

## HX602-S

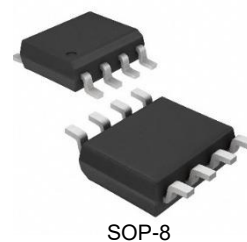
### Micro-Power 1 MHz, Low-Noise, RRIO, 2.7V CMOS Amplifiers

#### General Description

The HX602-S family of operational amplifiers, including single-, dual-, and quad-channel options, is specifically designed for cost-sensitive systems and applications. These amplifiers feature rail-to-rail input and output swings, low quiescent current (typically 100  $\mu\text{A}$ ), wide bandwidth (1 MHz), and very low noise (25 nV/  $\sqrt{\text{Hz}}$  at 1 kHz), making them highly suitable for battery-powered applications that require a balance between cost and performance. Examples of such applications include audio outputs, consumer electronics, smoke detectors, portable medical devices, and white goods. The low input bias current allows these amplifiers to be used with high impedance sources.

The robust design of the HX602-S amplifiers offers ease-of-use for circuit designers, with unity-gain stability even with capacitive loads up to 500 pF, integrated RF/EMI rejection filter, no phase reversal in overdrive conditions, and high electro-static discharge (ESD) protection (5-kV HBM).

The HX602-S amplifiers are optimized for operation at voltages ranging from +2.7 V ( $\pm 0.9$  V) to +5.5 V ( $\pm 2.75$  V) within a temperature range of 0  $^{\circ}\text{C}$  to 70  $^{\circ}\text{C}$ . They can also operate at voltages from +2.0 V ( $\pm 1.0$  V) to +5.5 V ( $\pm 2.75$  V) over an extended temperature range of -40  $^{\circ}\text{C}$  to +125  $^{\circ}\text{C}$ .



SOP-8

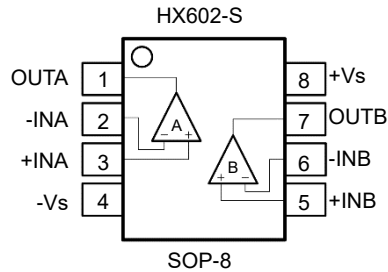
#### Features

- Rail-to-Rail Input and Output
- Low Input Offset Voltage: 0.5 mV
- Precision Amplifiers for Cost-Sensitive Systems
- Single 2.7 V to 5.5 V Supply Voltage Range at 0  $^{\circ}\text{C}$  to 70  $^{\circ}\text{C}$
- Extended Temperature Range: -40 $^{\circ}\text{C}$  to +125 $^{\circ}\text{C}$
- Low Noise: 25 nV/ $\sqrt{\text{Hz}}$  at 1 kHz
- Micro-Power: 100  $\mu\text{A}$  Supply Current Per Amplifier
- Internal RF/EMI Filter
- 1 MHz GBW for Unity-Gain Stable

#### Applications

- Sensor Signal Conditioning  
Sensor Interfaces, Loop-Powered, Active Filters
- Wireless Sensors  
Home Security, Remote Sensing, Wireless Metering
- Battery-Powered Instruments  
Consumer, Industrial, Medical, Notebooks
- Audio Outputs

## PIN CONFIGURATIONS



### Pin Description

Symbol	Description
-IN	Inverting input of the amplifier. The voltage range is from ( $V_{S-} - 0.1V$ ) to ( $V_{S+} + 0.1V$ ).
+IN	Non-inverting input of the amplifier. This pin has the same voltage range as -IN.
+Vs	Positive power supply.
-Vs	Negative power supply.
OUT	Amplifier output.

### Limiting Value

Parameter	Absolute Maximum Rating
Supply Voltage, $V_{S+}$ to $V_{S-}$	10.0 V
Signal Input Terminals: Voltage, Current	$V_{S-} - 0.5V$ to $V_{S+} + 0.5V$ , $\pm 10mA$
Output Short-Circuit	Continuous
Storage Temperature Range, $T_{stg}$	$-65^{\circ}C$ to $+150^{\circ}C$
Junction Temperature, $T_J$	$150^{\circ}C$
Lead Temperature Range (Soldering 10 sec)	$260^{\circ}C$

### Electrical Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
OFFSET VOLTAGE						
V <sub>OS</sub>	Input offset voltage			±0.5	±2.5	mV
		T <sub>A</sub> = -40 to +125 °C			±2.8	
V <sub>OS TC</sub>	Offset voltage drift	T <sub>A</sub> =-40 to +125 °C		±1	3	µV/°C
P <sub>SRR</sub>	Power supply rejection ratio	V <sub>S</sub> = 2.0 to 5.5 V, V <sub>CM</sub> < V <sub>S</sub> + -2V	80	110		dB
		T <sub>A</sub> = -40 to +125 °C	75			
INPUT BIAS CURRENT						
I <sub>B</sub>	Input bias current			20		fA

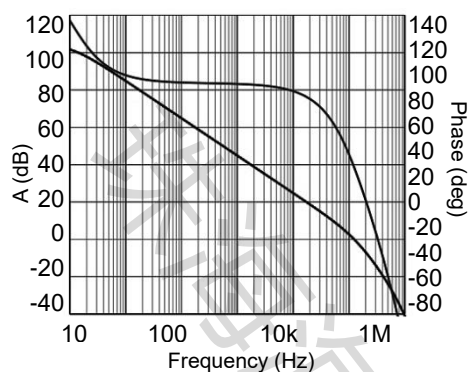
I <sub>OS</sub>	Input offset current			1		
NOISE						
V <sub>n</sub>	Input voltage noise	f = 0.1 to 10 Hz		5.6		μVP-P
e <sub>n</sub>	Input voltage noise density	f = 10 kHz		22		nV/√Hz
		f = 1 kHz		25		
I <sub>n</sub>	Input current noise density					
INPUT VOLTAGE						
V <sub>CM</sub>	Common-mode voltage range		V <sub>S</sub> -0.1		V <sub>S</sub> +0.1	V
CMRR	Common-mode rejection ratio	V <sub>S</sub> = 5.5 V, V <sub>CM</sub> = -0.1 to 5.6 V	70	83		dB
		V <sub>CM</sub> =0to5.3V,T <sub>A</sub> =-40 to +125℃	65			
		V <sub>S</sub> = 2.0 V, V <sub>CM</sub> = -0.1 to 2.1 V	65	77		
		V <sub>CM</sub> =0 to 2.7V,T <sub>A</sub> =-40to +125℃	60			
INPUT IMPEDANCE						
C <sub>IN</sub>	Input capacitance	Differential		2.0		pF
		Common mode		3.5		
OPEN-LOOP						
A <sub>VOL</sub>	Open-loop voltage A <sub>VOL</sub> gain	R <sub>L</sub> = 25 kΩ, V <sub>O</sub> = 0.05 to 3.5 V	90	105		dB
		T <sub>A</sub> = -40 to +125℃	85			
		R <sub>L</sub> = 2 kΩ, V <sub>O</sub> = 0.15 to 3.5 V	85	100		
		T <sub>A</sub> = -40 to +125℃	80			
FREQUENCY RESPONSE						
GBW	Gain bandwidth product			1		MHz
SR	Slew rate	G=+1,CL=100pF,VO=1.5to3.5V		1.2		V/μs
THD+N	Total harmonic distortion+noise	G= +1, f=1 kHz, VO = 1V <sub>RMS</sub>		0.002		%
t <sub>s</sub>	Settling time	To 0.1%, G = +1, 1V step		1.2		μs
		To 0.01%, G = +1, 1V step		1.5		
t <sub>OR</sub>	Overload recovery time	To 0.1%, V <sub>IN</sub> * Gain > V <sub>S</sub>		2		
OUTPUT						
V <sub>OH</sub>	High output voltage swing	R <sub>L</sub> = 25 kΩ	V <sub>S</sub> +9	V <sub>S</sub> +5		mV
		R <sub>L</sub> = 2 kΩ	V <sub>S</sub> +95	V <sub>S</sub> +63		
V <sub>OL</sub>	Low output voltage swing	R <sub>L</sub> = 25 kΩ		V <sub>S</sub> +3.5	V <sub>S</sub> +6	
		R <sub>L</sub> = 2 kΩ		V <sub>S</sub> +43	V <sub>S</sub> +65	
POWER SUPPLY						
V <sub>S</sub>	Operating supply voltage	T <sub>A</sub> = 0 to +70℃	2.7		5.5	V
		T <sub>A</sub> = -40 to +125℃	2.0		5.5	
I <sub>Q</sub>	Quiescent urrent(peramplifier)			100		μA
		T <sub>A</sub> = -40 to +125℃			160	
THERMAL CHARACTERISTICS						
T <sub>A</sub>	Operating temperature range		-40		+125	℃
θ <sub>JA</sub>	Package Thermal Resistance	SOT23-5L		190		℃/W
		SOP-8		125		
		SOP-14		115		

**Note**

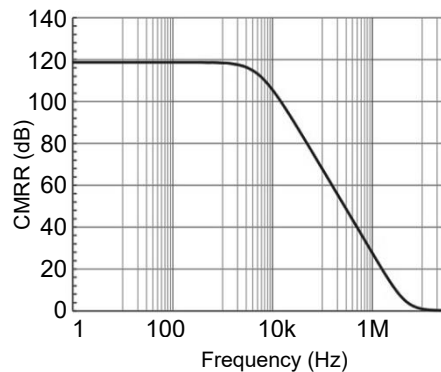
V<sub>S</sub> = 5.0V, T<sub>A</sub> = +25°C, V<sub>CM</sub> = V<sub>S</sub> / 2, V<sub>O</sub> = V<sub>S</sub> / 2, and R<sub>L</sub> = 10kΩ connected to V<sub>S</sub> / 2, unless otherwise noted.

## TYPICAL PERFORMANCE CHARACTERISTICS

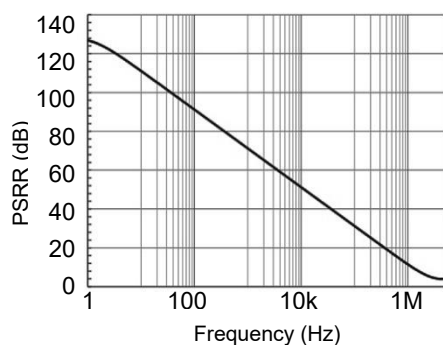
At  $T_A = +25^\circ\text{C}$ ,  $V_{CM} = V_S / 2$ , and  $R_L = 10\text{k}\Omega$  connected to  $V_S / 2$ , unless otherwise noted.



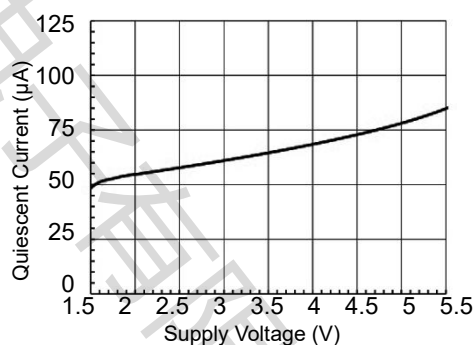
Open-loop Gain and Phase as a function of Frequency.



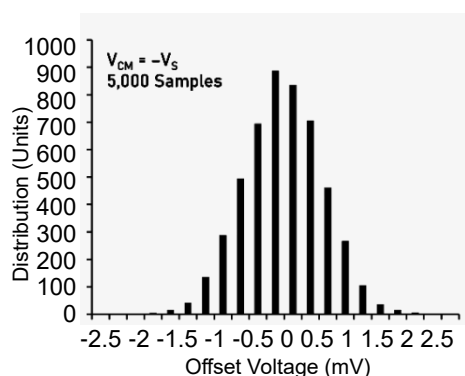
Common-mode Rejection Ratio as a function of Frequency.



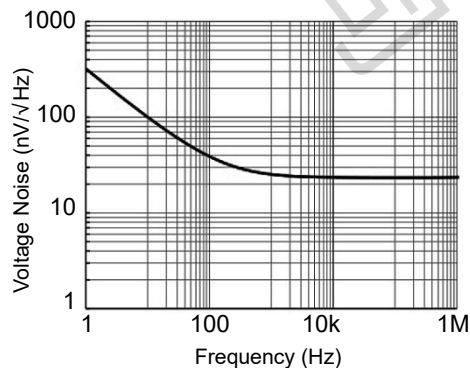
Power Supply Rejection Ratio as a function of Frequency.



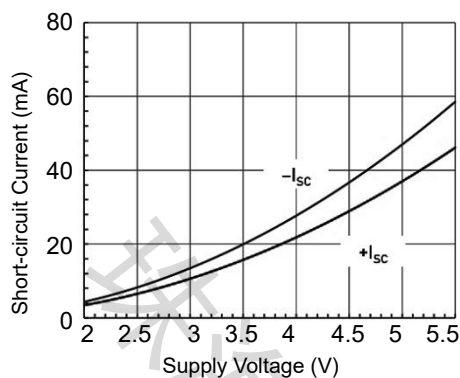
Quiescent Current as a function of Supply Voltage.



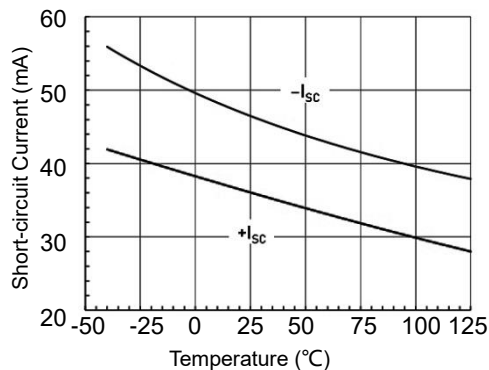
Offset Voltage Production Distribution



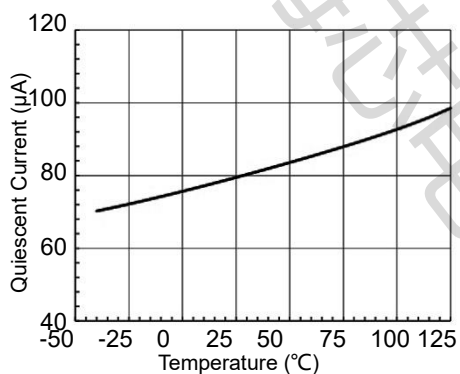
Input Voltage Noise Spectral Density as a function of Frequency.



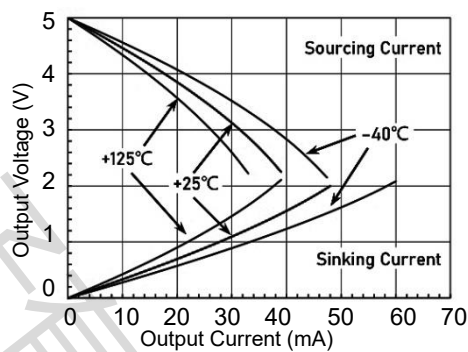
Short-circuit Current as a function of Supply Voltage.



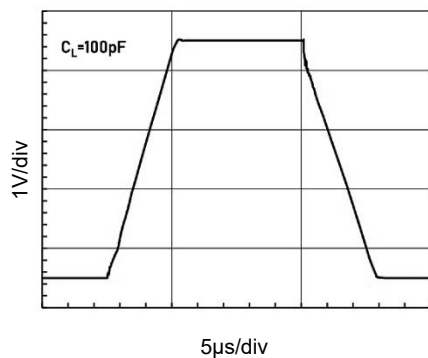
Short-circuit Current as a function of Temperature.



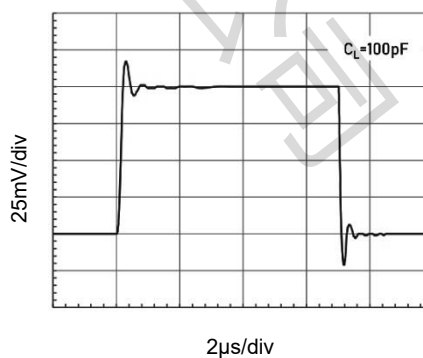
Quiescent Current as a function of Temperature.



Output Voltage Swing as a function of Output Current.

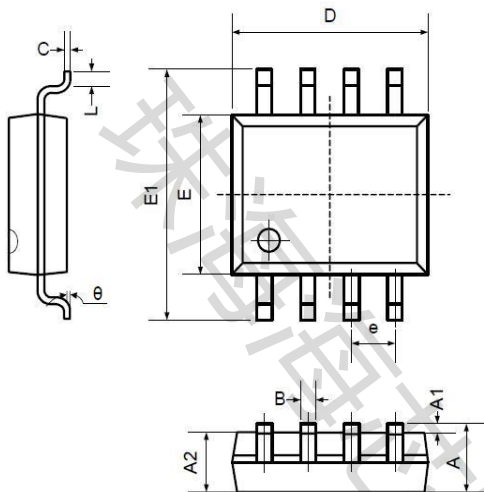


Large Signal Step Response.

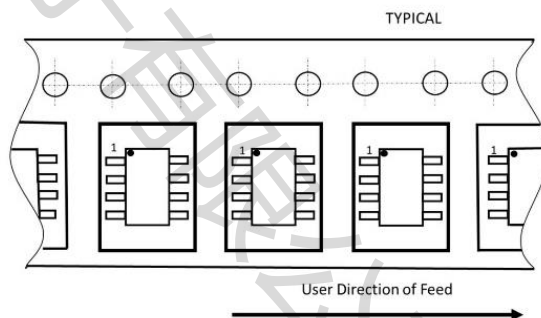
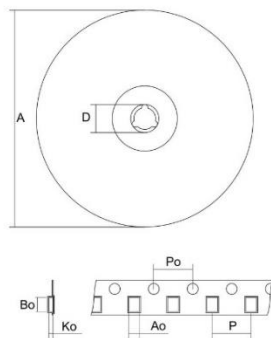


Small Signal Step Response.

## SOP-8 (Package Outline Dimensions)



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	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°



Part Number	Package Type	package	quantity
HX602-S	SOP-8	Taping	2500

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