

HX6001-ST/HX6002-S/HX6004-S

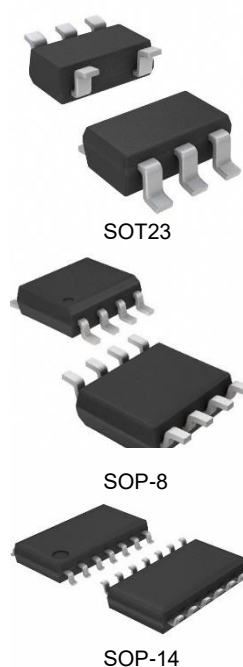
Micro-Power 1.5MHz, Low-Noise, RRIO, 1.8V CMOS Amplifiers

General Description

The HX6001-ST/HX6002-S/HX6004-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 75 μA), wide bandwidth (1.5 MHz), and very low noise (25 $\text{nV}/\sqrt{\text{Hz}}$ 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 HX6001-ST/HX6002-S/HX6004-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 HX6001-ST/HX6002-S/HX6004-S amplifiers are optimized for operation at voltages ranging from +1.8 V (± 0.9 V) to +5.5 V (± 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 (± 1.0 V) to +5.5 V (± 2.75 V) over an extended temperature range of -40 $^{\circ}\text{C}$ to +125 $^{\circ}\text{C}$.



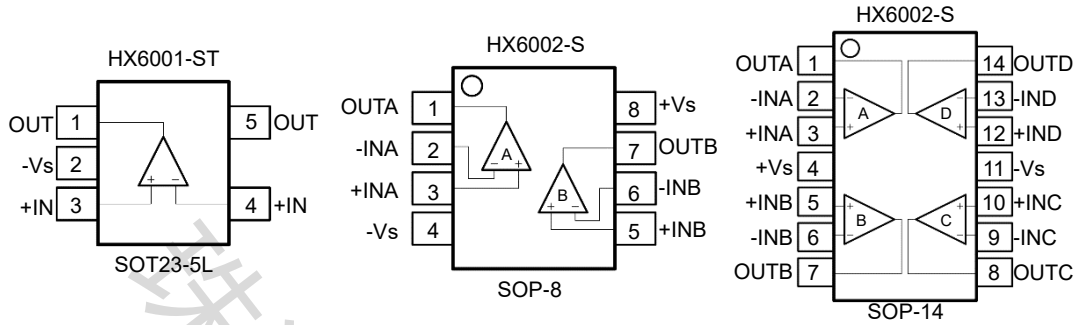
Features

- Rail-to-Rail Input and Output
- Low Input Offset Voltage: 0.5 mV
- Precision Amplifiers for Cost-Sensitive Systems
- Single 1.8 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 $\text{nV}/\sqrt{\text{Hz}}$ at 1 kHz
- Micro-Power: 75 μA Supply Current Per Amplifier
- Internal RF/EMI Filter
- 1.5 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	$V_{S-} - 0.5 V$ to $V_{S+} + 0.5 V$, $\pm 10 mA$
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_{OS}	Input offset voltage			± 0.5	± 2.5	mV
		$T_A = -40$ to $+125^{\circ}C$			± 2.8	
$V_{OS TC}$	Offset voltage drift	$T_A = -40$ to $+125^{\circ}C$		± 1	3	$\mu V/^{\circ}C$
P_{SRR}	Power supply rejection ratio	$V_S = 2.0$ to $5.5 V$, $V_{CM} < V_{S+} - 2V$	80	110		dB
		$T_A = -40$ to $+125^{\circ}C$	75			
INPUT BIAS CURRENT						
I_B	Input bias current			1		
		$T_A = +85$		150		

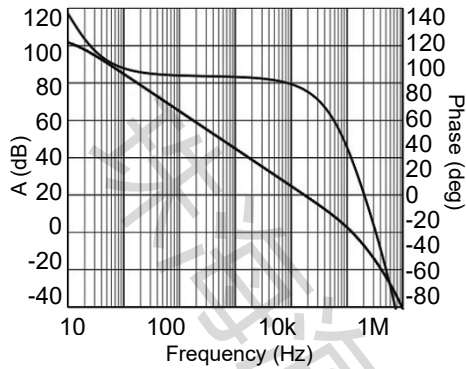
		$T_A = +125\text{ }^\circ\text{C}$		500		
I_{OS}	Input offset current			1		
NOISE						
V_n	Input voltage noise	$f = 0.1$ to 10 kHz		5.6		$\mu\text{VP-P}$
e_n	Input voltage noise density	$f = 10\text{ kHz}$		22		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$		25		
I_n	Input current noise density					
INPUT VOLTAGE						
V_{CM}	Common-mode voltage range		$V_{S-}-0.1$		$V_{S+}-0.1$	V
CMRR	Common-mode rejection ratio	$V_S = 5.5\text{ V}, V_{CM} = -0.1$ to 5.6 V	70	83		dB
		$V_{CM}=0$ to $5.3\text{ V}, T_A=-40$ to $+125\text{ }^\circ\text{C}$	65			
		$V_S = 2.0\text{ V}, V_{CM} = -0.1$ to 2.1 V	65	77		
		$V_{CM}=0$ to $1.8\text{ V}, T_A=-40$ to $+125\text{ }^\circ\text{C}$	60			
INPUT IMPEDANCE						
C_{IN}	Input capacitance	Differential		2.0		pF
		Common mode		3.5		
OPEN-LOOP						
A_{VOL}	Open-loop voltage A_{VOL} gain	$R_L = 25\text{ k}\Omega, V_O = 0.05$ to 3.5 V	90	105		dB
		$T_A = -40$ to $+125\text{ }^\circ\text{C}$	85			
		$R_L = 2\text{ k}\Omega, V_O = 0.15$ to 3.5 V	85	100		
		$T_A = -40$ to $+125\text{ }^\circ\text{C}$	80			
FREQUENCY RESPONSE						
GBW	Gain bandwidth product			1.5		MHz
SR	Slew rate	$G=+1, C_L=100\text{ pF}, V_O=1.5$ to 3.5 V		1.2		$\text{V}/\mu\text{s}$
THD+N	Total harmonic distortion+noise	$G= +1, f=1\text{ kHz}, V_O = 1V_{RMS}$		0.002		%
t_s	Settling time	To 0.1%, $G = +1, 1\text{ V}$ step		1.2		μs
		To 0.01%, $G = +1, 1\text{ V}$ step		1.5		
t_{OR}	Overload recovery time	To 0.1%, $V_{IN} * \text{Gain} > V_S$		2		
OUTPUT						
V_{OH}	High output voltage swing	$R_L = 25\text{ k}\Omega$	$V_{S+}-9$	$V_{S+}-5$		mV
		$R_L = 2\text{ k}\Omega$	$V_{S+}-95$	$V_{S+}-63$		
V_{OL}	Low output voltage swing	$R_L = 25\text{ k}\Omega$		$V_{S+}-3.5$	$V_{S+}-6$	mV
		$R_L = 2\text{ k}\Omega$		$V_{S+}-43$	$V_{S+}-65$	
POWER SUPPLY						
V_S	Operating supply voltage	$T_A = 0$ to $+70\text{ }^\circ\text{C}$	1.8	5.5		V
		$T_A = -40$ to $+125\text{ }^\circ\text{C}$	2.0	5.5		
I_Q	Quiescent current(peramplifier)			75	125	μA
		$T_A = -40$ to $+125\text{ }^\circ\text{C}$			160	
THERMAL CHARACTERISTICS						
T_A	Operating temperature range		-40		+125	$^\circ\text{C}$
θ_{JA}	Package Thermal Resistance	SOT23-5L		190		$^\circ\text{C}/\text{W}$
		SOP-8		125		
		SOP-14		115		

Note

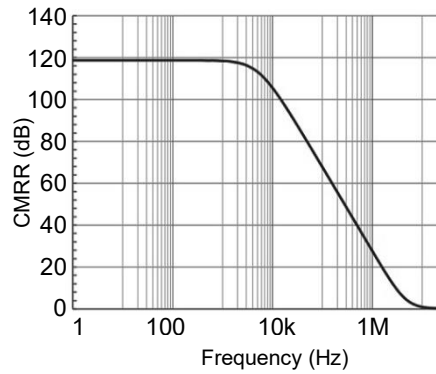
$V_S = 5.0\text{ V}, T_A = +25\text{ }^\circ\text{C}, V_{CM} = V_S / 2, V_O = V_S / 2,$ and $R_L = 10\text{ k}\Omega$ connected to $V_S / 2,$ unless otherwise noted.

TYPICAL PERFORMANCE CHARACTERISTICS

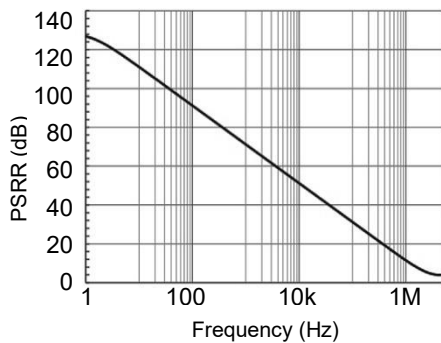
At TA = +25°C, VCM = VS / 2, and RL = 10kΩ connected to VS / 2, unless otherwise noted.



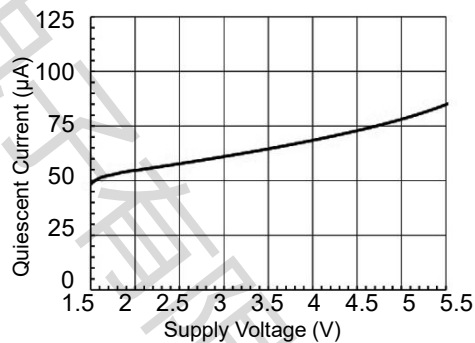
Open-loop Gain and Phase as a function of Frequency.



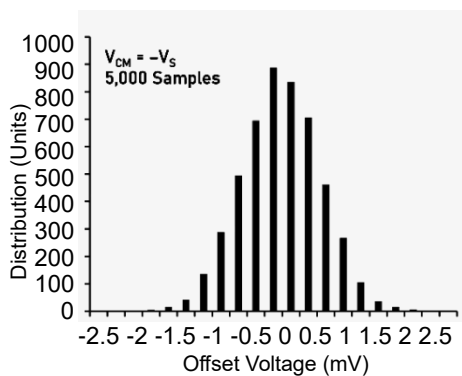
Common-mode Rejection Ratio as a function of Frequency.



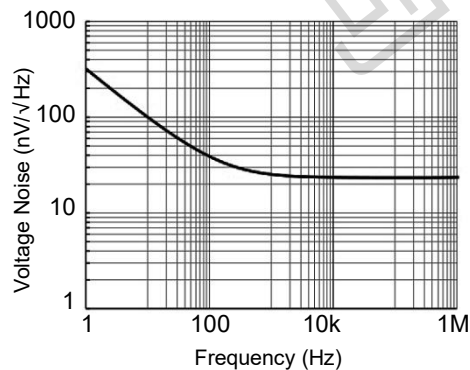
Power Supply Rejection Ratio as a function of Frequency.



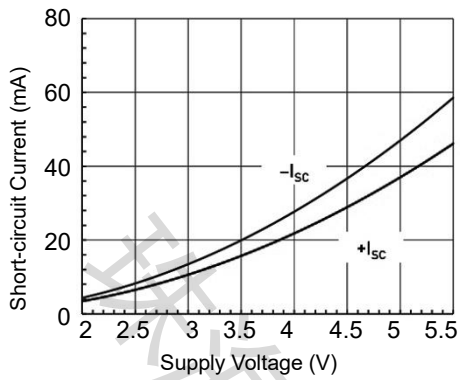
Quiescent Current as a function of Supply Voltage.



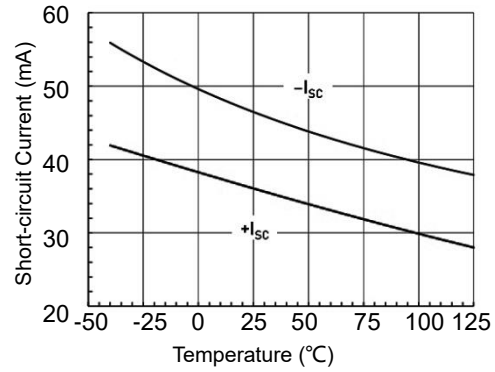
Offset Voltage Production Distribution



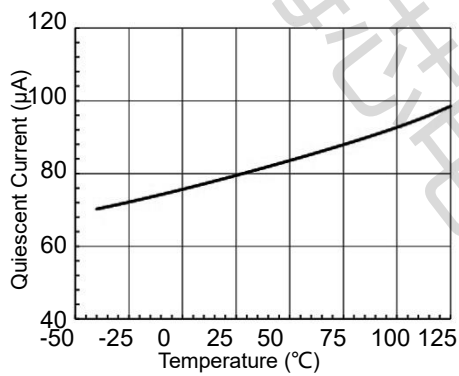
Input Voltage Noise Spectral Density as a function of Frequency.



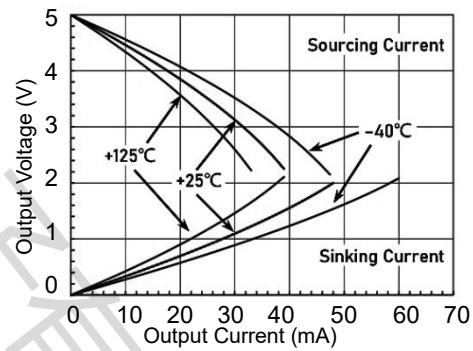
Short-circuit Current as a function of Supply Voltage.



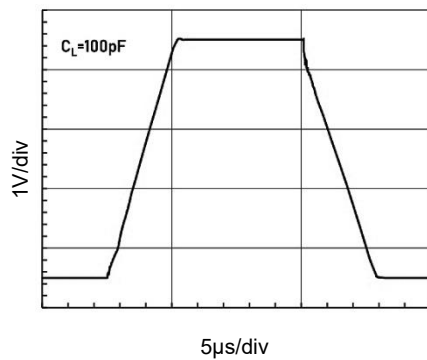
Short-circuit Current as a function of Temperature.



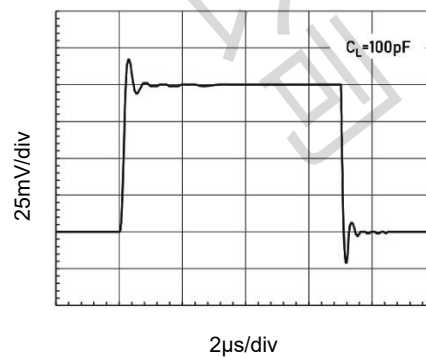
Quiescent Current as a function of Temperature.



Output Voltage Swing as a function of Output Current.



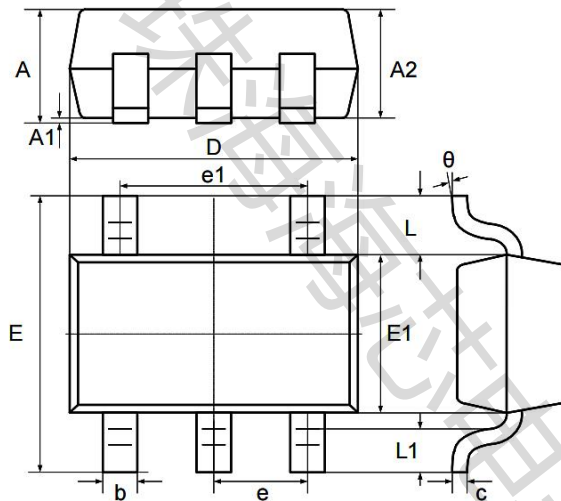
Large Signal Step Response.



Small Signal Step Response.

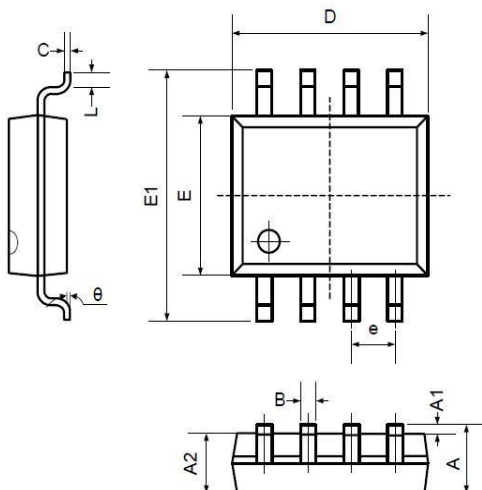
DIMENSIONAL DRAWINGS

SOT23-5L (Package Outline Dimensions)



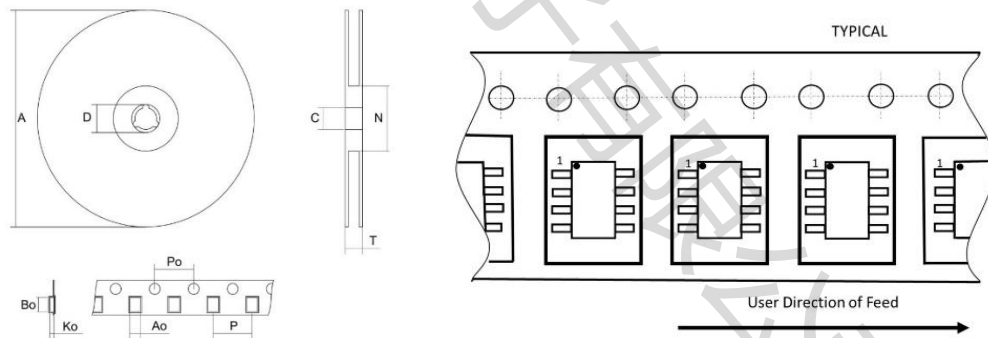
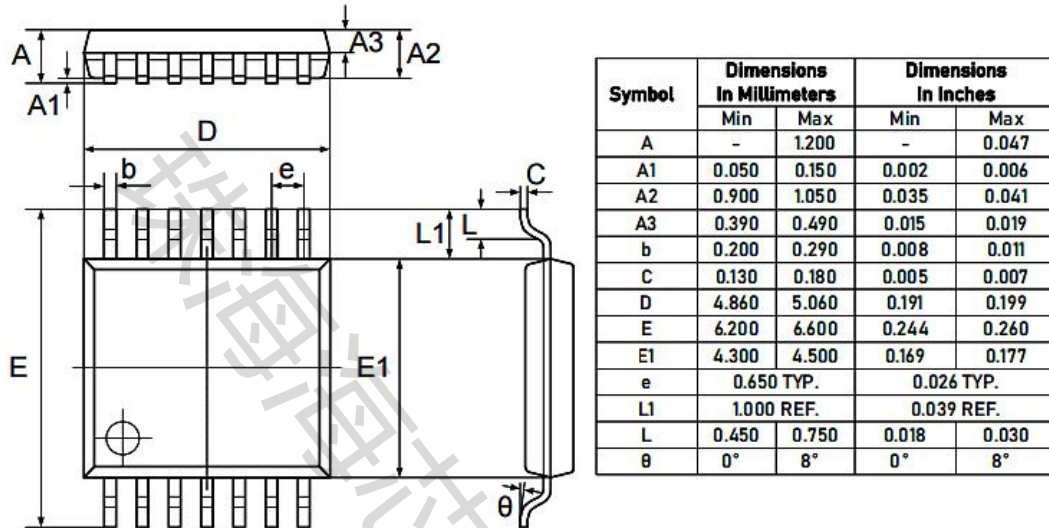
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	-	1.25	-	0.049
A1	0.04	0.10	0.002	0.004
A2	1.00	1.20	0.039	0.047
b	0.33	0.41	0.013	0.016
c	0.15	0.19	0.006	0.007
D	2.820	3.02	0.111	0.119
E1	1.50	1.70	0.059	0.067
E	2.60	3.00	0.102	0.118
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.60 REF		0.024 REF	
L1	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

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°

SOP-14 (Package Outline Dimensions)



Part Number	Package Type	package	quantity
HX6001-ST	SOT23-5L	Taping	3000
HX6002-S	SOP-8	Taping	2500
HX6004-S	SOP-14	Taping	2500

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