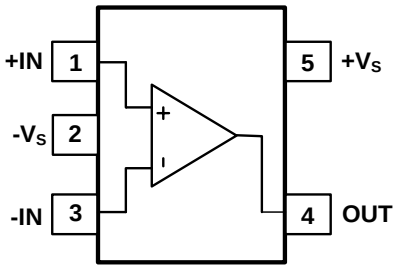
SOT-23-5/SC70-5

SGM8536



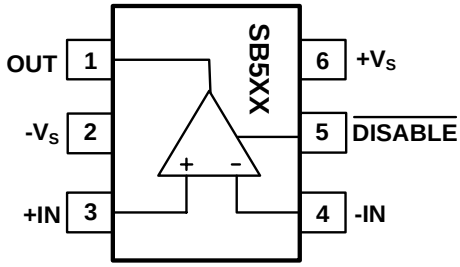
SOIC-8/MSOP-8

SGM8535BYN5G



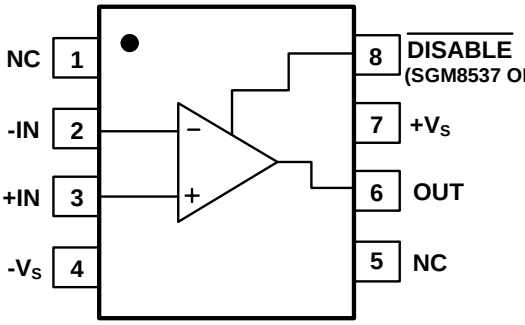
SOT-23-5

SGM8537



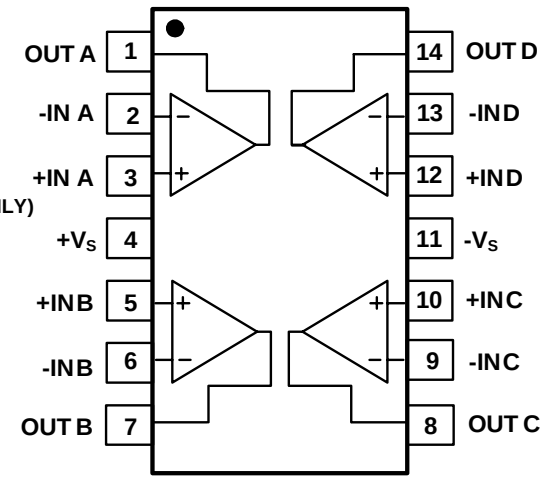
SOT-23-6

SGM8535/7



SOIC-8/MSOP-8
NC = NO CONNECT

SGM8538



TSSOP-14/SOIC-14

NOTE: The location of pin 1 on the SOT-23-6 is determined by orienting the package marking as shown.

ELECTRICAL CHARACTERISTICS: V_S = +5V

(At T_A = +25℃, V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
DC PERFORMANCE					
Input Offset Voltage (V_{OS})	V_{CM} = V_S/2		0.6	3.4	mV
	-40℃ ≤ T_A ≤ +85℃			3.8	
Input Bias Current (I_B)			3		pA
Input Offset Current (I_{OS})			3		pA
Input Offset Voltage Drift	V_{CM} = V_S/2		1.5		μV/℃
Open-Loop Gain (A_{OL})	R_L = 2kΩ, V_{OUT} = 0.2V to 4.8V	80	90		dB
	-40℃ ≤ T_A ≤ +85℃	75			
	R_L = 100kΩ, V_{OUT} = 0.035V to 4.965V	85	103		dB
	-40℃ ≤ T_A ≤ +85℃	77			
INPUT CHARACTERISTICS					
Input Common Mode Voltage Range (V_{CM})		-0.1		3.7	V
Common Mode Rejection Ratio (CMRR)	V_{CM} = -0.1V to 3.7V	70	85		dB
	-40℃ ≤ T_A ≤ +85℃	65			
OUTPUT CHARACTERISTICS					
Output Voltage Swing from Rail	R_L = 2kΩ		80	100	mV
	-40℃ ≤ T_A ≤ +85℃			110	
Output Short Circuit Current (I_{SC})		22	35		mA
	-40℃ ≤ T_A ≤ +85℃	18			
POWER-DOWN (SGM8537 only)					
Logic Low Voltage (V_{IL})				0.8	V
Logic High Voltage (V_{IH})		2			
POWER SUPPLY					
Quiescent Current (per Amplifier)	I_{OUT} = 0mA		80	130	μA
	-40℃ ≤ T_A ≤ +85℃			165	
Supply Current when Disabled (SGM8537 only)			100	1500	nA
Power Supply Rejection Ratio (PSRR)	V_S = +1.8V to +5.5V, V_{CM} = 0.5V	65	80		dB
	-40℃ ≤ T_A ≤ +85℃	60			
DYNAMIC PERFORMANCE					
Gain-Bandwidth Product (GBP)	R_L = 2kΩ, C_L = 100pF		1.5		MHz
Slew Rate	V_{OUT} = 2V_{PP}, A_V = 1		0.8		V/μs
Crosstalk	f = 1kHz		110		dB
Settling Time to 0.1% (t_S)	V_{OUT} = 2V_{PP}, f = 1kHz, A_V = 1, R_L = 2kΩ, C_L = 100pF		3.5		μs
Overload Recovery Time	R_L = 2kΩ, A_V = -50		7		μs
NOISE PERFORMANCE					
Input Voltage Noise (e_n)	f = 1kHz		30		nV/$\sqrt{Hz}$

ELECTRICAL CHARACTERISTICS: V_S = +1.8V

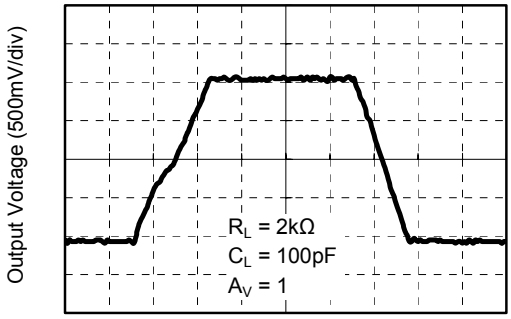
(At T_A = +25℃, V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
DC PERFORMANCE					
Input Offset Voltage (V_{OS})	V_{CM} = 0.5V		0.6	3.5	mV
	-40℃ ≤ T_A ≤ +85℃			4	
Input Bias Current (I_B)			3		pA
Input Offset Current (I_{OS})			3		pA
Input Offset Voltage Drift	V_{CM} = 0.5V		1.5		μV/℃
Open-Loop Gain (A_{OL})	R_L = 2kΩ, V_{OUT} = 0.2V to 1.6V	72	82		dB
	-40℃ ≤ T_A ≤ +85℃	65			
	R_L = 100kΩ, V_{OUT} = 0.035V to 1.765V	82	100		dB
	-40℃ ≤ T_A ≤ +85℃	75			
INPUT CHARACTERISTICS					
Input Common Mode Voltage Range (V_{CM})		-0.1		0.5	V
Common Mode Rejection Ratio (CMRR)	V_{CM} = -0.1V to 0.5V	64	78		dB
	-40℃ ≤ T_A ≤ +85℃	60			
OUTPUT CHARACTERISTICS					
Output Voltage Swing from Rail	R_L = 2kΩ		55	70	mV
	-40℃ ≤ T_A ≤ +85℃			100	
Output Short Circuit Current (I_{SC})		2.5	5		mA
	-40℃ ≤ T_A ≤ +85℃	2			
POWER-DOWN (SGM8537 only)					
Logic Low Voltage (V_{IL})				0.4	V
Logic High Voltage (V_{IH})		1.3			
POWER SUPPLY					
Quiescent Current (per Amplifier)	I_{OUT} = 0mA		75	125	μA
	-40℃ ≤ T_A ≤ +85℃			160	
Supply Current when Disabled (SGM8537 only)			10	1200	nA
DYNAMIC PERFORMANCE					
Gain-Bandwidth Product (GBP)	R_L = 2kΩ, C_L = 100pF		1.3		MHz
Slew Rate	V_{OUT} = 0.5V_{PP}, A_V = 1		0.7		V/μs
Crosstalk	f = 1kHz		110		dB
Settling Time to 0.1% (t_S)	V_{OUT} = 0.5V_{PP}, f = 1kHz, A_V = 1, R_L = 2kΩ, C_L = 100pF		2.5		μs
Overload Recovery Time	R_L = 2kΩ, A_V = -50		6		μs
NOISE PERFORMANCE					
Input Voltage Noise (e_n)	f = 1kHz		35		nV/$\sqrt{Hz}$

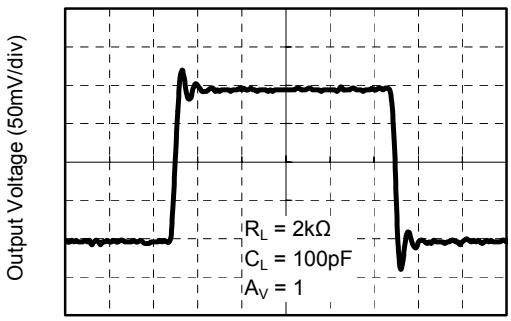
TYPICAL PERFORMANCE CHARACTERISTICS

(At T_A = +25℃, V_S = +5V, unless otherwise noted.)

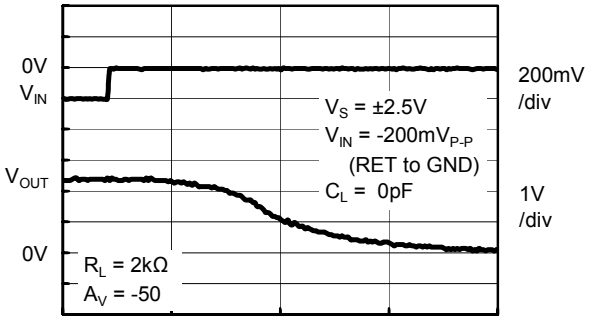
Large Signal Step Response



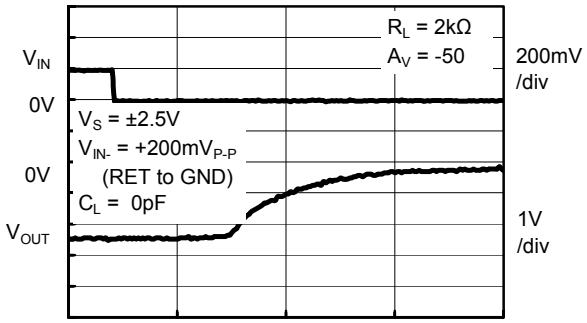
Small Signal Step Response



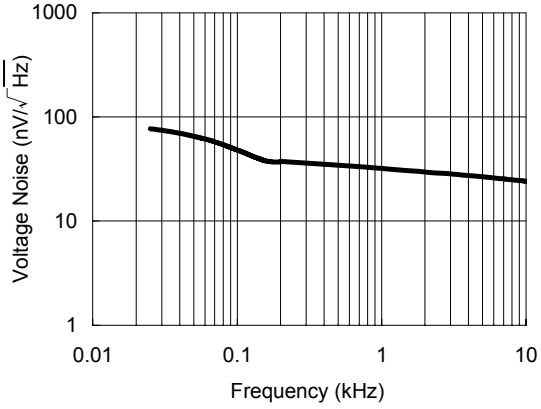
Positive Overvoltage Recovery



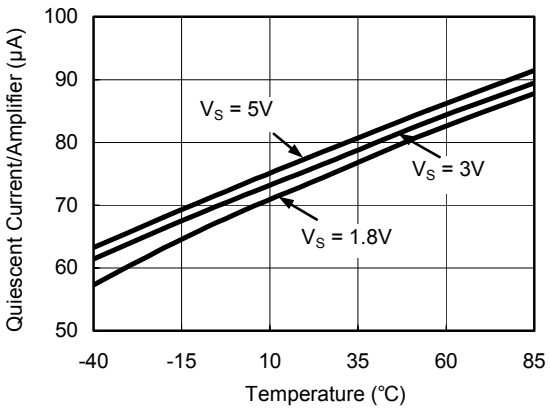
Negative Overvoltage Recovery



Input Voltage Noise Spectral Density vs. Frequency



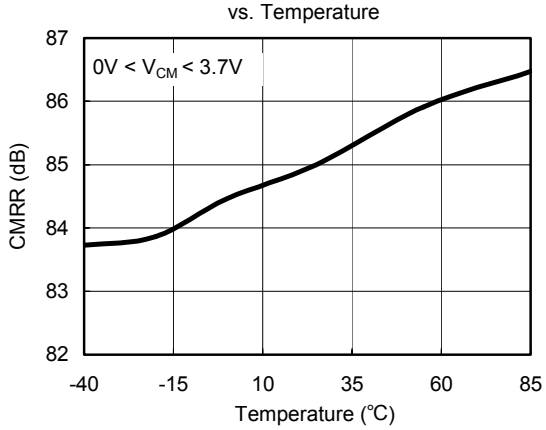
Quiescent Current vs. Temperature



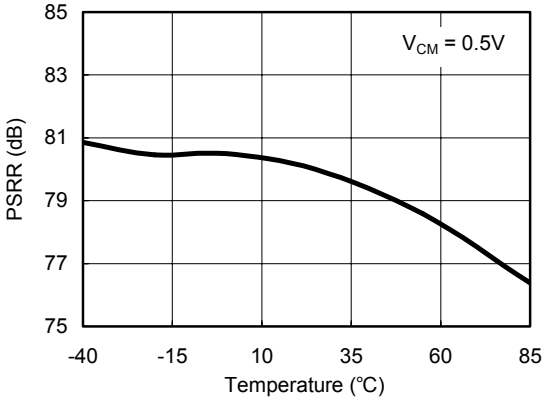
TYPICAL PERFORMANCE CHARACTERISTICS

(At T_A = +25℃, V_S = +5V, unless otherwise noted.)

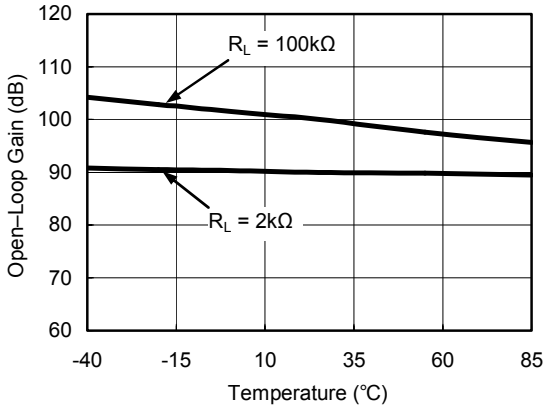
Common-Mode Rejection Ratio
vs. Temperature



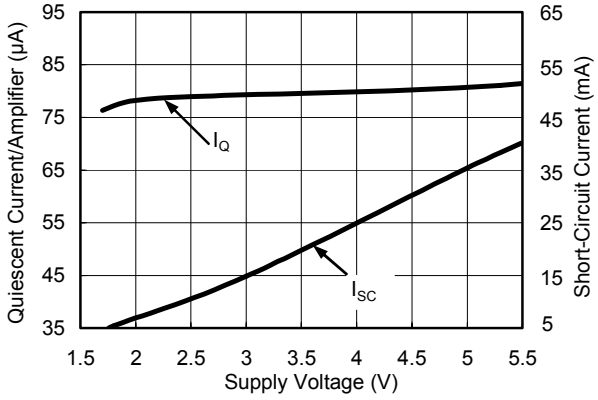
Power-Supply Rejection Ratio vs. Temperature



Open-Loop Gain vs. Temperature

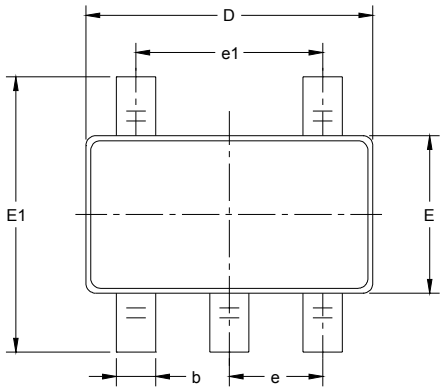


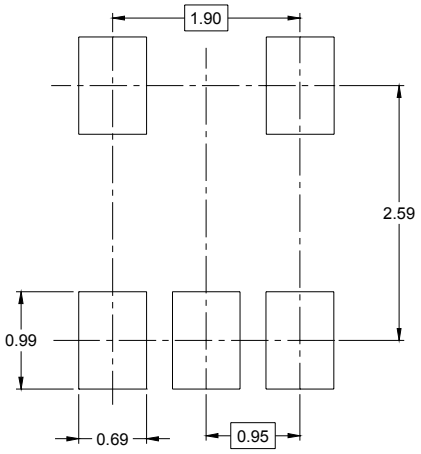
Quiescent Current and Short-Circuit Current
vs. Supply Voltage



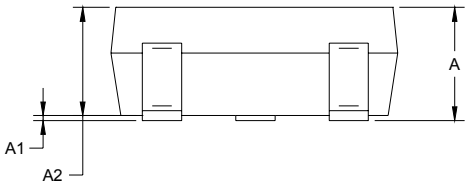
PACKAGE OUTLINE DIMENSIONS

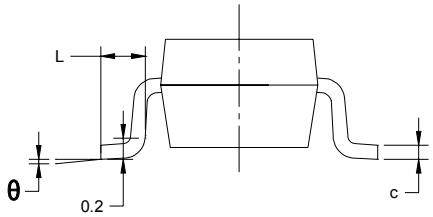
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

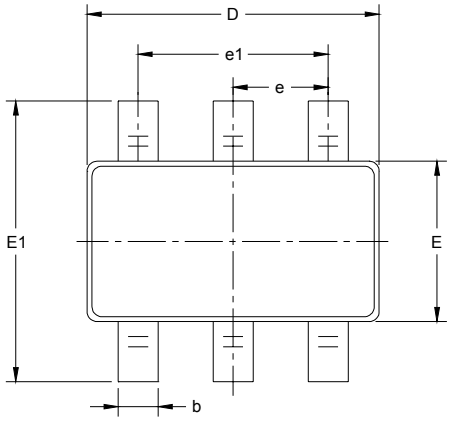


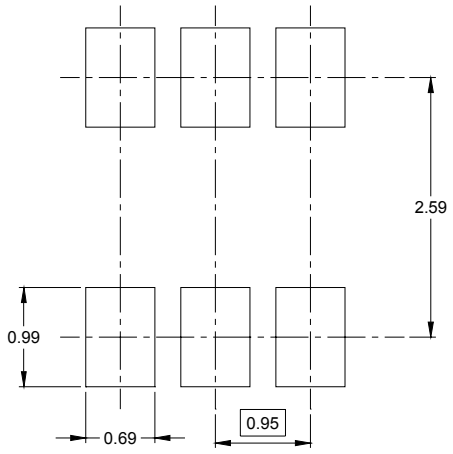


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

PACKAGE OUTLINE DIMENSIONS

SOT-23-6





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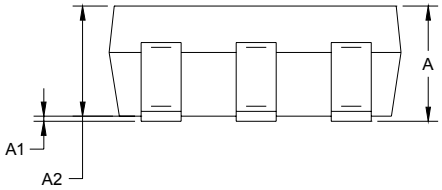
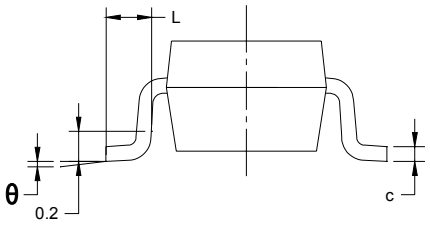
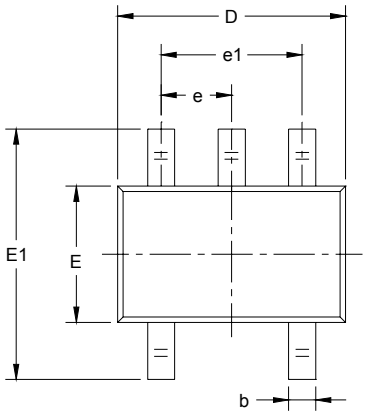


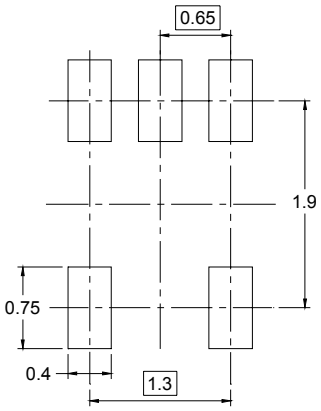


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

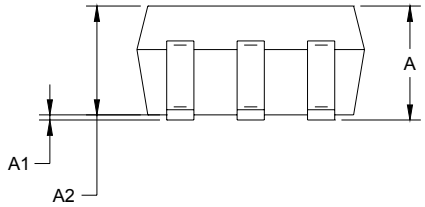
PACKAGE OUTLINE DIMENSIONS

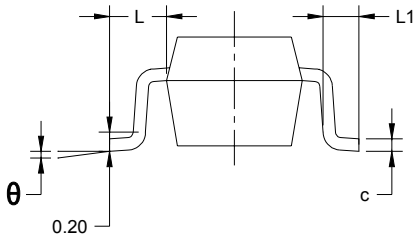
SC70-5





RECOMMENDED LAND PATTERN (Unit: mm)

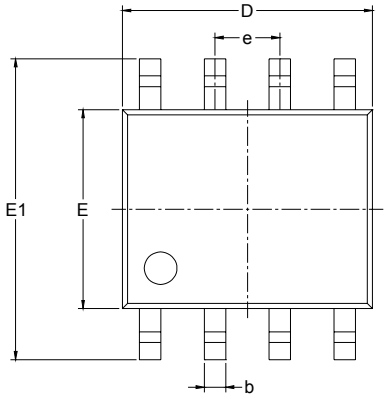


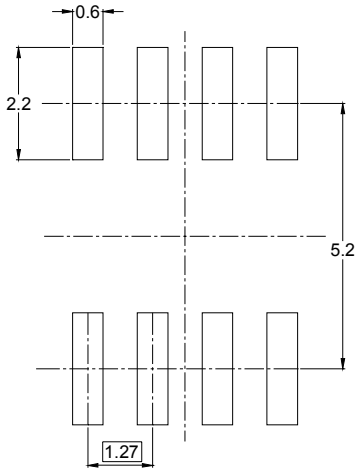


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 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°

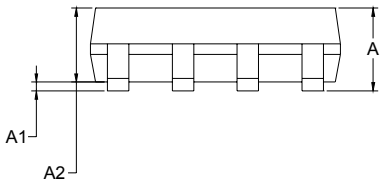
PACKAGE OUTLINE DIMENSIONS

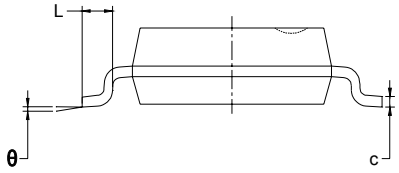
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

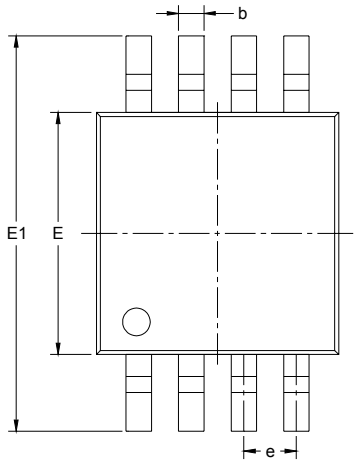


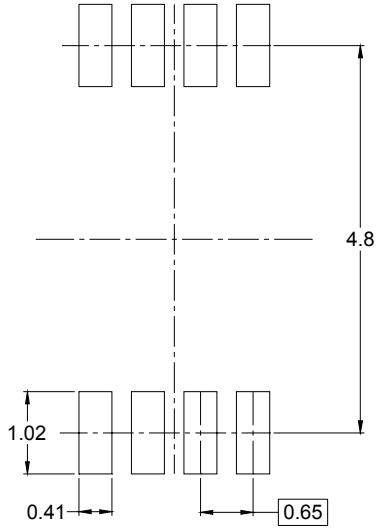


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

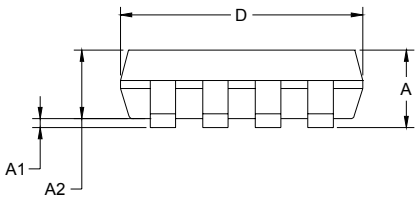
PACKAGE OUTLINE DIMENSIONS

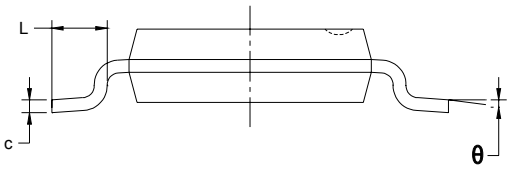
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)

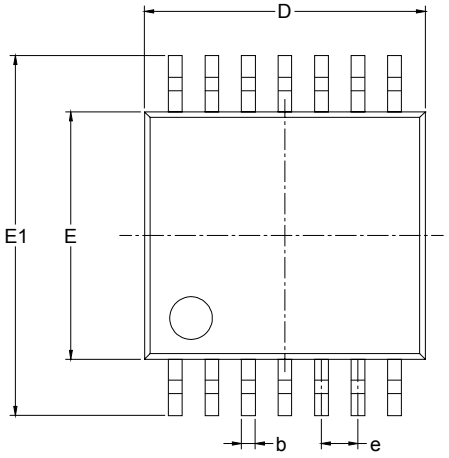


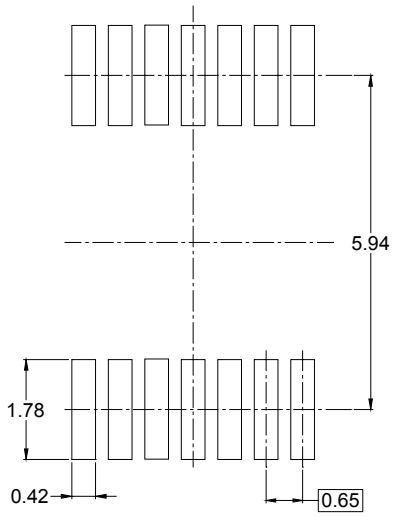


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

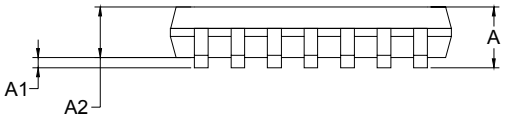
PACKAGE OUTLINE DIMENSIONS

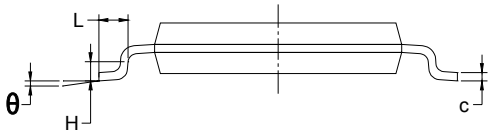
TSSOP-14





RECOMMENDED LAND PATTERN (Unit: mm)

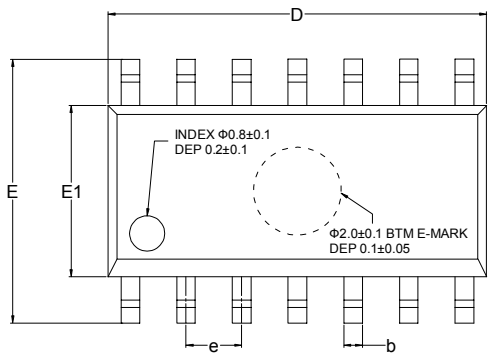


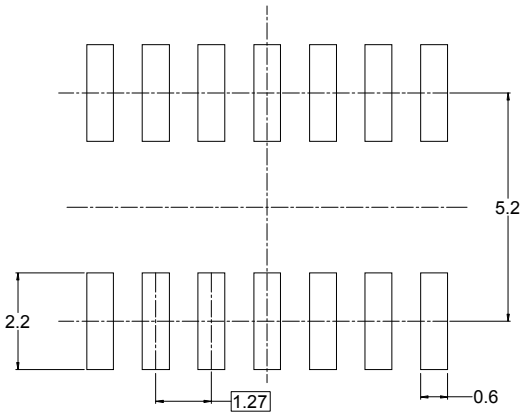


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

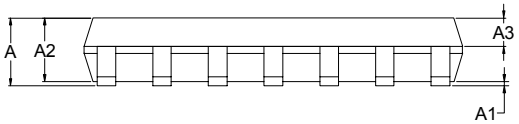
PACKAGE OUTLINE DIMENSIONS

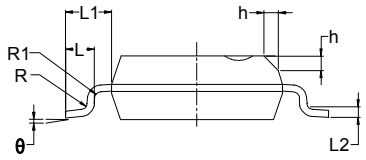
SOIC-14





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
b	0.36		0.49	0.014		0.019
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC			0.050 BSC		
L	0.45		0.80	0.018		0.032
L1	1.04 REF			0.040 REF		
L2	0.25 BSC			0.01 BSC		
R	0.07			0.003		
R1	0.07			0.003		
h	0.30		0.50	0.012		0.020
θ	0°		8°	0°		8°