High Voltage, Low Noise, Low Power Rail-to-Rail I/O Operational Amplifiers

Features

* Low Noise: 15nV/√Hz at 1kHz
* Low Offset Voltage: 1.2mV (MAX)
* Low Quiescent Current: 50μA/Amplifier (TYP)
* Gain-Bandwidth Product: 2.2MHz
* Rail-to-Rail Input and Output
* High Slew Rate: 8V/μs
* Wide Input Common Mode and Differential Voltage Ranges
* Low Input Bias Current
* Low Input Offset Current
* Output Short-Circuit Protection
* High Input Impedance
* Support Single or Dual Power Supplies: 3.3V to 36V or ±1.65V to ±18V
* -40℃ to +125℃ Operating Temperature Range
* Available in Green SOIC-14 and TSSOP-14 Packages

General Description

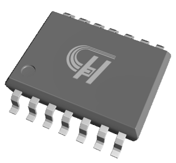
The HCR8224 is a quad, low noise, high Voltage, Low Noise, Low Power Rail-to-Rail I/O Operational Amplifiers, which can operate from 3.3V to 36V single supply or from ±1.65V to ±18V dual power supplies. It provides rail-to-rail input with a wide input common mode voltage range and rail-to-rail output voltage swing.

The HCR8224 provides high slew rate, low noise, bias current and offset.

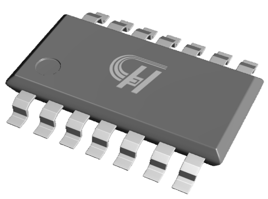
The HCR8224 is available in Green SOIC-14 and TSSOP-14 packages. It is specified over the extended -40℃ to +125℃ temperature range.

Applications

* High Impedance Sensor
* Photodiode Amplifier
* High End, Professional Audio
* DAC Output Amplifier
* Medical



TSSOP-14

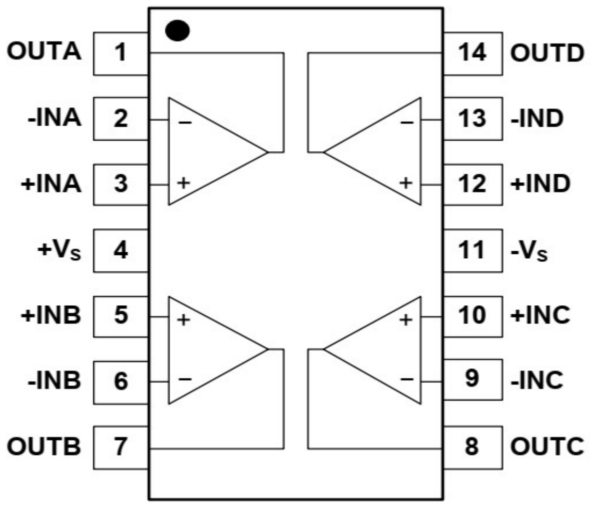


SOIC-14

Figure 1. Package Type of HCR8224

Pin Configuration

HCR8224 (TOP VIEW)



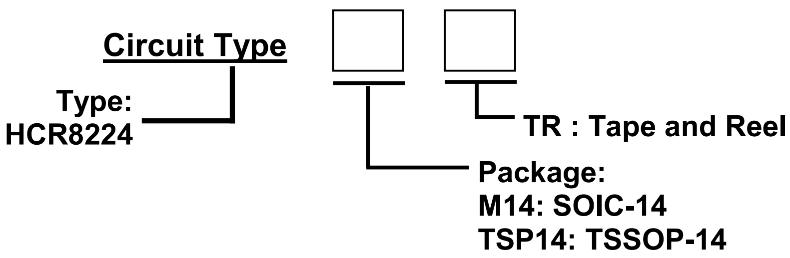
SOIC-14/TSSOP-14

Figure 2. Pin Configuration of HCR8224 (Top View)

Pin Function Table

Name	Function
+IN A, +IN B, +IN C, +IN D	Non-inverting Inputs
-IN A, -IN B, -IN C, -IN D	Inverting Inputs
+Vs	Positive Power Supply
-Vs	Negative Power Supply
OUTA, OUTB, OUTC, OUTD	Outputs

Ordering Information note 1



Ordering Code note 1

Part Number	Marking ID	Temperature Range	Package	Package Option
HCR8224M14TR	HCR8224MXX	-40'C to +125'C	SOIC-14	2500pcs/TR
HCR8224TSP14TR	HCR8224TXX	-40'C to +125'C	TSSOP-14	4000pcs/TR

Note 1. The "xx" is date code and Trace Code

Absolute Maximum Ratings [Note 2]

Parameter		Symbol	Value	Unit
Supply Voltage, +Vs to -Vs		V_{IN}	40V	V
Input/Output Voltage Range		V_{DF}	(-VS)-0.3 to (+VS)+0.3	V
Signal Input Current Terminals		I_O	±10	mA
Power Dissipation @TA=+25'C	TSSOP-14	P_D	1.1	W
	SOIC-14		1.5	W
Package Thermal Resistance	TSSOP-14	θJA	108	'C/W
	SOIC-14		81	'C/W
Package Thermal Resistance	TSSOP-14	θJC	35	'C/W
	SOIC-14		32	'C/W
Junction Temperature		TJ	+150	'C
Storage Temperature Range		T_{STG}	-65 to +150	'C
Lead Temperature (Soldering, 10s)		T_{LEAD}	+260	'C
ESD Susceptibility(HBM)		HBM	6000	V
ESD Susceptibility(MM)		MM	200	V
ESD Susceptibility(CDM)		CDM	1000	V

Note 2: Stresses above those listed under"Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Input Voltage Range	V_{IN}	3.3	36	V
Supply Voltage V+ to V-	V+, V-	±1.65	±18.0	V
Operating Temperature Range	Ta	-40	+125	'C

Electrical Characteristics

(At TA=+25'C, Vs=1.65V to ±18V and RL=2KΩ connected to 0V, Full=-40'C to +125'C, Unless Otherwise Noted.)

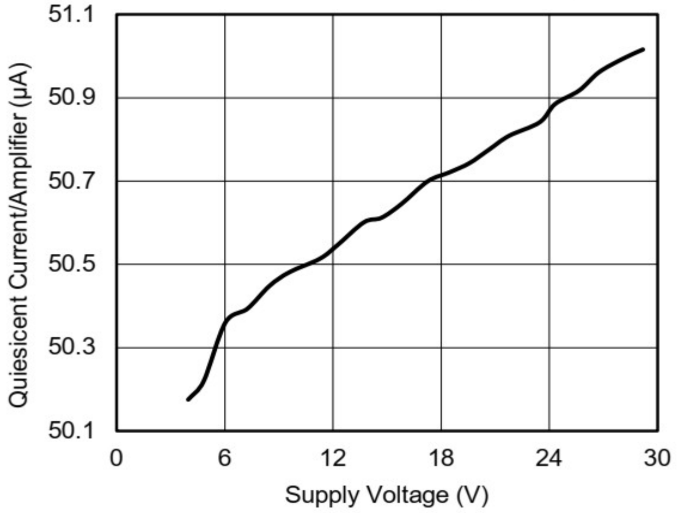
Parameter	Symbol	Conditions	TEMP	Min	Type	Max	Unit
Input Characteristics							
Input Offset Voltage	VOS	VCM=0V	+25'C	-	0.2	1.2	mV
			Full	-	-	1.4	
Input Offset Voltage Drift	ΔVOS/ΔT	-	Full	-	0.8	-	uV/'C
Input Bias Current	IB	VCM=0V	+25'C	-	±5	±120	pA
Input Offset Current	IOS	VCM=0V	+25'C	-	±5	±120	pA
Maximum Differential Input Voltage	|VID|	'-	Full	-	-	Vs	V
Maximum Input Difference Bias Current	|IID|	VS=±18V, VID=±18V	+25'C	-	2	3	uA
			Full	-	-	4	
Input Common Mode Voltage Range	VCM	-	Full	(-VS)-0.1	-	(+VS)+0.1	V
Common Mode Rejection Ration	CMRR	VS=±18V, (-VS)-0.1V<VCM<(+VS)+1.5V	+25'C	96	110	-	dB
			Full	85	-	-	
		VS=±18V, (-VS)-0.1V<VCM<(+VS)+0.1V	+25'C	78	88	-	
			Full	75	-	-	
Open-Loop Voltage Gain	AOL	(-VS)+0.2V<VOUT<(+VS)-0.2V, RL=10KΩ	+25'C	101	130	-	dB
			Full	98	-	-	
		(-VS)+0.5V<VOUT<(+VS)-0.5V, RL=2KΩ	+25'C	101	120	-	
			Full	81	-	-	
Output Characteristics							
Output Voltage Swing from Rail	VOUT	VS=±18V, RL=10KΩ	+25'C	-	65	85	mV
			Full	-	-	110	
		VS=±18V, RL=2KΩ	+25'C	-	320	420	mV
			Full	-	-	550	
Output Short-Circuit Current	ISC	VS=±18V	+25'C	±28	±40	-	mA
Power Supply							
Operating Voltage Range	VS	-	Full	3.3	-	36	V
Quiescent Current/Amplifier	IQ	IOUT=0	+25'C	-	50	67	uA
			Full	-	-	75	
Power Supply Rejection Ratio	PSRR	VS=3.3V to 36V	+25'C	105	125	-	dB
			Full	102	-	-	
Dynamic Performance							
Gain-Bandwidth Product	GBP	CL=50pF	+25'C	-	2.2	-	MHz
Phase Margin	ØO	CL=50pF	+25'C	-	65	-	'
Slew Rate	SR	VS=±2.5V to ±18V, G=+1	+25'C	-	8	-	V/us
Overload Recovery Time	ORT	VIN x G > VS	+25'C	-	1	-	us
Total Harmonic Distortion+Noise	THD+N	VS=±2.5V to ±18V, VOUT=2VP-P, f=1KHz, G=+1, RL=600Ω	+25'C	-	0.002	-	%
		VS=±2.5V to ±18V, VOUT=2VP-P, f=1KHz, G=+1, RL=2KΩ	+25'C	-	0.0005	-	
Noise							
Input Voltage Noise		f=0.1Hz to 10Hz	+25'C	-	3.5	-	uVP-P
Input Voltage Noise Density	en	f=10Hz	+25'C	-	80	-	nV √Hz
		f=1KHz	+25'C	-	15	-	
Input Current Noise Density	in	f=1KHz	+25'C	-	300	-	fA √Hz

High Voltage, Low Noise, Low Power Rail-to-Rail I/O Operational Amplifiers

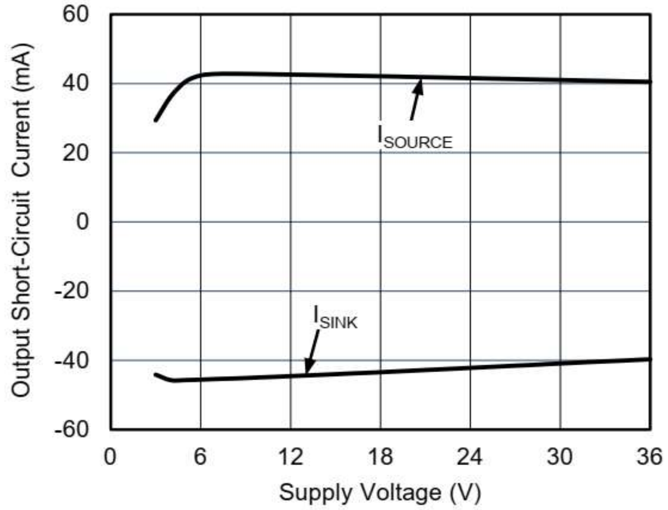
Typical Performance Characteristics

At TA=+25'C, VS=36V and RL=2KΩ, unless otherwise noted.

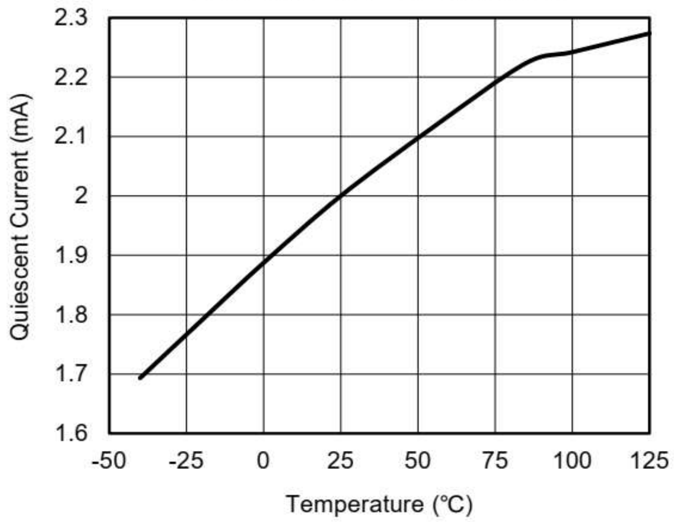
Quiescent Current vs. Supply Voltage



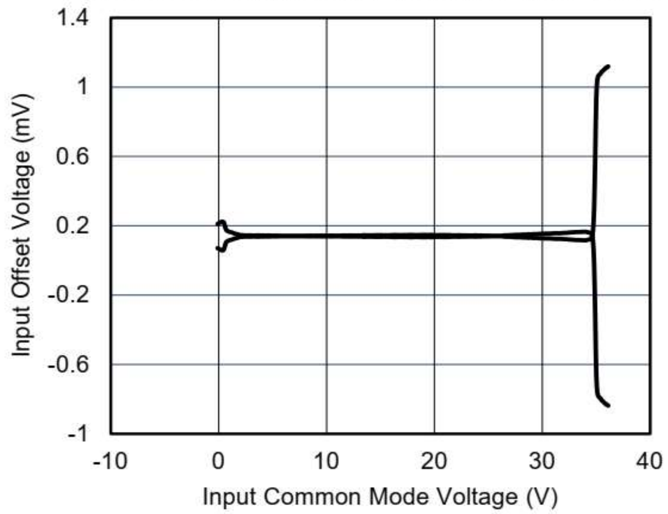
Output Short-Circuit Current vs. Supply Voltage



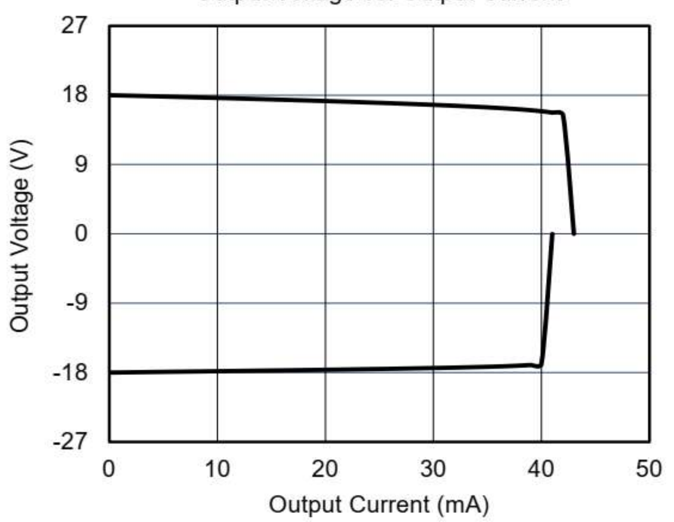
Quiescent Current vs. Temperature



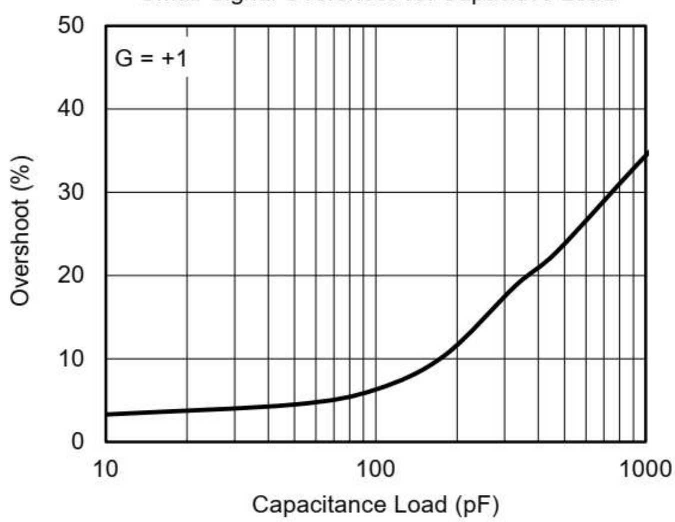
Input Offset Voltage vs. Input Common Mode Voltage



Output Voltage vs. Output Current

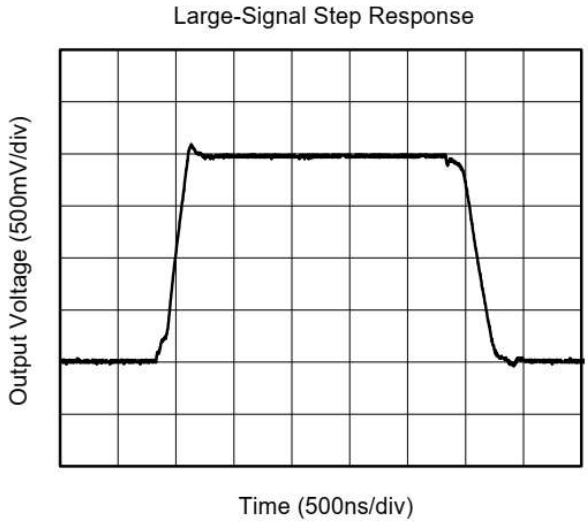


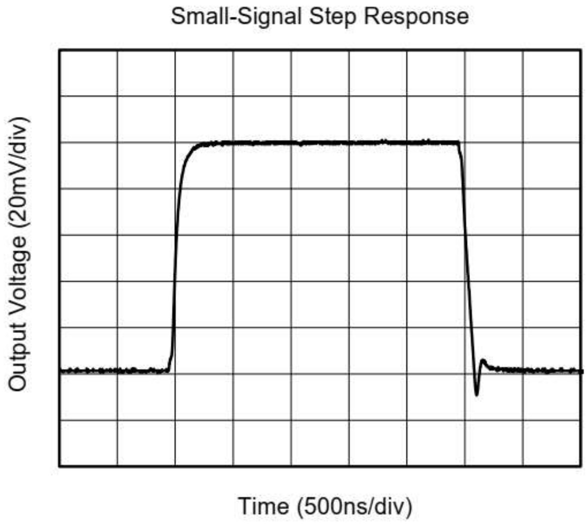
Small-Signal Overshoot vs. Capacitive Load

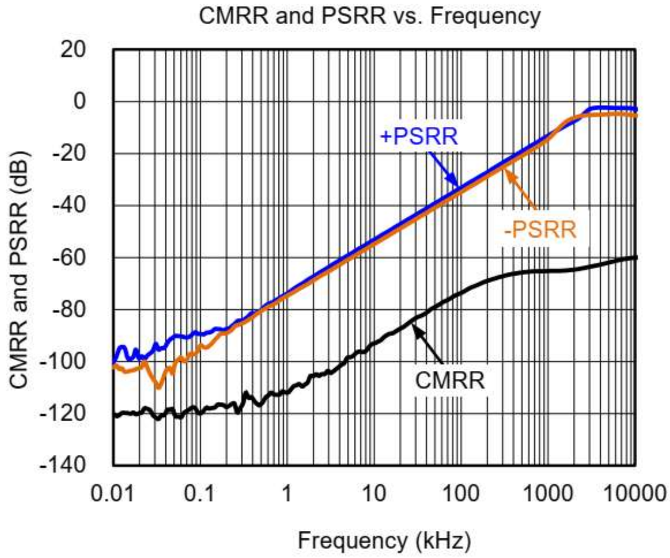


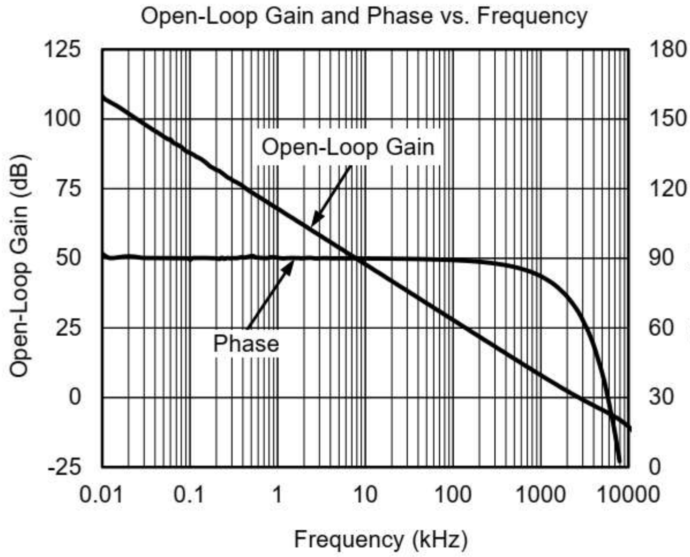
Typical Performance Characteristics (Con.)

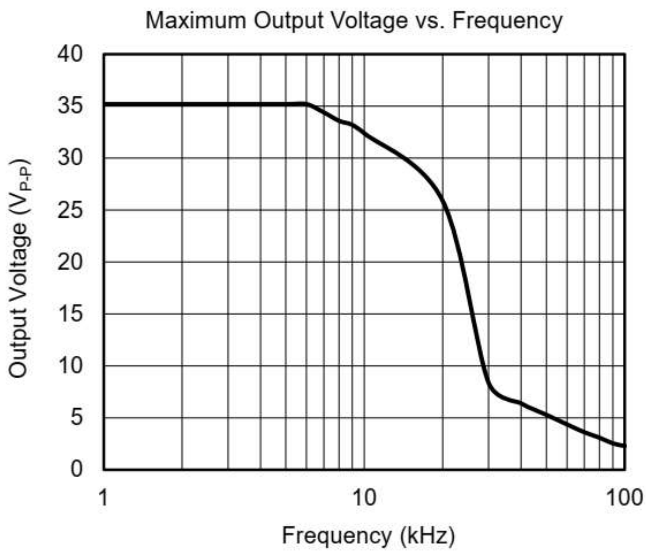
At TA=+25'C, VS=36V and RL=2KΩ, unless otherwise noted.

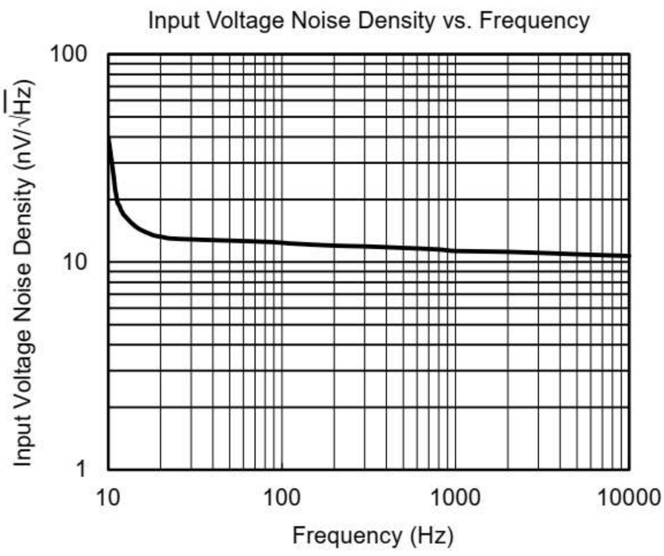






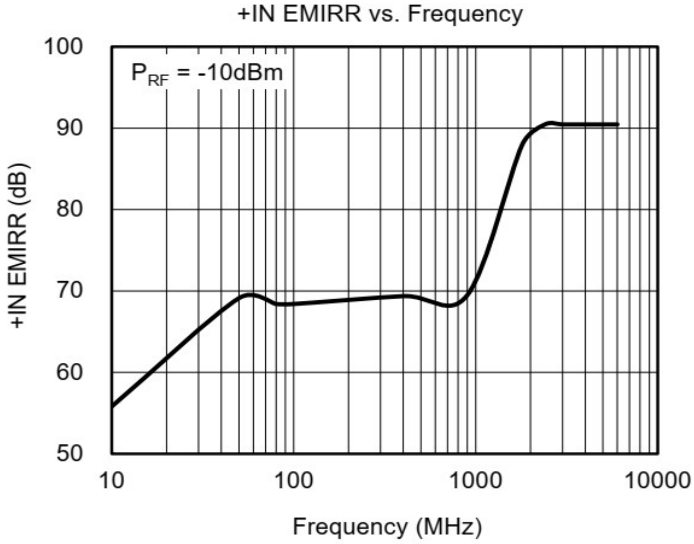


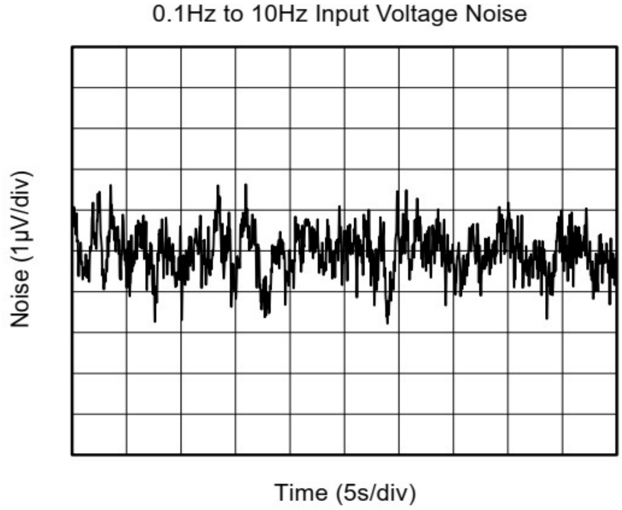


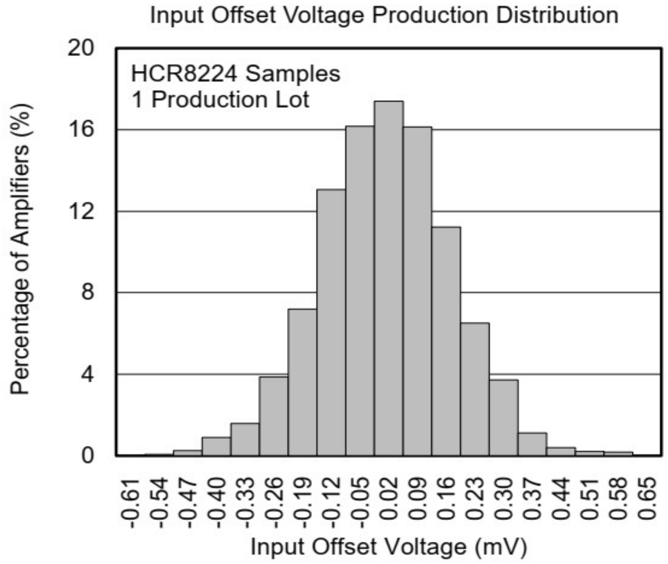


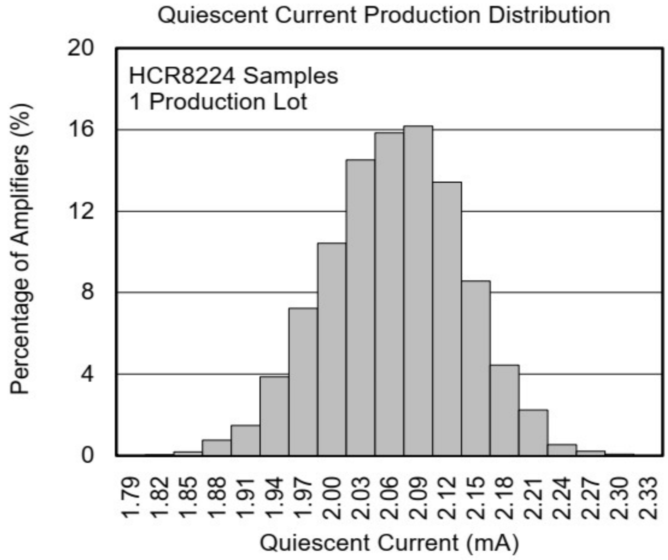
Typical Performance Characteristics (Con.)

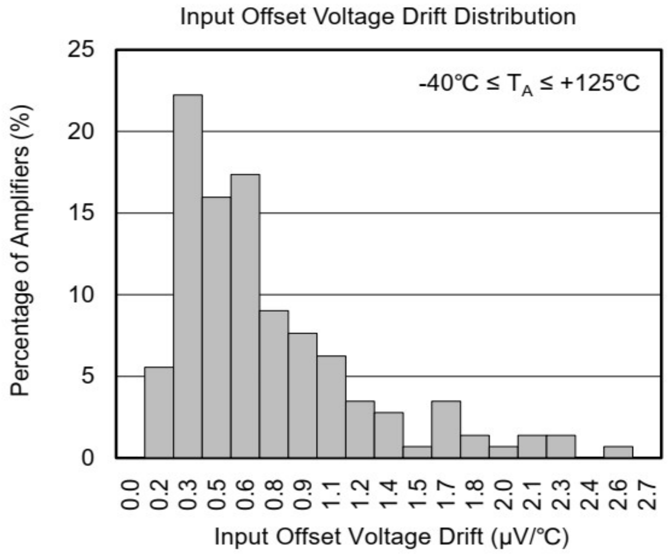
At TA=+25'C, VS=36V and RL=2KΩ, unless otherwise noted.











Application Information

The performance of the signal bandwidth and the noise is not decreased though the power consumption is minimized. In addition, the common mode rejection ratio (CMRR), power supply rejection ratio (PSRR) and the open loop gain (A_{OL}) are greater than 120dB typically. The system components should be selected carefully if users are desired to minimize the power consumption, which means that the large resistance should be taken into account. However, there are stray capacitances in any PCB board, which means that the large capacitance should be combined with these capacitors (RC delay) to affect the signal bandwidth and the stability of the feedback system. To avoid this issue, a feedback capacitor is required to enhance the stability and limit any gain peaking or overshoot.

Also, for decoupling, a 0.1μF capacitor is required to be placed a:

Operating Voltage

HCR8224 is typically tested or specified in the power supply range from 3.3V to 36V (or ±1.65V to ±18V).

Input Common Mode Voltage Range

For the common mode voltage at the inputs of HCR8224, it is operated from (-VS) - 0.1V to (+VS)+ 0.1V. The complementary structure at the input is applied for achieving the wide input common mode voltage range. The defined CMRR range is from (-VS) to (+VS) - 1V. Between (-VS) - 0.1V and (+VS)+0.1V the CMRR of the device in this region is lower since this is the transition region for the input structure of the HCR8224.

Noise

The performance of noise for HCR8224 is excellent. The resistors should be selected accordingly to prevent the thermal noise from being the dominant one, as the 0.1Hz to 10Hz noise for HCR8224 is just 3.5μVP-P, and wideband noise is 15nV/ √ Hz.

Input Over-Voltage Protection

The typical input biasing current is 5pA. However, if the input voltage level is 0.5V greater than the power supply rails of the operational amplifier, the current wil be increased exponentially. Also, to keep the input be increased exponentially. Also, to keep the input should be placed at the input of the amplifier to limit the input current within 10mA, which is shown in Figure 3.

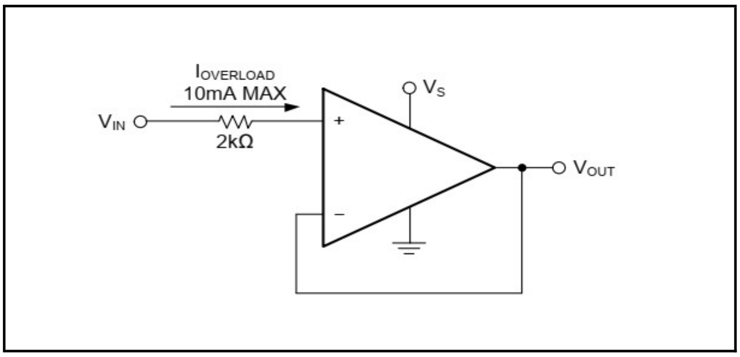


Figure 3. Protection for Input Current when Supply Voltage is Exceeded

Driving Capacitive Load with Stability

For unity-gain buffer application, the overshoot or gain peaking would be made if the load capacitance is greater than 30pF. To improve the ability of capacitive loading, one way is improving the voltage gain, and the other way is adding 10Ω to 20Ω isolated resistor at the output stage, which is shown in Figure 4. With this resistor, the ringing and gain peaking can be eliminated for light capacitive loading. However, if a resistive load is connected in parallel with the CL, the output will be divided by the RS and RL. Generally, if the RL is large, the influence is negligible.

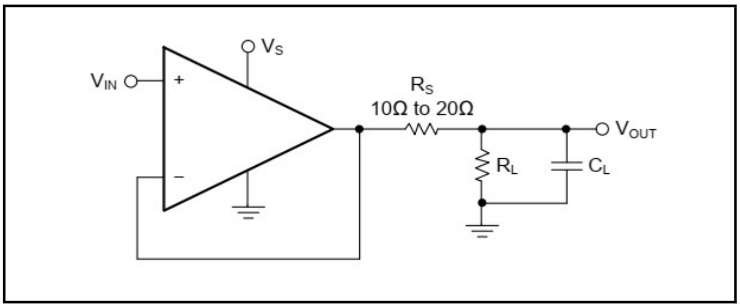


Figure 4. Capacitive Load Drive Improved by Series Resistor in Unity-Gain Buffer Configuration

Application Information (Con.)

For the inverting unity-gain application, the phase margin of the loop gain can be decreased by reacting of the gain and feedback resistors and the parasitic capacitance which is at the negative input pin. For best performance, decreasing the RF and RIN should be taken into account. However, if users desire to use large feedback and gain resistors, placing a 4pF to 6pF capacitor in parallel with the RF is a good choice for enhancing the stability of the feedback loop. Also, the gain peaking and the overshoot will be decreased accordingly. In Figure 5, CIN indicates the parasitic capacitance for the operational amplifier and the PCB.

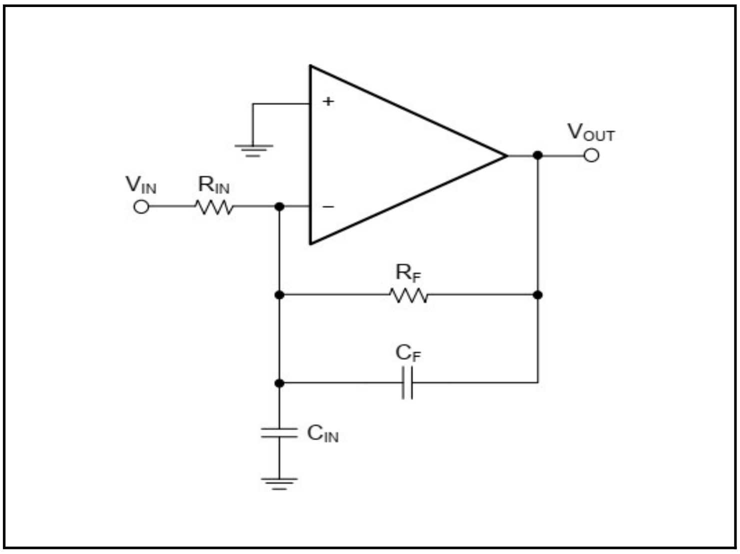


Figure 5. Enhancing the Stability of Large RF and RIN

Figure 6 through Figure 10 illustrate some low power application examples.

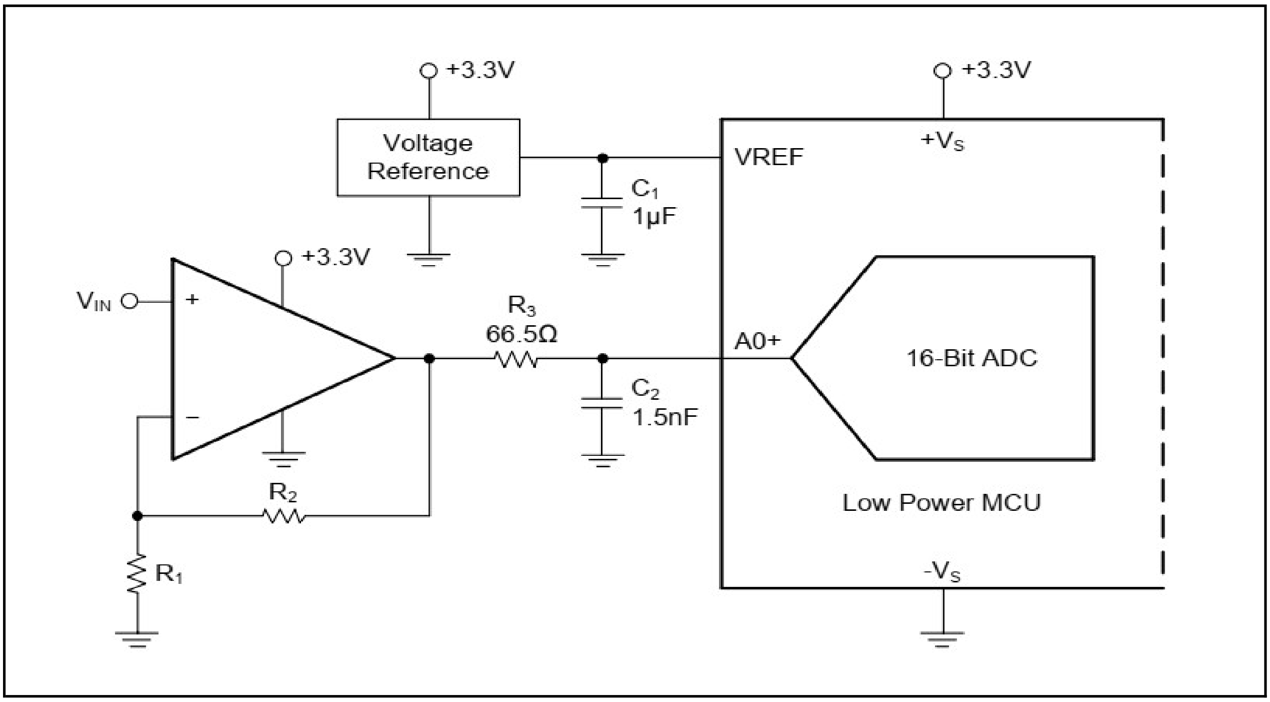


Figure 6. Single Amplifier Configurations for Driving Unipolar Precision ADC

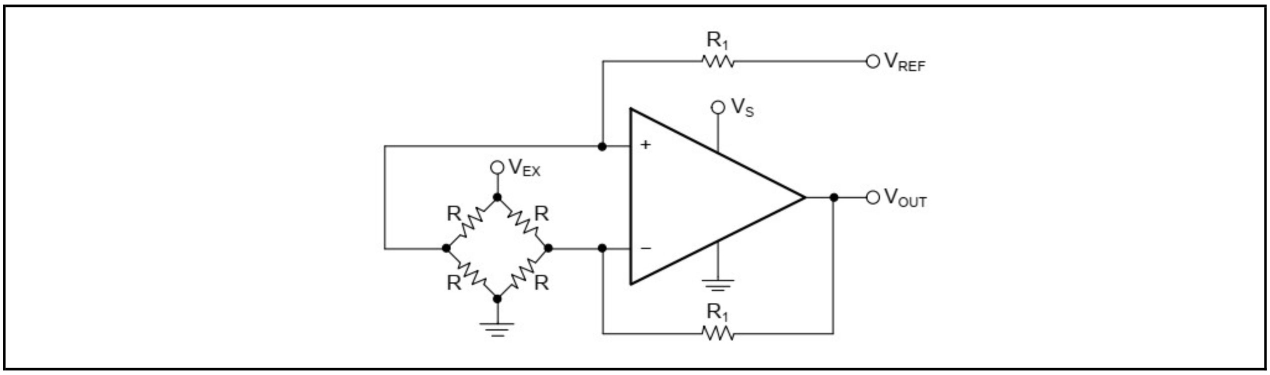
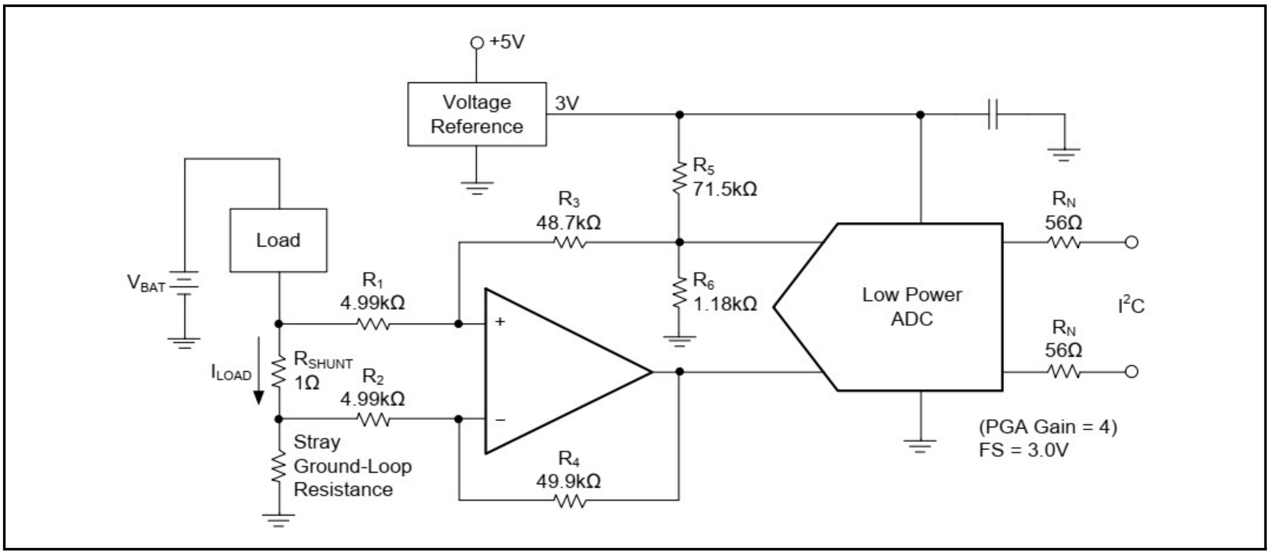


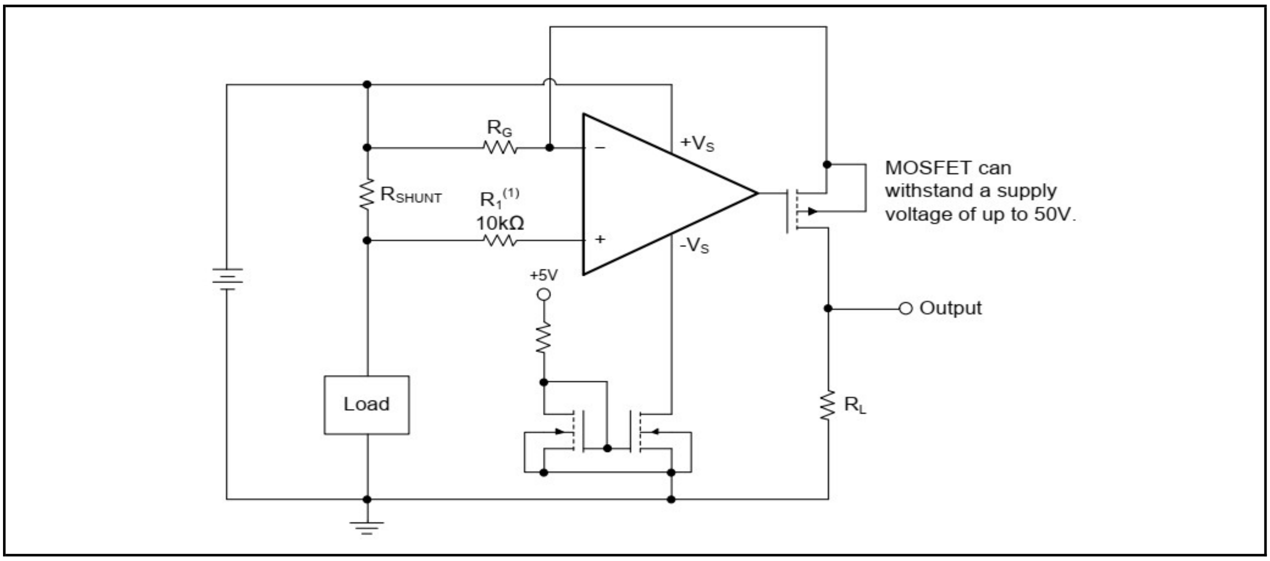
Figure 7. Bridge Amplifier Using a Single Operational Amplifier

Application Information (Con.)



NOTE: 1% resistors can provide sufficient common mode rejection to reduce the adverse effects caused by small ground-loop errors

Figure 8. Low-side Current Shunt Monitor



NOTE: 1. Current-limit resistor.

Figure 9. High-side Current Measurement

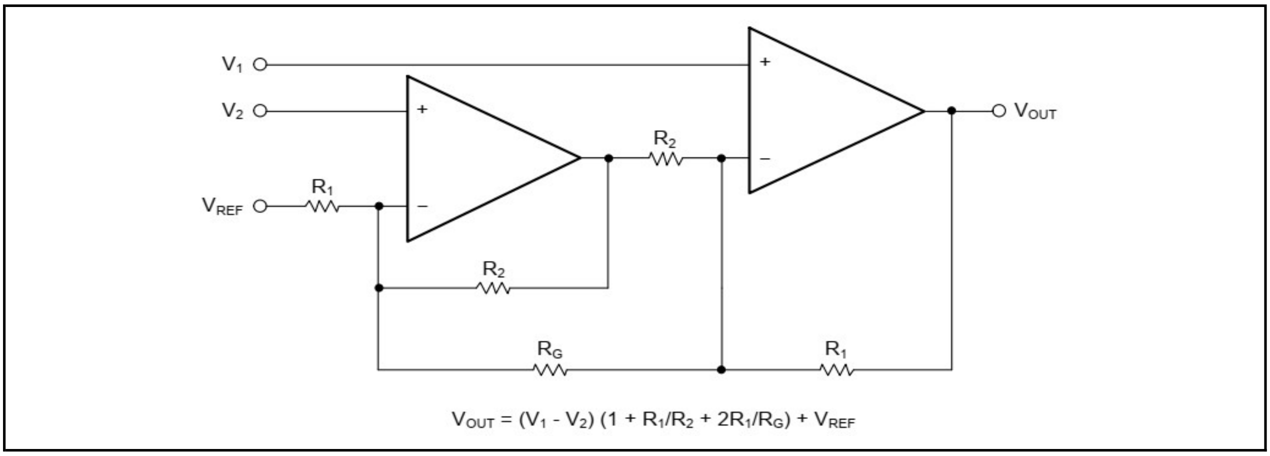
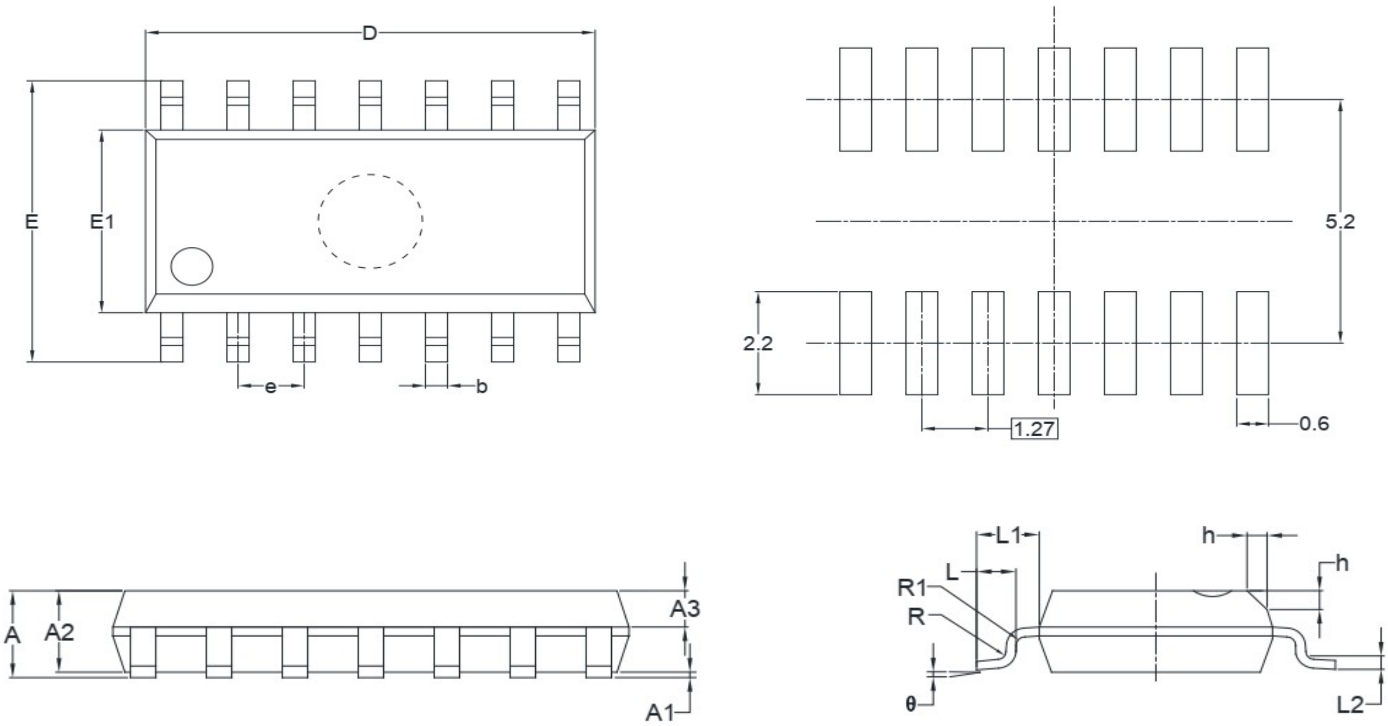


Figure 10. Low Power Instrumentation Amplifier Consisting of Two Operational Amplifiers

Package Outline Dimensions

PKG: SOIC-14 (M14)

Unit: mm

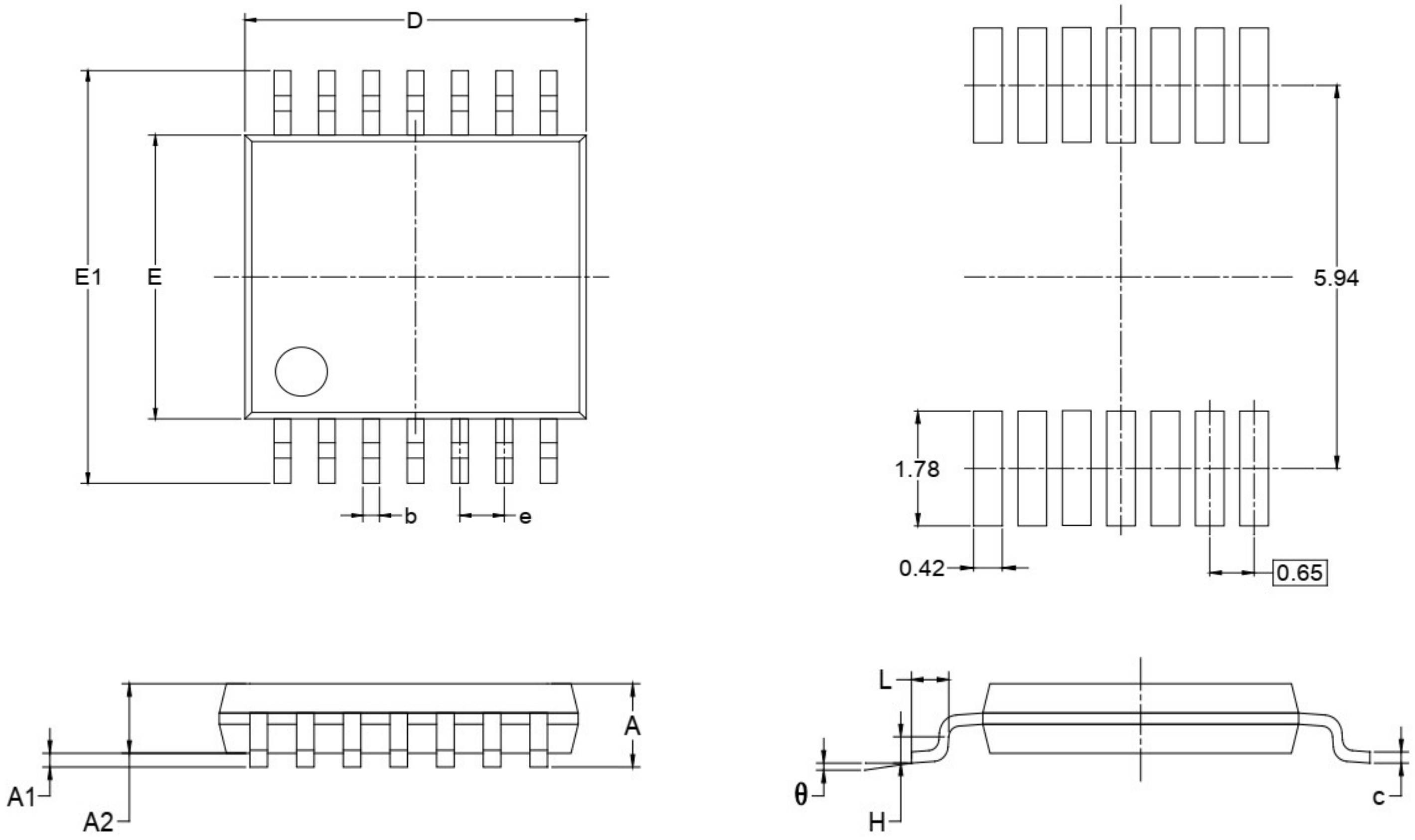


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	0.018	0.032
L1	1.04 REF		0.040 REF	
L2	0.25 BSC		0.01 BSC	
R	0.07		0.003	
R1	0.07		0.003	
h	0.30	0.50	0.012	0.020
θ	0°	8°	0°	8°

Package Outline Dimensions (Con.)

PKG: TSSOP-14 (TSP14)

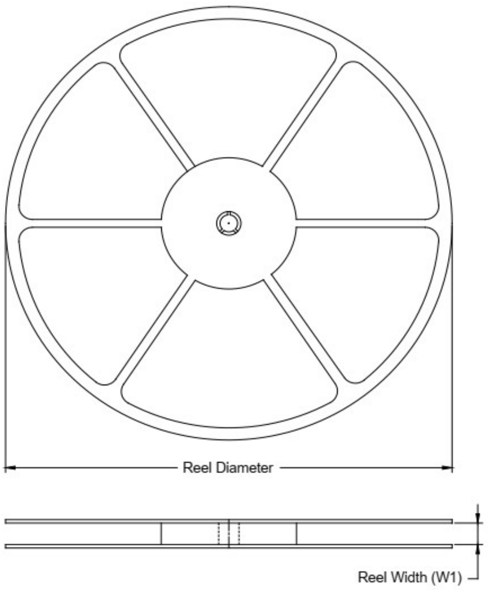
Unit: mm



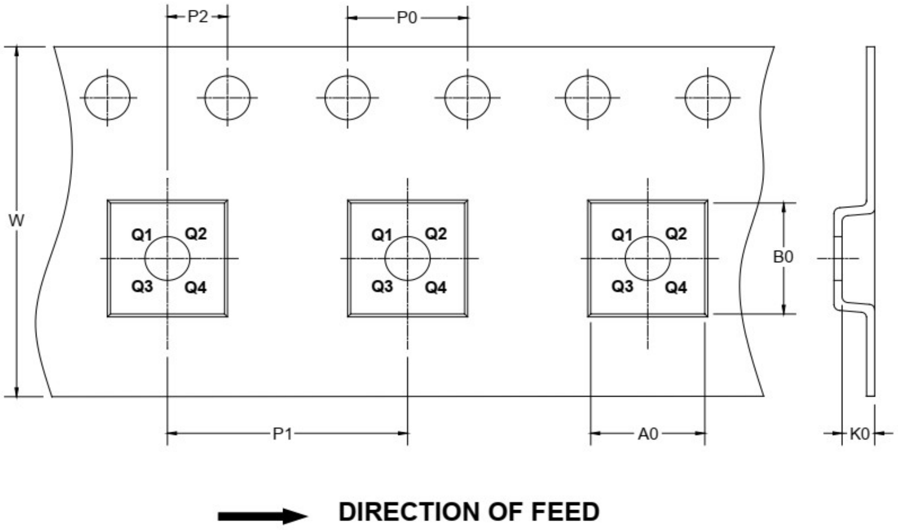
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS

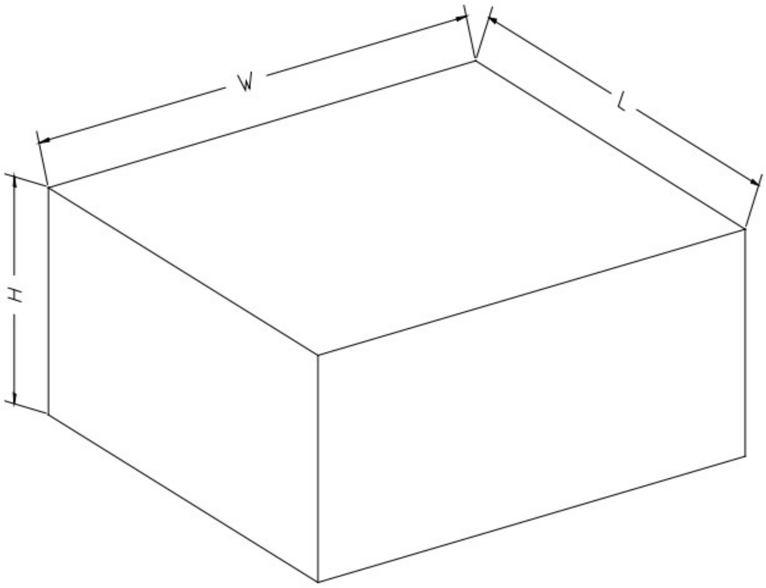


NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOIC-14	13″	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13″	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
13″	386	280	370	5