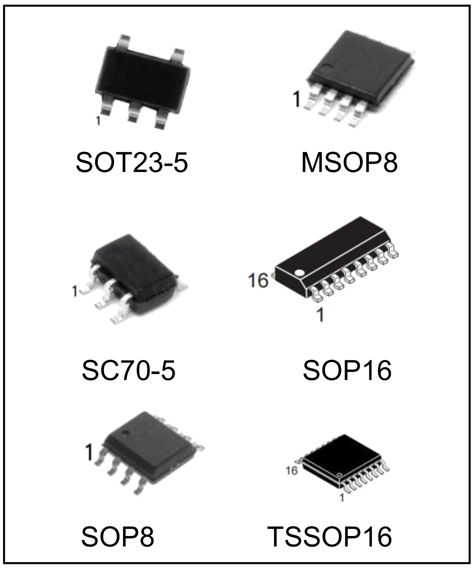
470μA, 6MHz, Rail-to-Rail I/O CMOS Operational Amplifier

FEATURES

- Low Cost
- Rail-to-Rail Input and Output 0.8mV Typical VOS
- 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 VS = 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 SOP-8
  HGV8634 Available in TSSOP-16 and SOP-16



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	SOP8	HGV8632	REEL	2500pcs/reel
HGV8632MM/TR	MSOP8	V8632	REEL	3000pcs/reel
HGV8634M/TR	SOP16	HGV8634	REEL	2500pcs/reel
HGV8634MT/TR	TSSOP16	HGV8634	REEL	2500pcs/reel

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 sp ecified over the extended industrial temperature range (−40°C to +125°C). The operating range is from 2.5V to 5.5V.

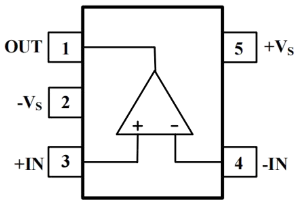
The single version HGV8631 is available in SC70-5, and SOT23-5 packages. The dual version HGV8632 is available in SOP-8 and MSOP-8 packages. The quad version HGV8634 is available in SOP-16 and TSSOP-16packages.

APPLICATIONS

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

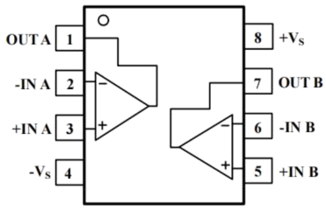
PIN CONFIGURATIONS (Top View)

HGV8631



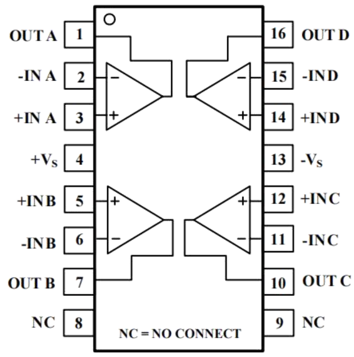
SOT23-5 / SC70-5

HGV8632



SO-8 / MSOP-8

HGV8634



TSSOP-16 / SO-16

ABSOLUTE MAXIMUM RATINGS

RATING		VALUE	UNIT
Supply Voltage,V+to V-		7.5	V
Common-Mode Input Voltage		(-Vs)-0.5 to (+Vs)+0.5	V
Storage Temperature Range		-60 to +150	℃
Junction Temperature		160	℃
Operating Temperature Range		-55 to+150	℃
Package Thermal Resistance @ TA=25℃	SC70-5,θJA	333	℃/W
	SOT23-5,θJA	190	℃/W
	SO-8,θJA	125	℃/W
	MSOP-8,θJA	216	℃/W
	SO-16,θJA	82	℃/W
	TSSOP-16,θJA	105	℃/W
Lead Temperature Range(Soldering 10 sec)		260	℃
ESD Susceptibility	HBM	1500	V
	MM	400	V

NOTES：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.

ELECTRICAL CHARACTERISTICS :VS = +5V

(At TA = +25℃,VCM = Vs/2, RL = 600Ω, unless otherwise noted)

PARAMETER	CONDITION	HGV8631/2/4 TYP	MIN/MAX OVER TEMPERATURE					
		+25℃	+25℃	0℃ to 70℃	-40℃ to 85℃	-40℃ to 125℃	UNITS	MIN /MAX
INPUT CHARACTERISTICS								
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(CMRR)	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 = 600Ω , Vo = 0.15V to 4.85V	97	90	87	86	79	dB	MIN
	R_L =10KΩ , Vo = 0.05V to 4.95V	108					dB	MIN
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta_T$)		2.4					μV/℃	TYP
OUTPUT CHARACTERISTICS								
Output Voltage Swing from Rail	R_L = 600Ω	0.1					V	TYP
	R_L = 10KΩ	0.015					V	
Output Current (I_{OUT})		53	49	45	40	35	mA	MIN
Closed-Loop Output Impedance	F = 200KHz, G = 1	3					Ω	TYP
POWER-DOWN DISABLE								
Turn-On Time		4					μs	TYP
Turn-Off Time		1.2					μs	TYP
$\overline{DISABLE}$ Voltage-Off			0.8				V	MAX
$\overline{DISABLE}$ Voltage-On			2				V	MIN
POWER SUPPLY								
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)	Vs=2.5V to+5.5V							
	V_{CM}=(-VS)+0.5V	91	80	78	78	77	dB	MIN
Quiescent Current/ Amplifier (I_Q)	I_{OUT}=0	470	590	660	680	740	μA	MAX
Supply Current when Disabled								
(SGM8633 only)		90					nA	MAX

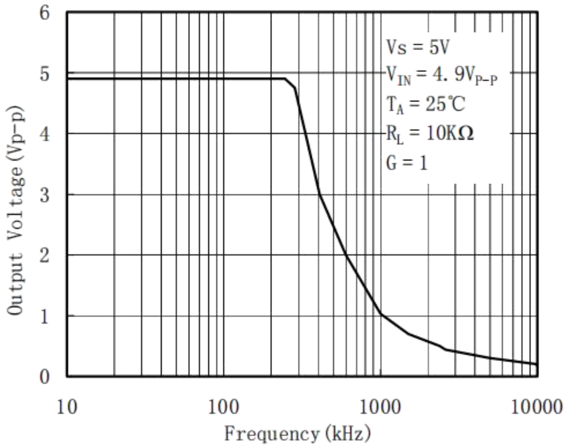
DYNAMIC PERFORMANCE								
Gain-Bandwidth Product (GBP)	R_L = 10KΩ	6					MH z	TYP
Phase Margin(φ_O)		60					degrees	TYP
Full Power Bandwidth(BW_P)	＜1% distortion, R_L = 600Ω	250					KHz	TYP
Slew Rate (SR)	G = +1 , 2V Step, R_L = 10KΩ	3.7					V/μs	TYP
Settling Time to 0.1%(t_S)	G = +1, 2 V Step, R_L = 600Ω	2.1					μs	TYP
Overload Recovery Time	V_{IN} ·Gain = Vs, R_L = 600Ω	0.9					μs	TYP
NOISE PERFORMANCE								
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.

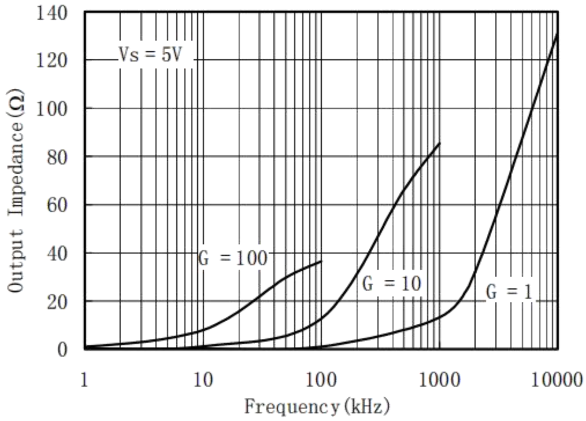
TYPICAL PERFORMANCE CHARACTERISTICS

At TA = +25℃,VCM = Vs/2, RL = 600Ω, unless otherwise noted.

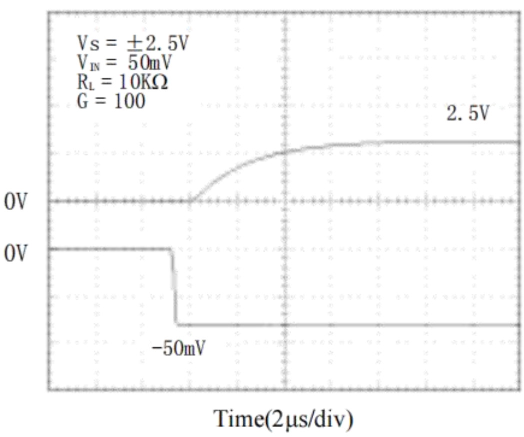
Closed-Loop Output Voltage Swing



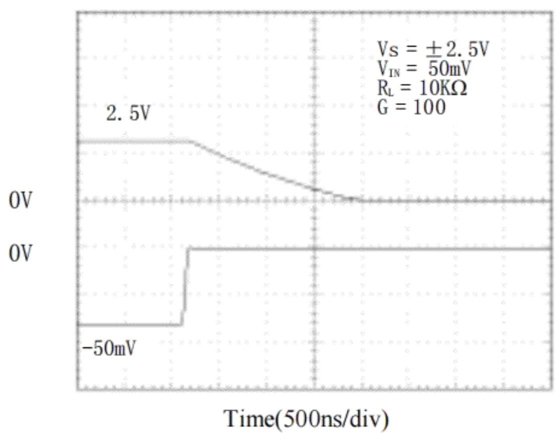
Output Impedance vs. Frequency



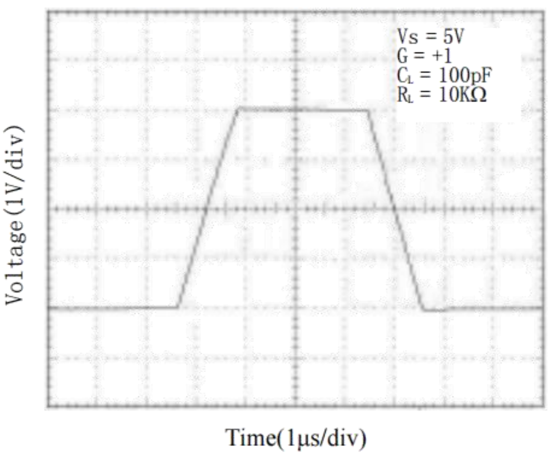
Positive Overload Recovery



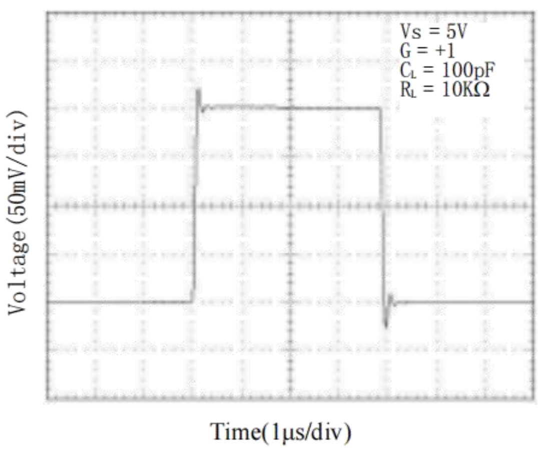
Negative Overload Recovery



Large-Signal Step Response

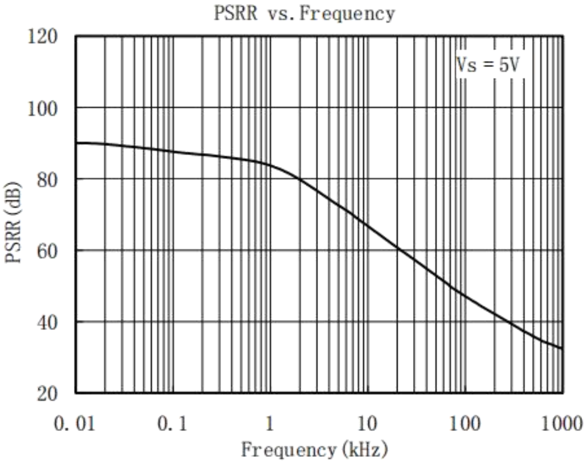


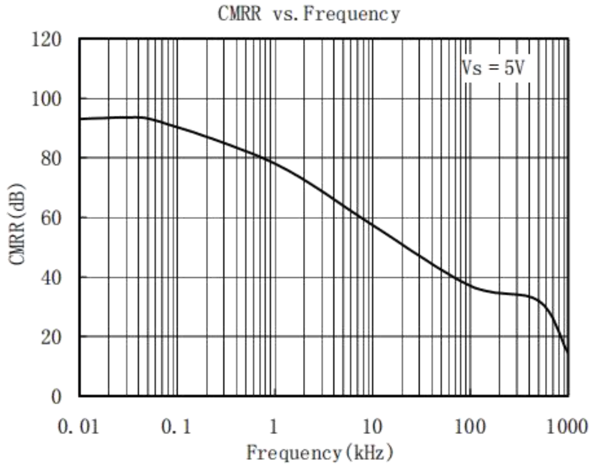
Small-Signal Step Response

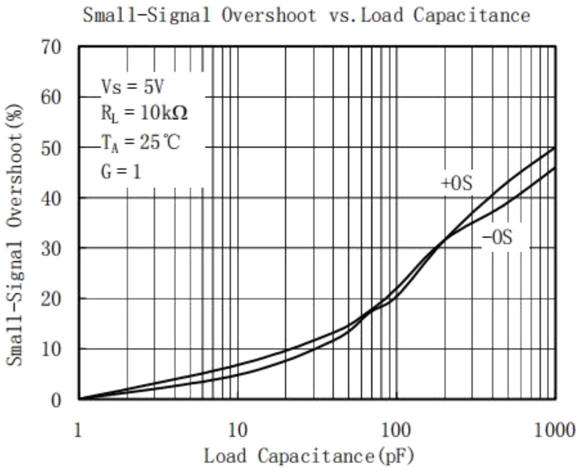


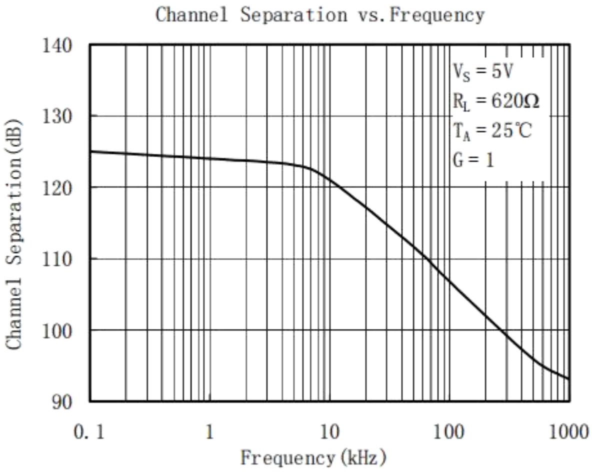
TYPICAL PERFORMANCE CHARACTERISTICS

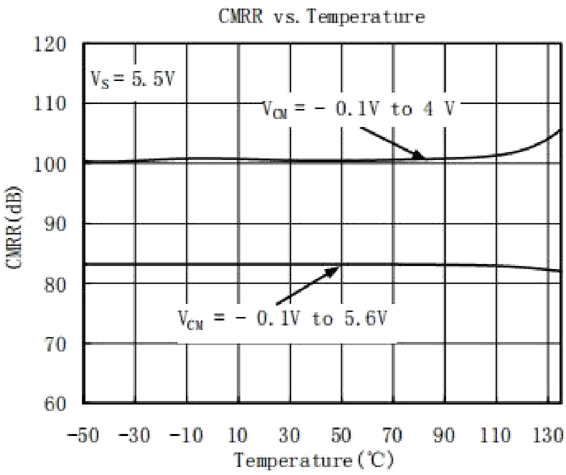
At TA = +25℃,VCM = Vs/2, RL = 600Ω, unless otherwise noted.

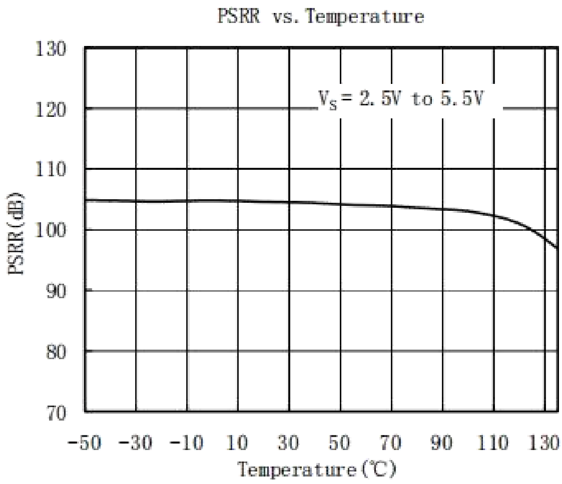












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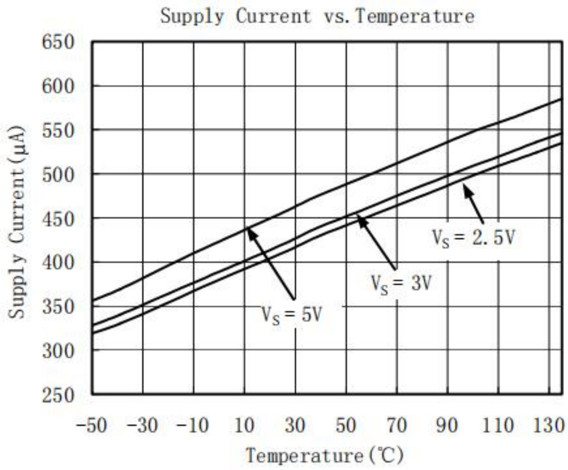
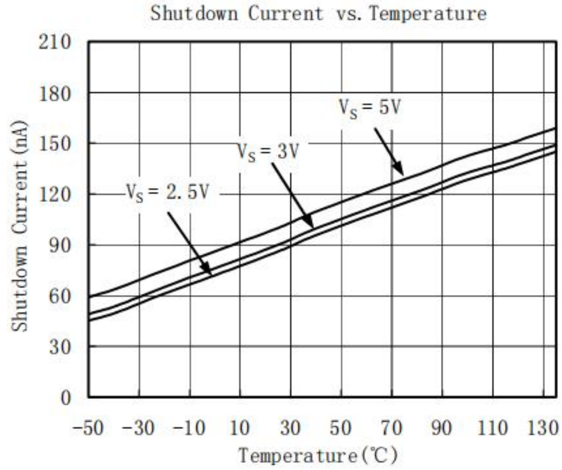
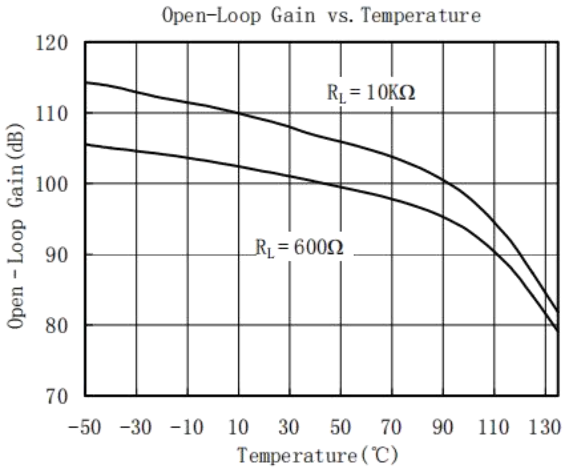
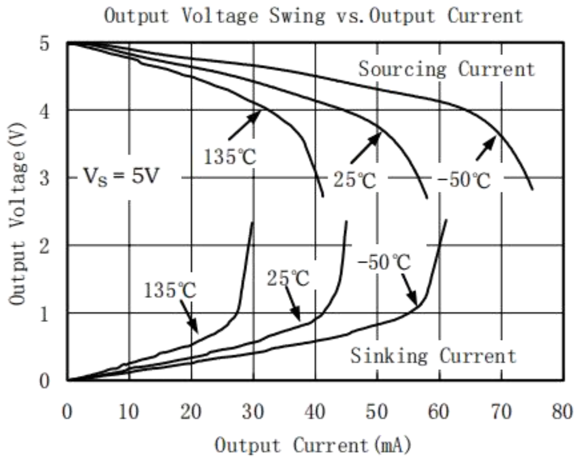
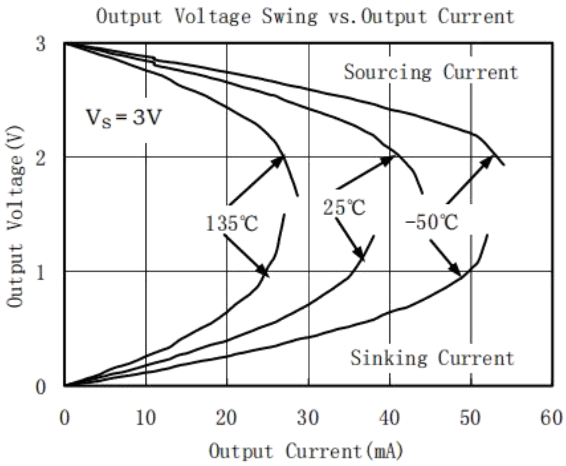
At TA = +25℃,VCM = Vs/2, RL = 600Ω, unless otherwise noted

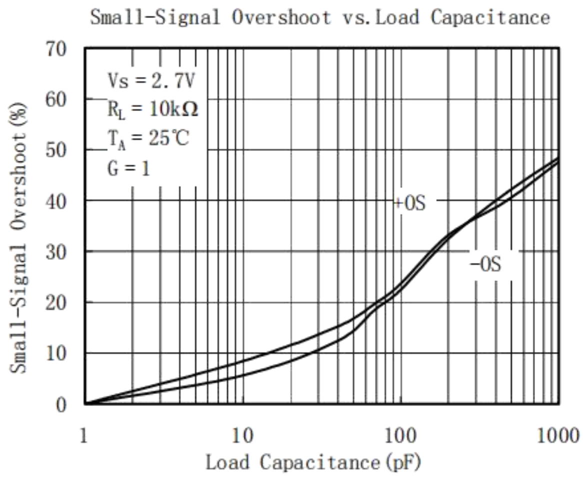






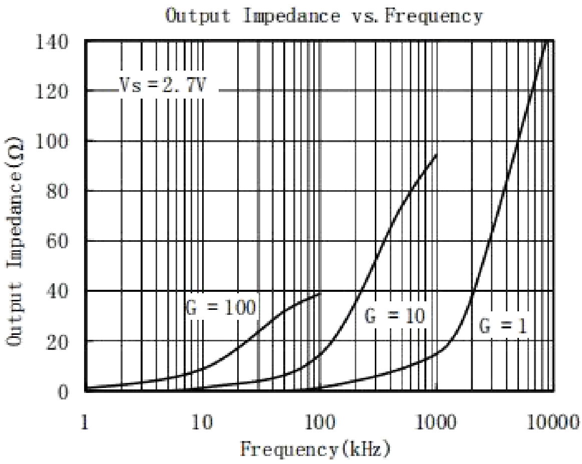


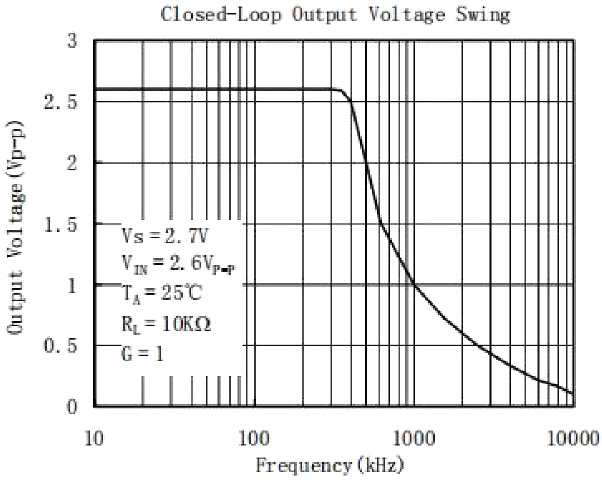


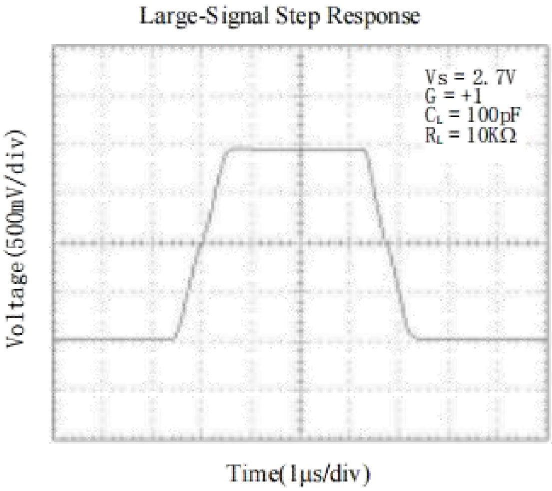


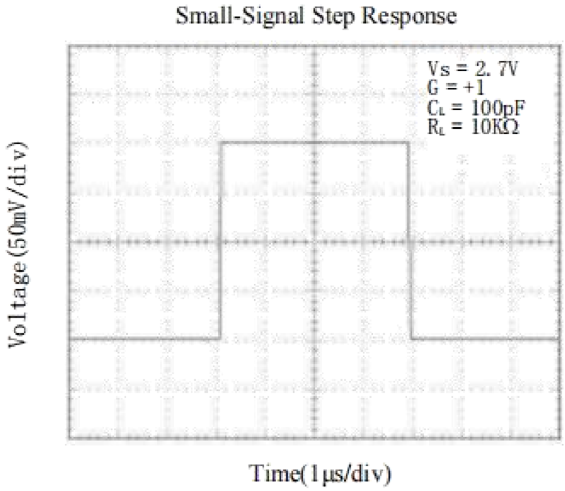
TYPICAL PERFORMANCE CHARACTERISTICS

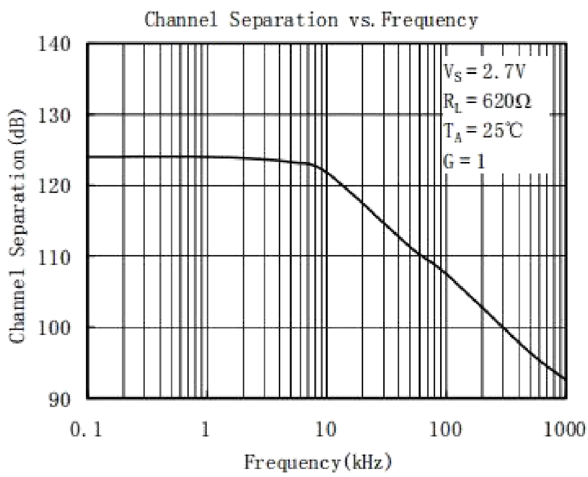
At TA = +25℃,VCM = Vs/2, RL = 600Ω, unless otherwise noted.

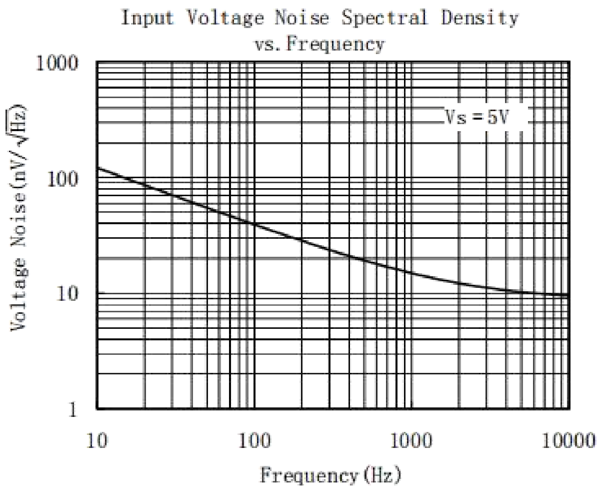












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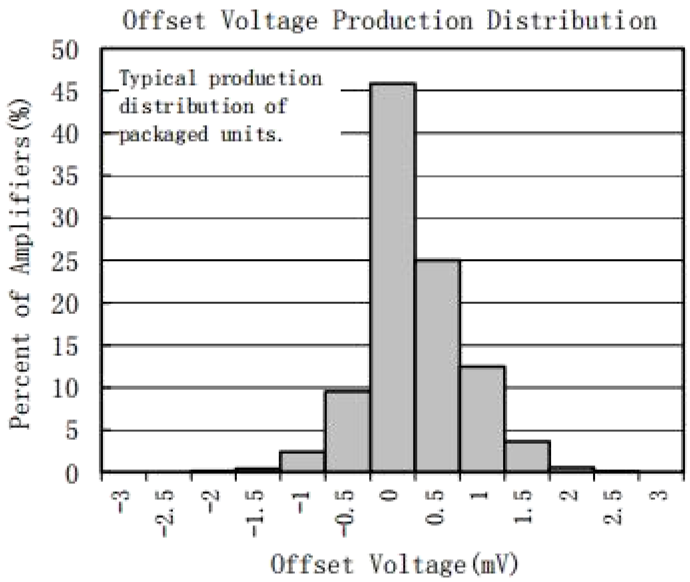


APPLICATION NOTES

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 Figure 1. The isolation resistor RISO and the load capacitor CL form a zero to increase stability. The bigger the RISO resistor value, the more stable VOUT will be. Note that this method results in a loss of gain accuracy because RISO forms a voltage divider with the RLOAD

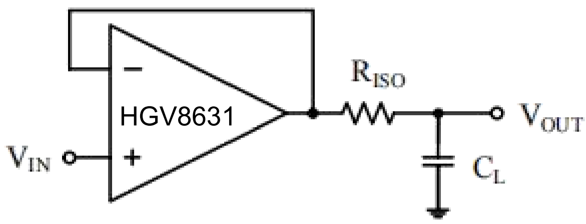


Figure 1. Indirectly Driving Heavy Capacitive Load

An improvement circuit is shown in Figure 2. It provides DC accuracy as well as AC stability. RF provides the DC accuracy by connecting the inverting signal with the output. CF and RIso 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.

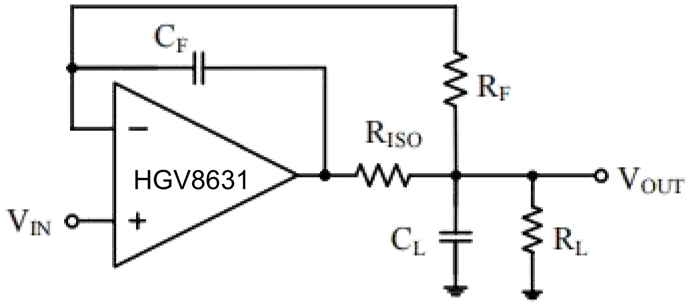


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

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 ±1.25V to ±2.75V supplies. For single-supply operation, bypass the power supply VDD with a 0.1μF ceramic capacitor which should be placed close to the VDD pin. For dual-supply operation, both the VDD and the VSS supplies should be bypassed to ground with separate 0.1μF ceramic capacitors. 2.2μF 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 operatio nal 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).

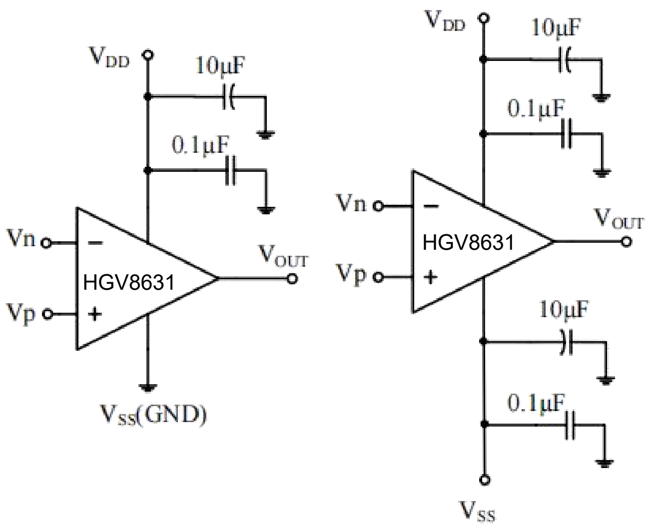


Figure 3. Amplifier with Bypass Capacitors

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 VOUT = (Vp – Vn) × R2 / R1 + Vref.

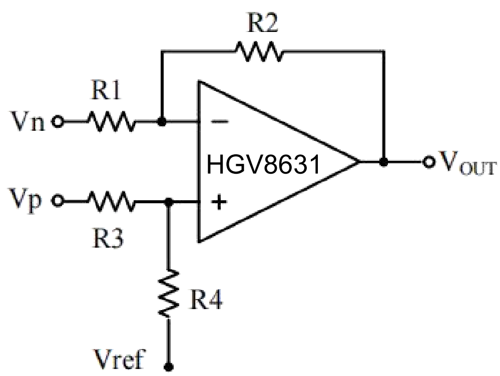


Figure 4. Differential Amplifier

Instrumentation Amplifier

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

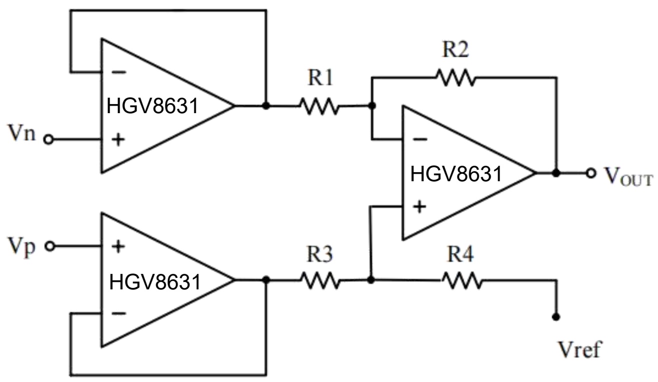


Figure 5. Instrumentation Amplifier

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 1/2πR2C. 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.

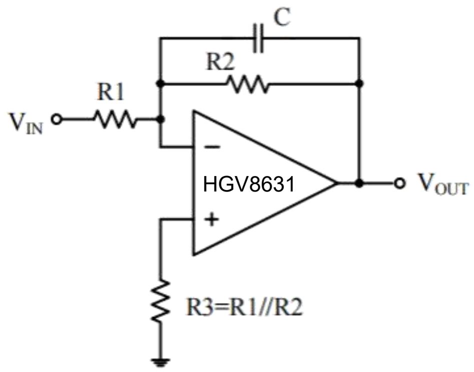
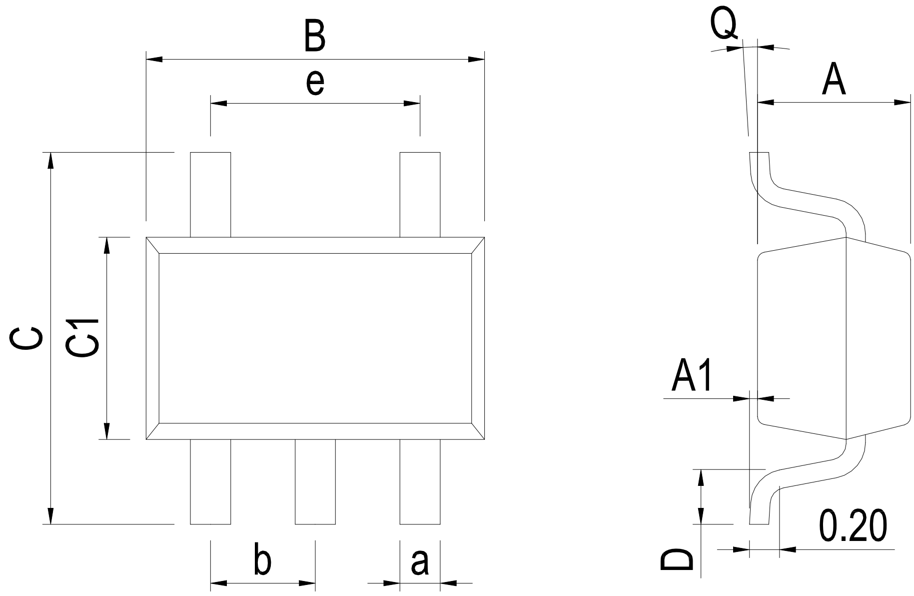


Figure6.LOW Pass Active Filter

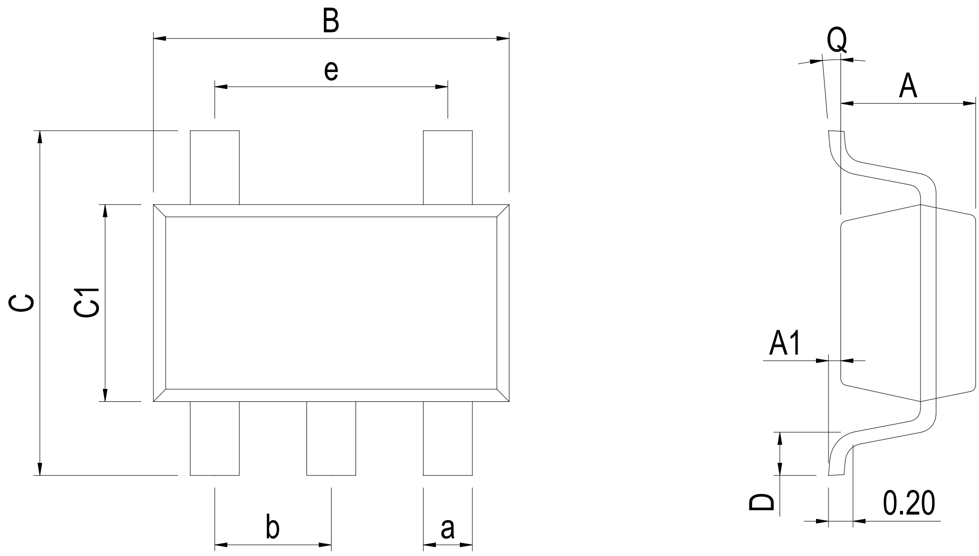
Physical Dimensions

SOT23-5



Dimensions In Millimeters(SOT23-5)										
Symbol:	A	A1	B	C	C1	D	Q	a	b	e
Min:	1.05	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°	0.40		

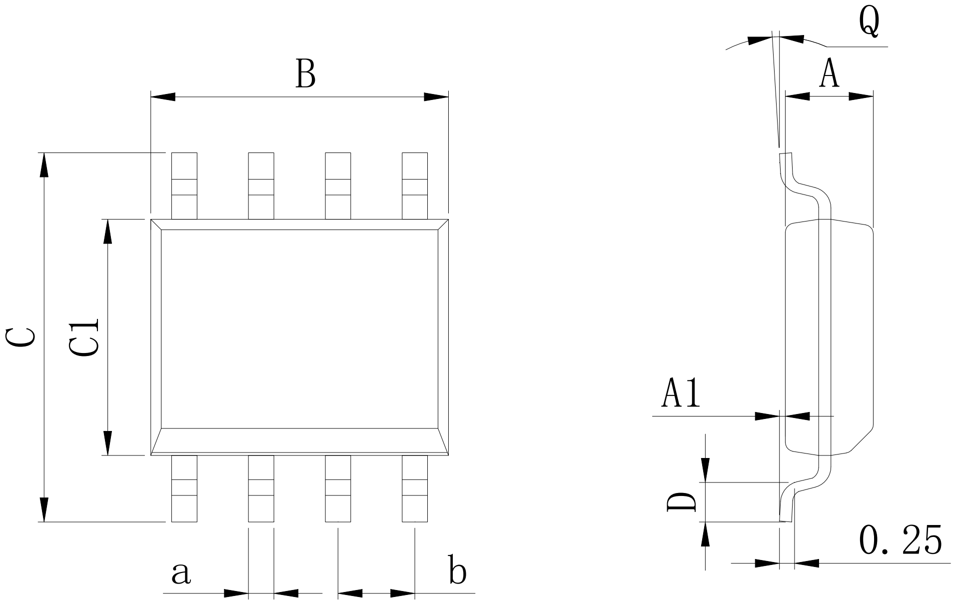
SC70-5



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°	0.30	0.65 BSC	1.30 BSC
Max:	1.00	0.15	2.20	2.45	1.35	0.46	8°	0.40		

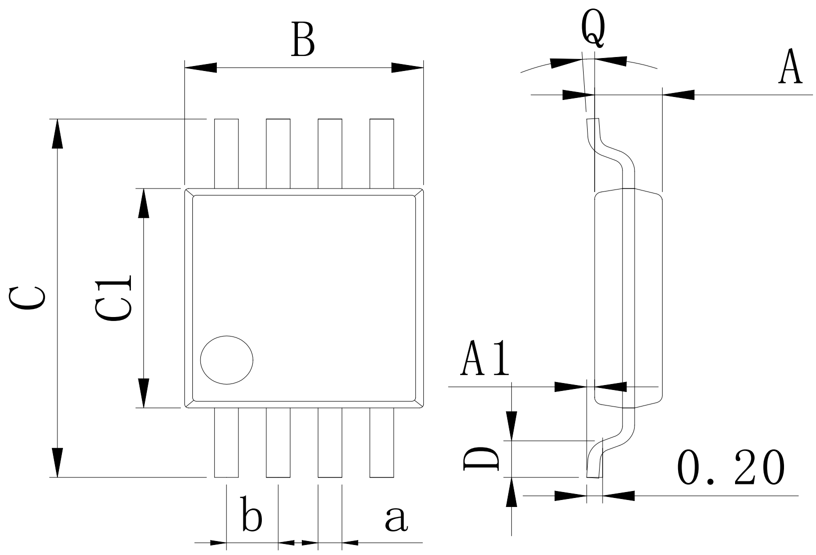
Physical Dimensions

SOP8



Dimensions In Millimeters(SOP8)									
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	

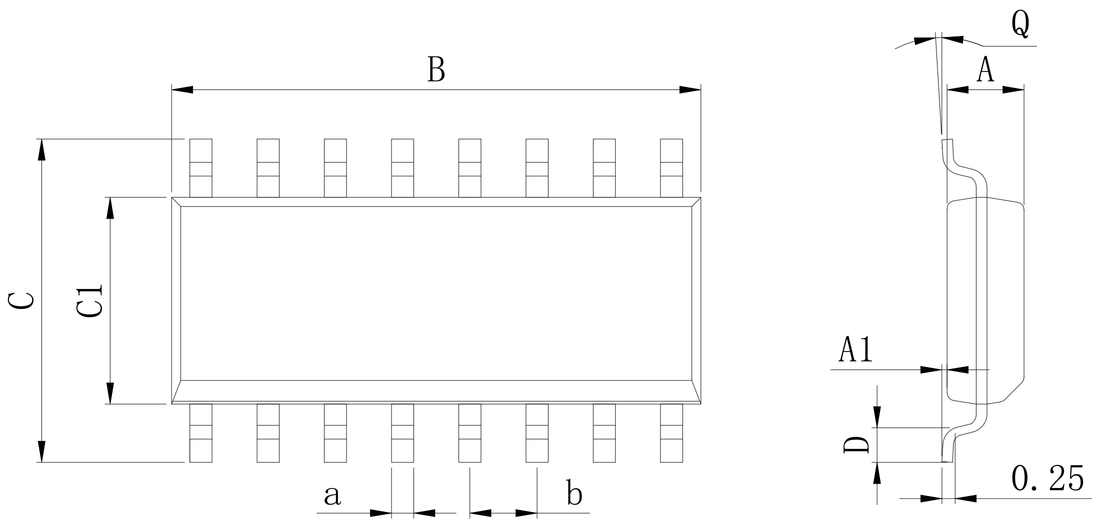
MSOP8



Dimensions In Millimeters(MSOP8)									
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	

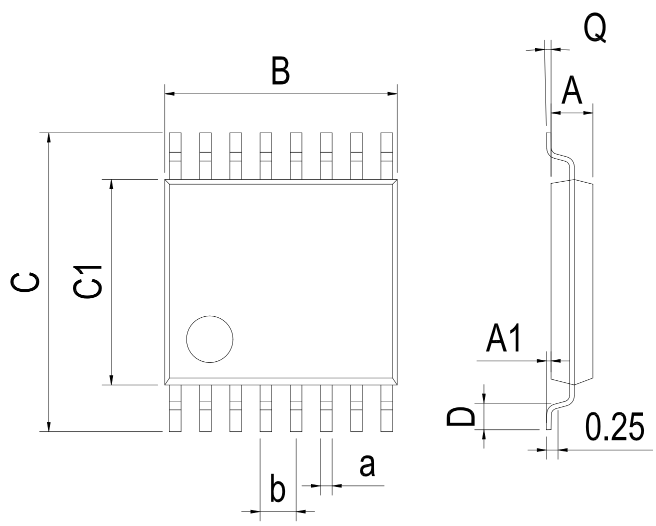
Physical Dimensions

SOP16



Dimensions In Millimeters(SOP16)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	9.80	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	10.0	6.20	4.00	0.80	8°	0.45	

TSSOP16



Dimensions In Millimeters(TSSOP16)									
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	

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