



SGM8541/2/4

1.1MHz, 46µA, Rail-to-Rail I/O CMOS Operational Amplifiers

PRODUCT DESCRIPTION

The SGM8541 (single), SGM8542 (dual) and SGM8544 (quad) are low cost, rail-to-rail input and 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 2.1V. The maximum recommended supply voltage is 5.5V. All are specified over the extended -40°C to +125°C temperature range.

The SGM8541/2/4 provide 1.1MHz bandwidth at a low current consumption of 46µA per amplifier. Very low input bias currents of 0.5pA enable SGM8541/2/4 to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail input and output 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, and signal conditioning and interfacing for transducers in very low power systems.

The SGM8541 single is available in the Green SOT-23-5, SC70-5 and SOIC-8 packages. The SGM8542 dual comes in the Green SOIC-8, MSOP-8 and TSSOP-8 packages. The quad SGM8544 is offered in Green TSSOP-14 and SOIC-14 packages.

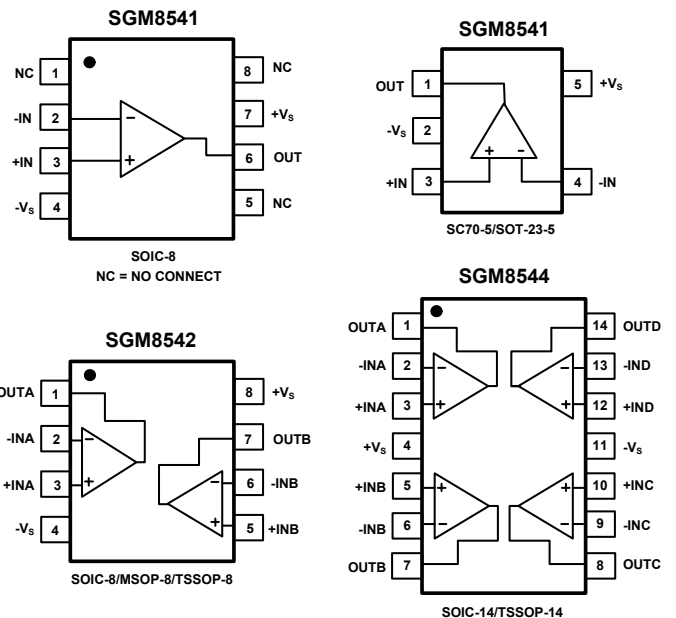
APPLICATIONS

- 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

FEATURES

- Low Cost
- Rail-to-Rail Input and Output
0.8mV Typical V_{OS}
- Unity Gain Stable
- Gain-Bandwidth Product: 1.1MHz
- Very Low Input Bias Current: 0.5pA
- Supply Voltage Range: 2.1V to 5.5V
- Input Voltage Range:
-0.1V to +5.6V with $V_S = 5.5V$
- Low Supply Current: 46µA/Amplifier
- Small Packaging
SGM8541 Available in SOIC-8, SC70-5 and SOT-23-5
SGM8542 Available in SOIC-8, MSOP-8 and TSSOP-8
SGM8544 Available in SOIC-14 and TSSOP-14

PIN CONFIGURATIONS (TOP VIEW)



PACKAGE/ORDERING INFORMATION

MODEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
SGM8541	SGM8541XC5/TR	SC70-5	Tape and Reel, 3000	8541
	SGM8541XN5/TR	SOT-23-5	Tape and Reel, 3000	8541
	SGM8541XS/TR	SOIC-8	Tape and Reel, 2500	SGM8541XS
SGM8542	SGM8542XS/TR	SOIC-8	Tape and Reel, 2500	SGM8542XS
	SGM8542XMS/TR	MSOP-8	Tape and Reel, 3000	SGM8542XMS
	SGM8542XTS8G/TR	TSSOP-8	Tape and Reel, 4000	SGM8542XTS8
SGM8544	SGM8544XS14/TR	SOIC-14	Tape and Reel, 2500	SGM8544XS14
	SGM8544XTS14/TR	TSSOP-14	Tape and Reel, 3000	SGM8544XTS14

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, +V _S to -V _S	6V
Input Common Mode Voltage	(-V _S) - 0.3V to (+V _S) + 0.3V
Storage Temperature Range.....	-65°C to +150°C
Junction Temperature	150°C
Operating Temperature Range	-40°C to +125°C
Package Thermal Resistance @ T _A = +25°C	
SC70-5, θ _{JA}	333°C/W
SOT-23-5, θ _{JA}	190°C/W
SOIC-8, θ _{JA}	125°C/W
MSOP-8, θ _{JA}	216°C/W
TSSOP-8, θ _{JA}	175°C/W
Lead Temperature (Soldering 10sec).....	260°C
ESD Susceptibility	
HBM.....	4000V
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.

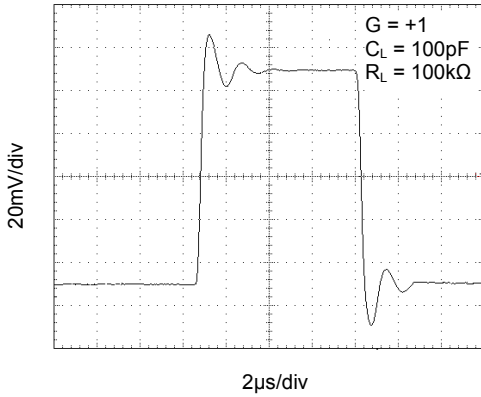
ELECTRICAL CHARACTERISTICS(At $V_S = +5V$, $R_L = 100k\Omega$ connected to $V_S/2$ and $V_{OUT} = V_S/2$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	SGM8541/2/4				
			TYP	MIN/MAX OVER TEMPERATURE			
			+25°C	+25°C	-40°C to +125°C	UNITS	MIN/MAX
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	$V_{CM} = V_S/2$	0.8	3.5		mV	MAX
Input Bias Current	I_B		0.5			pA	TYP
Input Offset Current	I_{OS}		0.5			pA	TYP
Input Common Mode Voltage Range	V_{CM}	$V_S = 5.5V$	-0.1 to +5.6			V	TYP
Common Mode Rejection Ratio	CMRR	$V_S = 5.5V, V_{CM} = -0.1V$ to +4V	87	71	69	dB	MIN
		$V_S = 5.5V, V_{CM} = -0.1V$ to +5.6V	80	60	56		
Open-Loop Voltage Gain	A_{OL}	$R_L = 5k\Omega, V_O = +0.1V$ to +4.9V	98	80	73	dB	MIN
		$R_L = 100k\Omega, V_O = +0.035V$ to +4.965V	105	85	74		
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		2.7			$\mu V/^\circ C$	TYP
OUTPUT CHARACTERISTICS							
Output Voltage Swing from Rail	V_{OH}	$R_L = 100k\Omega$	4.997	4.980	4.970	V	MIN
	V_{OL}	$R_L = 100k\Omega$	5	20	30	mV	MAX
	V_{OH}	$R_L = 10k\Omega$	4.992	4.970	4.960	V	MIN
	V_{OL}	$R_L = 10k\Omega$	8	30	40	mV	MAX
Output Current	I_{SOURCE}	$R_L = 10\Omega$ to $V_S/2$	85	60	45	mA	MIN
	I_{SINK}		75	60	45		
POWER SUPPLY							
Operating Voltage Range				2.1	2.5	V	MIN
				5.5	5.5	V	MAX
Power Supply Rejection Ratio	PSRR	$V_S = +2.5V$ to +5.5V, $V_{CM} = +0.5V$	87	70	64	dB	MIN
Quiescent Current/Amplifier	I_Q		46	69	89	μA	MAX
DYNAMIC PERFORMANCE ($C_L = 100pF$)							
Gain-Bandwidth Product	GBP		1.1			MHz	TYP
Slew Rate	SR	$G = +1, 2V$ Output Step	0.52			$V/\mu s$	TYP
Settling Time to 0.1%	t_s	$G = +1, 2V$ Output Step	5.3			μs	TYP
Overload Recovery Time		$V_{IN} \cdot \text{Gain} = V_S$	2.6			μs	TYP
NOISE PERFORMANCE							
Voltage Noise Density	e_n	$f = 1kHz$	27			nV/\sqrt{Hz}	TYP
		$f = 10kHz$	20			nV/\sqrt{Hz}	TYP

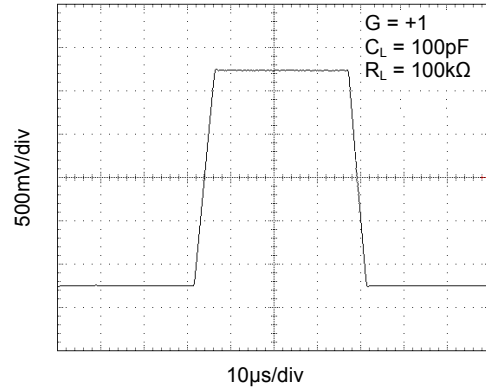
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 100\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.

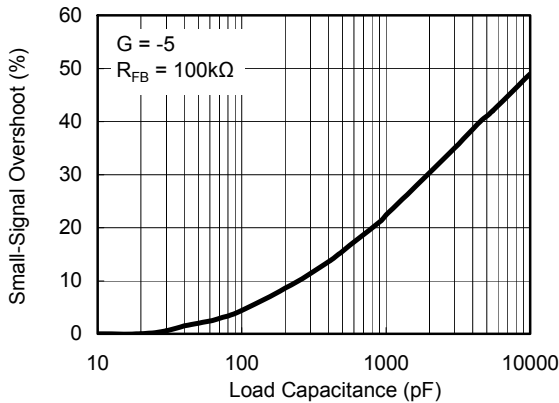
Small-Signal Step Response



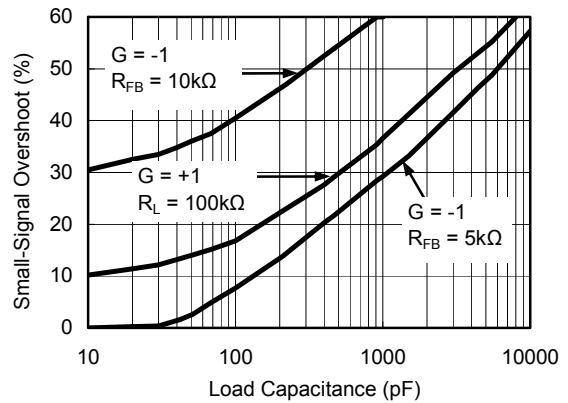
Large-Signal Step Response



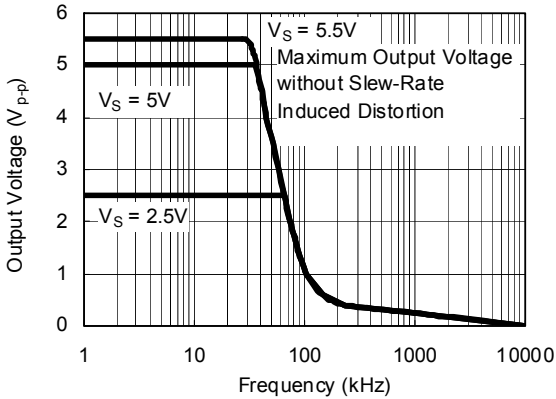
Small-Signal Overshoot vs. Load Capacitance



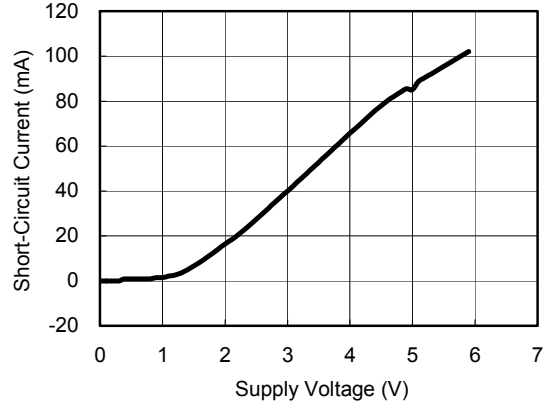
Small-Signal Overshoot vs. Load Capacitance



Maximum Output Voltage vs. Frequency

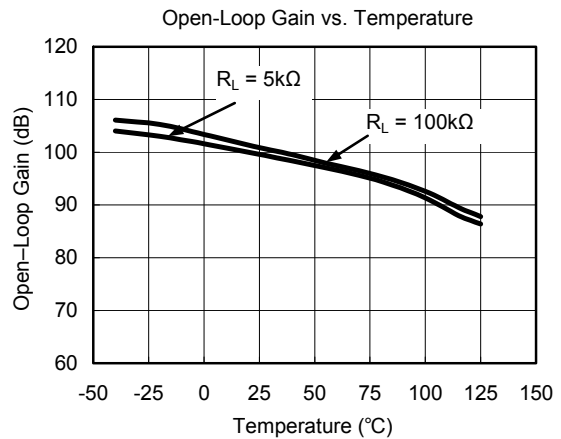
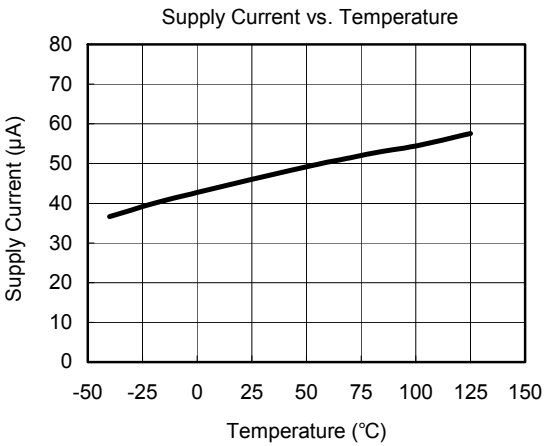
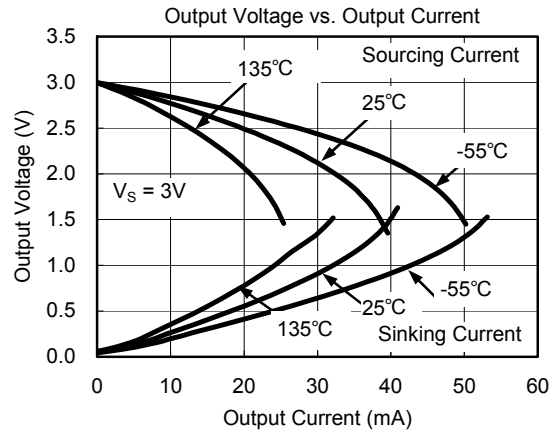
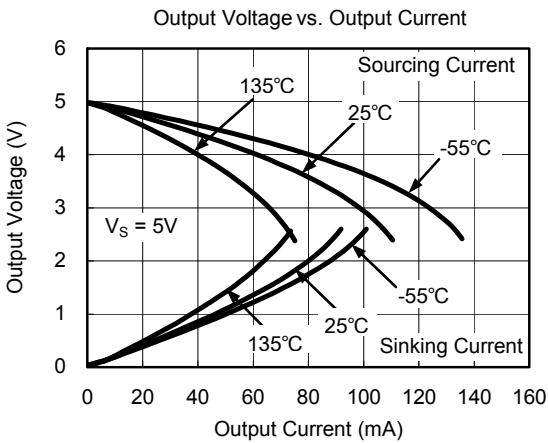
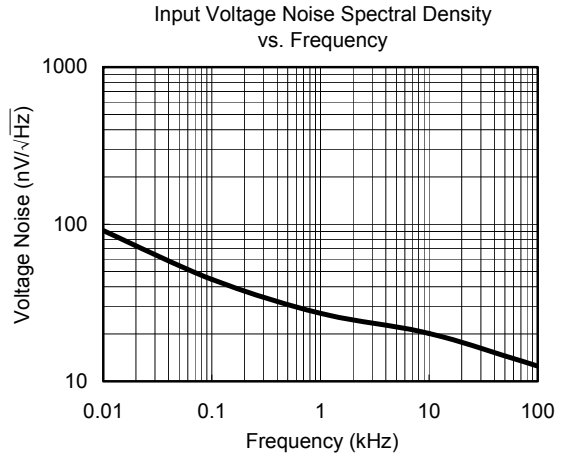
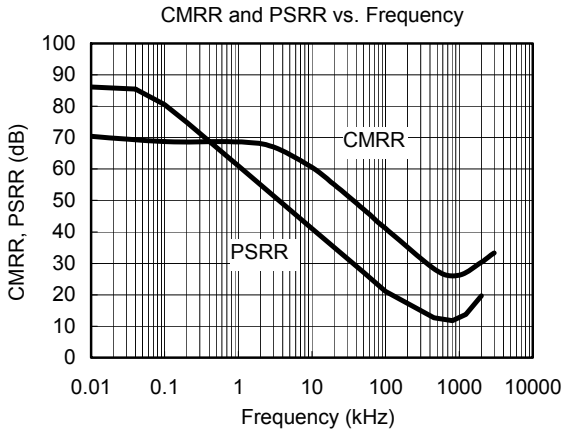


Short-Circuit Current vs. Supply Voltage



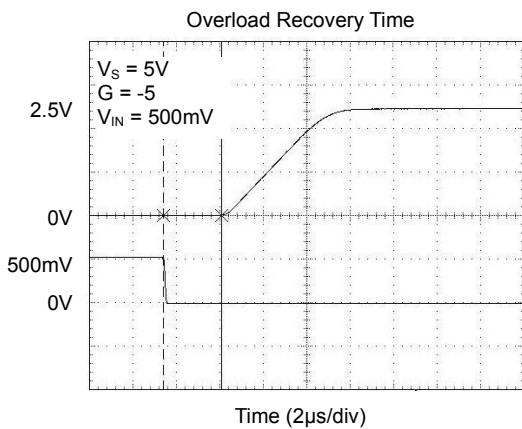
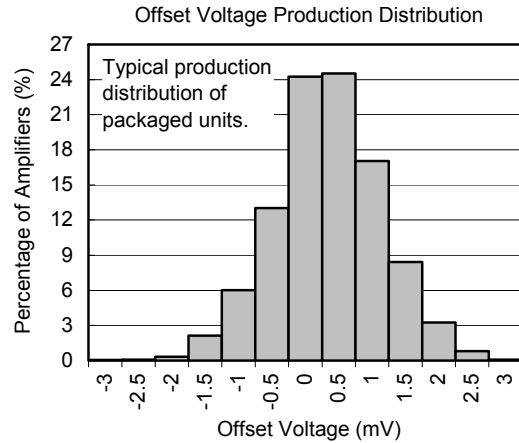
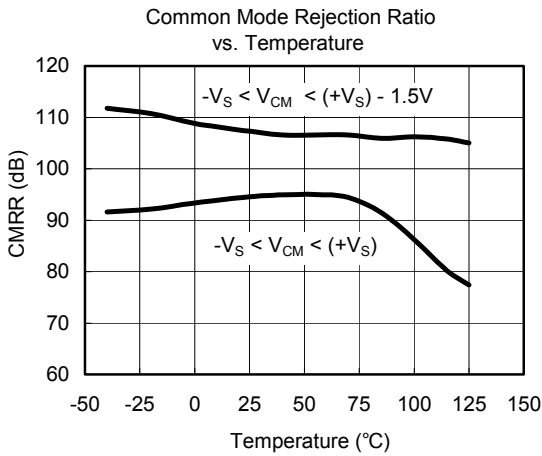
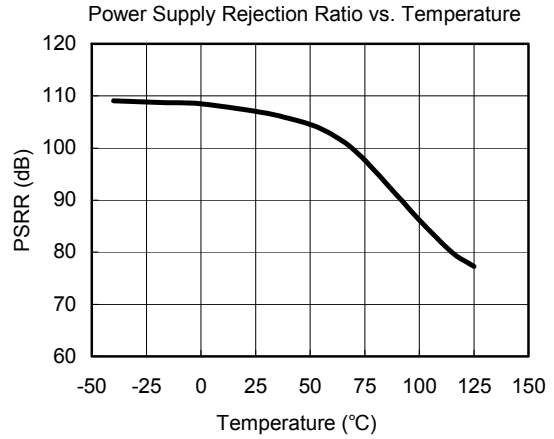
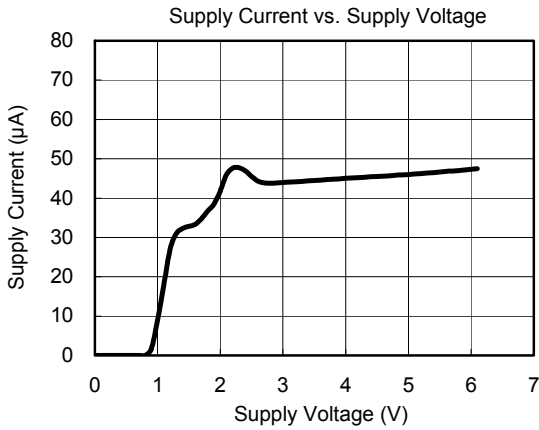
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 100\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.



TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 100\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.



APPLICATION NOTES

Driving Capacitive Loads

The SGM8541/2/4 can directly drive 250pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive driving capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 1. The isolation resistor R_{ISO} and the load capacitor C_L form a zero to increase stability. The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. Note that this method results in a loss of gain accuracy because R_{ISO} forms a voltage divider with the R_{LOAD} .

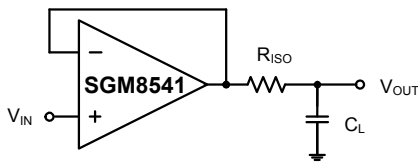


Figure 1. Indirectly Driving Heavy Capacitive Load

An improved circuit is shown in Figure 2. It provides DC accuracy as well as AC stability. R_F provides the DC accuracy by connecting the inverting signal with the output. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

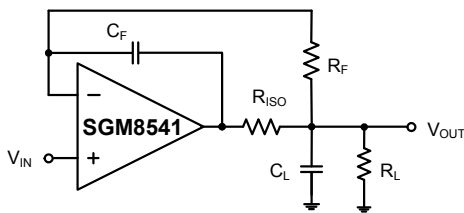


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-buffer configuration, there are two other ways to increase the phase margin: (a) by increasing the amplifier's gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

Power-Supply Bypassing and Layout

The SGM8541/2/4 family operates from either a single +2.1V to +5.5V supply or dual ±1.05V to ±2.75V supplies. For single-supply operation, bypass the power supply + V_S with a 0.1µF ceramic capacitor which should be placed close to the + V_S pin. For dual-supply operation, both the + V_S and the - V_S supplies should be bypassed to ground with separate 0.1µF ceramic capacitors. 2.2µF tantalum capacitor can be added for better performance.

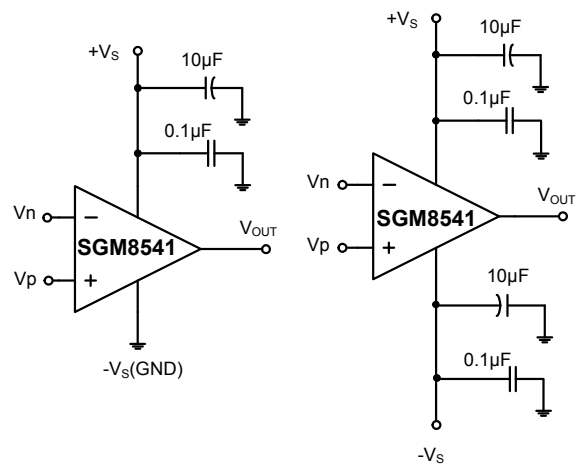


Figure 3. Amplifier with Bypass Capacitors

TYPICAL APPLICATION CIRCUITS

Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistor ratios are equal to $(R_4/R_3 = R_2/R_1)$, then $V_{OUT} = (V_p - V_n) \times R_2/R_1 + V_{REF}$.

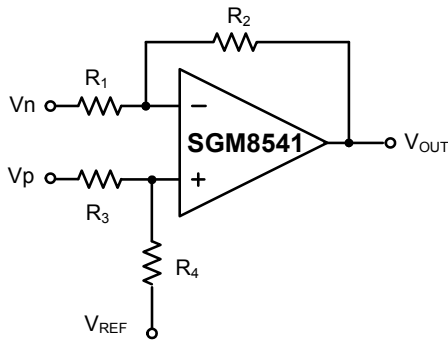


Figure 4. Differential Amplifier

Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with a high input impedance.

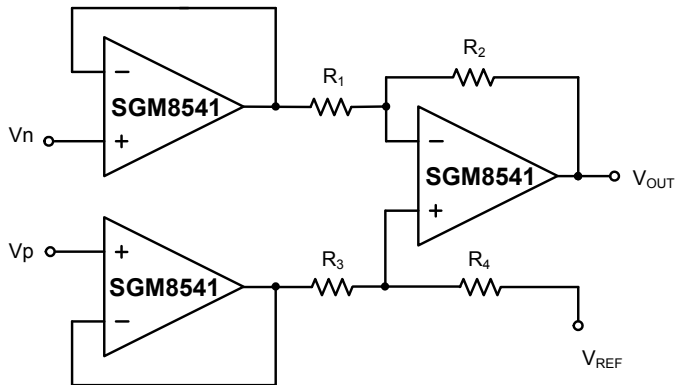


Figure 5. Instrumentation Amplifier

Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of $(-R_2 / R_1)$ and the -3dB corner frequency is $1/2\pi R_2 C$. Make sure the filter bandwidth is within the bandwidth of the amplifier. The large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.

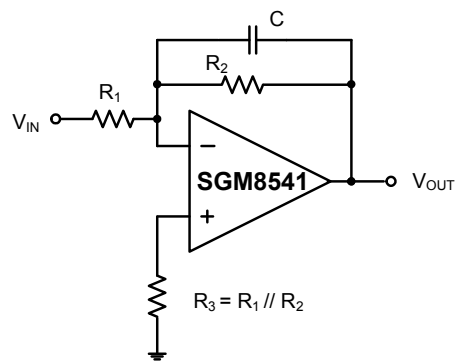
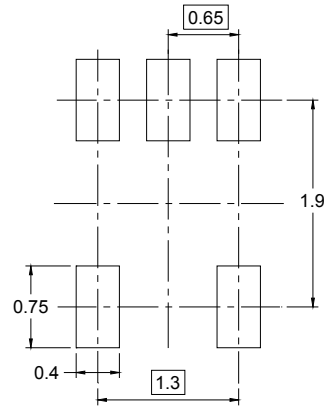
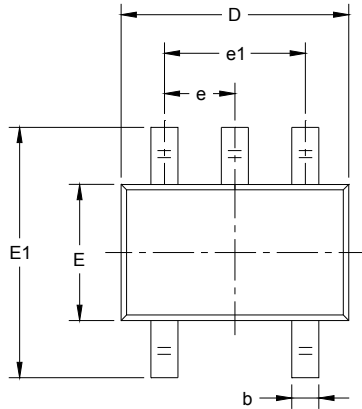


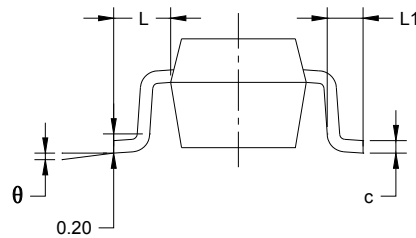
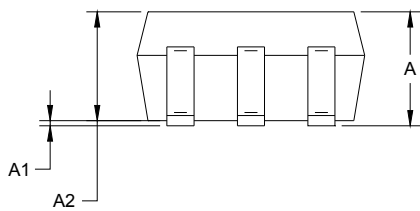
Figure 6. Low Pass Active Filter

PACKAGE OUTLINE DIMENSIONS

SC70-5



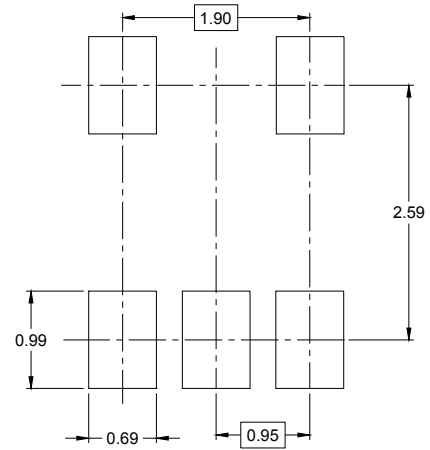
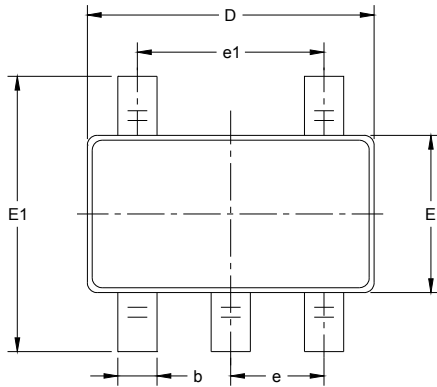
RECOMMENDED LAND PATTERN (Unit: mm)



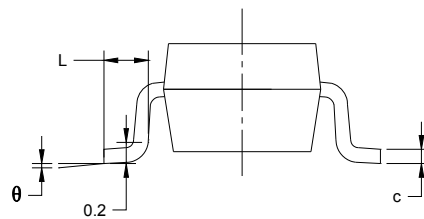
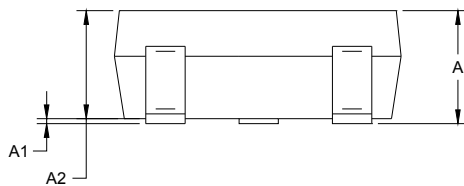
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026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

SOT-23-5



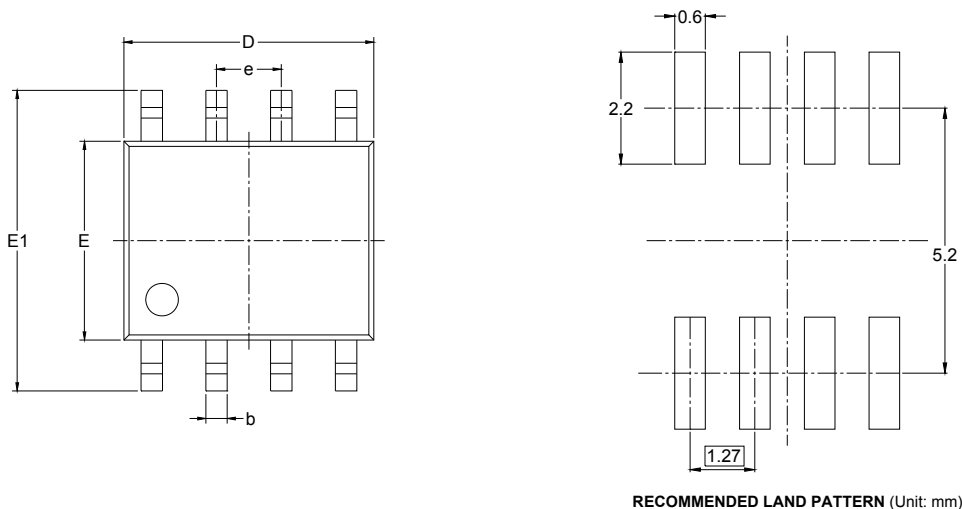
RECOMMENDED LAND PATTERN (Unit: mm)



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

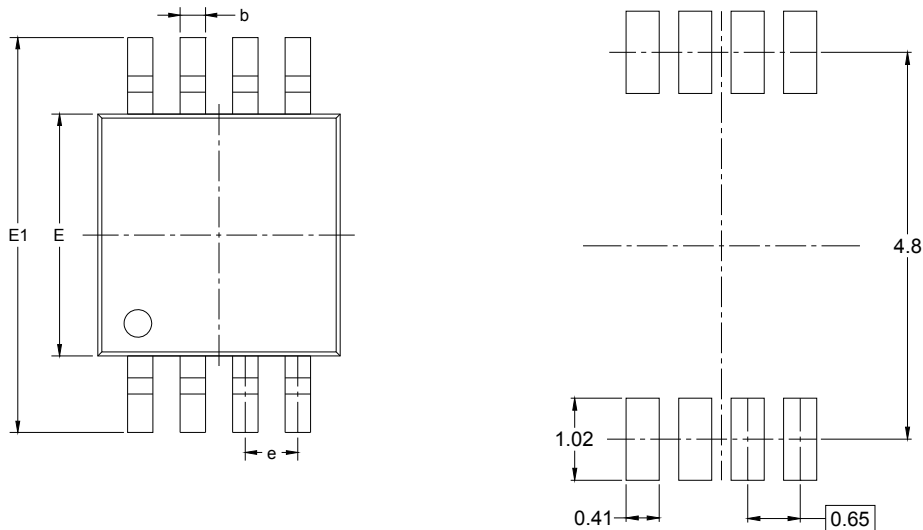
SOIC-8



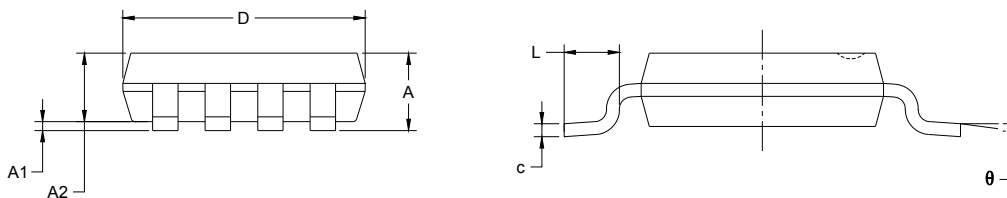
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

PACKAGE OUTLINE DIMENSIONS

MSOP-8



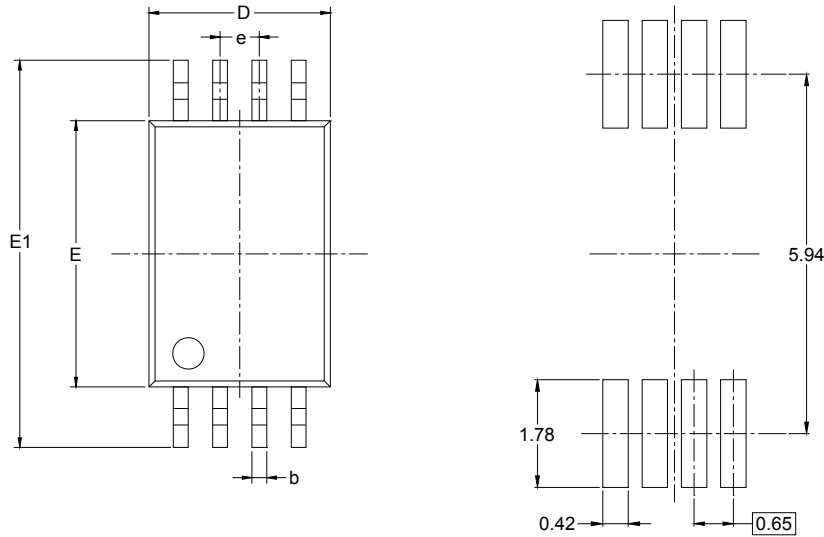
RECOMMENDED LAND PATTERN (Unit: mm)



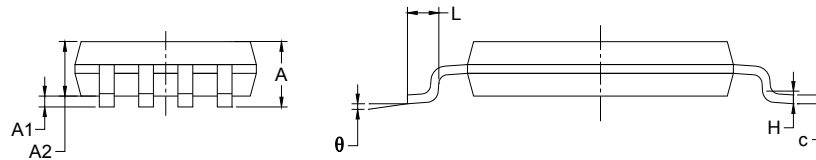
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

PACKAGE OUTLINE DIMENSIONS

TSSOP-8



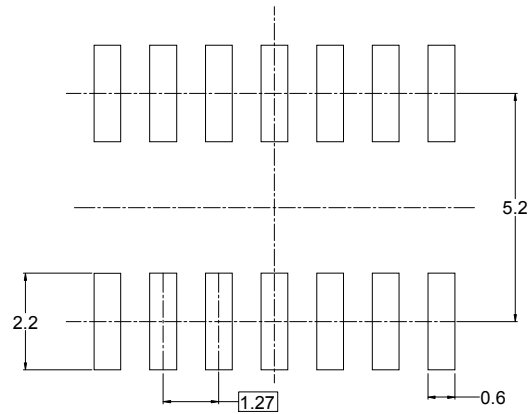
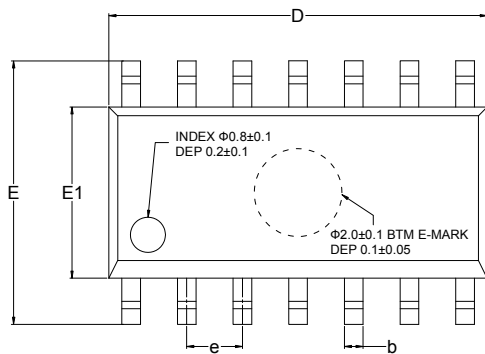
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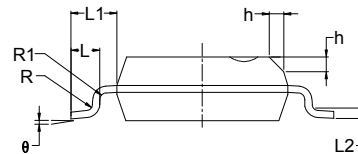
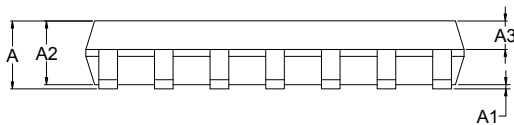
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

PACKAGE OUTLINE DIMENSIONS

SOIC-14



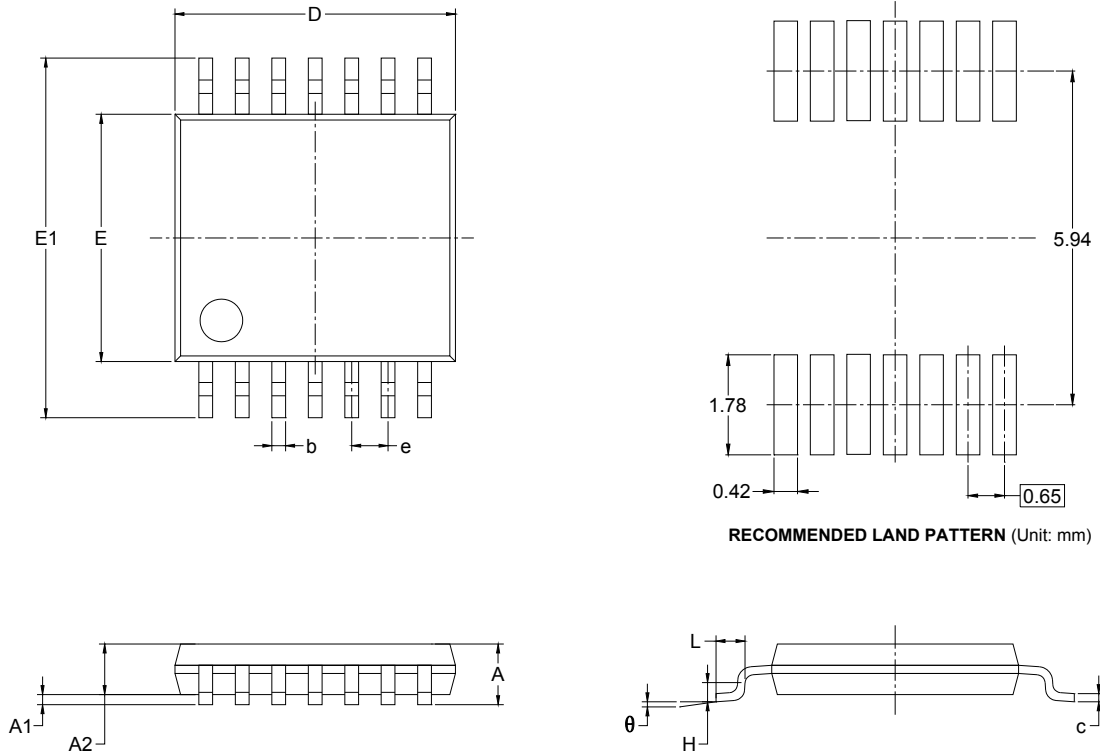
RECOMMENDED LAND PATTERN (Unit: mm)



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°

PACKAGE OUTLINE DIMENSIONS

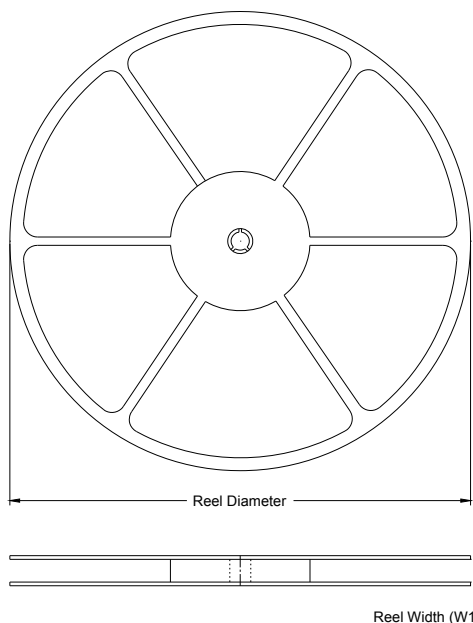
TSSOP-14



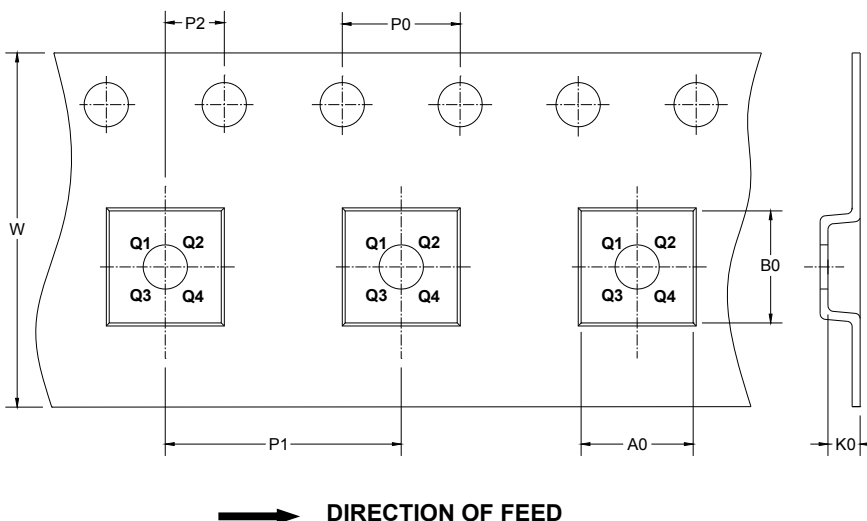
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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

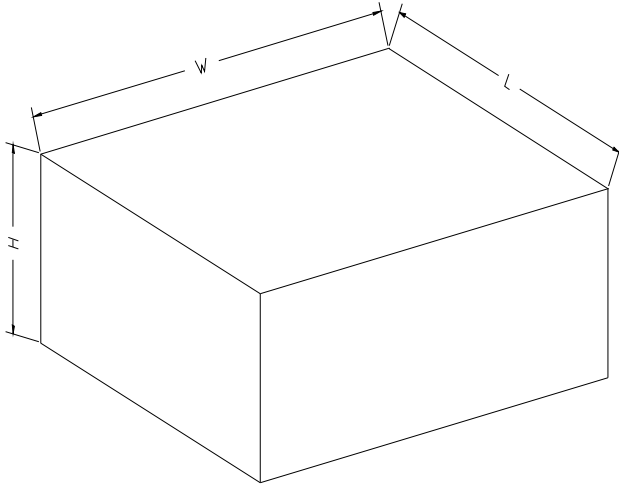
KEY PARAMETER LIST OF TAPE AND REEL

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	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3
SC70-5	7"	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3
SOIC-8	13"	12.4	6.4	5.4	2.1	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.2	3.3	1.5	4.0	8.0	2.0	12.0	Q1
TSSOP-8	13"	12.4	6.76	3.3	1.8	4.0	8.0	2.0	12.0	Q1
SOIC-14	13"	16.4	6.6	9.3	2.1	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13"	12.4	6.95	5.6	1.2	4.0	8.0	2.0	12.0	Q1

SGM8541/2/4

1.1MHz, 46 μ A, Rail-to-Rail I/O CMOS Operational Amplifiers

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