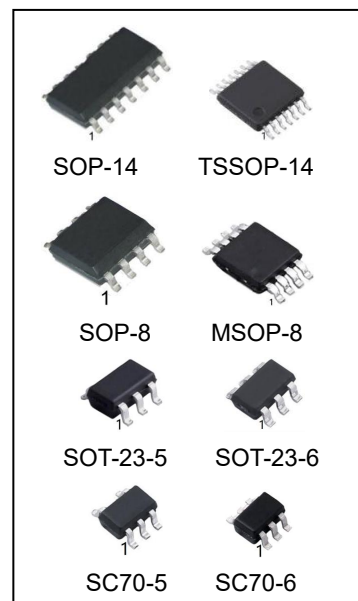


600nA 14.5KHz CMOS Rail-to-Rail IO Opamp with RF Filter

Features

- Single-Supply Operation from +1.4V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 14.5KHz (Typ)
- Low Input Bias Current: 1pA (Typ)
- Low Offset Voltage: 3mV (Max)
- Quiescent Current: 600nA per Amplifier (Typ)
- Chip Select with HGV6043NH(active High) and HGV6043NL(active Low)
- Operating Temperature: -40°C ~ +125°C
- Embedded RF Anti-EMI Filter
- Small Package:
 - HGV6041 Available in SOT-23-5 ,SC70-5 and SOP-8 Packages
 - HGV6042 Available in SOP-8 and MSOP-8 Packages
 - HGV6043NH Available in SOT-23-6 and SC70-6 Packages
 - HGV6043NL Available in SOT-23-6 and SC70-6 Packages
 - HGV6044NL Available in SOP-14 and TSSOP-14 Packages



Ordering Information

Device	Package Type	Marking	Packing	Packing Qty
HGV6041M5/TR	SOT-23-5	6041	REEL	3000pcs/reel
HGV6041M7/TR	SC70-5(SOT-353)	6041	REEL	3000pcs/reel
HGV6041M/TR	SOP-8	V6041	REEL	2500pcs/reel
HGV6042M/TR	SOP-8	V6042	REEL	2500pcs/reel
HGV6042MM/TR	MSOP-8	V6042	REEL	3000pcs/reel
HGV6043NHM6/TR	SOT-23-6	043H	REEL	3000pcs/reel
HGV6043NHM7/TR	SC70-6	043H	REEL	3000pcs/reel
HGV6043NLM6/TR	SOT-23-6	043L	REEL	3000pcs/reel
HGV6043NLM7/TR	SC70-6	043L	REEL	3000pcs/reel
HGV6044M/TR	SOP-14	V6044	REEL	2500pcs/reel
HGV6044MT/TR	TSSOP-14	V6044	REEL	2500pcs/reel

General Description

The HGV604X family has a high gain-bandwidth product of 14.5KHz, a slew rate of 6V/ms, and a quiescent current of 600nA/amplifier at 5V. The HGV604X 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 3mV for HGV604X 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 HGV6041 single is available in Green SC70-5 SOT-23-5 and SOP-8 packages. The HGV6042 Dual is available in Green SOP-8 and MSOP-8 packages. The HGV6043 single is available in Green SC70-6 and SOT-23-6 packages. The HGV6044 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

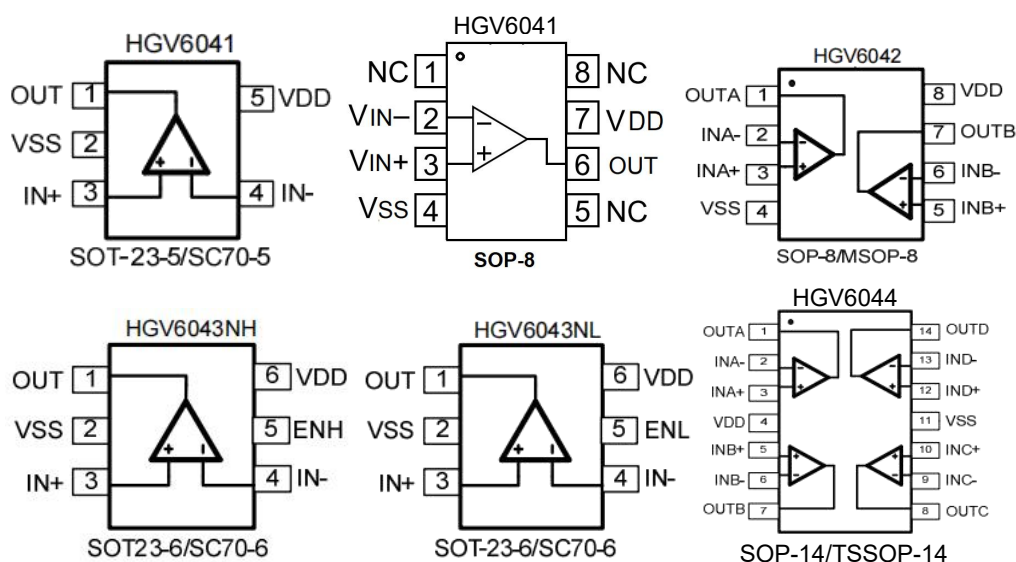


Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max	Units
Power Supply Voltage (VDD to Vss)	-0.5	+7.5	V
Analog Input Voltage (IN+ or IN-)	Vss-0.5	VDD+0.5	V
PDB Input Voltage	Vss-0.5	+7	V
Operating Temperature Range ⁽¹⁾	-40	+125	°C
Junction Temperature	+160		°C
Storage Temperature Range	-55	+150	°C
Lead Temperature (soldering, 10sec)	+260°C		°C
Package Thermal Resistance (TA=+25°C)			
SOP-8, θJA	125		°C/W
MSOP-8, θJA	216		°C/W
SOT-23-5, θJA	190		°C/W
SOT-23-6, θJA	190		°C/W
SC70-5, θJA	333		°C/W
SC70-6, θJA	333		°C/W
ESD Susceptibility			
HBM	6		KV
MM	300		V

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.

Note(1): Operating temperature range: -40°C to +125°C. This product is designed for industrial grade applications. For automotive grade versions compliant with AEC-Q100, please conduct internal screening per the standard or contact our sales team for availability.

Electrical Characteristics

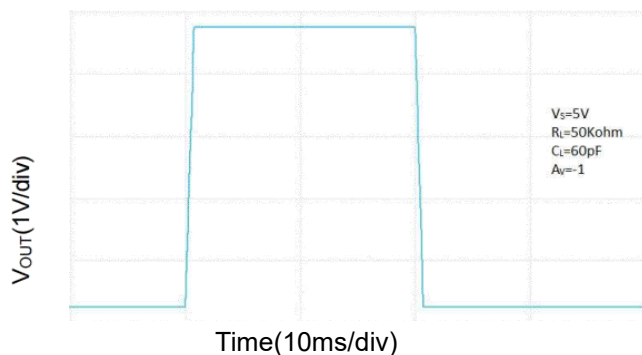
(At $V_S = +5V$, $R_L = 1M\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	HGV6041/6042/6043			
			TYP	MIN	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage	VOS	VCM = VS/2	0.4		3	mV
Input Bias Current	IB		1			pA
Input Offset Current	IOS		1			pA
Common-Mode Voltage Range	VCM	VS = 5.5V	-0.1 to +5.6			V
Common-Mode Rejection Ratio	CMRR	VS = 5V, VCM = -0.1V to 2.5V	78	66		dB
		VS = 5V, VCM = -0.1V to 5.1V	84	67		
Open-Loop Voltage Gain	AOL	Vs=1.4V, RL = 50kΩ, VO = Vs-0.1V	86	75		dB
		Vs=5V, RL = 50kΩ, VO = Vs-0.1V	93	84		
Input Offset Voltage Drift	ΔVOS/ΔT		2.5			μV/℃
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	VOH	Vs=1.4V, RL = 50kΩ	1.395	1.390		V
	VOL		4.5		10	mV
	VOH	Vs=5V, RL = 50kΩ	4.997	4.990		V
	VOL		3.5		10	mV
Output Current	ISOURCE	RL = 10Ω to VS/2	20			mA
	ISINK		20			
POWER SUPPLY						
Operating Voltage Range	VCC		1.4		5.5	V
Power Supply Rejection Ratio	PSRR	VS = +1.4V to +5.5V, VCM = +0.5V	80	77		dB
Quiescent Current / Amplifier	IQ		600			nA
Shutdown Current / Amplifier	IQ_off	HGV6043NH / HGV6043NL	54			nA
DYNAMIC PERFORMANCE (CL = 100pF)						
Gain-Bandwidth Product	GBP		14.5			KHz
Slew Rate	SR	G = +1, 2V Output Step	6			V/ms

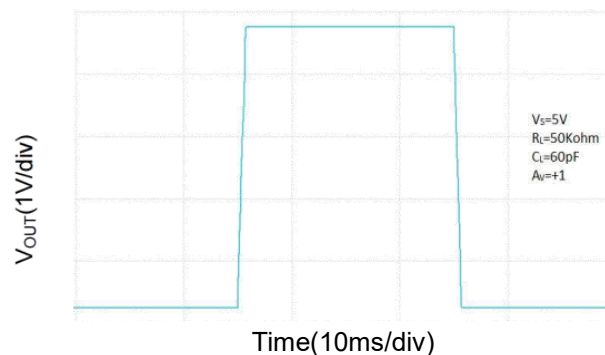
Typical Performance characteristics

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.

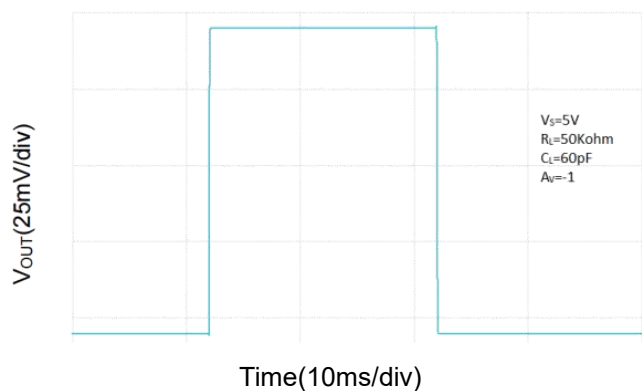
Large Signal Inverting Pulse Response



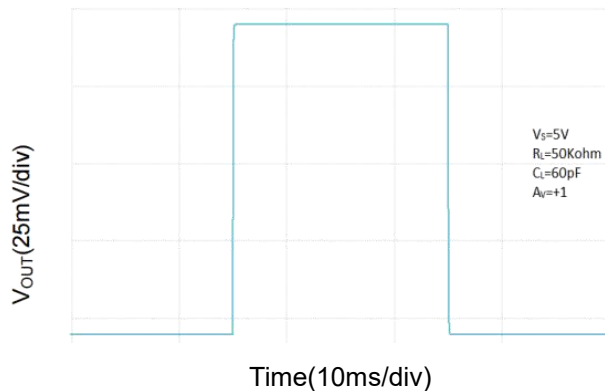
Large Signal Non-Inverting Pulse Response



Small Signal Inverting Pulse Response

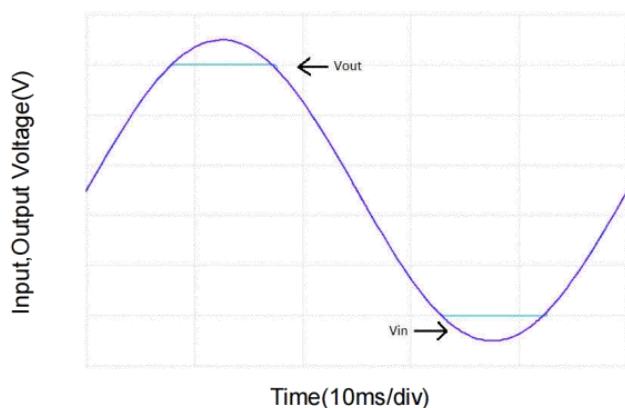


Small Signal Non-Inverting Pulse Response

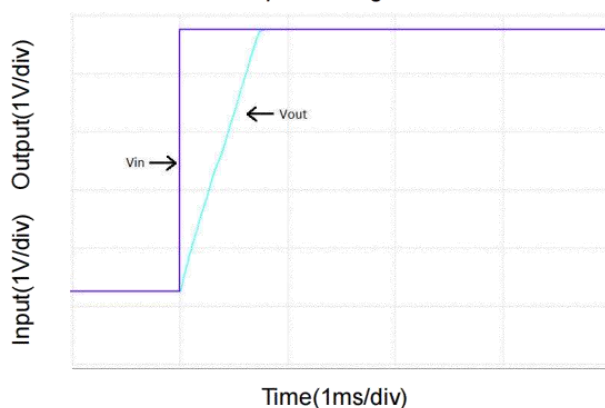


At $T_A=+25^{\circ}\text{C}$, $V_S=+5\text{V}$, and $R_L=100\text{K}\Omega$ connected to $V_S/2$, unless otherwise noted.

No Phase Reversal



Output Settling Time



Application Note

Size

HGV604X family series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the HGV604X family packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

HGV604X 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 $0.1\mu F$ ceramic capacitor should be placed close to the VDD pin in single supply operation. For dual supply operation, both VDD and VSS supplies should be bypassed to ground with separate $0.1\mu F$ ceramic capacitors.

Low Supply Current

The low supply current (typical 600nA per channel) of HGV604X family will help to maximize battery life. They are ideal for battery powered systems.

Operating Voltage

HGV604X 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 HGV604X family extends 100mV beyond the supply rails ($VSS-0.1V$ to $VDD+0.1V$). 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 HGV604X family can typically swing to less than 50mV from supply rail in light resistive loads ($>50k\Omega$).

Capacitive Load Tolerance

The HGV604X 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.

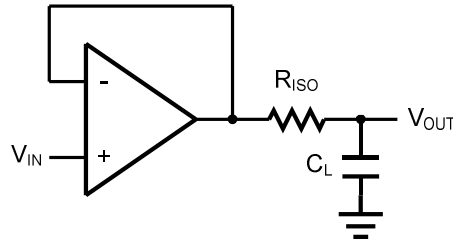


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

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.

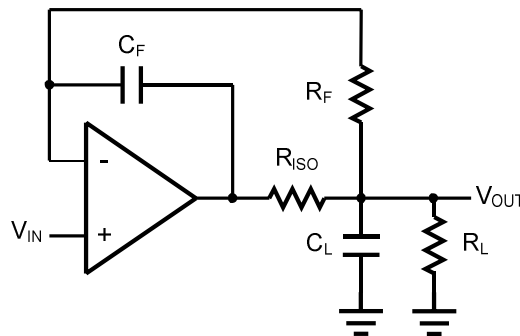


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common to 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 HGV604X family.

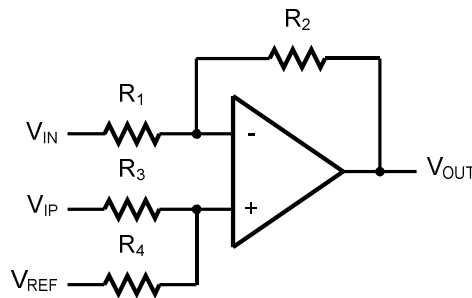


Figure 4. Differential Amplifier

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

If the resistor ratios are equal (i.e. R₁=R₃ and R₂=R₄), 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 $f_c = 1/(2\pi R_3 C_1)$.

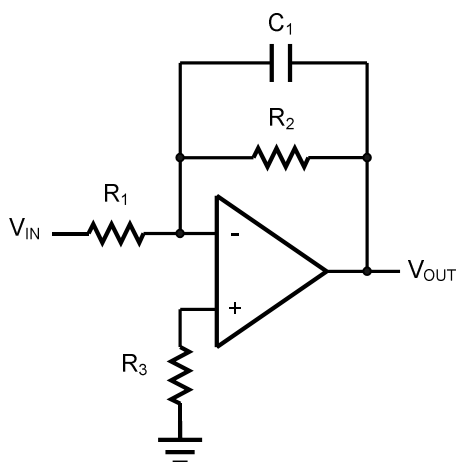


Figure 5. Low Pass Active Filter

Instrumentation Amplifier

The triple HGV604X 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.

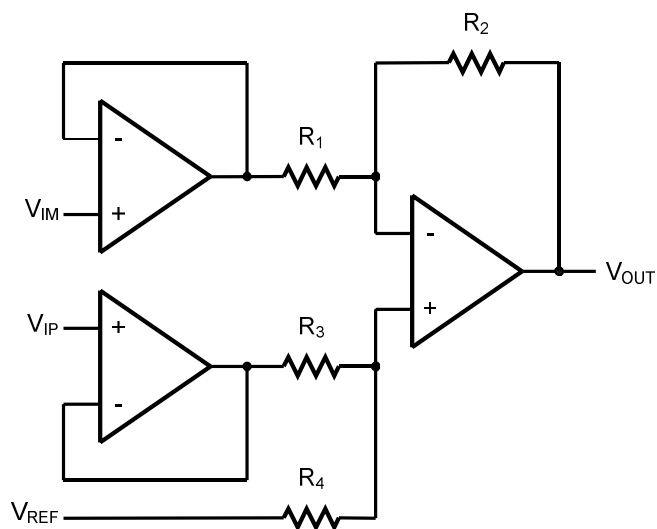
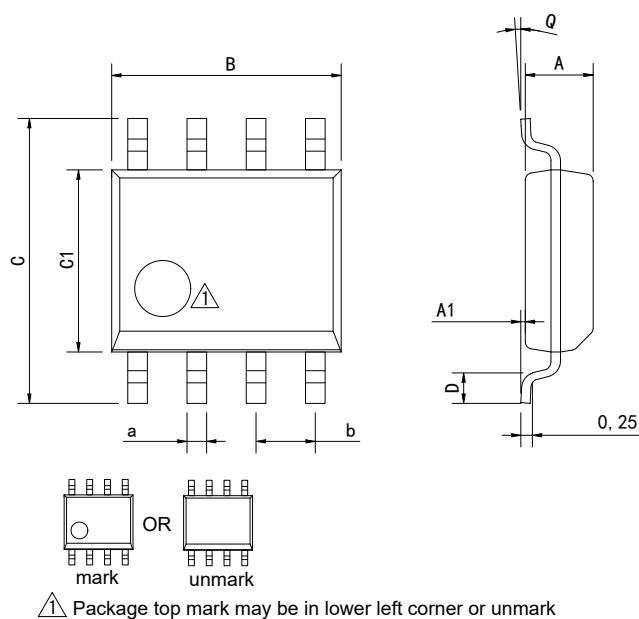


Figure 6. Instrument Amplifier

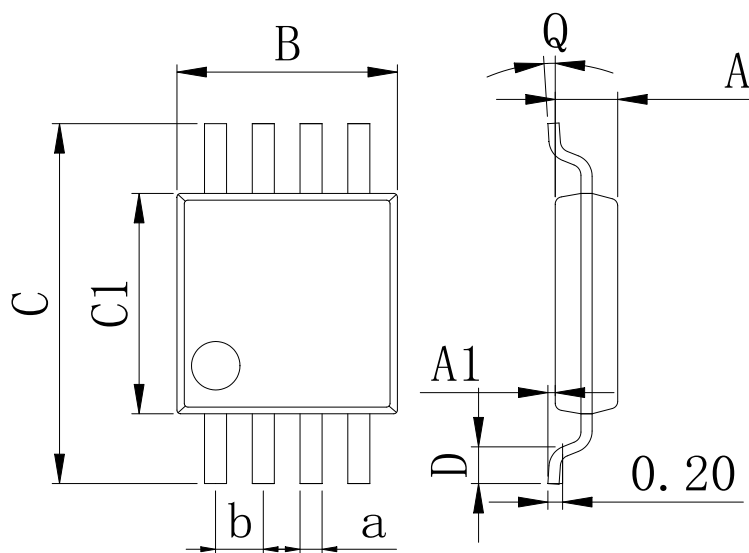
Physical Dimensions

SOP-8



Dimensions In Millimeters(SOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

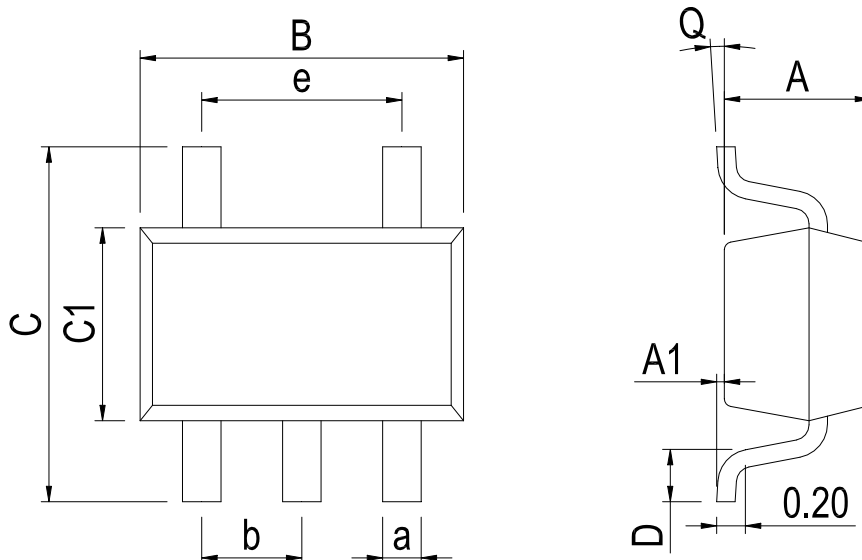
MSOP-8



Dimensions In Millimeters(MSOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.80	0.05	2.90	4.75	2.90	0.35	0°	0.25	0.65 BSC
Max:	0.90	0.20	3.10	5.05	3.10	0.75	8°	0.35	

Physical Dimensions

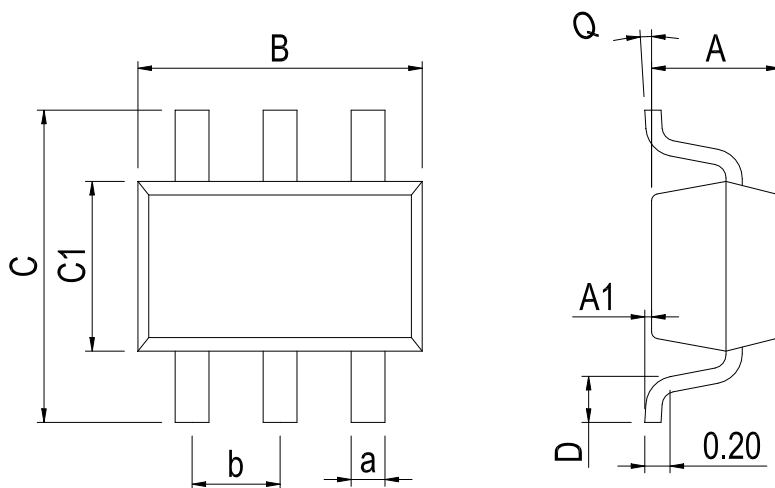
SOT-23-5



Dimensions In Millimeters(SOT-23-5)

Symbol:	A	A1	B	C	C1	D	Q	a	b	e
Min:	1.00	0.00	2.82	2.65	1.50	0.30	0°	0.30	0.95 BSC	1.90 BSC
Max:	1.15	0.15	3.02	2.95	1.70	0.60	8°	0.50		

SOT-23-6

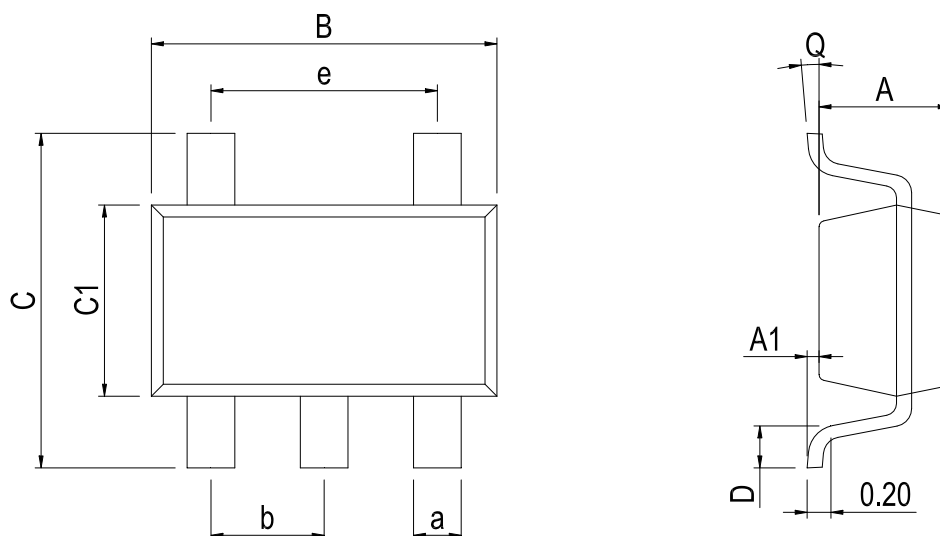


Dimensions In Millimeters(SOT-23-6)

Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.00	0.00	2.82	2.65	1.50	0.30	0°	0.30	0.95 BSC
Max:	1.15	0.15	3.02	2.95	1.70	0.60	8°	0.50	

Physical Dimensions

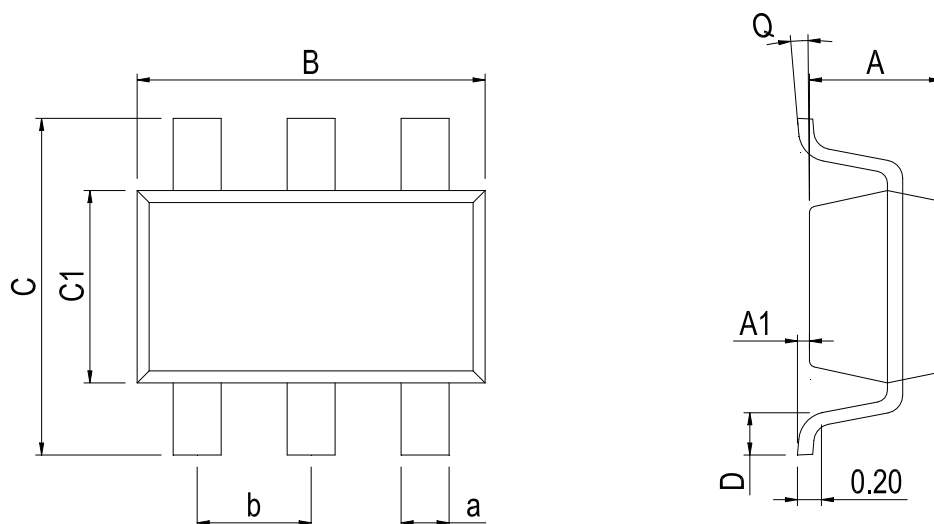
SC70-5



Dimensions In Millimeters(SC70-5)

Symbol:	A	A1	B	C	C1	D	Q	a	b	e
Min:	0.90	0.00	2.00	2.15	1.15	0.26	0°	0.15	0.65	1.30 BSC
Max:	1.00	0.15	2.20	2.45	1.35	0.46	8°	0.35	BSC	

SC70-6

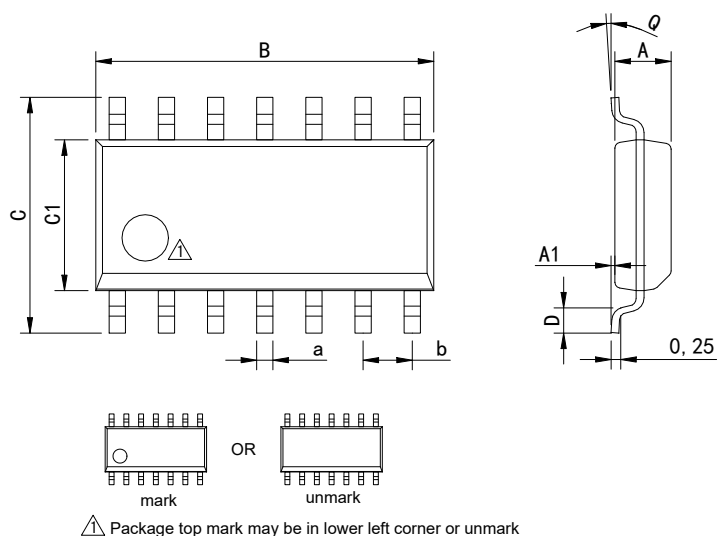


Dimensions In Millimeters(SC70-6)

Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.90	0.00	2.00	2.15	1.15	0.26	0°	0.15	0.65 BSC
Max:	1.00	0.15	2.20	2.45	1.35	0.46	8°	0.35	

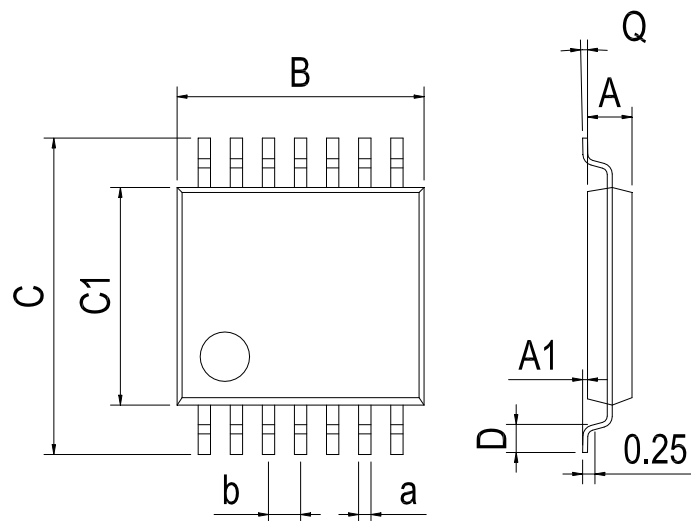
Physical Dimensions

SOP-14



Dimensions In Millimeters(SOP-14)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	8.55	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	8.75	6.20	4.00	0.80	8°	0.45	

TSSOP-14



Dimensions In Millimeters(TSSOP-14)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.85	0.05	4.90	6.20	4.30	0.40	0°	0.20	0.65 BSC
Max:	0.95	0.20	5.10	6.60	4.50	0.80	8°	0.25	

Revision History

REVISION NUMBER	DATE	REVISION	PAGE
V1.0	2015-10	New	1-13
V1.1	2018-10	Update encapsulation type	3
V1.2	2024-10	Update SOT-23-5and SOT-23-6Physical dimension、 Update Lead Temperature	10、 3
V1.3	2025-9	Add 6044 model	1
V1.4	2025-12	Update important statements、 Update SOP-8 and SOP-14Dimension drawing	9、 12、 13

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