

Features

- Single-Supply Operation from +1.4V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 15KHz (Typ.)
- Low Input Bias Current: 1pA (Typ.)
- Low Offset Voltage: 2.5mV (Max.)
- Quiescent Current: 600nA per Amplifier (Typ.)
- Operating Temperature: -40°C ~ +125°C
- Embedded RF Anti-EMI Filter
- Small Package:
- GS6041 Available in SOT23-5 and SC70-5 Packages
- GS6042 Available in SOP-8, MSOP-8 and DFN-8 Packages
- GS6043 Available in SOP-8 and MSOP-8 Packages
- GS6044 Available in SOP-14 and TSSOP-14 Packages

General Description

The GS6041 family has a high gain-bandwidth product of 15KHz, a slew rate of 4.5V/ms, and a quiescent current of 600nA/amplifier at 5V. The GS6041 family is designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common mode voltage range includes ground, and the maximum input offset voltage is 2.5mV for GS6041 family. They are specified over the extended industrial temperature range (-40°C to +125°C). The operating range is from 1.4V to 5.5V. The GS6041 single is available in Green SC70-5 and SOT23-5 packages. The GS6042 Dual is available in Green SOP-8, MSOP-8 and DFN-8 packages. The GS6044 Quad is available in Green SOP-14 and TSSOP-14 packages.

Applications

- ASIC Input or Output Amplifier
- Sensor Interface
- Medical Communication
- Smoke Detectors
- Audio Output
- Piezoelectric Transducer Amplifier
- Medical Instrumentation
- Portable Systems

Pin Configuration

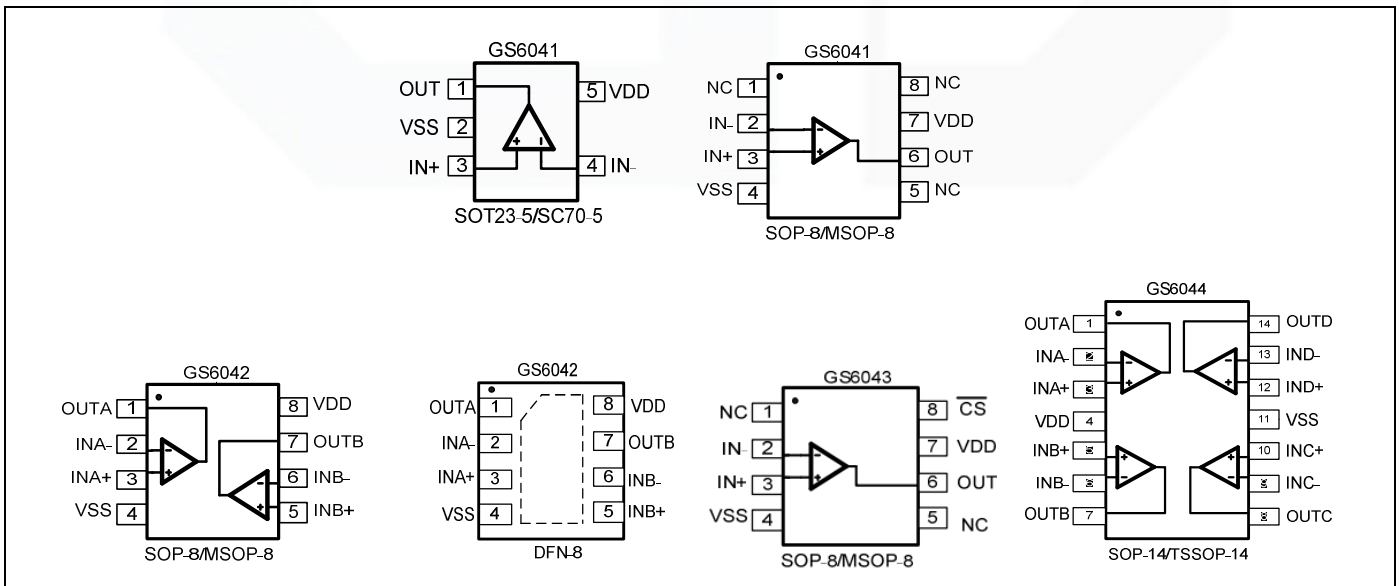


Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to V_{SS})	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	$V_{SS}-0.5V$	$V_{DD}+0.5V$
PDB Input Voltage	$V_{SS}-0.5V$	+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 ($T_A=+25^\circ\text{C}$)		
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	6KV	
MM	300V	

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
GS6041	Single	GS6041-CR	SC70-5	Tape and Reel,3000	6041
		GS6041-TR	SOT23-5	Tape and Reel,3000	6041
		GS6041-SR	SOP-8	Tape and Reel,4000	GS6041
		GS6041-MR	MSOP-8	Tape and Reel,3000	GS6041
GS6042	Dual	GS6042-SR	SOP-8	Tape and Reel,4000	GS6042
		GS6042-MR	MSOP-8	Tape and Reel,3000	GS6042
		GS6042-FR	DFN-8	Tape and Reel,3000	GS6042
GS6043	Single	GS6043-SR	SOP-8	Tape and Reel,4000	GS6043
		GS6043-MR	MSOP-8	Tape and Reel,3000	GS6043
GS6044	Quad	GS6044-TR	TSSOP-14	Tape and Reel,3000	GS6044
		GS6044-SR	SOP-14	Tape and Reel,2500	GS6044

Electrical Characteristics

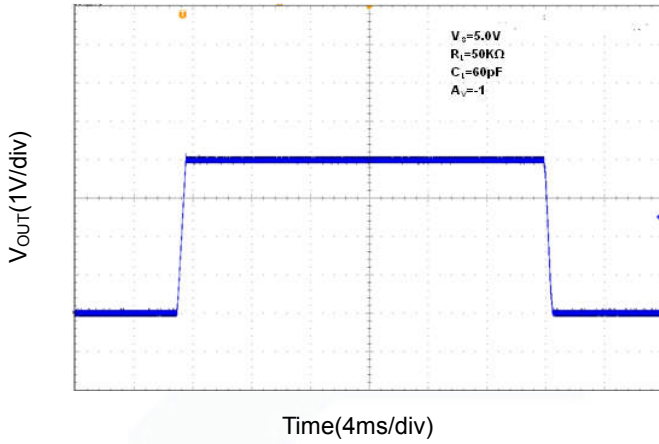
(At $V_S = +5V$, $R_L = 1M\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	GS6041/6042/6044			
			TYP	MIN	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	$V_{CM} = V_S/2$	0.4	-2.5	2.5	mV
Input Bias Current	I_B		1			pA
Input Offset Current	I_{OS}		1			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 2.5V	84	70		dB
		$V_S = 5V, V_{CM} = -0.1V$ to 5.1V	83	67		
Open-Loop Voltage Gain	A_{OL}	$V_S=1.4V, R_L = 50k\Omega, V_O = V_S-0.1V$	80	75		dB
		$V_S=5V, R_L = 50k\Omega, V_O = V_S-0.1V$	93	84		
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		2.5			$\mu V/^\circ C$
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V_{OH}	$V_S=1.4V, R_L = 50k\Omega$	1.395	1.39		V
	V_{OL}		4.5		10	mV
	V_{OH}	$V_S=5V, R_L = 50k\Omega$	4.997	4.990		V
	V_{OL}		3.5		10	mV
Output Current	I_{SOURCE}	$R_L = 10\Omega$ to $V_S/2$	60	45	84	mA
	I_{SINK}		60	45	75	
POWER SUPPLY						
Operating Voltage Range			1.4			V
			5.5			V
Power Supply Rejection Ratio	PSRR	$V_S = +1.4V$ to $+5.5V, V_{CM} = +0.5V$	80	77		dB
Quiescent Current / Amplifier	I_Q		600			nA
DYNAMIC PERFORMANCE (CL = 100pF)						
Gain-Bandwidth Product	GBP		15			KHz
Slew Rate	SR	$G = +1, 2V$ Output Step	4.5			V/ms

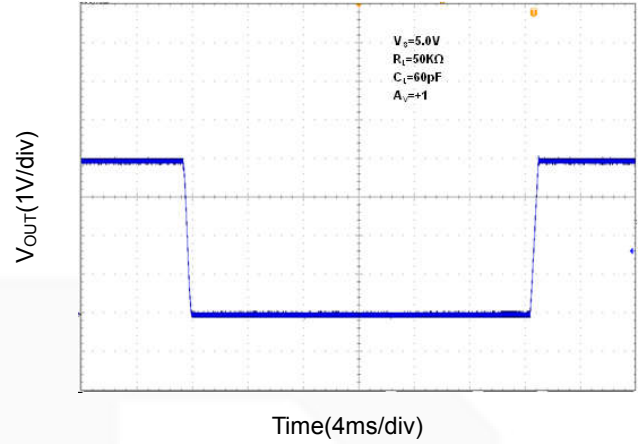
Typical Performance characteristics

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.

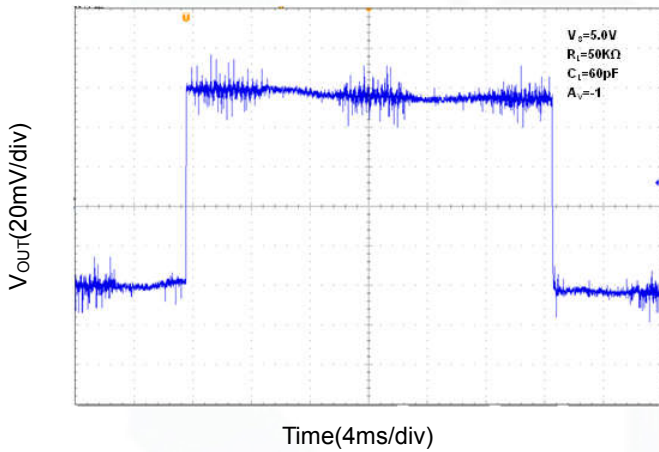
Large Signal Inverting Pulse Response



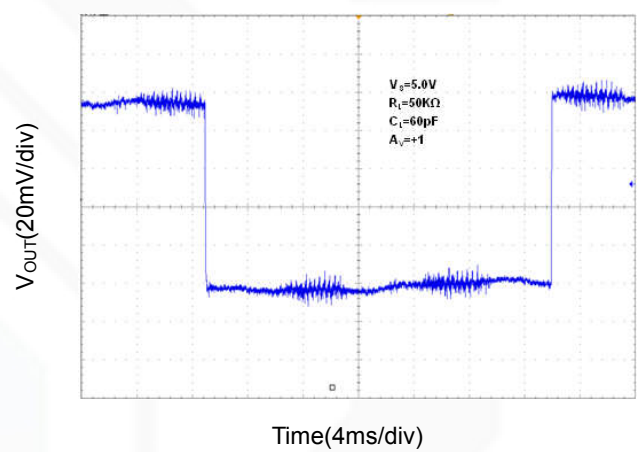
Large Signal Non-Inverting Pulse Response



Small Signal Inverting Pulse Response



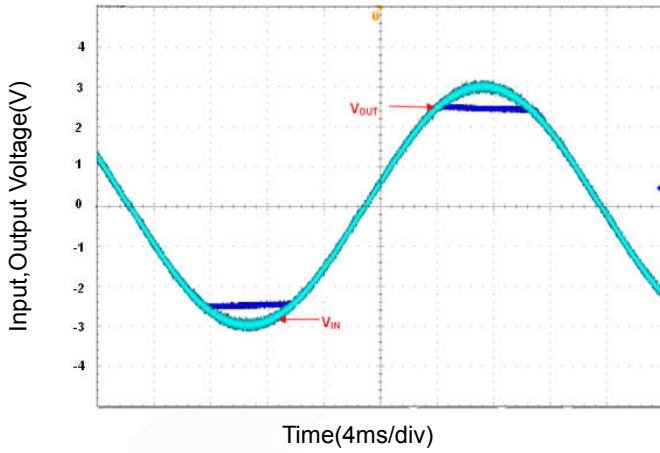
Small Signal Non-Inverting Pulse Response



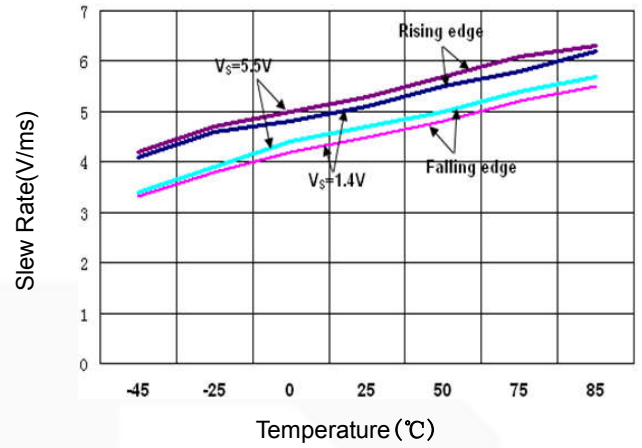
Typical Performance characteristics

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.

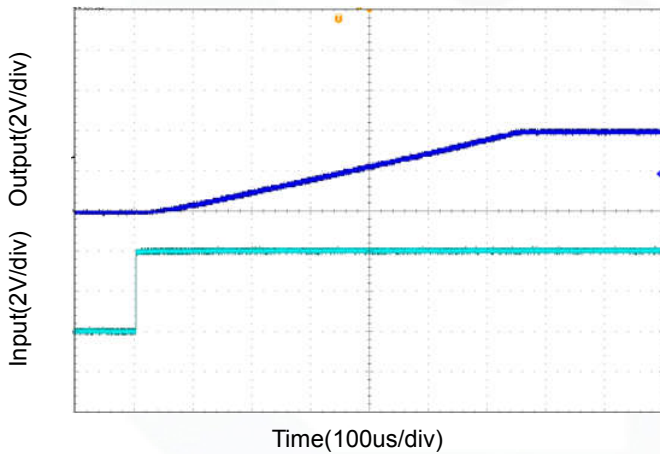
No Phase Reversal



Slew Rate vs. Temperature



Output Settling Time



Application Note

Size

GS6041 family series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the GS6041 family packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

GS6041 family series operates from a single 1.4V to 5.5V supply or dual $\pm 0.7V$ to $\pm 2.75V$ supplies. For best performance, a 0.1 μF 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 0.1 μF ceramic capacitors.

Low Supply Current

The low supply current (typical 500nA per channel) of GS6041 family will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

GS6041 family operates under wide input supply voltage (1.4V to 5.5V). In addition, all temperature specifications apply from $-40^{\circ}C$ to $+125^{\circ}C$. 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 GS6041 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 GS6041 family can typically swing to less than 10mV from supply rail in light resistive loads ($>50k\Omega$).

Capacitive Load Tolerance

The GS6041 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.

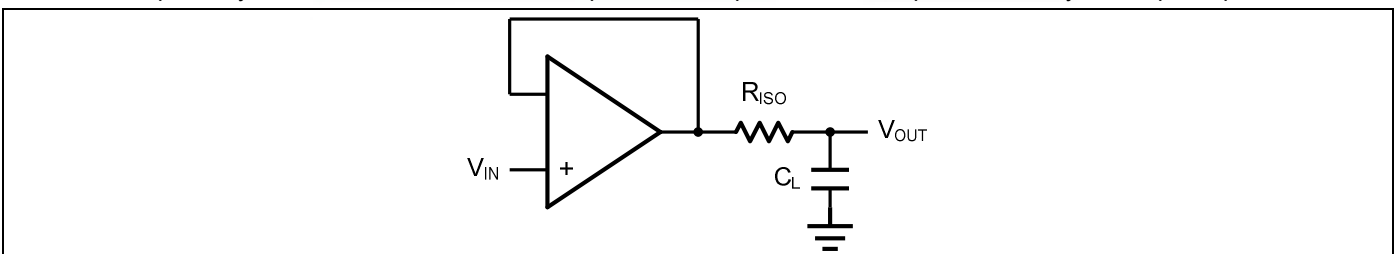


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

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.

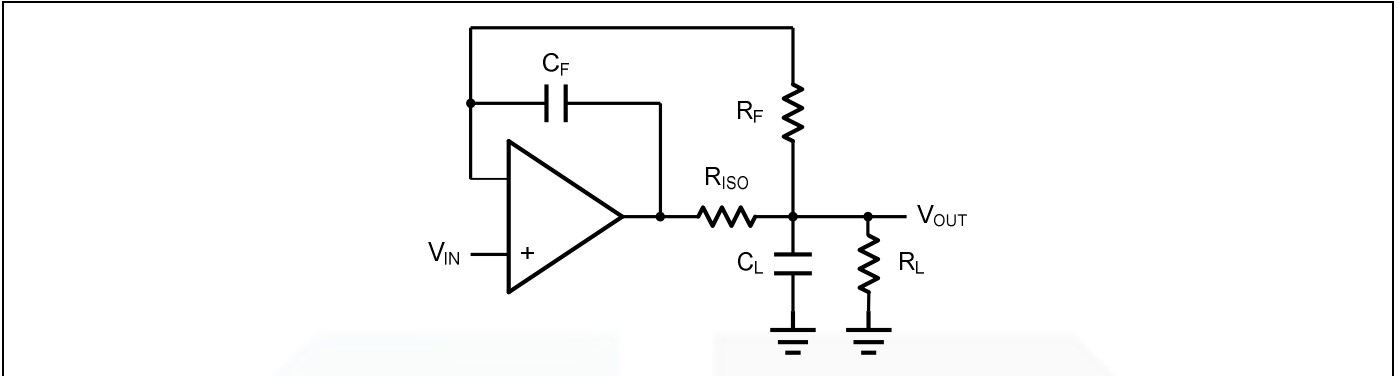


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

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 GS6041 family.

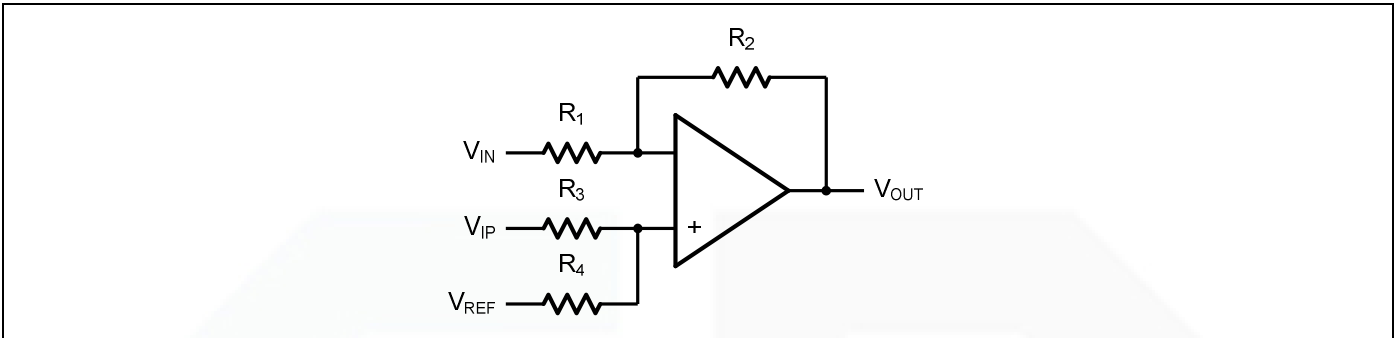


Figure 4. Differential Amplifier

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

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 $f_c=1/(2\pi R_3 C_1)$.

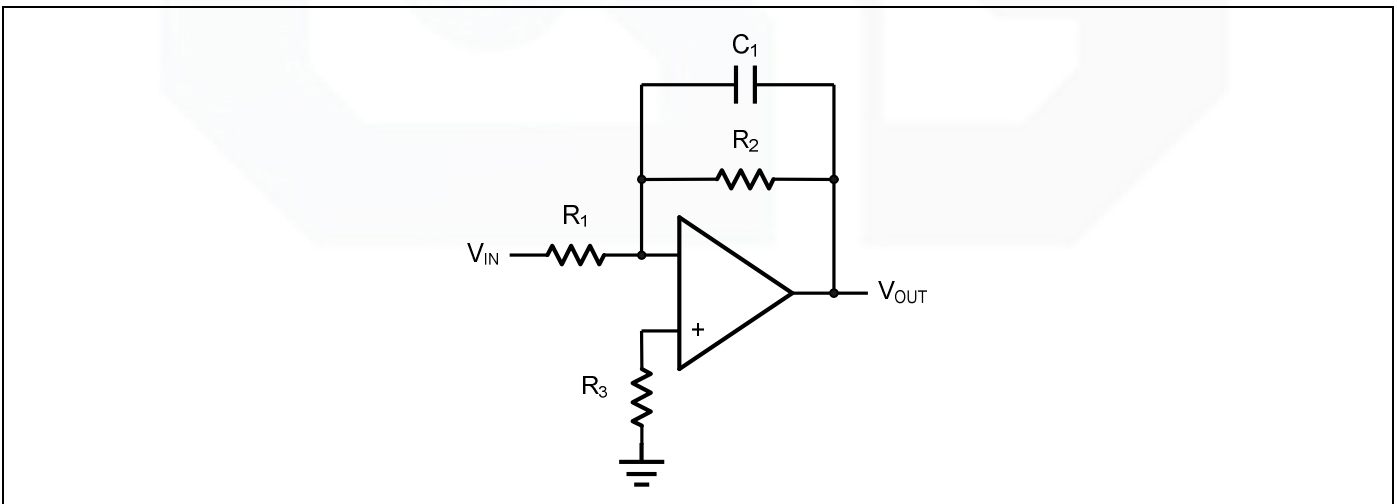


Figure 5. Low Pass Active Filter

Instrumentation Amplifier

The triple GS6041 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.

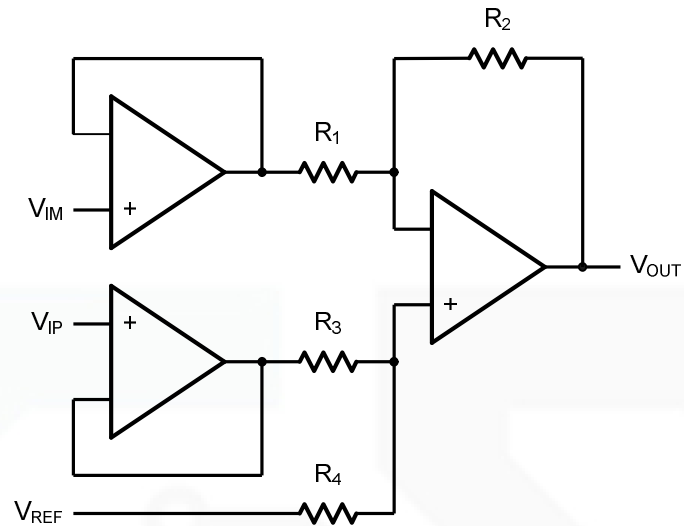
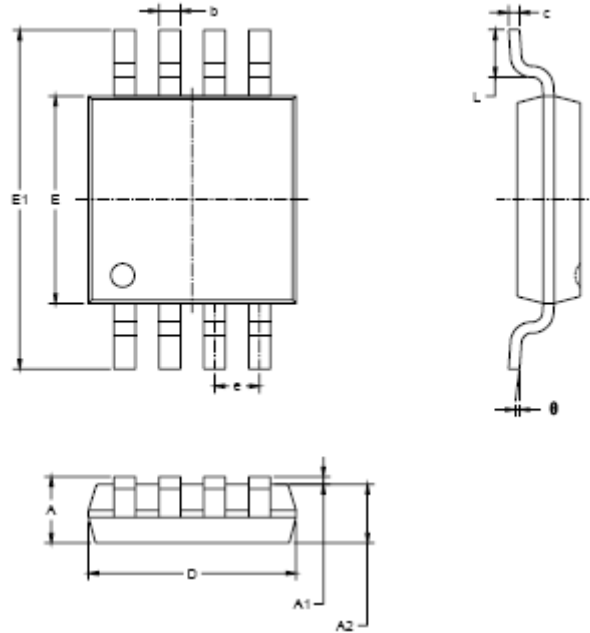


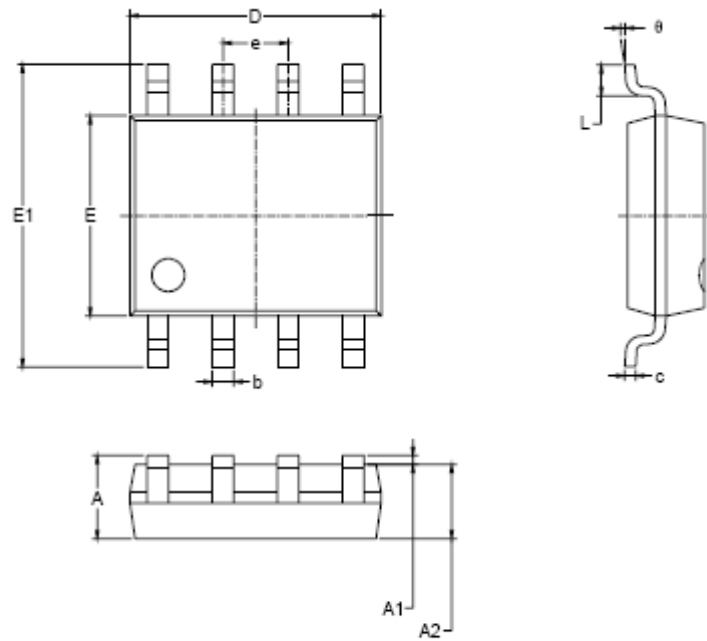
Figure 6. Instrument Amplifier

Package Information

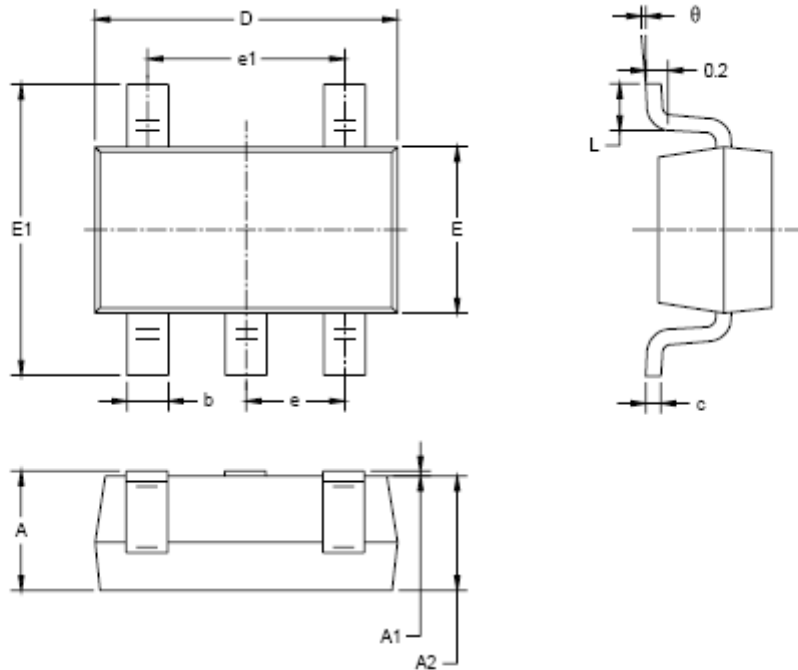
MSOP-8



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	0.008
A2	0.760	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	4.760	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°

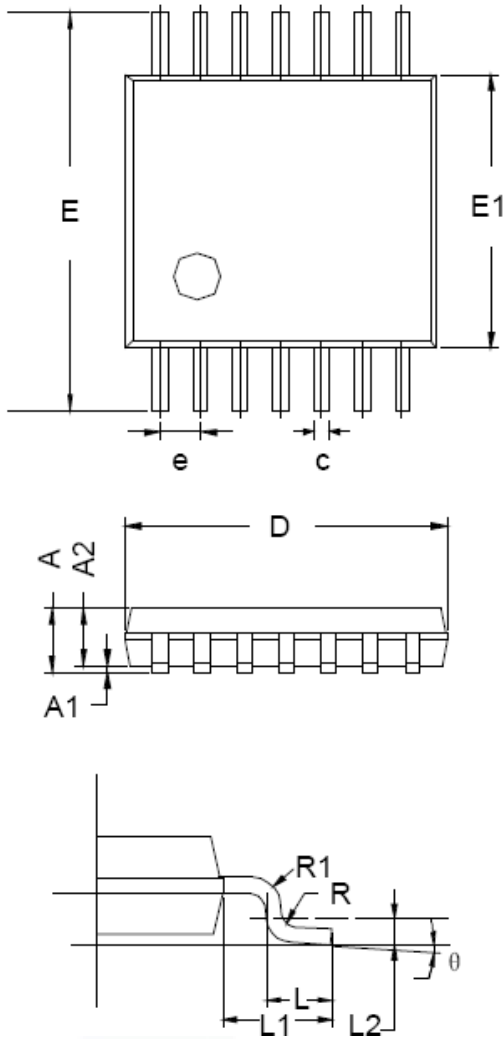
SOP-8


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°

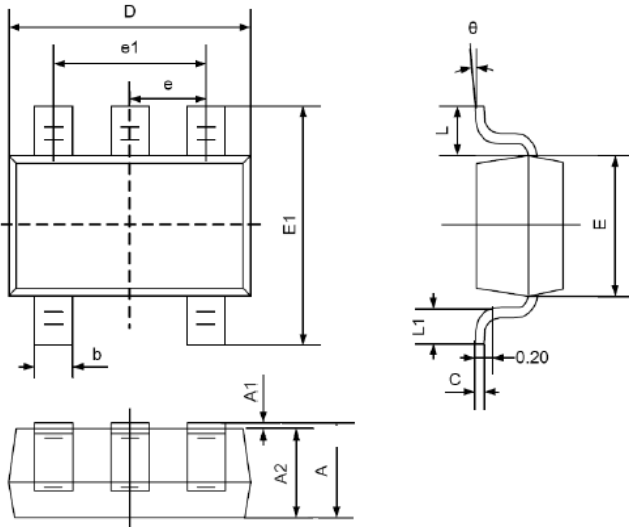
SOT23-5


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	0.118
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°

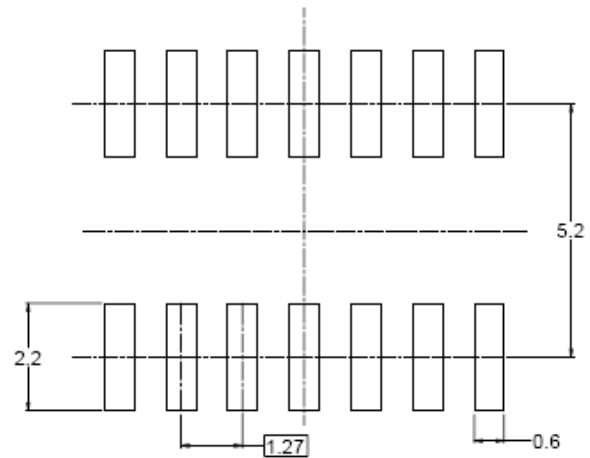
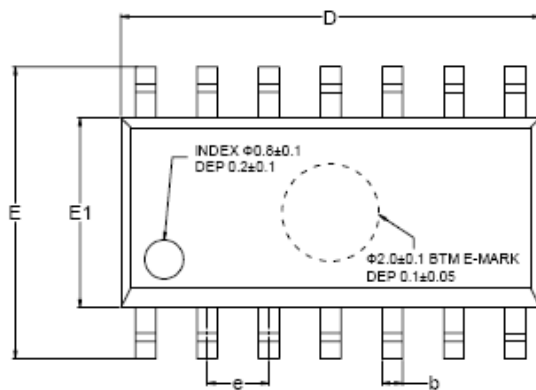
TSSOP-14



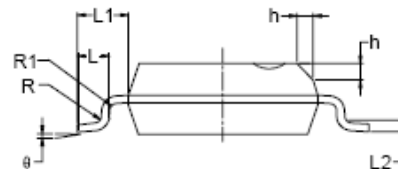
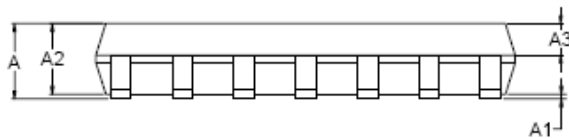
Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
b	0.20	-	0.28
c	0.10	-	0.19
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
θ	0°	-	8°

SC70-5


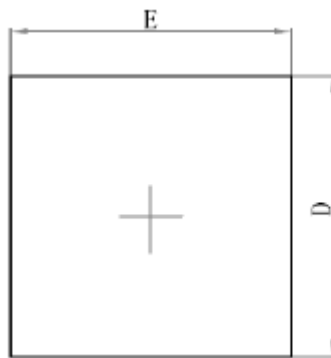
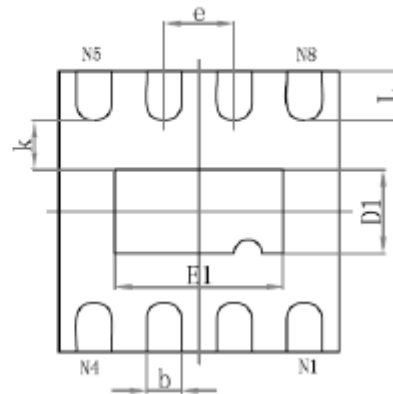
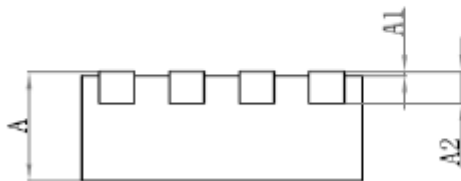
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
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°

DFN-8

Top View

Bottom View

Side View

Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	0.80	0.85	0.9	0.031	0.033	0.035
A1	0.00	0.02	0.05	0.000	0.001	0.002
A2	0.153	0.203	0.253	0.006	0.008	0.010
b	0.18	0.24	0.30	0.007	0.009	0.012
D	1.9	2.0	2.1	0.075	0.079	0.083
E	1.9	2.0	2.1	0.075	0.079	0.083
D1	0.5	0.6	0.7	0.020	0.024	0.028
E1	1.1	1.2	1.3	0.043	0.047	0.051
e		0.50			0.20	
k	0.2			0.008		
L	0.25	0.35	0.45	0.010	0.014	0.018