SGM8651/SGM8652/SGM8653
SGM8654/SGM8655
50MHz, Rail-to-Rail Output CMOS Operational Amplifiers

GENERAL DESCRIPTION

The SGM8651/3 (single), SGM8652/5 (dual) and SGM8654 (quad) are high precision, low distortion and noise operational amplifiers with voltage feedback function. These devices can operate from 2.5V to 5.5V single supply. The SGM8651/2/3/4/5 feature a 2mV (TYP) input offset voltage and offer a low supply current of 2.3mA/amplifier.

The SGM8651/2/3/4/5 have excellent performance. They exhibit a gain-bandwidth product of 50MHz and a slew rate of 66V/μs.

The fast settling time and low distortion make the operational amplifiers appropriate for high speed ADC/DAC. The supply current of SGM8653/5 is 75μA in shutdown mode. The devices are suitable for use in portable instrumentation and battery-powered systems.

The SGM8651 is available in Green SOT-23-5 and SOIC-8 packages. The SGM8652 is available in Green SOIC-8 and MSOP-8 packages. The SGM8653 is available in Green SOT-23-6 and SOIC-8 packages. The SGM8654 is available in Green SOIC-14 and TSSOP-14 packages. The SGM8655 is available in a Green MSOP-10 package. They are specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **Input Offset Voltage: 2mV (TYP)**
- **Low Input Voltage Noise: 8.7nV/$\sqrt{Hz}$**
- **High Speed:**
  - **Gain-Bandwidth Product: 50MHz**
  - **High Slew Rate: 66V/μs**
  - **Settling Time to 0.1% with 2V Step: 60ns**
- **Overload Recovery Time: 25ns**
- **Rail-to-Rail Output**
- **Supply Voltage Range: 2.5V to 5.5V**
- **Input Common Mode Voltage Range:**
  - **-0.2V to 3.8V with V_S = 5V**
- **Low Supply Current:**
  - **2.3mA/Amplifier (TYP)**
  - **75μA/Amplifier Shutdown Current for SGM8653/5**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  - **SGM8651 Available in Green SOT-23-5 and SOIC-8 Packages**
  - **SGM8652 Available in Green MSOP-8 and SOIC-8 Packages**
  - **SGM8653 Available in Green SOT-23-6 and SOIC-8 Packages**
  - **SGM8654 Available in Green TSSOP-14 and SOIC-14 Packages**
  - **SGM8655 Available in a Green MSOP-10 Package**

APPLICATIONS

ADC/DAC
Filter
Data Acquisition
Process Control
Audio & Video Processing
Test Equipment
Cell Phone PA Control
Broadband Communication

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8651	SOT-23-5	-40℃ to +125℃	SGM8651XN5/TR	8651	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8651XS/TR	SGM8651XS	Tape and Reel, 2500
SGM8652	MSOP-8	-40℃ to +125℃	SGM8652XMS/TR	SGM8652XMS	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8652XS/TR	SGM8652XS	Tape and Reel, 2500
SGM8653	SOT-23-6	-40℃ to +125℃	SGM8653XN6/TR	8653	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8653XS/TR	SGM8653XS	Tape and Reel, 2500
SGM8654	SOIC-14	-40℃ to +125℃	SGM8654XS14/TR	SGM8654XS14	Tape and Reel, 2500
	TSSOP-14	-40℃ to +125℃	SGM8654XTS14/TR	SGM8654XTS14	Tape and Reel, 3000
SGM8655	MSOP-10	-40℃ to +125℃	SGM8655XMS/TR	SGM8655XMS	Tape and Reel, 3000

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, $+V_S$ to $-V_S$ 7.5V
Input Common Mode Voltage ..... $(-V_S)$ - 0.5V to $(+V_S)$ + 0.5V
Package Thermal Resistance @ T_A = +25℃
SOT-23-5, θ_{JA} ..... 190℃/W
SOT-23-6, θ_{JA} ..... 190℃/W
SOIC-8, θ_{JA} ..... 125℃/W
MSOP-8, θ_{JA} ..... 216℃/W
MSOP-10, θ_{JA} ..... 216℃/W
Junction Temperature ..... +160℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 1000V
MM 400V

RECOMMENDED OPERATING CONDITIONS

Operating 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

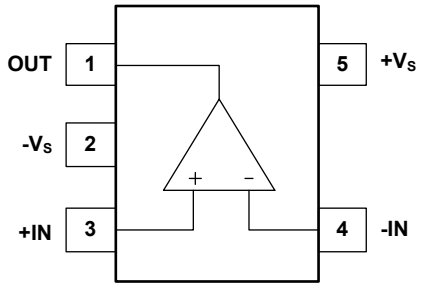
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

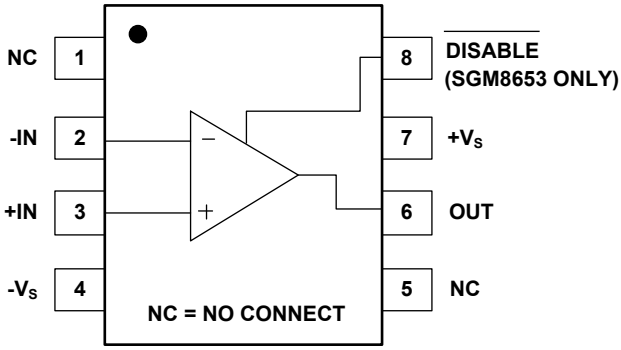
PIN CONFIGURATIONS

SGM8651 (TOP VIEW)



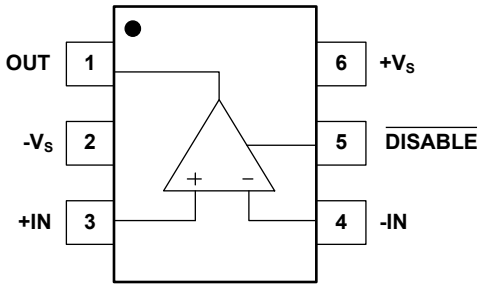
SOT-23-5

SGM8651/8653 (TOP VIEW)



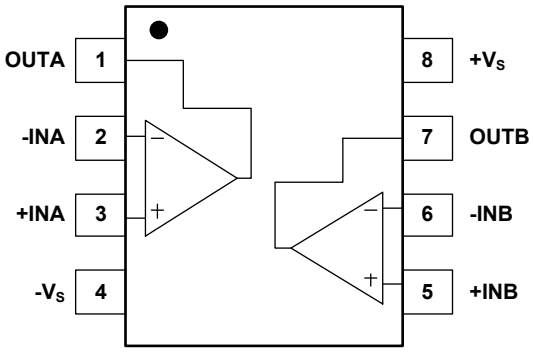
SOIC-8

SGM8653 (TOP VIEW)



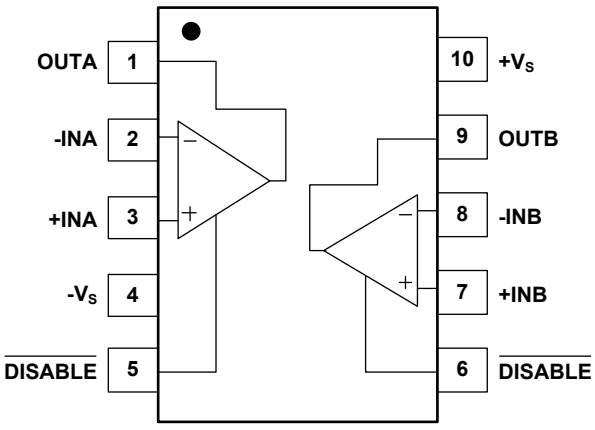
SOT-23-6

SGM8652 (TOP VIEW)



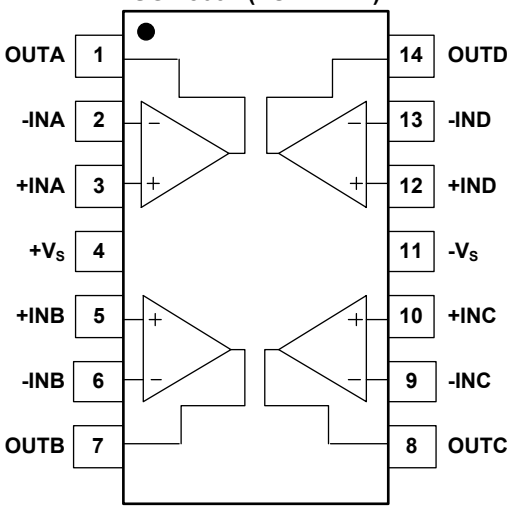
SOIC-8/MSOP-8

SGM8655 (TOP VIEW)



MSOP-10

SGM8654 (TOP VIEW)



TSSOP-14/SOIC-14

ELECTRICAL CHARACTERISTICS

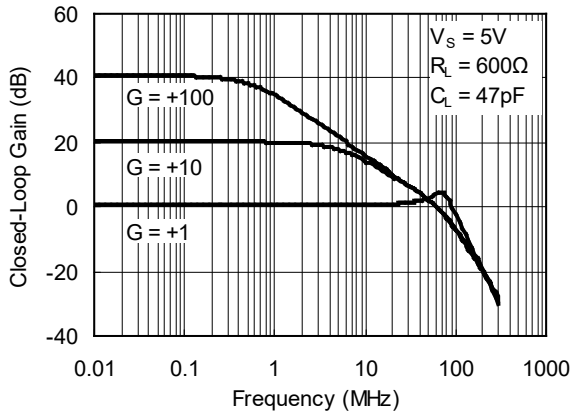
(At T_A = +25℃, V_S = 5V, R_L = 600Ω connected to V_S/2, unless otherwise noted.)

PARAMETER	CONDITIONS	SGM8651/2/3/4/5						
		TYP	MIN/MAX OVER TEMPERATURE					
		+25℃	+25℃	0℃ to +70℃	-40℃ to +85℃	-40℃ to +125℃	UNITS	MIN/ MAX
Dynamic Performance								
Gain-Bandwidth Product (GBP)	G = +10	50					MHz	TYP
Slew Rate	G = +1, 2V Output step	66					V/μs	TYP
Settling Time to 0.1%	G = +1, 2V Output step	60					ns	TYP
Overload Recovery Time	V_{IN}·G = +V_S	25					ns	TYP
Noise Performance								
Input Voltage Noise Density (e_n)	f = 100kHz	16					nV/$\sqrt{Hz}$	TYP
	f = 1MHz	8.7					nV/$\sqrt{Hz}$	TYP
DC Performance								
Input Offset Voltage (V_{OS})		±2	±8	±8.9	±9.5	±9.8	mV	MAX
Input Offset Voltage Drift		4.5					μV/℃	TYP
Input Bias Current (I_B)		6					pA	TYP
Input offset Current (I_{OS})		2					pA	TYP
Open-Loop Gain (A_{OL})	V_{OUT} = 0.3V to 4.7V, R_L = 150Ω	80	75	74	74	73	dB	MIN
	V_{OUT} = 0.2V to 4.8V, R_L = 1kΩ	104	92	91	91	80	dB	MIN
Input Characteristics								
Input Common Mode Voltage Range (V_{CM})		-0.2 to +3.8					V	TYP
Common Mode Rejection Ratio(CMRR)	V_{CM} = -0.1V to 3.5V	80	66	65	65	62	dB	MIN
Output Characteristics								
Output Voltage Swing from Rail	R_L = 150Ω	0.12					V	TYP
	R_L = 1kΩ	0.03					V	TYP
Output Current		127	100	96	89	82	mA	MIN
Closed-Loop Output Impedance	f < 100kHz, G = +1	0.08					Ω	TYP
Power-Down Disable (SGM8653/5 Only)								
Turn-On Time		220					ns	TYP
Turn-Off Time		150					ns	TYP
$\overline{DISABLE}$ Voltage-Off			0.8				V	MAX
$\overline{DISABLE}$ Voltage-On			2				V	MIN
Power Supply								
Operating Voltage Range			2.5	2.7	2.7	2.7	V	MIN
			5.5	5.5	5.5	5.5	V	MAX
Quiescent Current (per Amplifier)		2.3	2.9	3.4	3.8	4	mA	MAX
Supply Current when Disabled per Amplifier (SGM8653/5 Only)		75	120	127	130	137	μA	MAX
Power Supply Rejection Ratio (PSRR)	ΔV_S = 2.7V to 5.5V, V_{CM} = (-V_S) + 0.5	80	67	67	65	62	dB	MIN

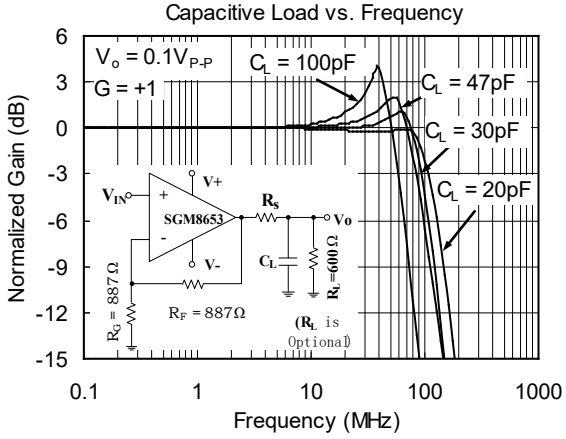
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A= +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω, C_L = 47pF, and R_L= 600Ω, unless otherwise noted.

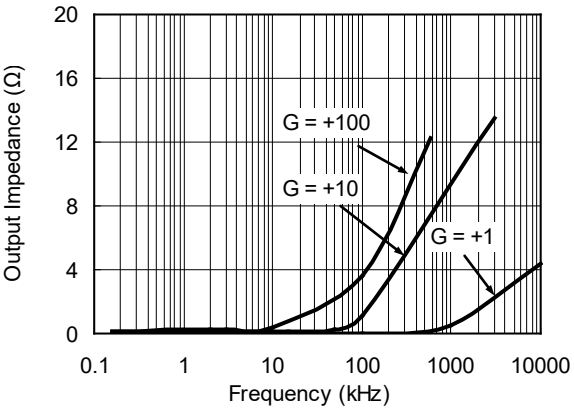
Closed-Loop Gain vs. Frequency



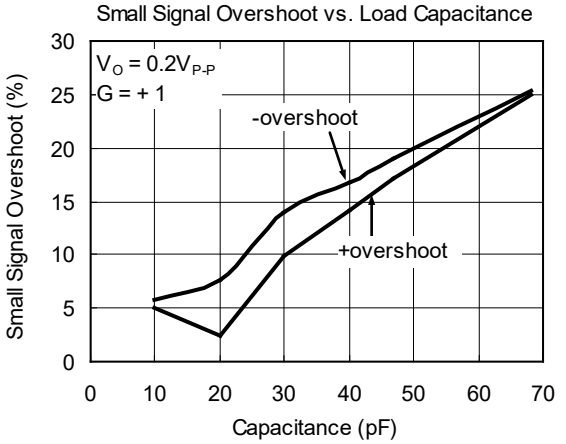
Capacitive Load vs. Frequency



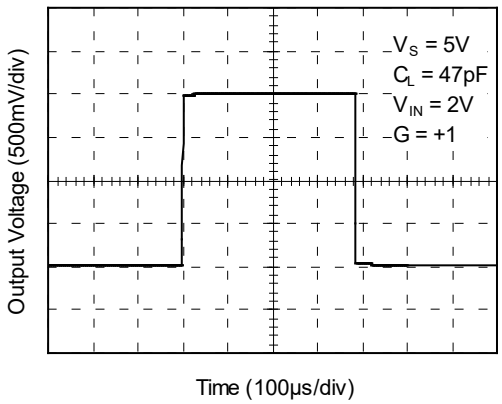
Output Impedance vs. Frequency



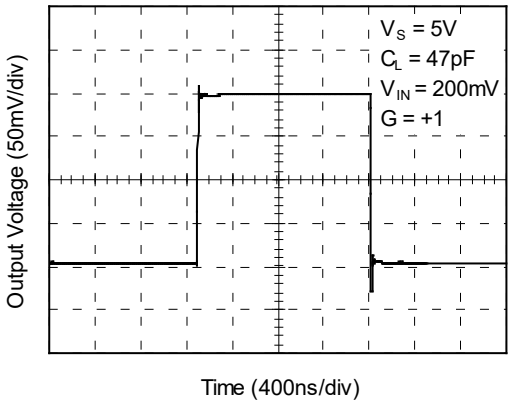
Small Signal Overshoot vs. Load Capacitance



Large Signal Step Response



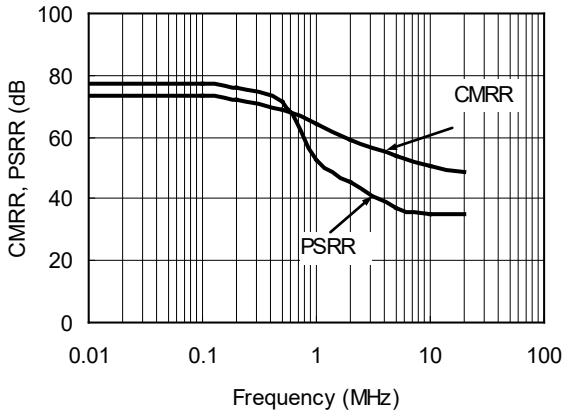
Small Signal Step Response



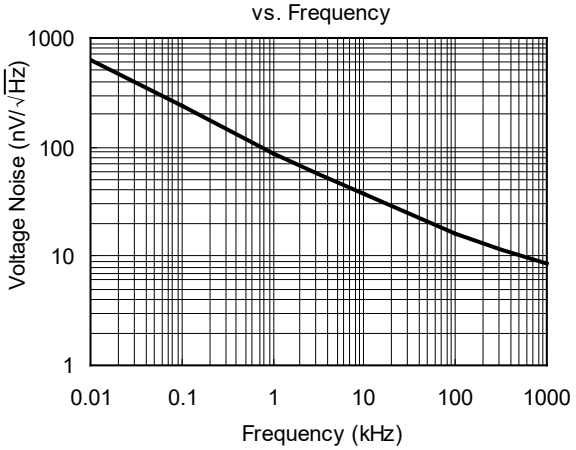
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A= +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω, C_L = 47pF, and R_L= 600Ω, unless otherwise noted.

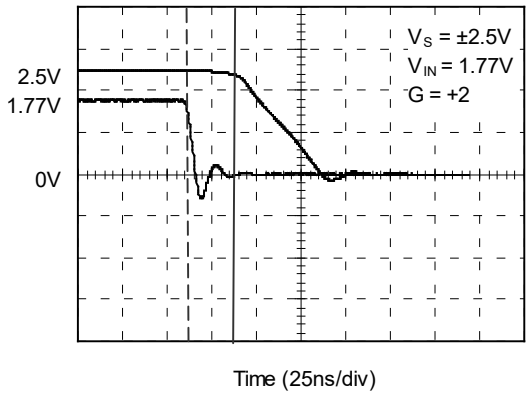
CMRR and PSRR vs. Frequency



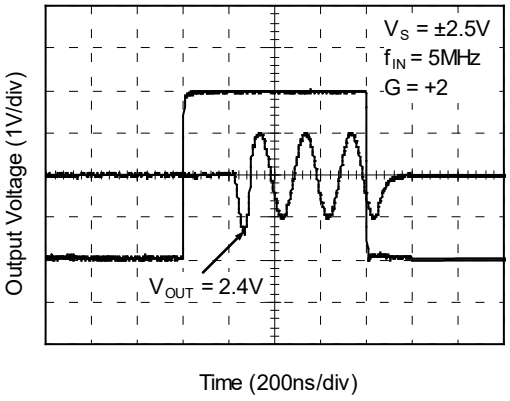
Input Voltage Noise Spectral Density vs. Frequency



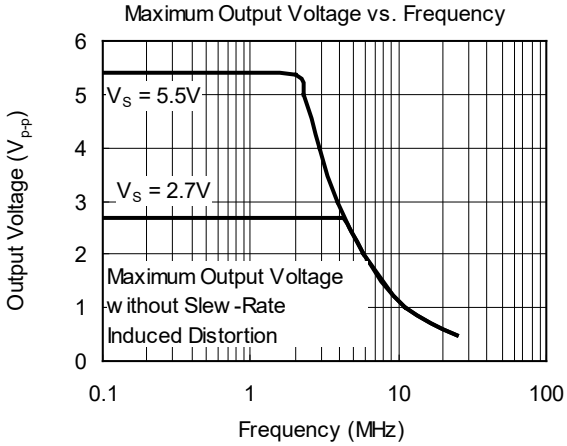
Overload Recovery Time



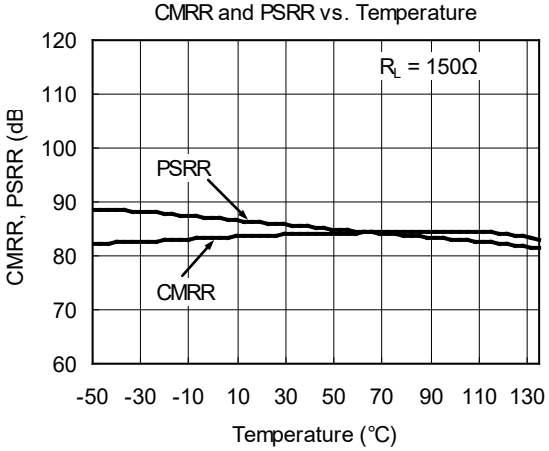
Large-Signal Disable/Enable Response



Maximum Output Voltage vs. Frequency



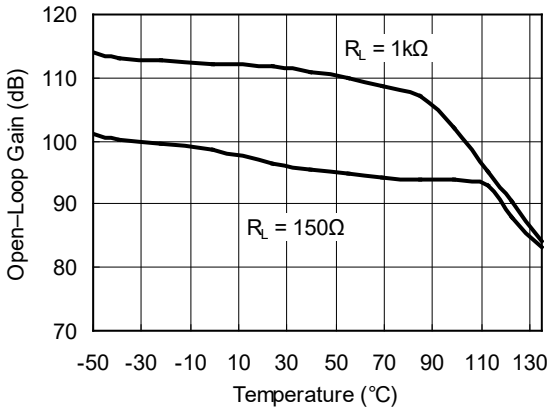
CMRR and PSRR vs. Temperature



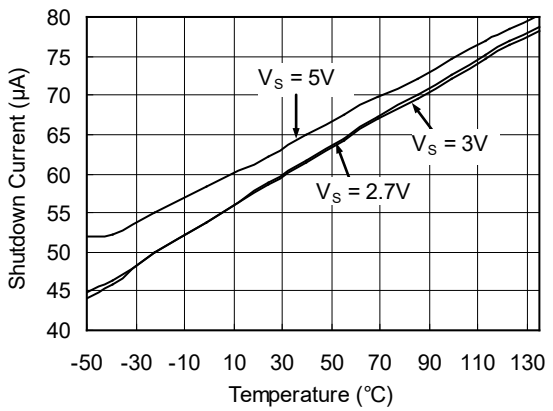
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A= +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω, R_L = 150Ω connected to Vs/2, unless otherwise noted.

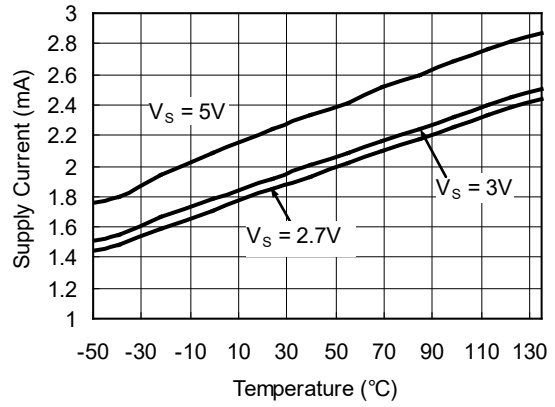
Open-Loop Gain vs. Temperature



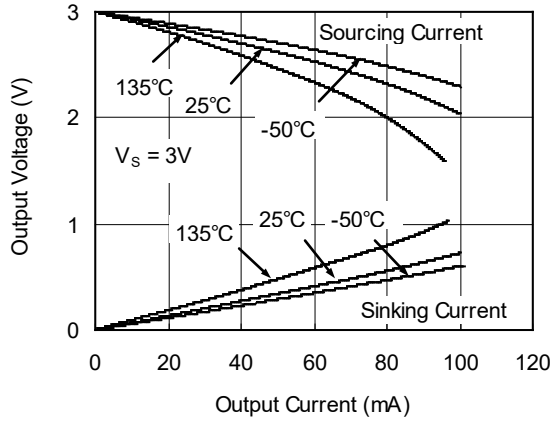
Shutdown Current vs. Temperature



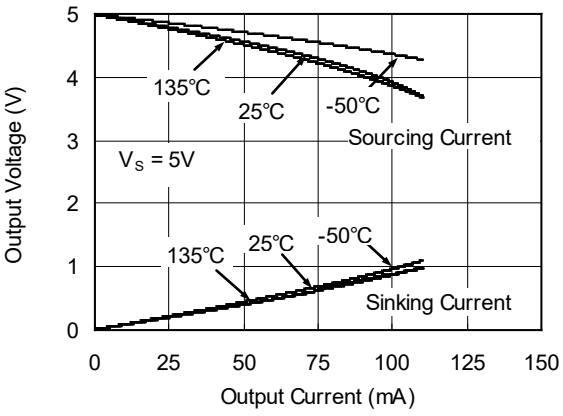
Supply Current vs. Temperature



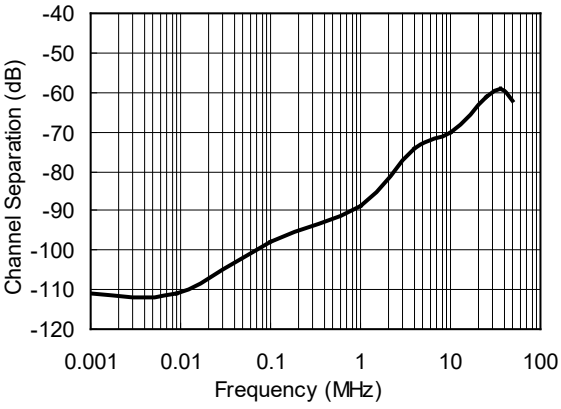
Output Voltage Swing vs. Output Current



Output Voltage Swing vs. Output Current

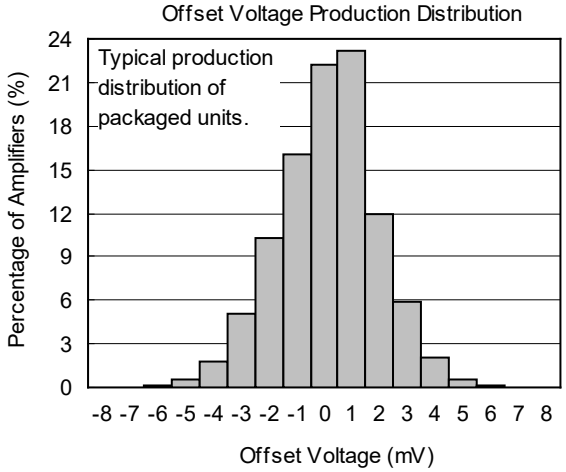


Channel Separation vs. Frequency



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A= +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω, R_L = 150Ω connected to V_S/2, unless otherwise noted.



REVISION HISTORY

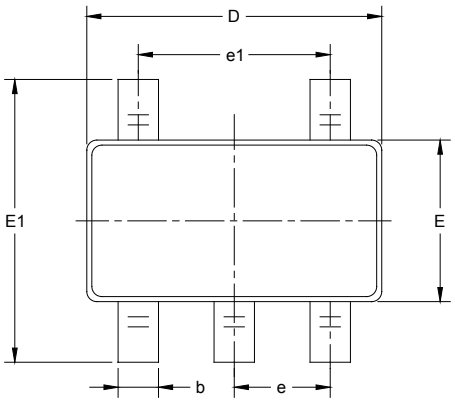
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

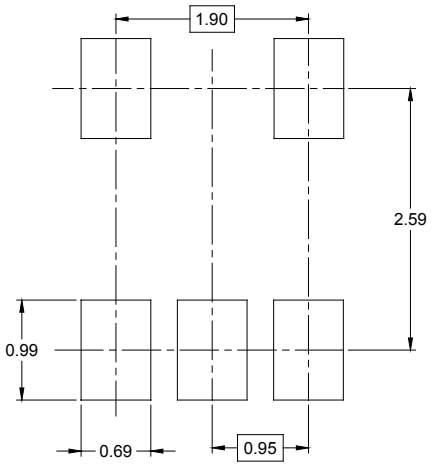
JANUARY 2013 – REV.C.1 to REV.C.2	Page
Changed Pin Configurations section	4

APRIL 2009 – REV.C to REV.C.1	Page
Changed from 16 pin to 14 pin	All

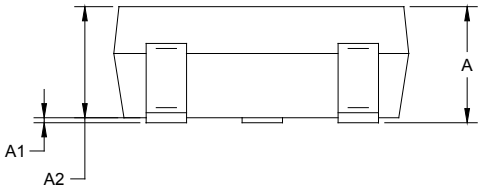
PACKAGE OUTLINE DIMENSIONS

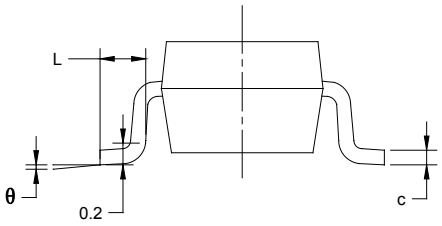
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

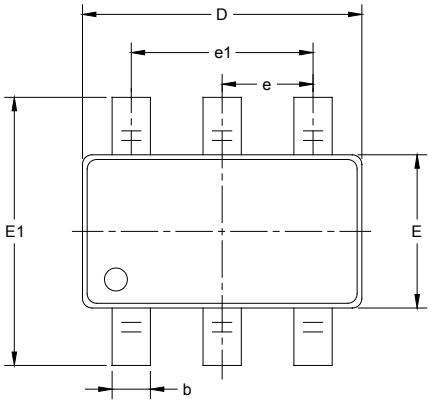


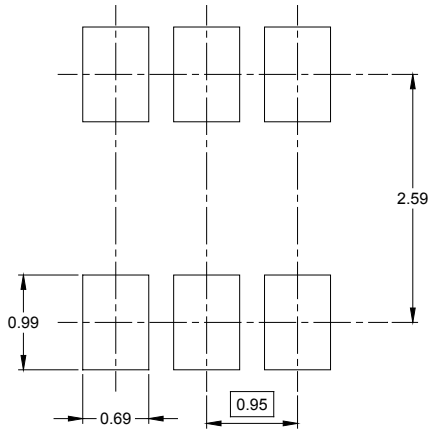


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

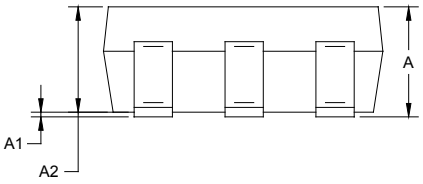
PACKAGE OUTLINE DIMENSIONS

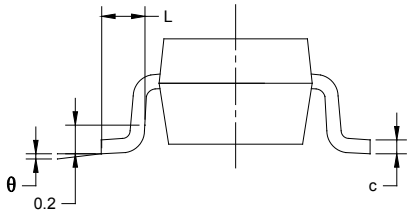
SOT-23-6





RECOMMENDED LAND PATTERN (Unit: mm)

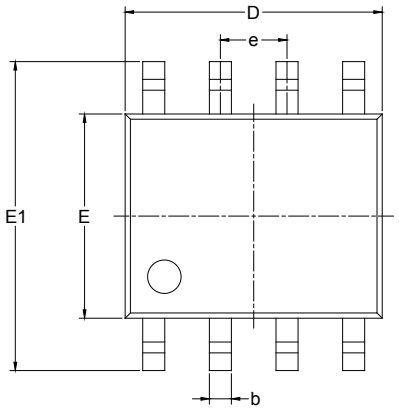


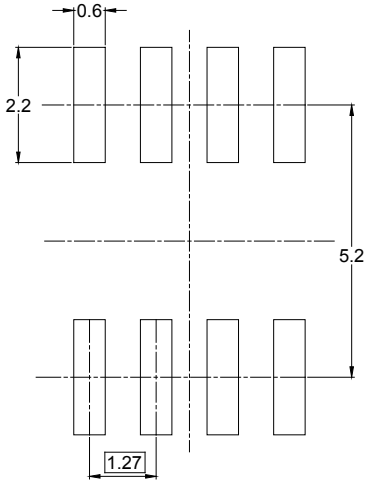


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

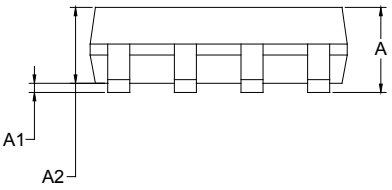
PACKAGE OUTLINE DIMENSIONS

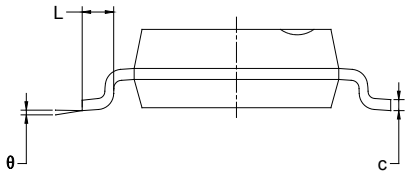
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

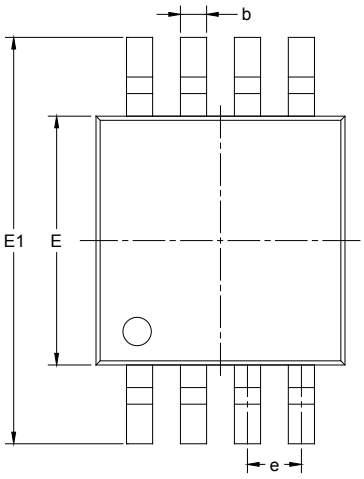


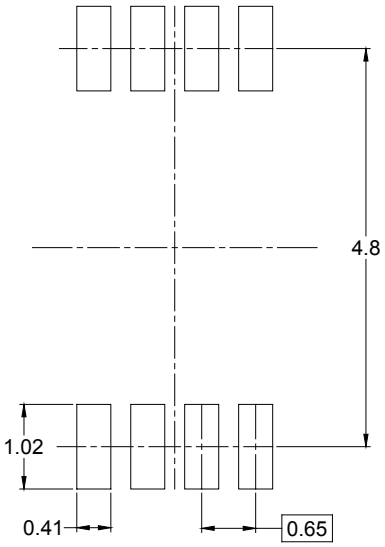


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

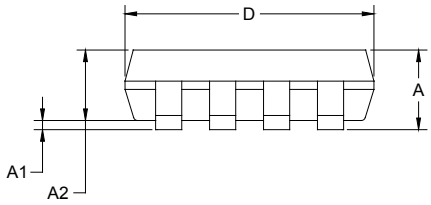
PACKAGE OUTLINE DIMENSIONS

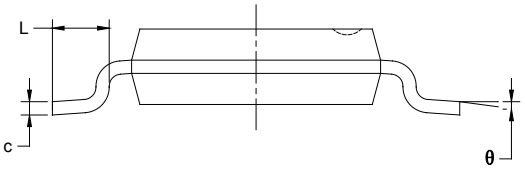
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)

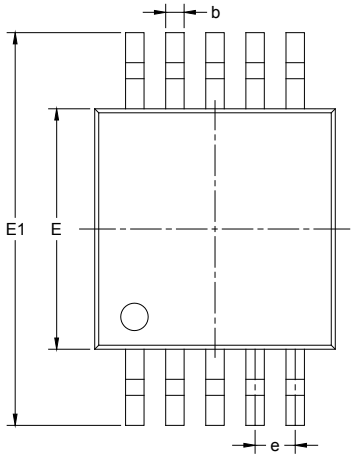


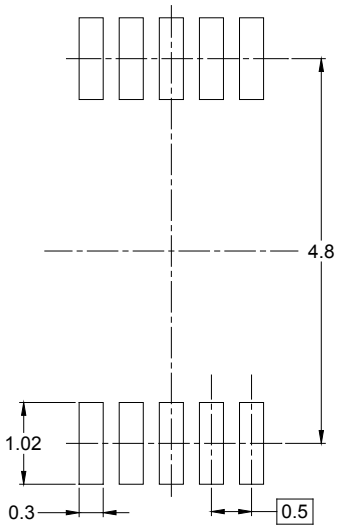


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

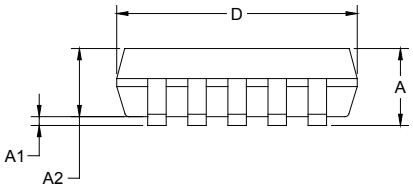
PACKAGE OUTLINE DIMENSIONS

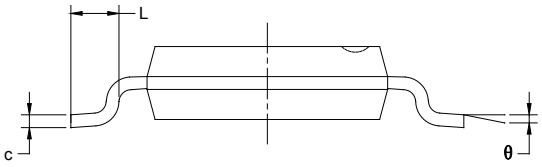
MSOP-10





RECOMMENDED LAND PATTERN (Unit: mm)

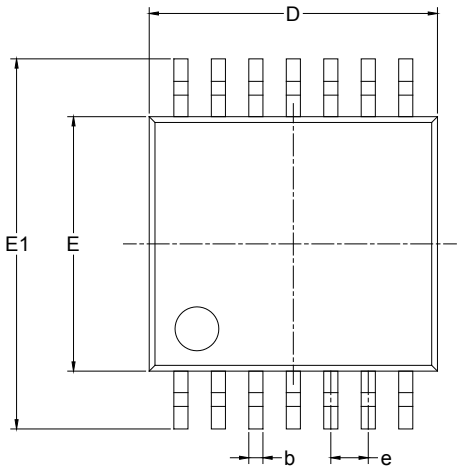


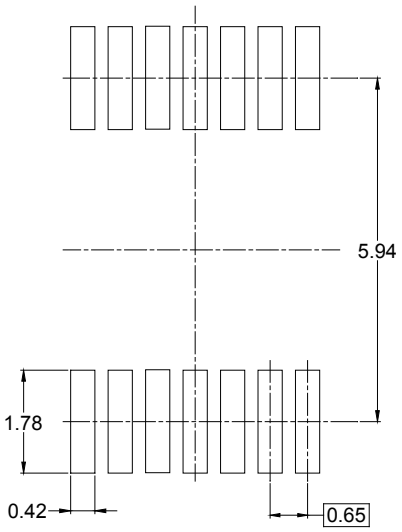


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.180	0.280	0.007	0.011
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.500 BSC		0.020 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

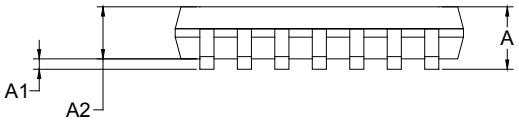
PACKAGE OUTLINE DIMENSIONS

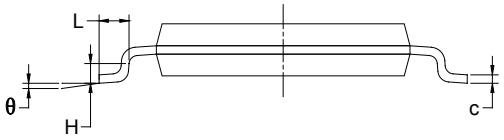
TSSOP-14





RECOMMENDED LAND PATTERN (Unit: mm)

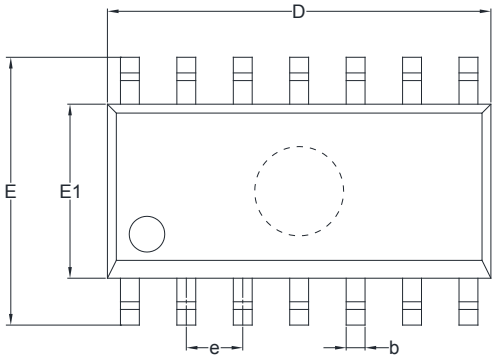


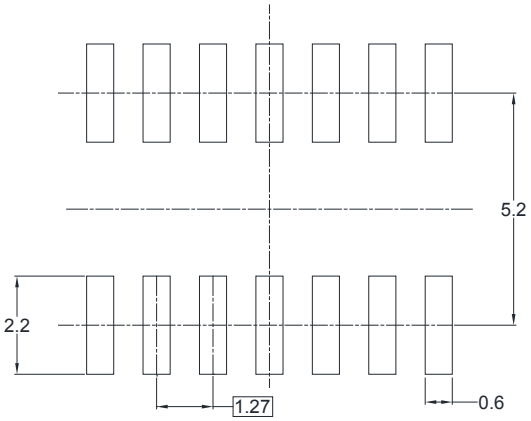


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

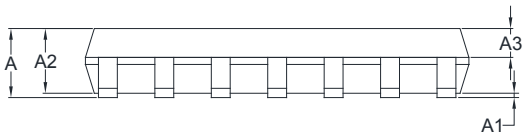
PACKAGE OUTLINE DIMENSIONS

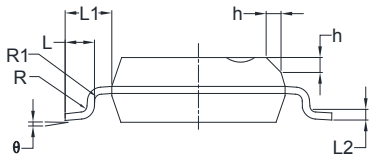
SOIC-14





RECOMMENDED LAND PATTERN (Unit: mm)

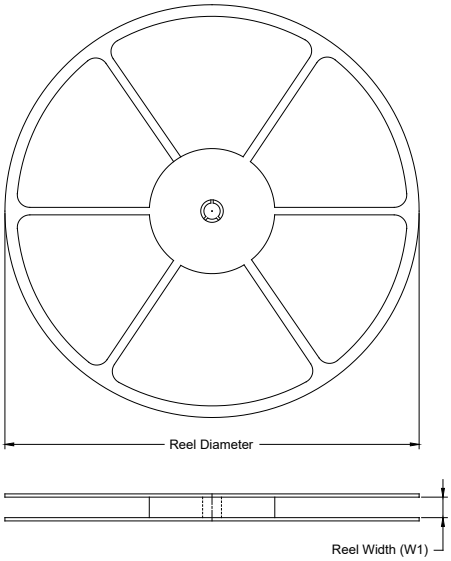




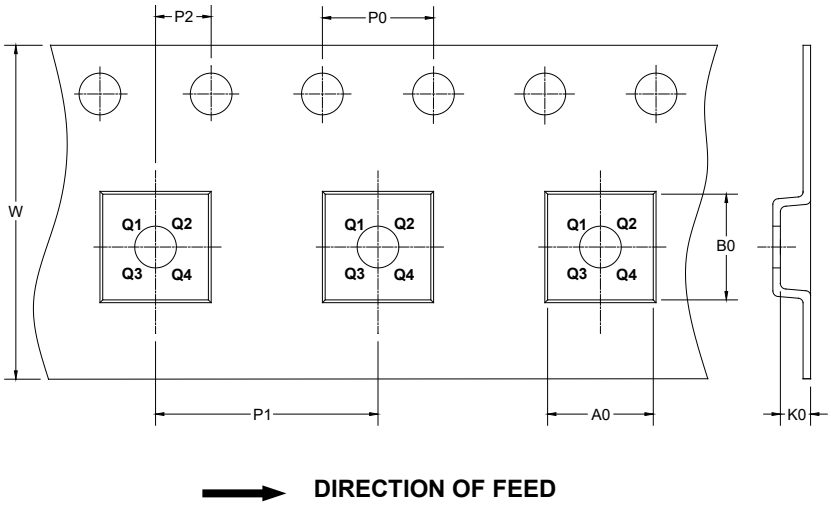
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	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°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



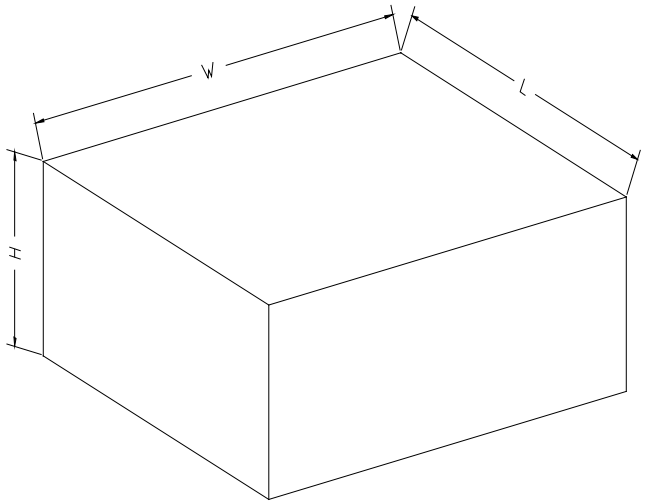
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOT-23-6	7″	9.5	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3
SOIC-8	13″	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13″	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
MSOP-10	13″	12.4	5.20	3.30	1.20	4.0	8.0	2.0	12.0	Q1
TSSOP-14	13″	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOIC-14	13″	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	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
7″ (Option)	368	227	224	8
7″	442	410	224	18
13″	386	280	370	5

DD0002