

# HGV8631/HGV8632/HGV8634

## 470μA, 6MHz, Rail-to-Rail I/O CMOS Operational Amplifier

### PRODUCT DESCRIPTION

The HGV8631(single), HGV8632(dual), and HGV8634 (quad) are low noise, low voltage, and low power power operational amplifiers, that can be designed into a wide range of applications. The HGV8631/2/4 have a high gain-bandwidth product of 6MHz, a slew rate of 3.7V/μs, and a quiescent current of 470μA/amplifier at 5V.

The HGV8631/2/4 are 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 are 3.5mV for HGV8631/2/4. They are specified over the extended industrial temperature range (-40°C to +125°C). The operating range is from 2.5V to 5.5V.

The single version, HGV8631, is available in SC70-5, and SOT23-5 packages. The dual version HGV8632 is available in SO-8 and MSOP-8 packages. The quad version HGV8634 is available in SO-16 and TSSOP-16 packages.

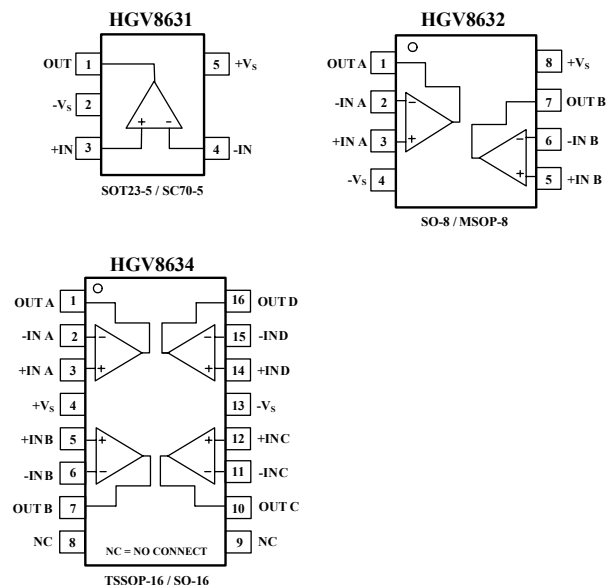
### APPLICATIONS

- Sensors
- Audio
- Active Filters
- A/D Converters
- Communications
- Test Equipment
- Cellular and Cordless Phones
- Laptops and PDAs
- Photodiode Amplification
- Battery-Powered Instrumentation

### FEATURES

- Low Cost
- Rail-to-Rail Input and Output  
0.8mV Typical  $V_{OS}$
- High Gain-Bandwidth Product: 6MHz
- High Slew Rate: 3.7V/μs
- Settling Time to 0.1% with 2V Step: 2.1μs
- Overload Recovery Time: 0.9μs
- Low Noise : 12 nV/ $\sqrt{Hz}$
- Operates on 2.5 V to 5.5V Supplies
- Input Voltage Range = - 0.1 V to +5.6 V with  $V_s = 5.5 V$
- Low Power  
470μA/Amplifier Typical Supply Current
- Small Packaging  
HGV8631 Available in SC70-5, SOT23-5  
HGV8632 Available in MSOP-8 and SO-8  
HGV8634 Available in TSSOP-16 and SO-16

### PIN CONFIGURATIONS (Top View)



**ORDERING INFORMATION**

DEVICE	Package Type	MARKING	Packing	Packing Qty
HGV8631M5/TR	SOT23-5	V8631	REEL	3000pcs/reel
HGV8631M7/TR	SC70-5	V8631	REEL	3000pcs/reel
HGV8632M/TR	SOP-8L	V8632	REEL	2500pcs/reel
HGV8632MM/TR	MSOP-8L	V8632	REEL	2500pcs/reel
HGV8634M/TR	SOP-16L	HGV8634	REEL	2500pcs/reel
HGV8634MT/TR	TSSOP-16L	V8634	REEL	2500pcs/reel

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage, V+ to V- .....	7.5 V
Common-Mode Input Voltage .....	(-V <sub>S</sub> ) - 0.5 V to (+V <sub>S</sub> ) +0.5V
Storage Temperature Range.....	-65°C to +150°C
Junction Temperature.....	160°C
Operating Temperature Range.....	-55°C to +150°C
Package Thermal Resistance @ T <sub>A</sub> = 25°C	
SC70-5, θ <sub>JA</sub> .....	333°C/W
SOT23-5, θ <sub>JA</sub> .....	190°C/W
SO-8, θ <sub>JA</sub> .....	125°C/W
MSOP-8, θ <sub>JA</sub> .....	216°C/W
SO-16, θ <sub>JA</sub> .....	82°C/W
TSSOP-16, θ <sub>JA</sub> .....	105°C/W
Lead Temperature Range (Soldering 10 sec) .....	260°C
ESD Susceptibility	
HBM.....	1500V
MM.....	400V

**NOTES**

1. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification 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. Shengbang Micro-electronics 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.

## ELECTRICAL CHARACTERISTICS : $V_S = +5V$

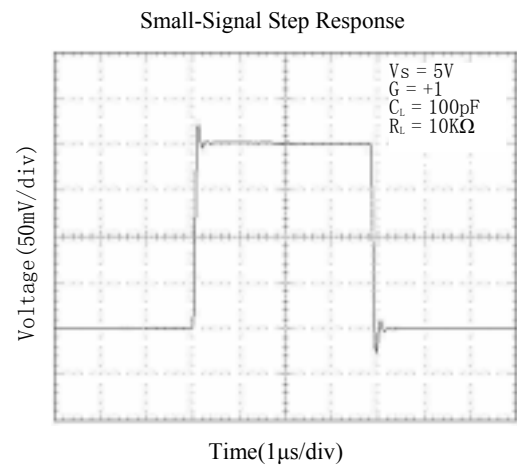
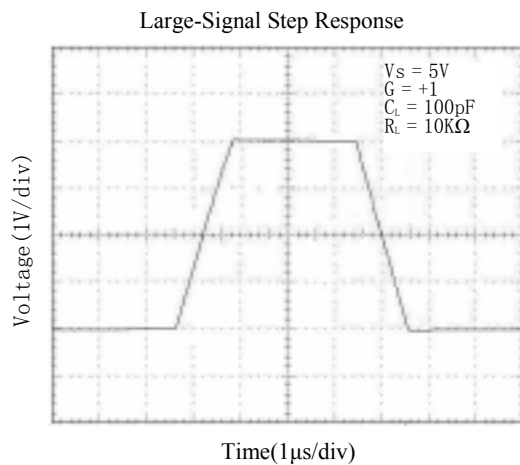
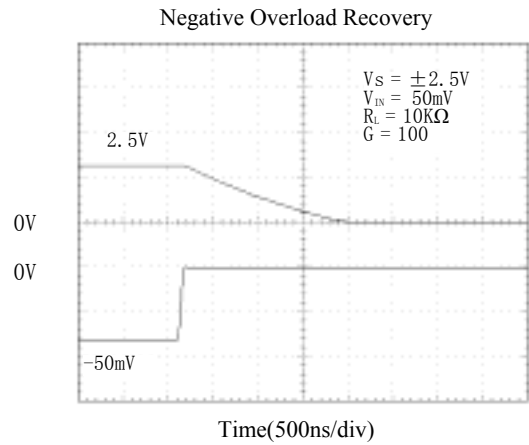
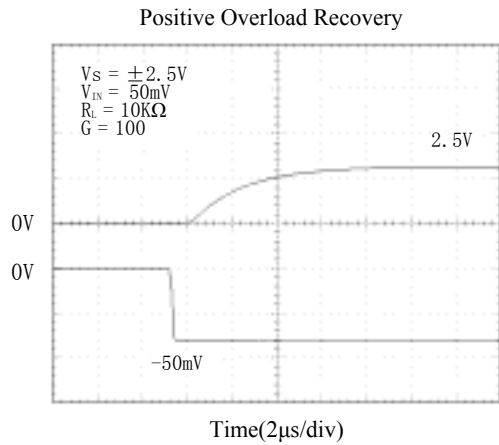
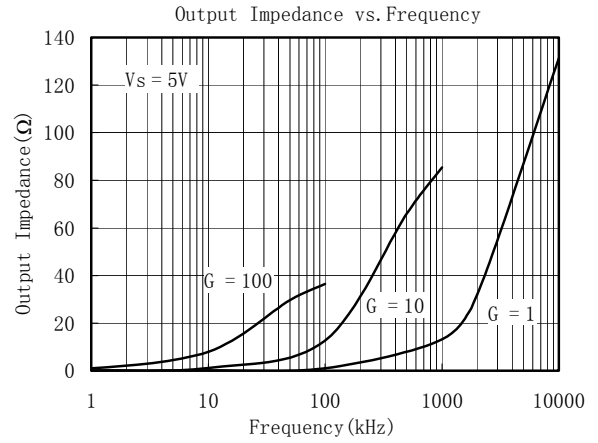
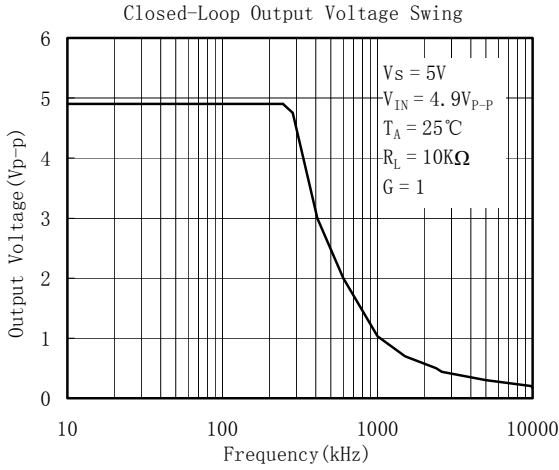
(At  $T_A = +25^\circ C$ ,  $V_{CM} = V_S/2$ ,  $R_L = 600\Omega$ , unless otherwise noted)

PARAMETER	CONDITION	HGV8631/2/4							
		TYP	MIN/MAX OVER TEMPERATURE					UNITS	MIN/MAX
		+25°C	+25°C	0°C to 70°C	-40°C to 85°C	-40°C to 125°C			
<b>INPUT CHARACTERISTICS</b>									
Input Offset Voltage ( $V_{OS}$ )		0.8	3.5	3.9	4.3	4.6	mV	MAX	
Input Bias Current ( $I_B$ )		1					pA	TYP	
Input Offset Current ( $I_{OS}$ )		1					pA	TYP	
Common-Mode Voltage Range ( $V_{CM}$ )	$V_S = 5.5V$	-0.1 to +5.6					V	TYP	
Common-Mode Rejection Ratio(CMRRR)	$V_S = 5.5V, V_{CM} = -0.1V$ to 4 V	90	75	74	74	73	dB	MIN	
	$V_S = 5.5V, V_{CM} = -0.1V$ to 5.6 V	83					dB	MIN	
Open-Loop Voltage Gain( $A_{OL}$ )	$R_L = 600\Omega, V_o = 0.15V$ to 4.85V	97	90	87	86	79	dB	MIN	
	$R_L = 10K\Omega, V_o = 0.05V$ to 4.95V	108					dB	MIN	
Input Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ )		2.4					$\mu V/^\circ C$	TYP	
<b>OUTPUT CHARACTERISTICS</b>									
Output Voltage Swing from Rail	$R_L = 600\Omega$	0.1					V	TYP	
	$R_L = 10K\Omega$	0.015					V	TYP	
Output Current ( $I_{OUT}$ )		53	49	45	40	35	mA	MIN	
Closed-Loop Output Impedance	$F = 200KHz, G = 1$	3					$\Omega$	TYP	
<b>POWER-DOWN DISABLE</b>									
Turn-On Time		4					$\mu s$	TYP	
Turn-Off Time		1.2					$\mu s$	TYP	
$\overline{DISABLE}$ Voltage-Off			0.8				V	MAX	
$\overline{DISABLE}$ Voltage-On			2				V	MIN	
<b>POWER SUPPLY</b>									
Operating Voltage Range			2.5	2.5	2.5	2.5	V	MIN	
			5.5	5.5	5.5	5.5	V	MAX	
Power Supply Rejection Ratio (PSRR)	$V_S = +2.5 V$ to + 5.5 V $V_{CM} = (-V_S) + 0.5V$	91	80	78	78	77	dB	MIN	
Quiescent Current/ Amplifier ( $I_Q$ )	$I_{OUT} = 0$	470	590	660	680	740	$\mu A$	MAX	
Supply Current when Disabled (SGM8633 only)		90					nA	MAX	
<b>DYNAMIC PERFORMANCE</b>									
Gain-Bandwidth Product (GBP)	$R_L = 10K\Omega$	6					MHz	TYP	
Phase Margin( $\phi_o$ )		60					degrees	TYP	
Full Power Bandwidth( $BW_F$ )	< 1% distortion, $R_L = 600\Omega$	250					KHz	TYP	
Slew Rate (SR)	$G = +1, 2V$ Step, $R_L = 10K\Omega$	3.7					V/ $\mu s$	TYP	
Settling Time to 0.1% ( $t_s$ )	$G = +1, 2 V$ Step, $R_L = 600\Omega$	2.1					$\mu s$	TYP	
Overload Recovery Time	$V_{IN} \cdot Gain = V_S, R_L = 600\Omega$	0.9					$\mu s$	TYP	
<b>NOISE PERFORMANCE</b>									
Voltage Noise Density ( $e_n$ )	$f = 1kHz$	12					$nV/\sqrt{Hz}$	TYP	
Current Noise Density( $i_n$ )	$f = 1kHz$	3					$fA/\sqrt{Hz}$	TYP	

Specifications subject to change without notice.

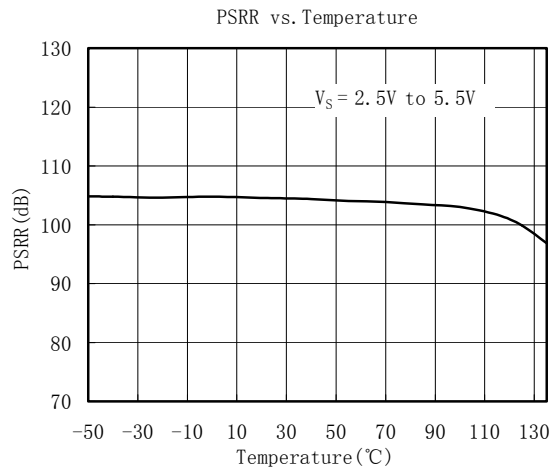
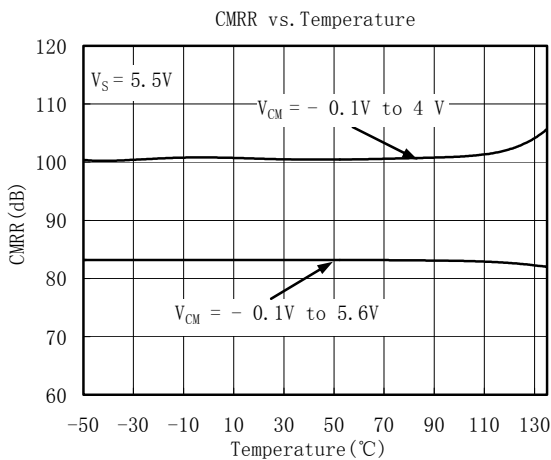
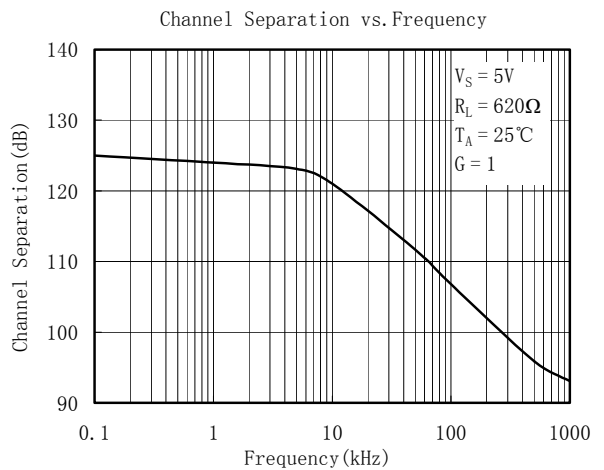
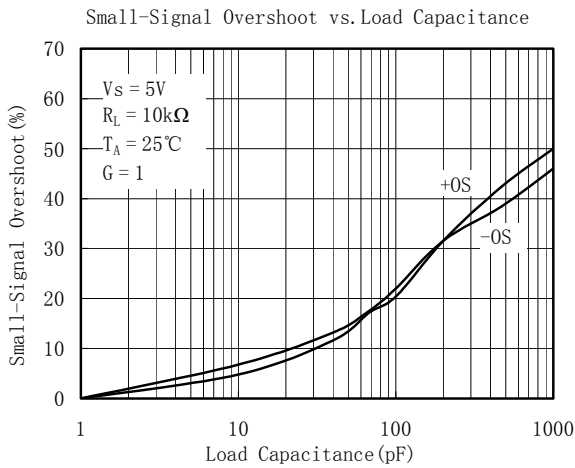
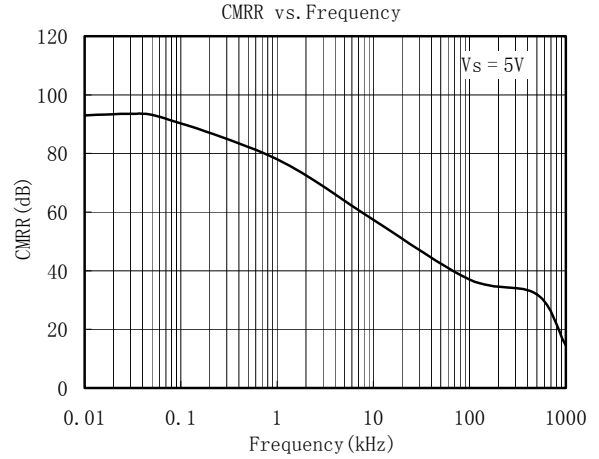
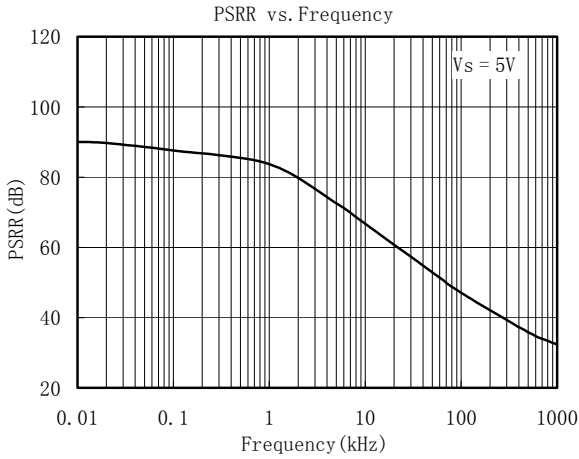
# TYPICAL PERFORMANCE CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_{CM} = V_S/2$ ,  $R_L = 600\Omega$ , unless otherwise noted.



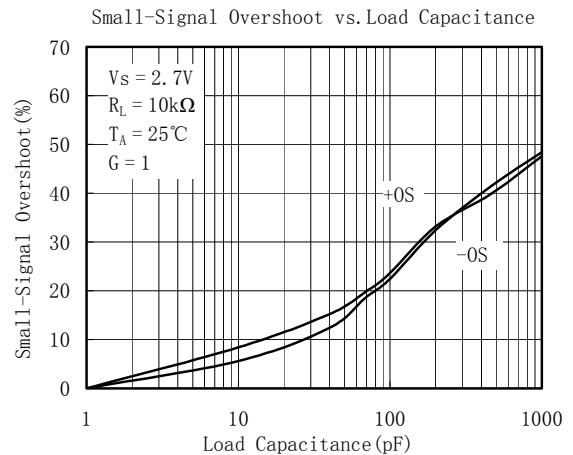
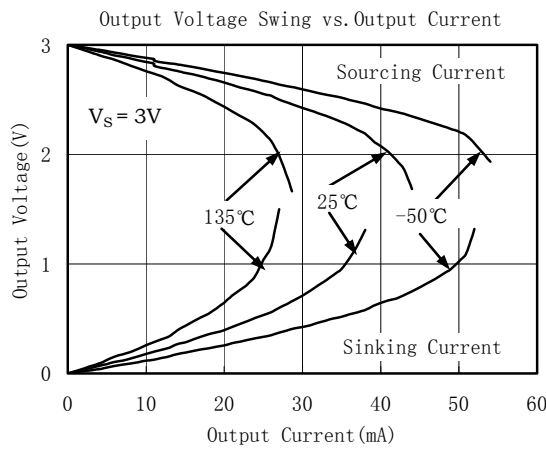
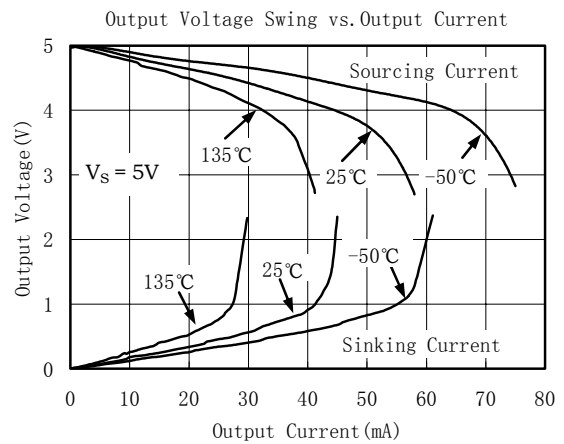
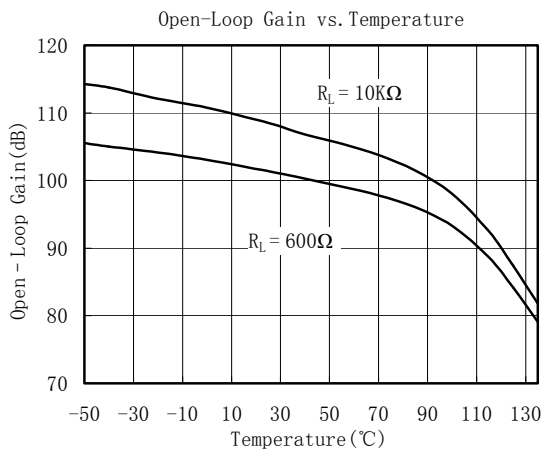
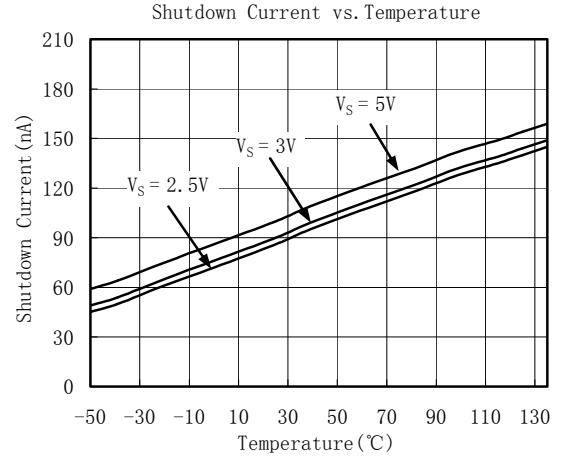
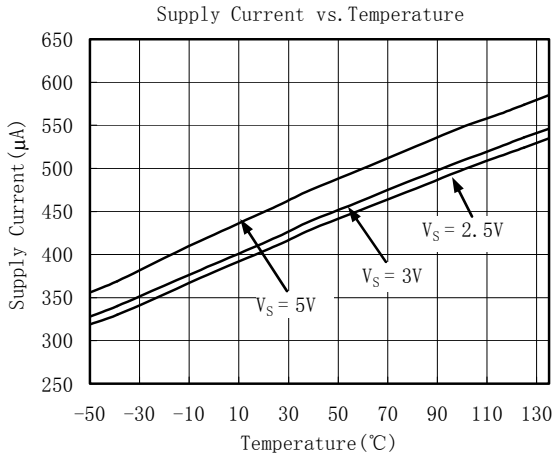
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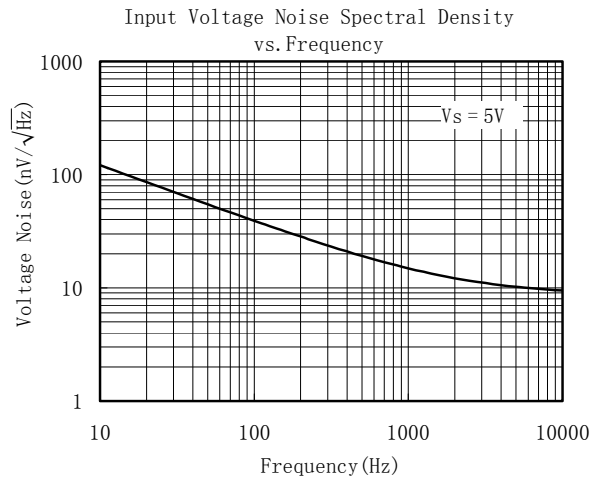
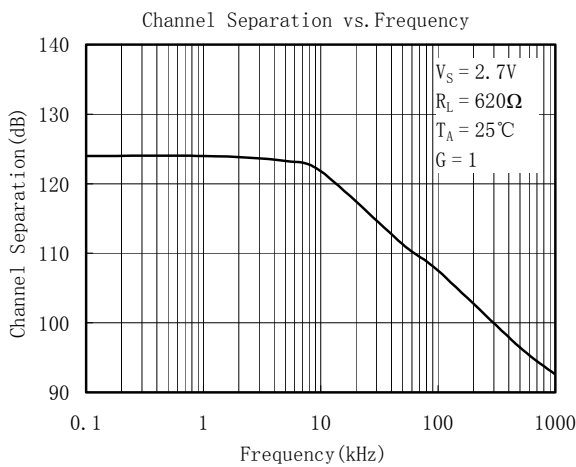
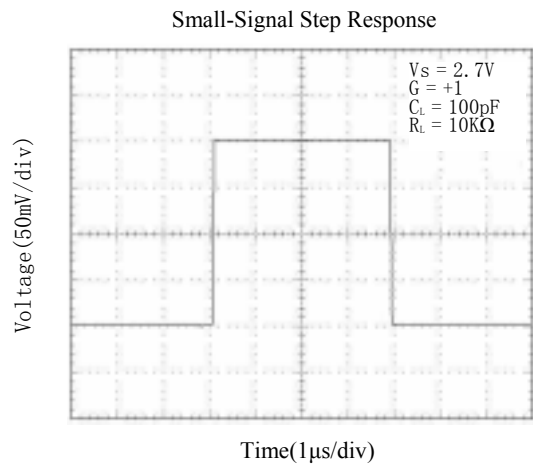
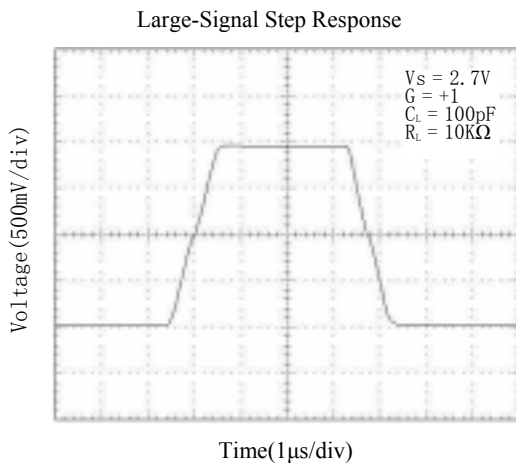
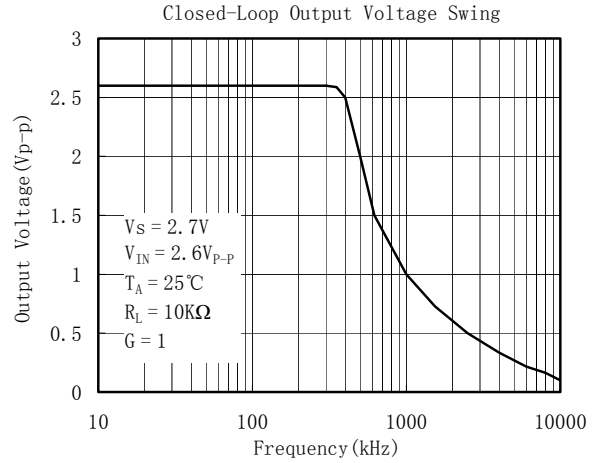
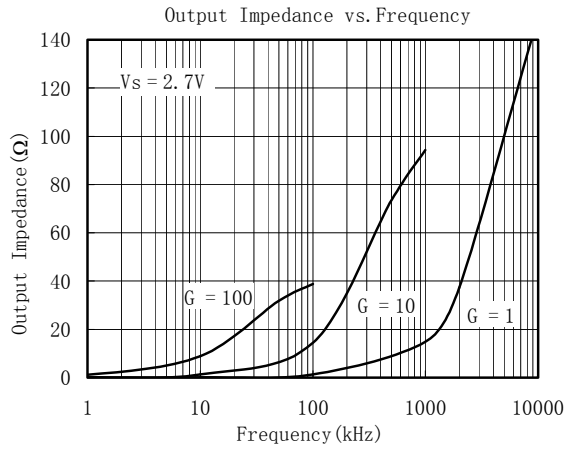
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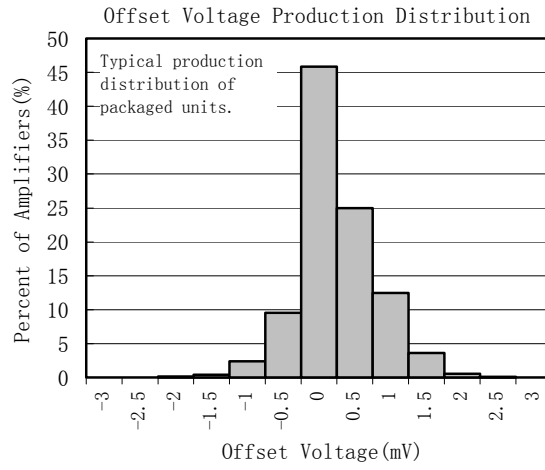
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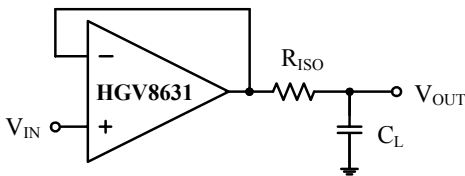




## APPLICATION NOTES

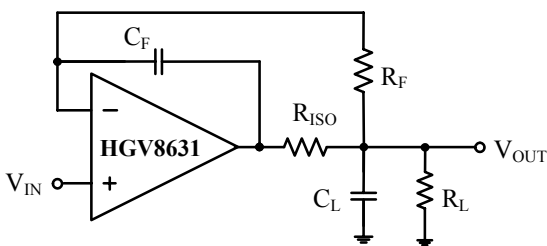
### Driving Capacitive Loads

The HGV863x can directly drive 1000pF 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 drive 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 improvement 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**

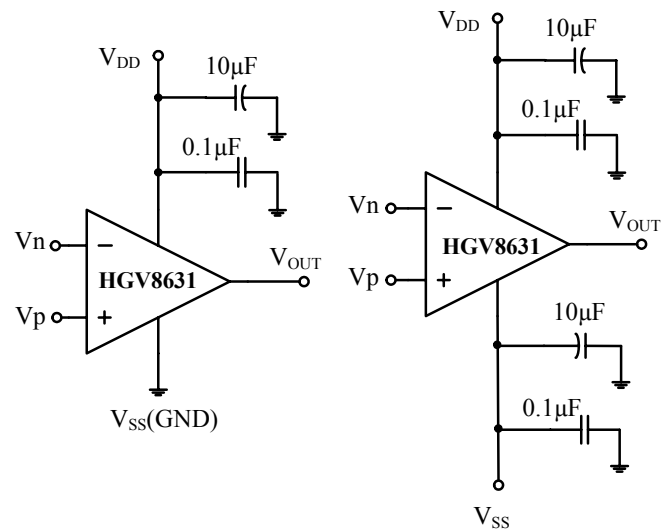
For no-buffer configuration, there are two others ways to increase the phase margin: (a) by increasing the amplifier's gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

### Power-Supply Bypassing and Layout

The HGV863x family operates from either a single +2.5V to +5.5V supply or dual  $\pm 1.25V$  to  $\pm 2.75V$  supplies. For single-supply operation, bypass the power supply  $V_{DD}$  with a  $0.1\mu F$  ceramic capacitor which should be placed close to the  $V_{DD}$  pin. For dual-supply operation, both the  $V_{DD}$  and the  $V_{SS}$  supplies should be bypassed to ground with separate  $0.1\mu F$  ceramic capacitors.  $2.2\mu F$  tantalum capacitor can be added for better performance.

Good PC board layout techniques optimize performance by decreasing the amount of stray capacitance at the op amp's inputs and output. To decrease stray capacitance, minimize trace lengths and widths by placing external components as close to the device as possible. Use surface-mount components whenever possible.

For the operational amplifier, soldering the part to the board directly is strongly recommended. Try to keep the high frequency big current loop area small to minimize the EMI (electromagnetic interfacing).



**Figure 3. Amplifier with Bypass Capacitors**

### Grounding

A ground plane layer is important for HGV863x circuit design. The length of the current path speed currents in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

### Input-to-Output Coupling

To minimize capacitive coupling, the input and output signal traces should not be parallel. This helps reduce unwanted positive feedback.

## Typical Application Circuits

### Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistors ratios are equal ( $R4 / R3 = R2 / R1$ ), then  $V_{OUT} = (Vp - Vn) \times R2 / R1 + Vref$ .

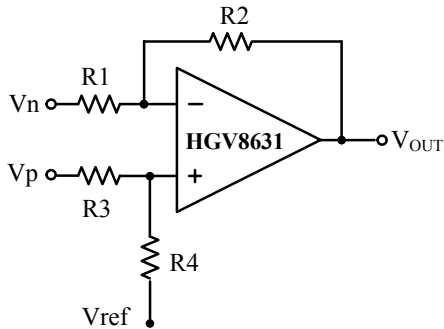


Figure 4. Differential Amplifier

### Instrumentation Amplifier

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

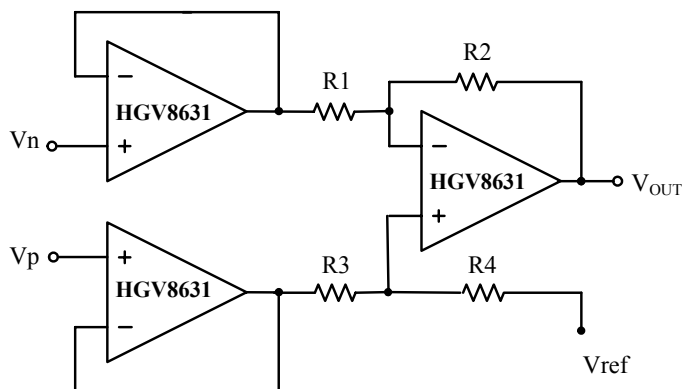


Figure 5. Instrumentation Amplifier

### Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of  $(-R2/R1)$  and the  $-3dB$  corner frequency is  $1/2\pi R2C$ . Make sure the filter 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 resistors value as low as possible and consistent with output loading consideration.

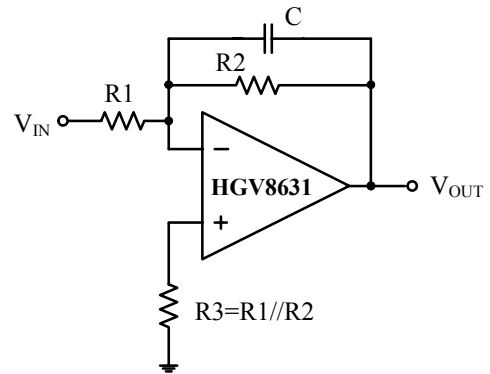
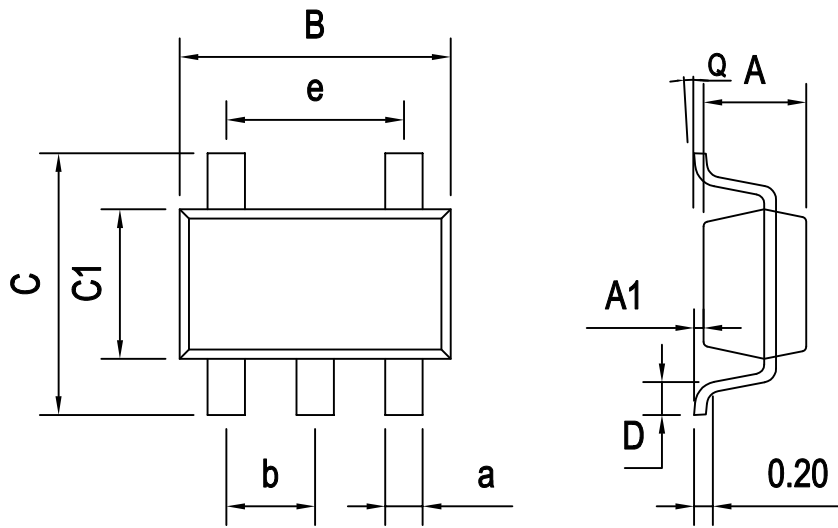


Figure 6. Low Pass Active Filter

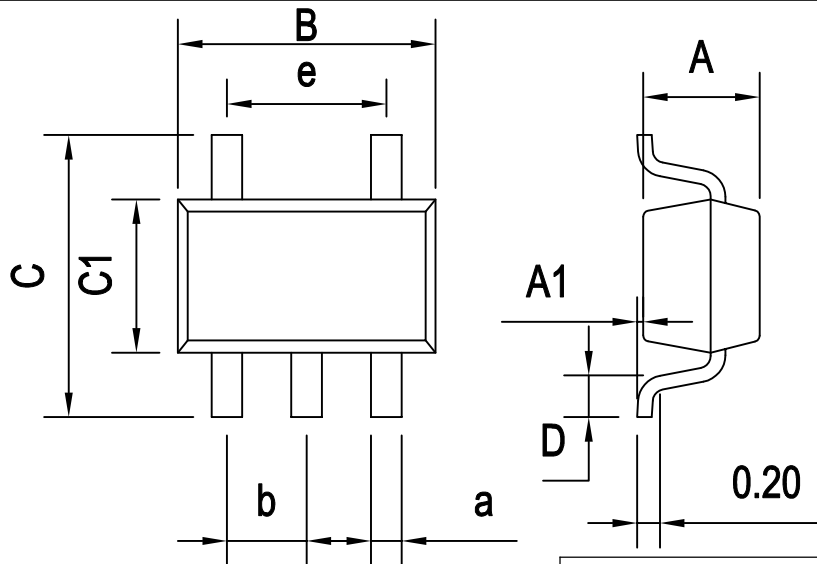
PACKAGE

SOT23-5



Dimensions In Millimeters					
Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	1.050	1.150	D	0.300	0.600
A1	0.000	0.100	Q	0°	8°
B	2.820	3.020	a	0.400 TYP	
C	2.650	2.950	b	0.950 TYP	
C1	1.500	1.700	e	1.900 TYP	

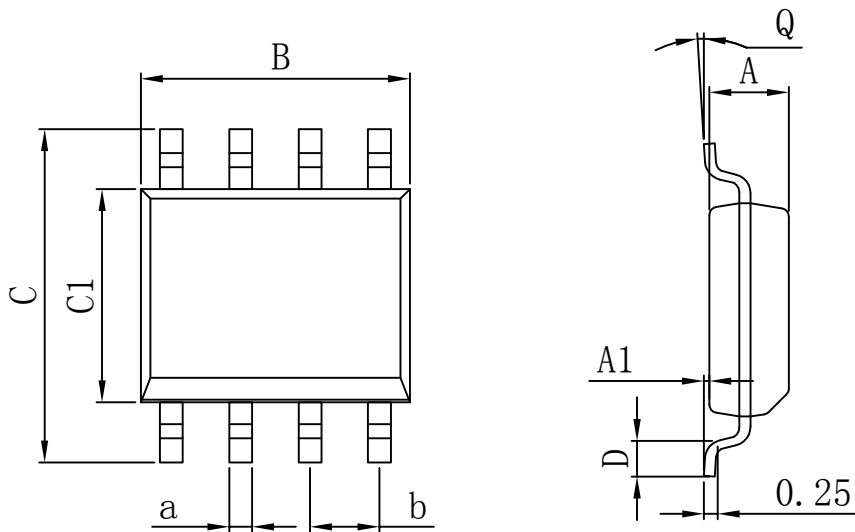
SC70-5



Dimensions In Millimeters					
Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	0.900	1.000	D	0.260	0.460
A1	0.000	0.100	Q	0°	8°
B	2.000	2.200	a	0.250 TYP	
C	2.150	2.450	b	0.650 TYP	
C1	1.150	1.350	e	1.300 TYP	

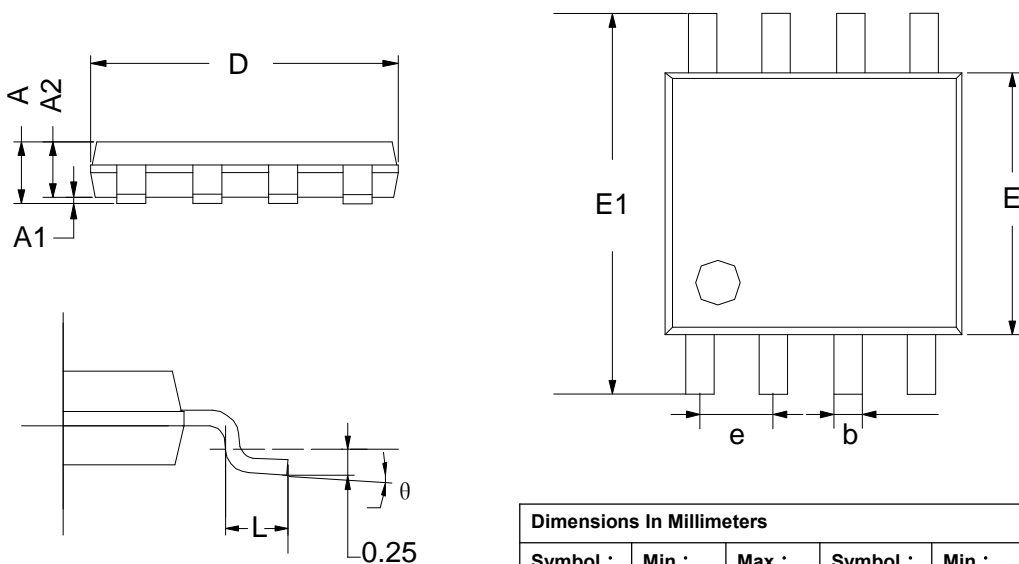
PACKAGE

SOP8



Dimensions In Millimeters					
Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	1.225	1.570	D	0.400	0.950
A1	0.100	0.250	Q	0°	8°
B	4.800	5.100	a	0.420 TYP	
C	5.800	6.250	b	1.270 TYP	
C1	3.800	4.000			

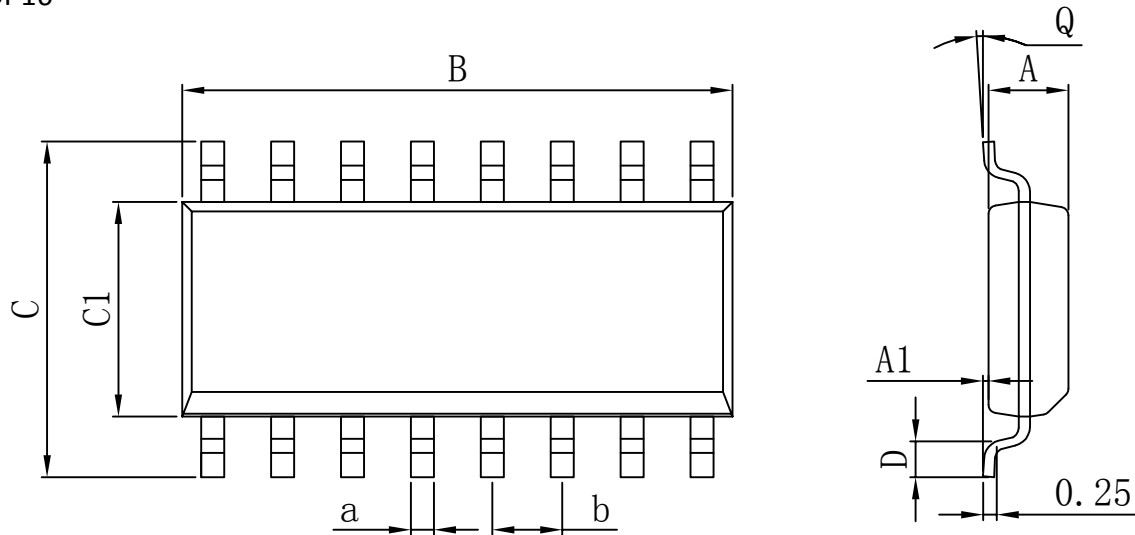
MSOP8



Dimensions In Millimeters					
Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	0.800	1.200	E1	4.700	5.100
A1	0	0.200	L	0.410	0.650
A2	0.760	0.970	θ	0°	6°
D	2.900	3.100	b	0.300 TYP	
E	2.900	3.100	e	0.650 TYP	

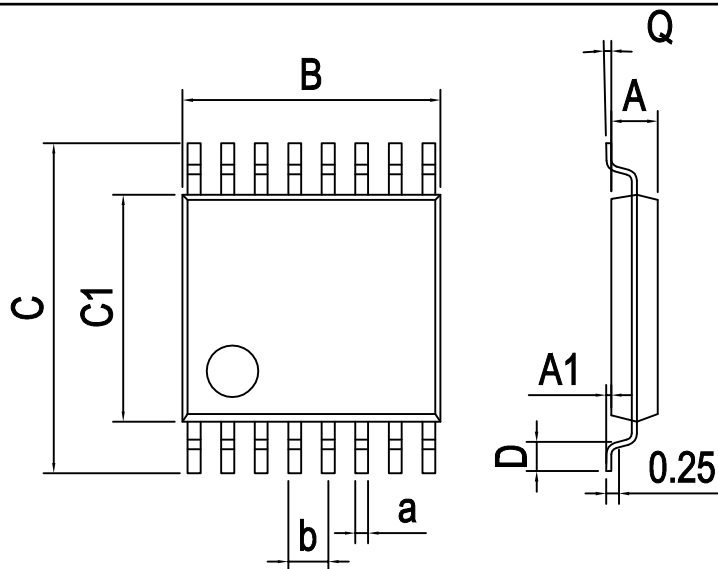
PACKAGE

SOP16



Dimensions In Millimeters					
Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	1.225	1.570	D	0.400	0.950
A1	0.100	0.250	Q	0°	8°
B	9.800	10.00	a	0.420 TYP	
C	5.800	6.250	b	1.270 TYP	
C1	3.800	4.000			

TSSOP16



Dimensions In Millimeters					
Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	0.800	1.000	D	0.400	0.850
A1	0.050	0.150	Q	0°	8°
B	4.900	5.100	a	0.240 TYP	
C	6.250	6.550	b	0.650 TYP	
C1	4.300	4.500			

Important statement:

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