Features

- **Single-Supply Operation from +2.0V ~ +5.5V**
- **Rail-to-Rail Input / Output**
- **Gain-Bandwidth Product: 1.6MHz (Typ@25°C)**
- **Low Offset Voltage: 5μV (Max@25°C)**
- **Quiescent Current: 180uA per Amplifier (Typ)**
- **Operating Temperature: -40°C ~ +125°C**
- **Zero Drift: 0.027μV/°C (Typ)**
- **Embedded RF Anti-EMI Filter**
- **Small Package:**

GS8537 Available in SOT23-5 and SOP-8 Packages
GS8538 Available in SOP-8 and MSOP-8 Packages
GS8539 Available in SOP-14 and TSSOP-14 Packages

General Description

The GS853X amplifier is single/dual/quad supply, micro-power, zero-drift CMOS operational amplifiers, the amplifiers offer bandwidth of 1.6MHz, rail-to-rail inputs and outputs, and single-supply operation from 2.0V to 5.5V. GS853X uses auto-zero technique to provide very low offset voltage (less than 5μV maximum) and near zero drift over temperature. Low quiescent supply current of 180uA per amplifier and very low input bias current make the devices an ideal choice for low offset, low power consumption and high impedance applications. The GS853X offers excellent CMRR without the crossover associated with traditional complementary input stages. This design results in superior performance for driving analog-to-digital converters (ADCs) without degradation of differential linearity.

The GS8537 Single is available in SOT23-5 and SOP-8 packages. And the GS8538 Dual is available in MSOP-8 and SOP-8 packages. The GS8539 Quad is available in Green SOP-14 and TSSOP-14 packages. The extended temperature range of -40oC to +125oC over all supply voltages offers additional design flexibility.

Applications

- Transducer Application
- Weight Scale Sensor
- Electronics Scales
- Handheld Test Equipment
- Set-Top Boxes
- Portable/Battery-Powered Applications
- Temperature Sensors
- Laptop/Notebook Computers/TFT Panels

Pin Configuration

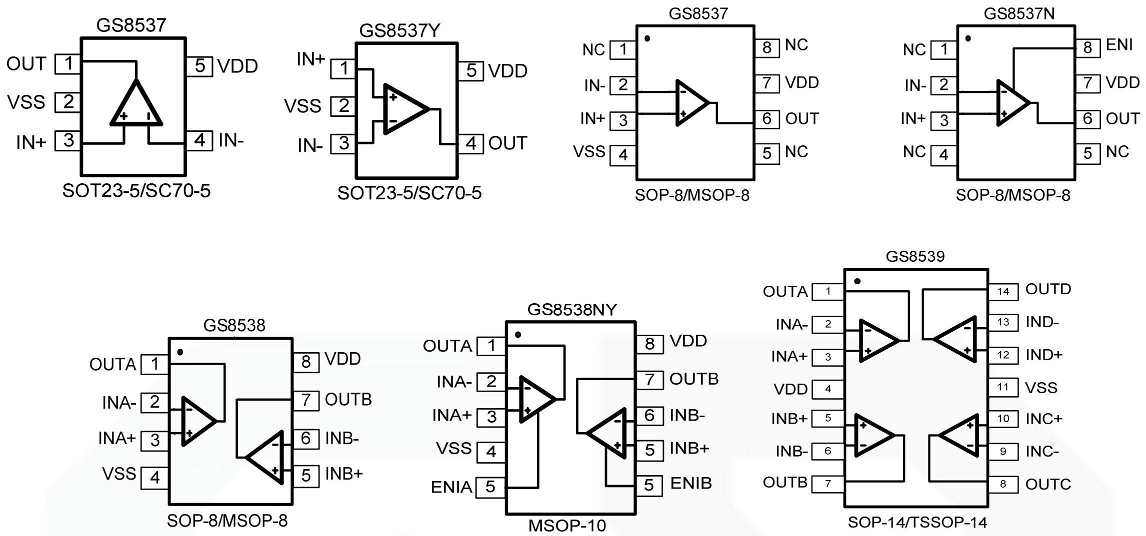


Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	V_{DD}+0.5V
PDB Input Voltage	Vss-0.5V	+7V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+260°C	
Package Thermal Resistance (T_A=+25℃)		
SOP-8, θ_{JA}	125°C/W	
MSOP-8, θ_{JA}	216°C/W	
SOT23-5, θ_{JA}	190°C/W	
SC70-5, θ_{JA}	333°C/W	
ESD Susceptibility		
HBM	4.5KV	
MM	350V	

Note: Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Package/Ordering Information

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
GS8537	Single	GS8537-TR	SOT23-5	Tape and Reel,3000	8537
		GS8537-SR	SOP-8	Tape and Reel,4000	GS8537
GS8538	Dual	GS8538-SR	SOP-8	Tape and Reel,4000	GS8538
		GS8538-MR	MSOP-8	Tape and Reel,3000	GS8538
GS8539	Quad	GS8539-TR	TSSOP-14	Tape and Reel,3000	GS8539
		GS8539-SR	SOP-14	Tape and Reel,2500	GS8539

Electrical Characteristics

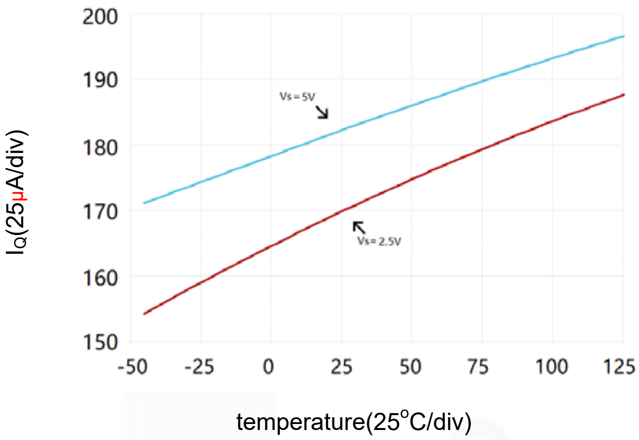
(At V_S = +5V, V_{CM} = V_S/2, R_L = ∞ connected to V_S/2, V_{OUT} = V_S/2 and T_A =+25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	GS8537/8538/8539			
			TYP	MIN	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	V_{CM} = V_S/2	1	-5	5	μV
Input Bias Current	I_B		100			pA
Input Offset Current	I_{OS}		10			pA
Common-Mode Voltage Range	V_{CM}	V_S = 5.5V	-0.1 to +5.6			V
Common-Mode Rejection Ratio	CMRR	V_S = 5V, V_{CM} = -0.1V to 5.1V	120	100		dB
Open-Loop Voltage Gain	A_{OL}	Vs=5V, R_L = 10kΩ, V_{CM} = -0.1V to 5.1V	130	100		dB
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta_T$		0.027	0.13		μV/℃
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V_{OH}	Vs=5V, RL = 100kΩ	4.998	4.99		V
	V_{OL}		1		10	mV
	V_{OH}	Vs=5V, RL = 10kΩ	4.98	4.95		V
	V_{OL}		10		30	mV
Output Current	I_{SOURCE}	Vs=5V	50			mA
	I_{SINK}		55			
POWER SUPPLY						
Operating Voltage Range			2.0			V
			5.5			V
Power Supply Rejection Ratio	PSRR	VS = +2.5V to +5.5V, VCM = +0.5V	120	100		dB
Quiescent Current / Amplifier	I_Q		180			uA
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	GBP		1.5			MHz
Slew Rate	SR	G = +1, 2V Output Step	0.8			V/μs
NOISE PERFORMANCE						
Input Voltage Noise	e_np-p	f = 0.1Hz to 10Hz	2.0			μV_{P-P}
Input Voltage Noise	e_n	f = 1kHz	96			$nV\sqrt{Hz}$
		f = 10kHz	33			
SHUTDOWN						
Shutdown Current / Amplifier	I_{Q_SD}		1		5	μA

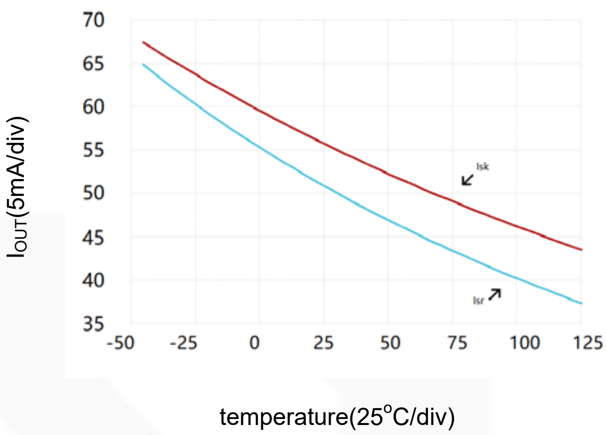
Typical Performance characteristics

At T_A=+25°C, V_S=+5V, and R_L= ∞ connected to $V_S/2$, unless otherwise noted.

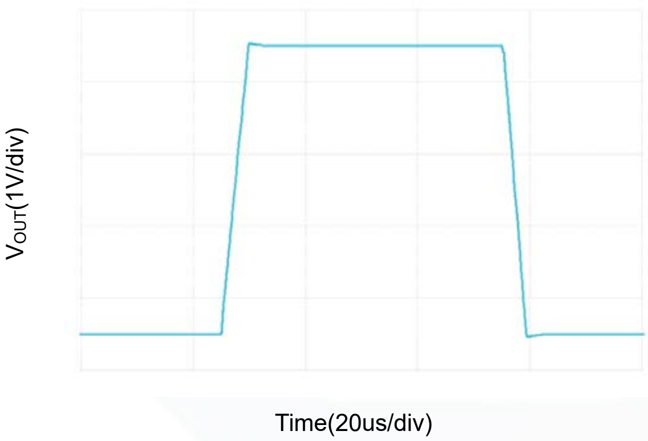
Supply Current vs. Temperature



Output Short-Circuit Current vs. Temperature



Large Signal Pulse Response



Small Signal Pulse Response

Application Note

Size

GS853X family series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the GS853X family packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

GS853X family series operates from a single 2.0V to 5.5V supply or dual ±1.0V to ±2.75V supplies. For best performance, a 0.1μF ceramic capacitor should be placed close to the V_{DD} pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate 0.1μF ceramic capacitors.

Low Supply Current

The low supply current (typical 180uA per channel) of GS853X family will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

GS853X family operates under wide input supply voltage (2.0V to 5.5V). In addition, all temperature specifications apply from -40°C to +125°C. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

Rail-to-Rail Input

The input common-mode range of GS853X family extends 100mV beyond the supply rails (V_{SS}-0.1V to V_{DD}+0.1V). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of GS853X family can typically swing to less than 50mV from supply rail in light resistive loads (>10kΩ).

Capacitive Load Tolerance

The GS853X family is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 2. shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

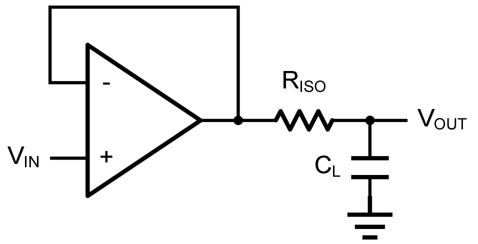


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load R_L in parallel with the capacitive load, a voltage divider (proportional to R_{ISO}/R_L) is formed, this will result in a gain error.

The circuit in *Figure 3* is an improvement to the one in *Figure 2*. R_F provides the DC accuracy by feed-forward the V_{IN} to R_L. 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 the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of C_F. This in turn will slow down the pulse response.

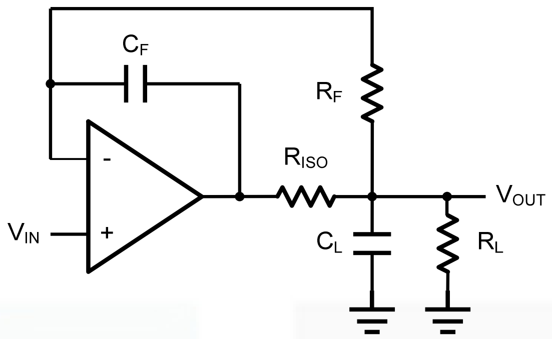


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 4. shown the differential amplifier using GS853X family.

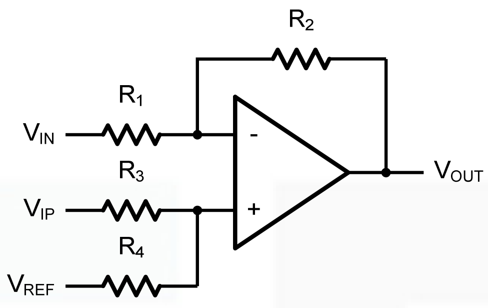


Figure 4. Differential Amplifier

$$V_{OUT}=\left(\frac{R_1+R_2}{R_3+R_4}\right)\frac{R_4}{R_1}V_{IN}-\frac{R_2}{R_1}V_{IP}+\left(\frac{R_1+R_2}{R_3+R_4}\right)\frac{R_3}{R_1}V_{REF}$$

If the resistor ratios are equal (i.e. $R_1=R_3$ and $R_2=R_4$), then

$$V_{OUT}=\frac{R_2}{R_1}(V_{IP}-V_{IN})+V_{REF}$$

Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_C=1/(2\pi R_3C_1)$.

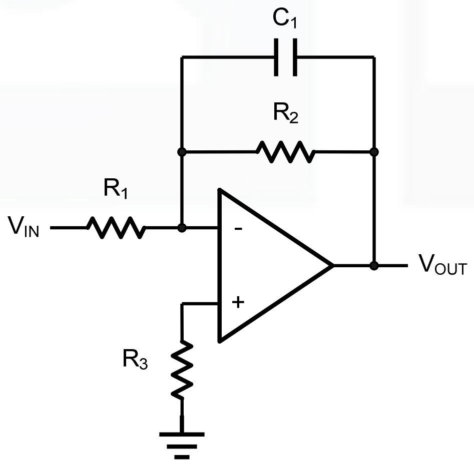


Figure 5. Low Pass Active Filter

Instrumentation Amplifier

The triple GS853X family can be used to build a three-op-amp instrumentation amplifier as shown in Figure 6. The amplifier in Figure 6 is a high input impedance differential amplifier with gain of R_2/R_1. The two differential voltage followers assure the high input impedance of the amplifier.

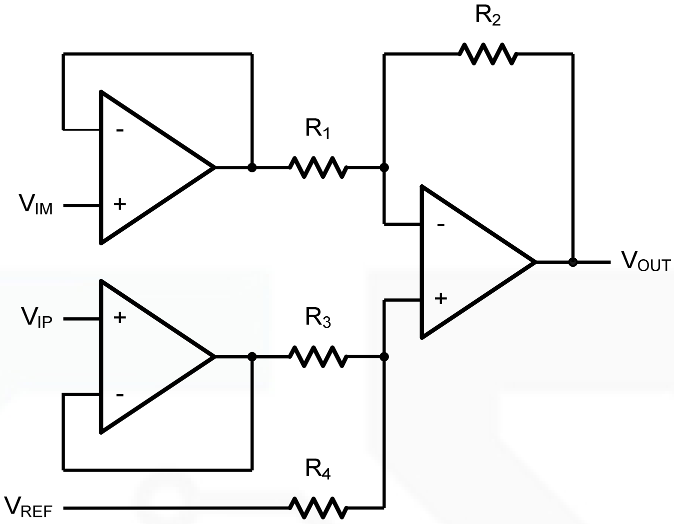
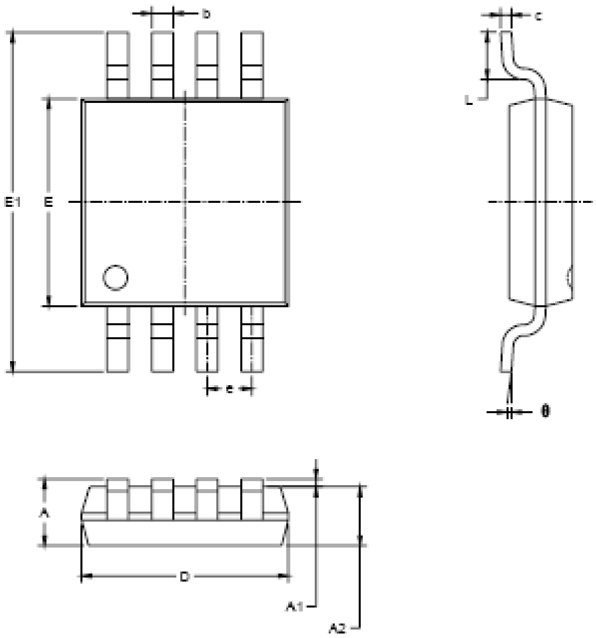


Figure 6. Instrument Amplifier

.

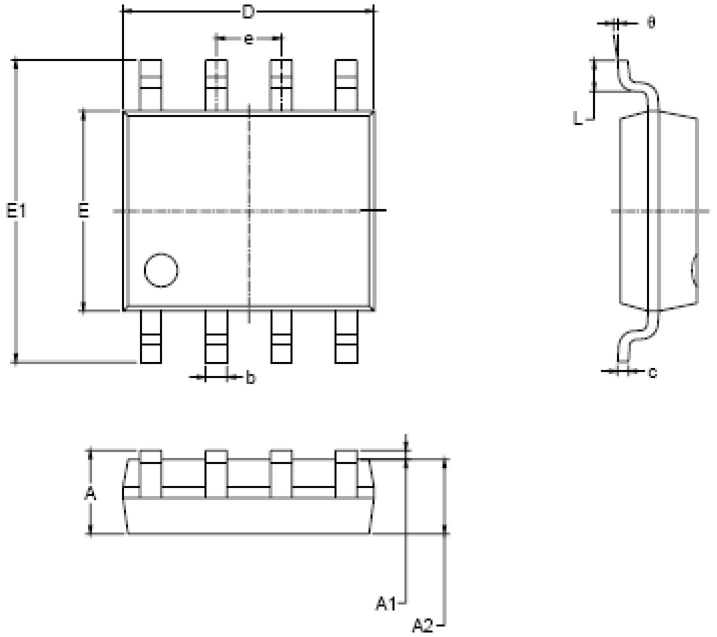
Package Information

MSOP-8



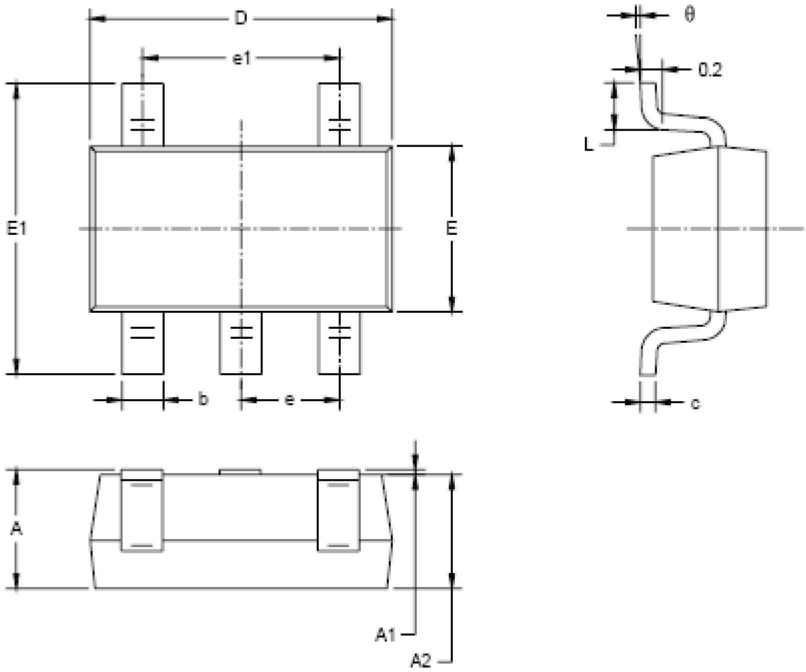
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

SOP-8



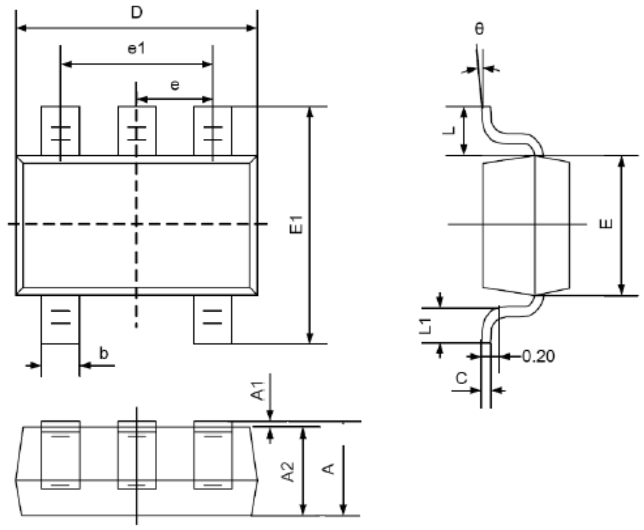
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

SOT23-5



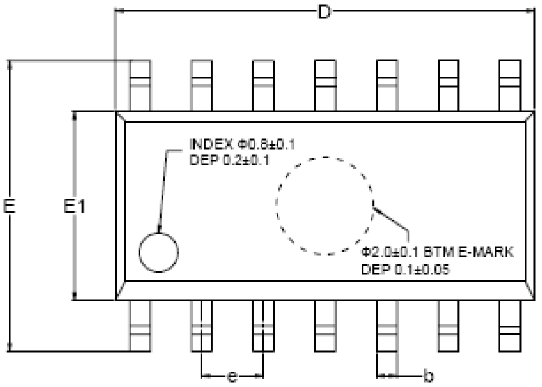
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

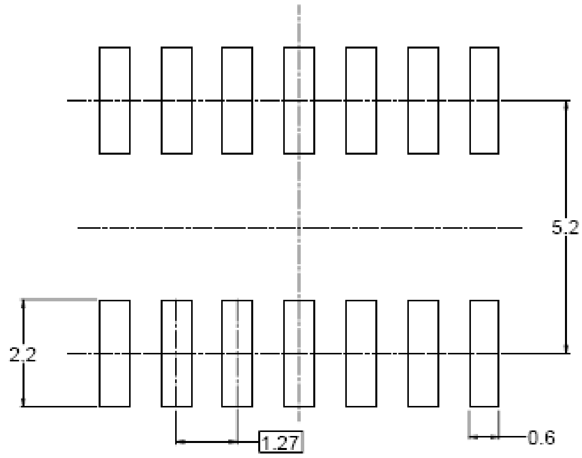
SC70-5



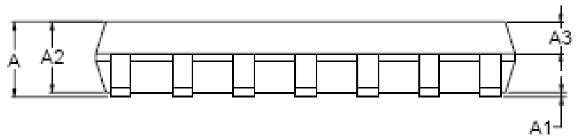
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
e1	1.200	1.400	0.047	0.055
L	0.525REF		0.021REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

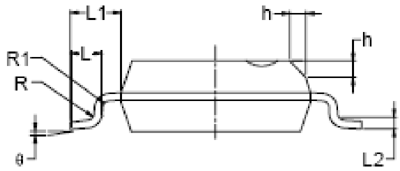
SOP-14





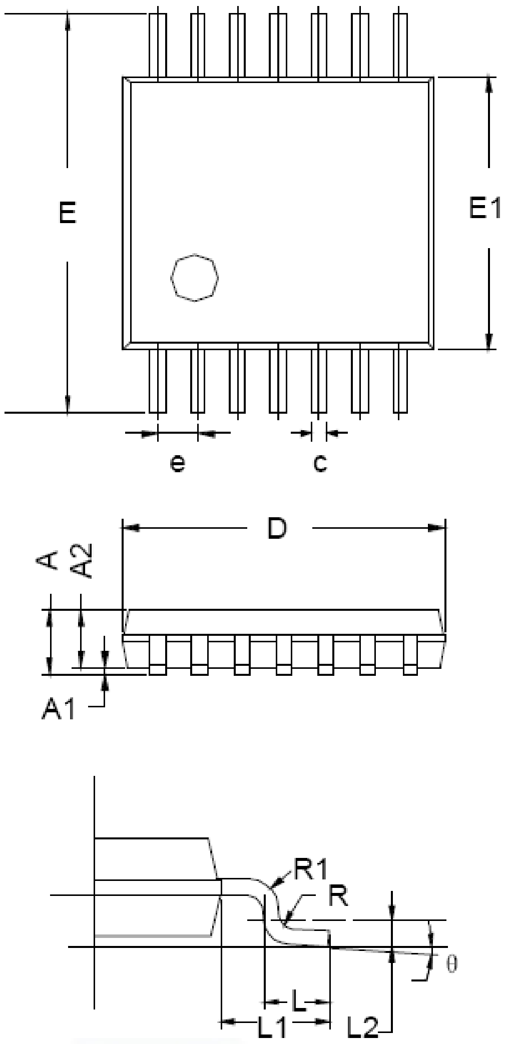
RECOMMENDED LAND PATTERN (Unit: mm)





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°

TSSOP-14



Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
b	0.20	-	0.28
c	0.10	-	0.19
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
θ	0°	-	8°