

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier**Features**

- * High Gain Bandwidth : 7MHz
- * Slew Rate: 3.8V/ μ s
- * Input Offset Voltage: ± 0.7 mV(Typ.) Vos
- * Low Noise: 7.5nV/ $\sqrt{\text{Hz}}$ at 10KHz
- * Rail-to-Rail Input and Output
- * Supply Voltage Range: 2.5V to 5.5V
- * Input Voltage Range: -0.1V to 5.6V
with Vs = 5.5V
- * Low Power:
 - HCR621: 600uA(Typ.)
 - HCR622/HCR624: 800uA/Amplifier(Typ.)
- * Operating Temperature: -40°C to +125°C

Applications

- * Active filter & Sensors
- * Photodiode Amplification
- * Test Equipment
- * Driving A/D Converters
- * Laptops and PDAs

General Description ^{note a}

The HCR621 (single) /HCR622 (dual) /HCR624 (quad) are operational amplifiers, which are optimized for low voltage /low noise and low power operation. These devices can operate from 2.5V to 5.5V single supply, and consume low quiescent current.

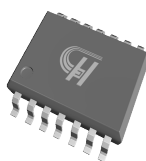
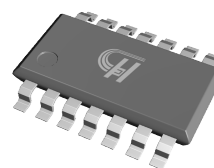
The HCR621 /2 /4 feature a 3mV maximum input offset voltage. The minimum input common mode voltage is within 0.1V below the negative rail, and the output swing is rail-to-rail with heavy loads. They exhibit a high gain-bandwidth product of 7MHz and a slew rate of 3.7V/ μ s.

These specifications make the operational amplifiers appropriate for various applications.

The HCR621 is available in Green SOT23-5 packages.

The HCR622 is available in Green SOIC-8, MSOP-8 and TSSOP-8 packages

The HCR624 is available in Green SOIC-14 and TSSOP-14 packages. They are specified over the extended industrial temperature range from -40 °C to +125°C.

**SOT23-5****TSSOP-8****MSOP-8****SOIC-8(SOP-8)****TSSOP-14****SOIC-14(SOP-14)****Figure 1. Package Type of HCR621/HCR622/HCR624**

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Pin Configuration

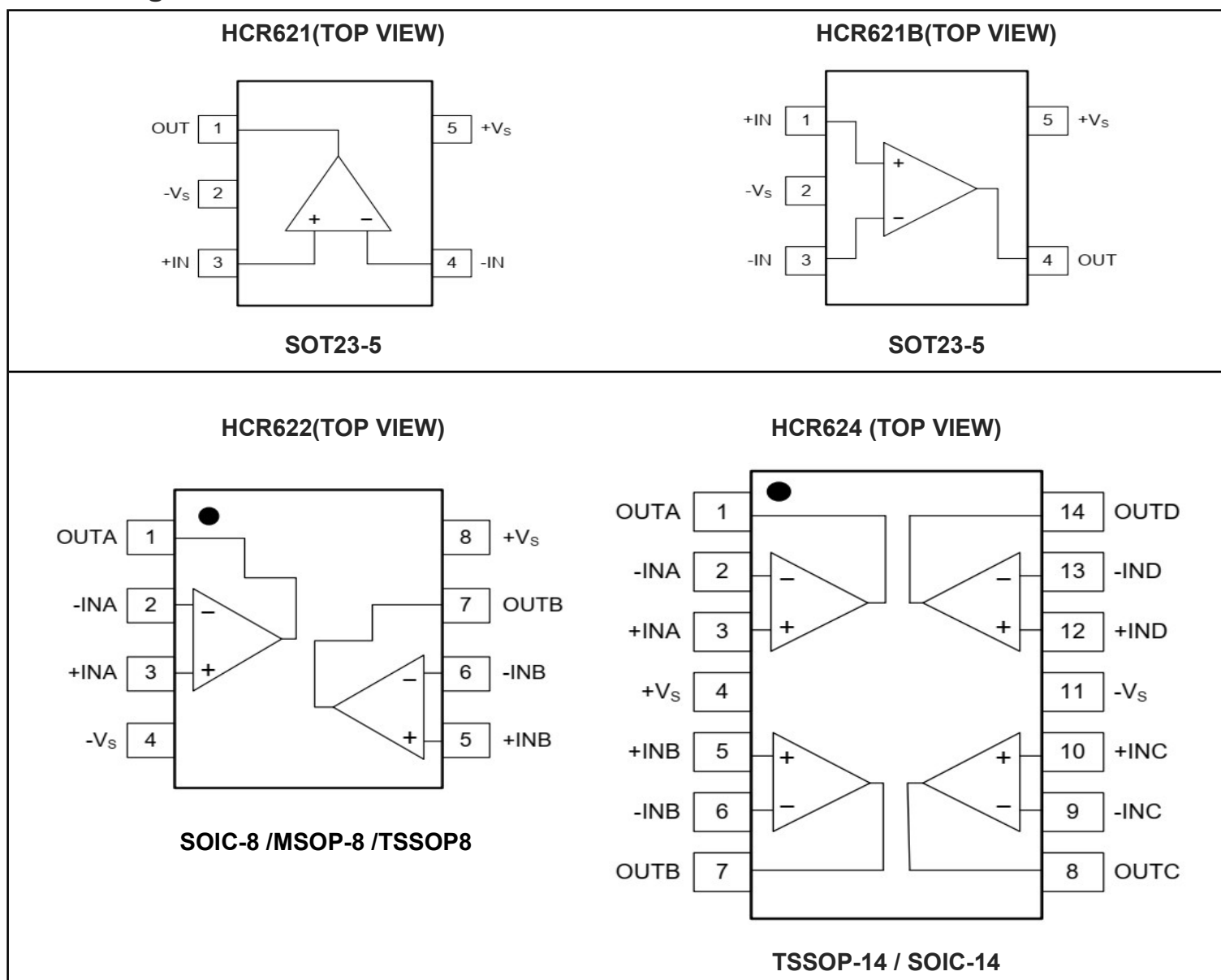
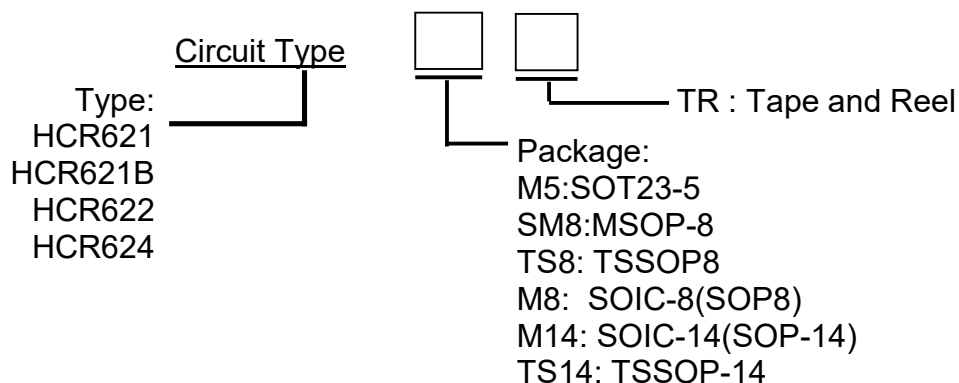


Figure 2. Pin Configuration of HCR621/HCR622/HCR624(Top View)

Pin Function Table

Name	Function
+IN, +INA, +INB, +INC, +IND	Non-inverting Inputs
-IN, -INA, -INB, -INC, -IND	Inverting Inputs
+Vs	Positive Power Supply
-Vs	Negative Power Supply
OUT, OUTA, OUTB, OUTC, OUTD	Outputs

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Ordering Information

Ordering Code

Part Number	Channel	Marking ⁽¹⁾	Op Temp('C)	MSL ⁽²⁾	Package	Package Qty
HCR621/M5TR	1	621	-40'C to +125'C	MSL3	SOT23-5	3000pcs/TR
HCR621B/M5TR	1	621B	-40'C to +125'C	MSL3	SOT23-5	3000pcs/TR
HCR622/SM8TR	2	HCR622xx	-40'C to +125'C	MSL3	MSOP-8	4000pcs/TR
HCR622/TS8TR	2	HCR622xx	-40'C to +125'C	MSL3	TSSOP8	4000pcs/TR
HCR622/M8TR	2	HCR622xx	-40'C to +125'C	MSL3	SOIC-8 (SOP-8)	4000pcs/TR
HCR624/M14TR	4	HCR624xx	-40'C to +125'C	MSL3	SOIC-14 (SOP-14)	2500pcs/TR
HCR624/TS14TR	4	HCR624xx	-40'C to +125'C	MSL3	TSSOP-14	4000pcs/TR

note 1: There may be additional marking, which relates to the lot trace code information(data code and vendor code), the logo or the environmental category on the device.

2: HCRSEMI classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F. Please align with HCRSEMI if your end application is quite critical to the preconditioning setting or if you have special requirement.

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Absolute Maximum Ratings

Over operating free-air temperature range(unless otherwise noted) ^[1]

Parameter		Symbol	Min.	Max.	Unit
Supply Voltage, +Vs to -Vs		V+	-	+7.0	V
Signal Input Voltage ^[2]		VIN	(V-) -0.5	(V+) +0.5	V
Signal Output Voltage ^[3]		Vout	(V-) -0.5	(V+) +0.5	V
Signal Input Current ^[2]		IIN	-10	+10	mA
Signal Output Current ^[3]		IO	-70	+70	mA
Output Short-circuit ^[4]		-	Continuous		-
Thermal Resistance @TA=+25°C ^[5]	SOT23-5	θJA	230		'C/W
	SOIC-8 (SOP8)	θJA	110		'C/W
	MSOP-8	θJA	170		'C/W
	TSSOP-8	θJA	240		'C/W
	SOIC-14	θJA	90		'C/W
	TSSOP-14	θJA	105		'C/W
Operating Temperature Range ^{note 2}		TOPR	-40 to +125		'C
Junction Temperature ^[6]		TJ	+150		'C
Storage Temperature Range		TSTG	-65 to +150		'C
Lead Temperature (Soldering, 10s)		TLEAD	260		'C
Human Body Model ESD Protection		ESD HBM	±5		KV
Machine Model ESD Protection		ESD MM	±400		V

Note: [1].Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

[2]. Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.

[3].Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ±70mA or less.

[4]. Short-circuit to ground, one amplifier per package.

[5]. The package thermal impedance is calculated in accordance with JEDEC-51.

[6].The maximum power dissipation is a function of TJ(MAX), RθJA, and TA. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_J(\text{MAX}) - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

Recommended Operating Conditions

Parameter		Symbol	Min.	Max.	Unit
Supply Voltage, +Vs to -Vs	Signal-supply	VIN	2.5	5.5	V
	Dual-supply		±1.25	±2.75	V
Operating Temperature Range		Ta	-40	+125	'C

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Electrical Characteristics

(TA=25°C, Vs=+5V, RL=10KΩ connected to Vs/2, and VOUT=Vs/2. Full^[9]=-40°C to 125°C, Unless Otherwise Specified.)

Parameter	Symbol	Conditions	Temp	Min	Type	Max	Unit
Input Characteristics							
Input Offset Voltage	V _{OS}	V _{CM} =V _S /2	25°C	-3.0	±0.7	3.0	mV
Input Offset Voltage Average Drift	V _{OS} TC		Full	-	2.0	-	uV/°C
Input Bias Current ^{[4][5]}	I _B		25°C	-	±1	±10	pA
Input Offset Current ^[4]	I _{OS}		25°C	-	±1	±10	pA
Common-Mode Voltage Range	V _{CM}	V _S =5.5V	25°C	-0.1	-	+5.6	V
Common Mode Rejection Ratio	CMRR	V _S =5.5V, V _{CM} = -0.1V to 4V	25°C	74	92	-	dB
			Full	68	-	-	
		V _S =5.5V, V _{CM} = -0.1V to 5.6V	25°C	62	83	-	
			Full	60	-	-	
Output Characteristics							
Open-Loop Voltage Gain	A _{OL}	R _L =2KΩ, V _{out} =+0.15V to 4.85V	25°C	96	102	-	dB
			Full	83	-	-	
		R _L =10KΩ, V _{out} =+0.05V to 4.95V	25°C	98	106	-	
			Full	85	-	-	
Output Voltage Swing from Rail	V _{OH}	R _L =2KΩ	25°C	-	40	-	mV
	V _{OL}	R _L =10KΩ	25°C	-	7	-	
Output Short-Circuit Current ^{[6][7]}	I _{out}	-	25°C	-	50	-	mA
Power Supply							
Operating Voltage Range	V _S		25°C	2.5	-	5.5	V
Quiescent Current per Amplifier	I _Q		25°C	-	600	800	uA
Power Supply Rejection Ratio	PSRR	V _S =2.5V to 5.5V, V _{CM} =(-V _S)+0.5V	25°C	78	93	-	dB
			Full	72	-	-	
Dynamic Performance							
Gain Bandwidth Product	GBP	-	25°C	-	7	-	MHz
Phase Margin	∅ _o	-	25°C	-	64	-	°
Slew Rate ^[8]	SR	-	25°C	-	3.7	-	V/us
Settling Time to 0.1%	t _s	-	25°C	-	0.5	-	us
Overload Recovery Time		V _{IN} XGain>=V _S	25°C	-	0.5	-	us

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier**Electrical Characteristics (con.)**

(TA=25°C, Vs=+5V, RL=10KΩ connected to Vs/2, and VOUT=Vs/2. Full=-40°C to 125°C, Unless Otherwise Specified.)

Parameter	Symbol	Conditions	Temp	Min	Type	Max	Unit
Noise Performance							
Voltage Noise Density	en	f=1KHz	25°C	-	11	-	nV/ √ Hz
		f=10KHz	25°C	-	7.5	-	nV/ √ Hz

Note: [1].Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

[2]. Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

[3]. Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

[4]. This parameter is ensured by design and/or characterization and is not tested in production.

[5]. Positive current corresponds to current flowing into the device.

[6]. The maximum power dissipation is a function of TJ(MAX), RθJA, and TA. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

[7]. Short circuit test is a momentary test.

[8]. Number specified is the slower of positive and negative slew rates.

[9]. Specified by characterization only.

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier
Typical Performance Characteristics.

(At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.)

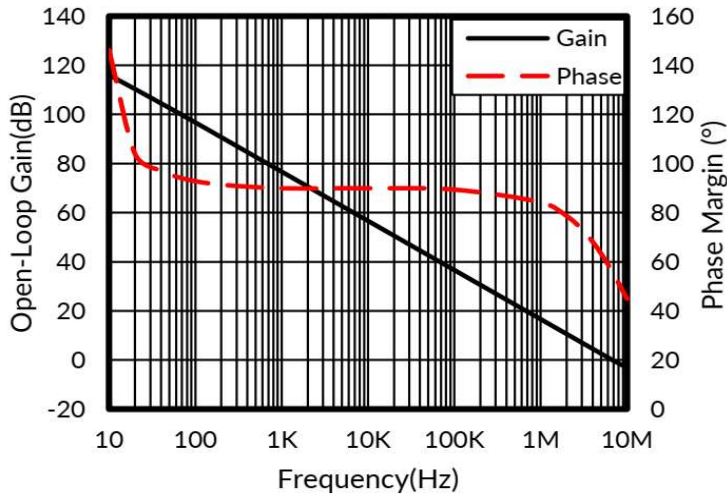


Figure 3. Open-Loop Gain and Phase vs Frequency

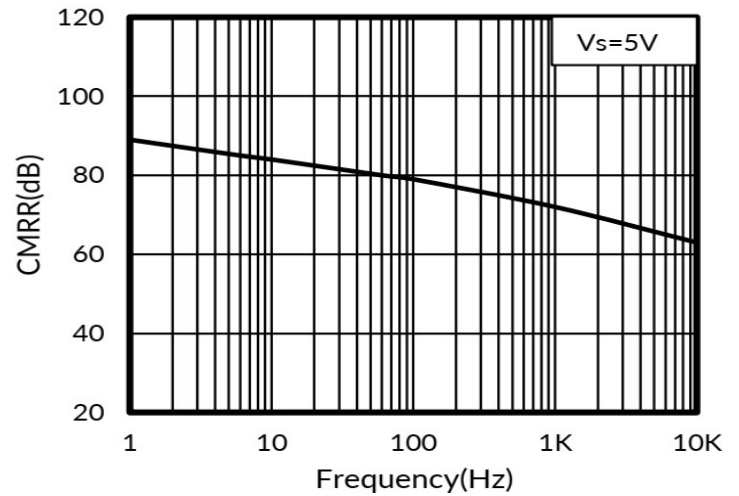


Figure 4. Common-Mode Rejection Ratio vs Frequency

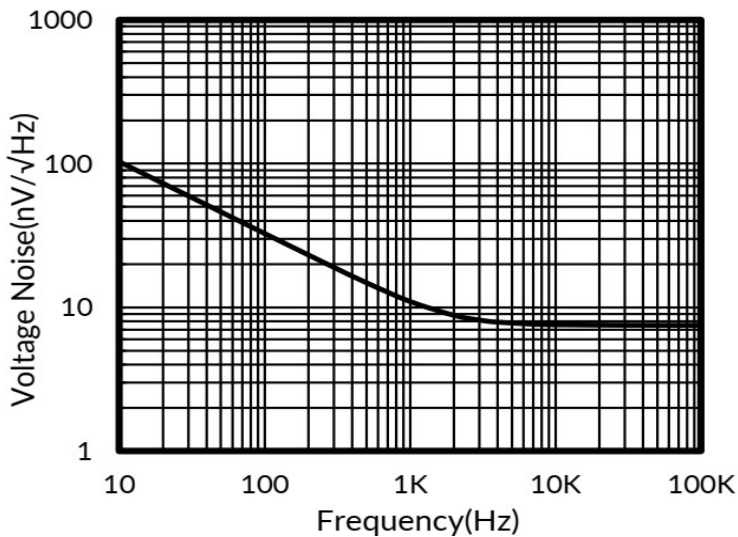


Figure 5. Input Voltage Noise Spectral Density vs Frequency

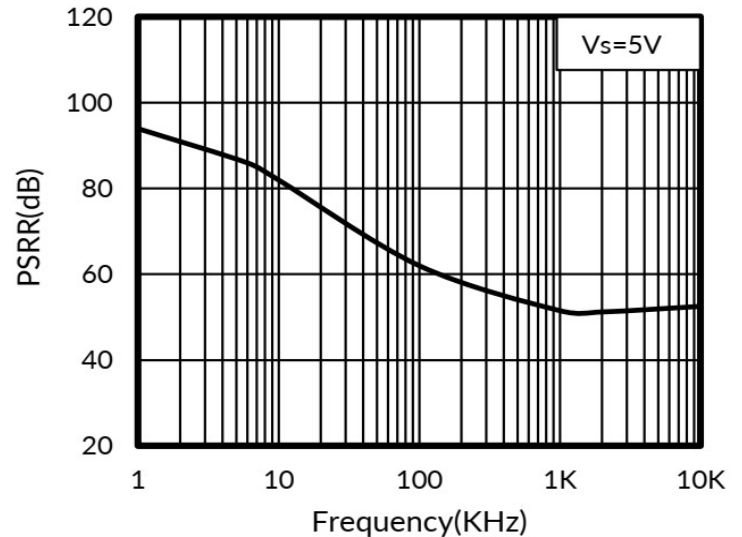


Figure 6. Power-Supply Rejection Ratio vs Frequency

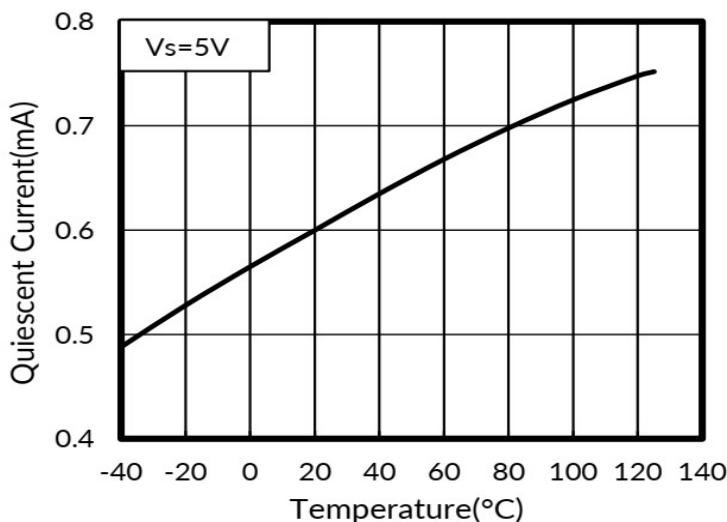


Figure 7. Quiescent Current vs Temperature

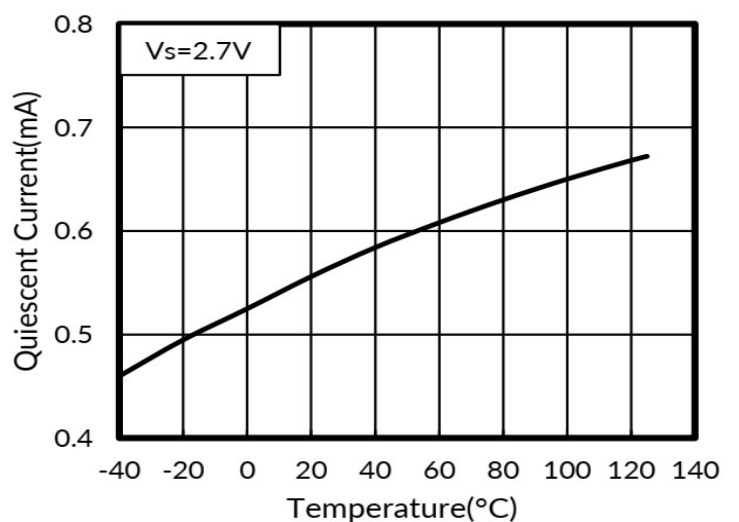


Figure 8. Quiescent Current vs Temperature

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Typical Performance Characteristics(con.)

(At $T_A = +25^{\circ}\text{C}$, $V_S = 5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.)

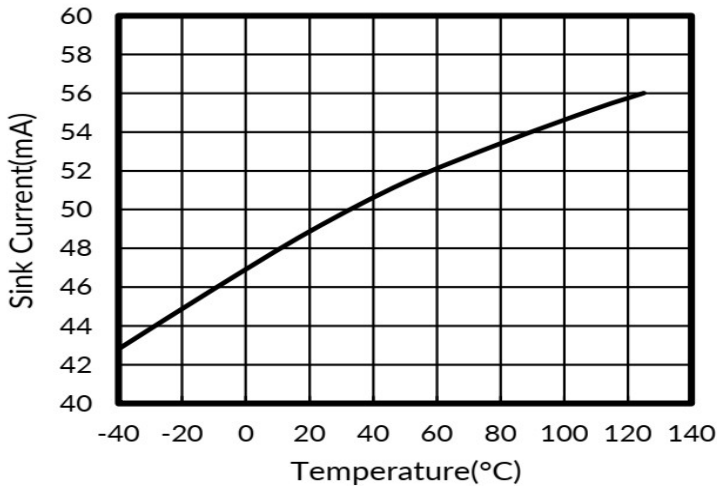


Figure 9. Sink Current vs Temperature

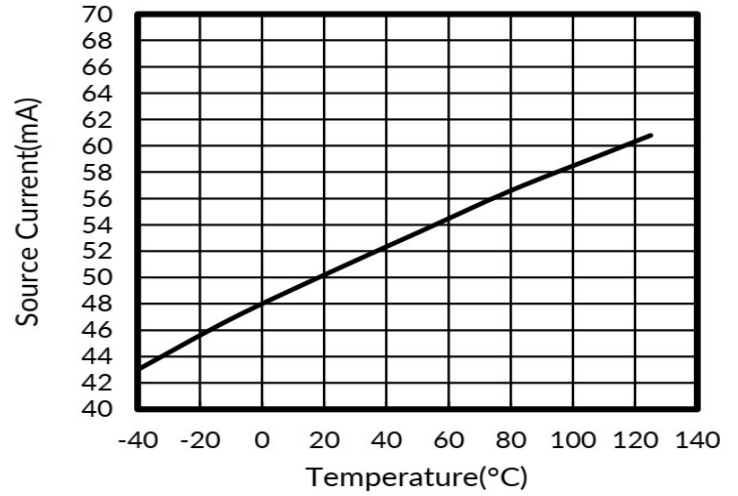


Figure 10. Source Current vs Temperature

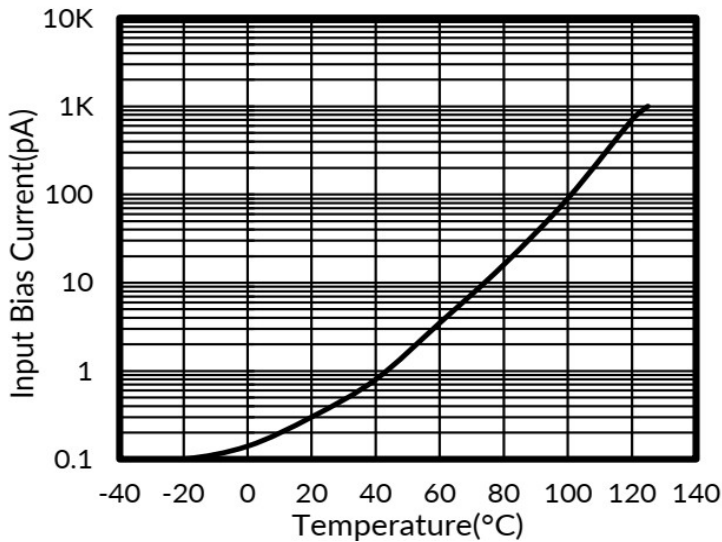


Figure 11. Input Bias Current vs Temperature

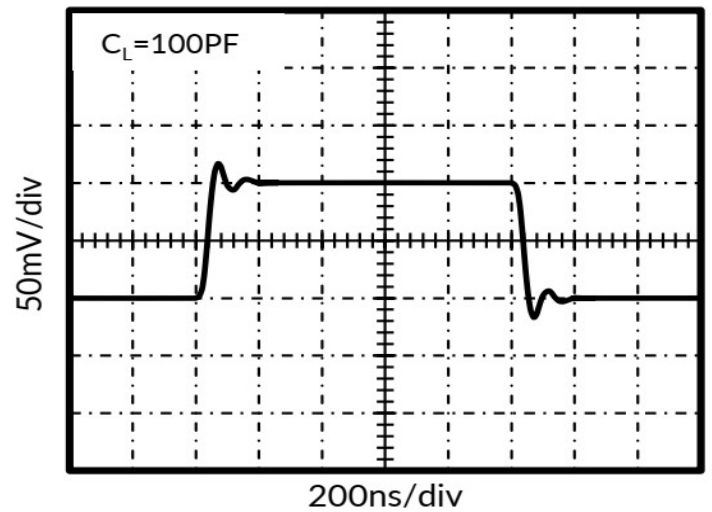


Figure 12. Small-Signal Step Response

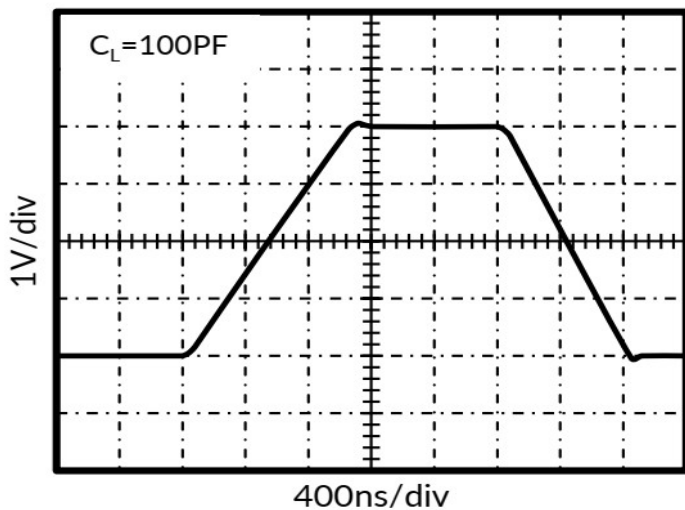


Figure 13. Large-Signal Step Response

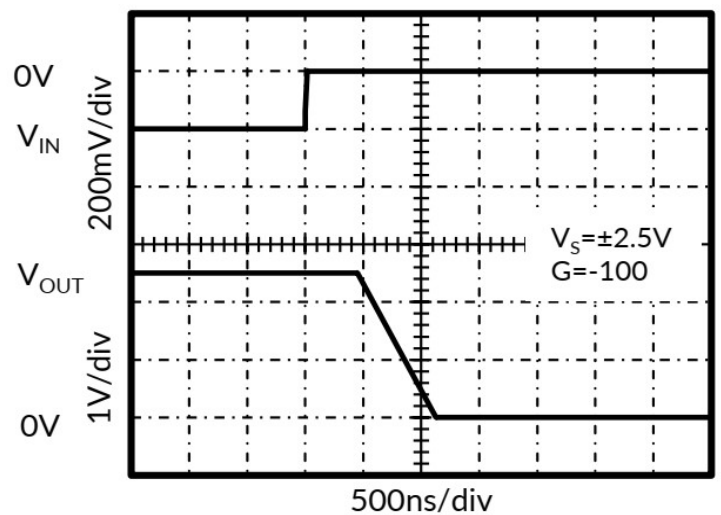


Figure 14. Positive Overload Recovery

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Typical Performance Characteristics(con.)

(At $T_A = +25^{\circ}\text{C}$, $V_S = 5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.)

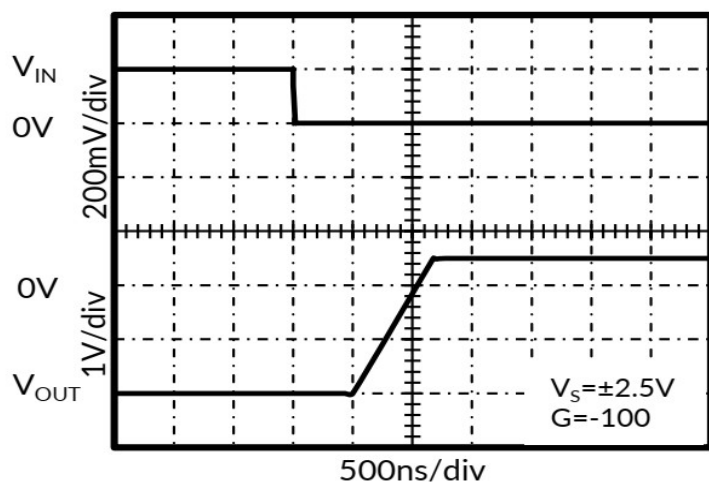


Figure 15. Negative Overload Recovery

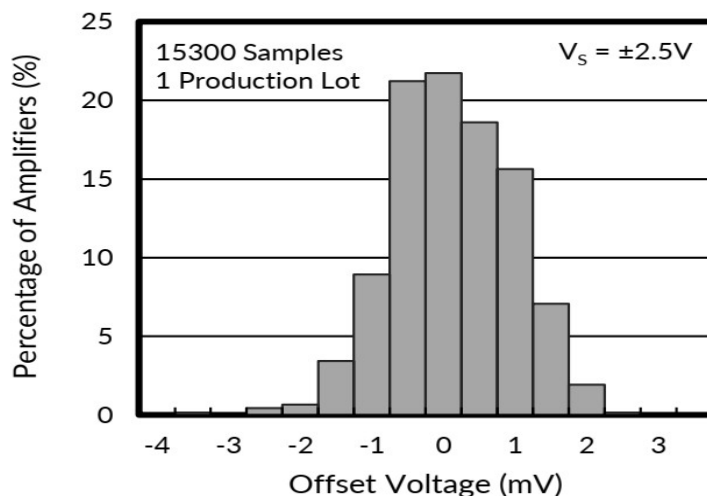


Figure 16. Offset Voltage Production Distribution

Detailed Description

Overview

The HCR621, HCR622, HCR624 are high precision, rail-to-rail operational amplifiers that can be run from a single supply voltage 2.5V to 5.5V($\pm 1.25\text{V}$ to $\pm 2.75\text{V}$). Supply voltages higher than 7V(absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Good layout practice mandates use of a $0.1\mu\text{F}$ capacitor place closely across the supply pins.

Phase Reversal Protection

The HCR621/HCR622/HCR624 family has internal phase-reversal protection. Many op amps exhibit phase reversal when the input is driven beyond the linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the HCR621/HCR622/HCR624 prevents phase reversal with excessive common-mode voltage. Instead, the appropriate rail limits the output voltage. This performance is shown in figure 17.



Figure 17. Output Waveform Devoid of Phase Reversal During an Input Overdrive Condition

EMI Rejection Ratio (EMIRR)

The electromagnetic interference (EMI) rejection ratio, or EMIRR, describes the EMI immunity of operational amplifiers. An adverse effect that is common to many operational amplifiers is a change in the offset voltage as a result of RF signal rectification. An operational amplifier that is more efficient at rejecting this change in offset as a result of EMI has a higher EMIRR and is quantified by a decibel value. Measuring EMIRR can be performed in many ways, but this document provides the EMIRR IN+, which specifically describes the EMIRR performance when the RF signal is applied to the noninverting input pin of the operational amplifier.

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier

Detailed Description(con)

EMI Rejection Ratio (EMIRR)

In general, only the noninverting input is tested for EMIRR for the following three reasons:

- Operational amplifier input pins are known to be the most sensitive to EMI, and typically rectify RF signals better than the supply or output pins.
- The noninverting and inverting operational amplifier inputs have symmetrical physical layouts and exhibit nearly matching EMIRR performance.
- EMIRR is easier to measure on noninverting pins than on other pins because the noninverting input pin can be isolated on a printed-circuit-board (PCB). This isolation allows the RF signal to be applied directly to the noninverting input pin with no complex interactions from other components or connecting PCB traces.

The EMIRR IN+ of the HCR621/HCR622/HCR624 is plotted versus frequency in Figure 18. If available, any dual and quad operational amplifier device versions have approximately identical EMIRR IN+ performance. The HCR621/HCR622/HCR624 unity-gain bandwidth is 7MHz. EMIRR performance below this frequency denotes interfering signals that fall within the operational amplifier bandwidth.

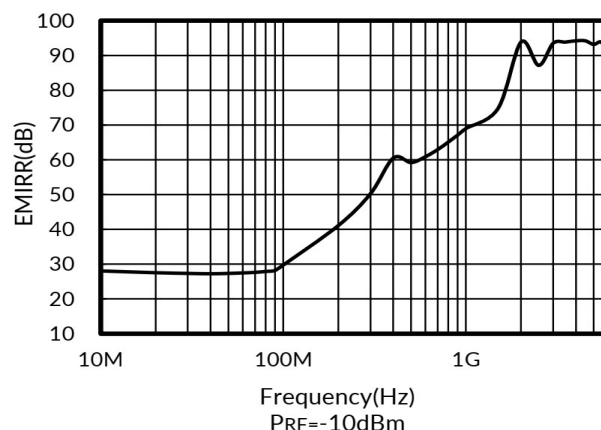


Figure 18. HCR621/HCR622/HCR624 EMIRR vs Frequency

EMIRR IN+ Test Configuration

Figure 19 shows the circuit configuration for testing the EMIRR IN+. RF source is connected to the operational amplifier noninverting input pin using a transmission line. The operational amplifier is configured in a unity-gain buffer topology with the output connected to a low-pass filter (LPF) and a digital multimeter (DMM). A large impedance mismatch at the operational amplifier input causes a voltage reflection; however, this effect is characterized and accounted for when determining the EMIRR IN+. The resulting dc offset voltage is sampled and measured by the multimeter. The LPF isolates the multimeter from residual RF signals that can interfere with multimeter accuracy.

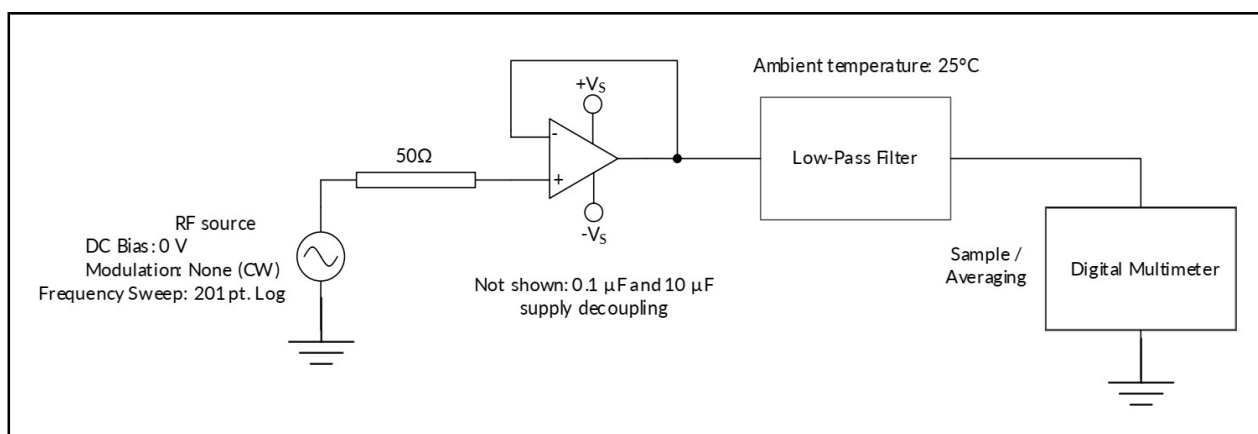


Figure 19. EMIRR IN+ Test Configuration Schematic

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Application Note

The HCR621/HCR622/HCR624 are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V ($\pm 1.25\text{V}$ to $\pm 2.75\text{V}$). Supply voltages higher than 7V (absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Good layout practice mandates use of a 0.1 μF capacitor place closely across the supply pins.

Typical Applications

25-kHz Low-pass Filter

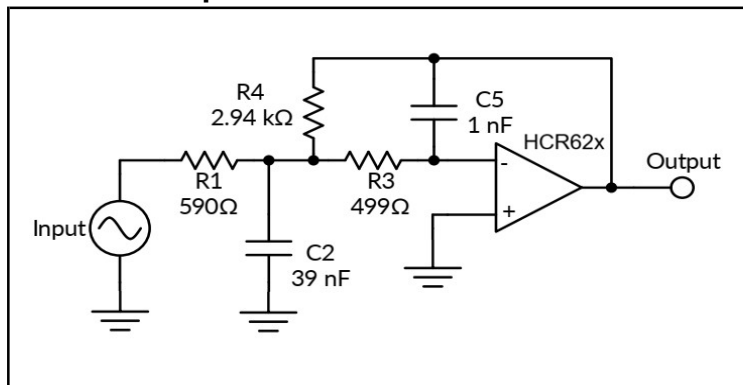


Figure 20. 25-kHz Low-pass Filter

Design Requirements

Low-pass filters are commonly employed in signal processing applications to reduce noise and prevent aliasing.

The HCR621/HCR622/HCR624 devices are ideally suited to construct high-speed, high-precision active filters. Figure 20 shows a second-order, low-pass filter commonly encountered in signal processing applications.

Use the following parameters for this design example:

- Gain = 5 V/V (inverting gain)
- Low-pass cutoff frequency = 25 kHz
- Second-order Chebyshev filter response with 3-dB gain peaking in the passband

Detailed Design Procedure

The infinite-gain multiple-feedback circuit for a low-pass network function is shown in Figure 20. Use Equation 1 to calculate the voltage transfer function.

$$\frac{\text{Output}}{\text{Input}}(s) = \frac{-1/R_1 R_3 C_2 C_5}{s^2 + (s/C_2) (1/R_1 + 1/R_3 + 1/R_4) + 1/R_3 R_4 C_2 C_5} \quad (1)$$

This circuit produces a signal inversion. For this circuit, the gain at dc and the low-pass cutoff frequency are calculated by Equation 2:

$$\text{Gain} = \frac{R_4}{R_1} \quad (2)$$

$$f_c = \frac{1}{2\pi} \sqrt{1/R_3 R_4 C_2 C_5}$$

Application Curve

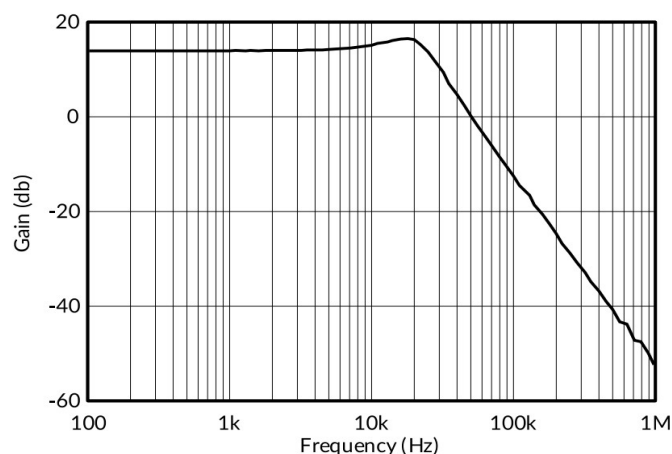


Figure 21. Low-Pass Filter Transfer Function

Layout Guidelines

Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1 μF capacitor closely across the supply pins. These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI susceptibility.

Layout Example

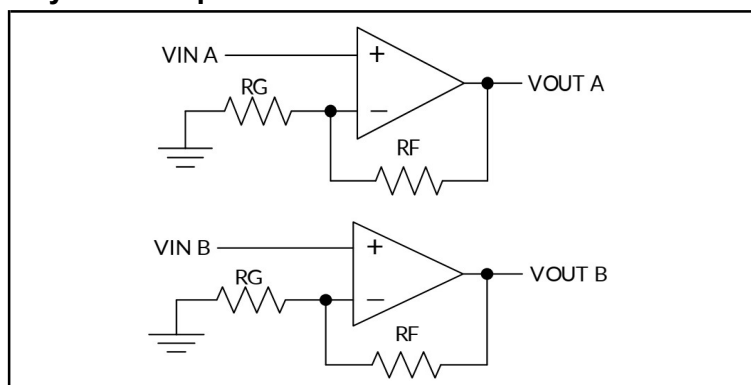
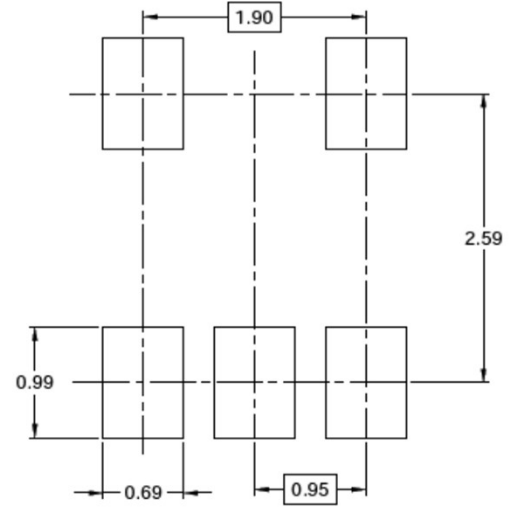
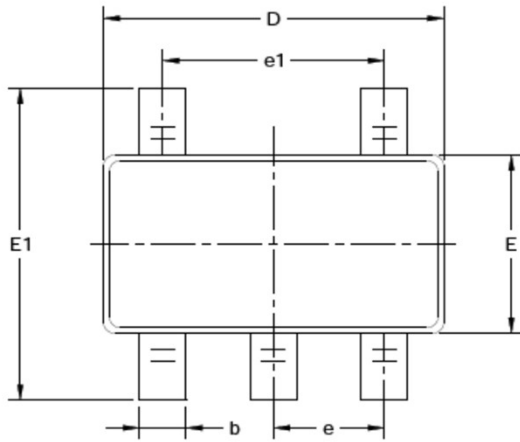


Figure 22. Schematic Representation

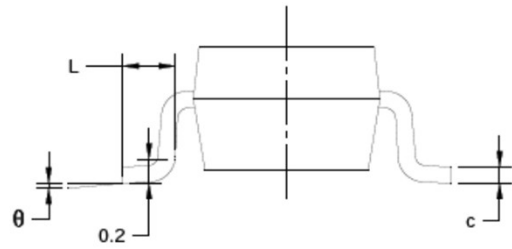
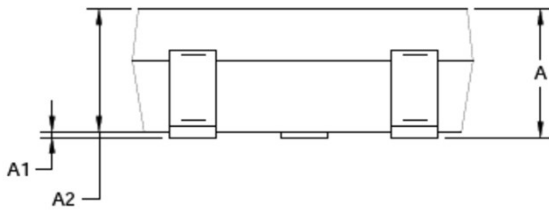
7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier

Mechanical Dimensions

M5: SOT23-5 package



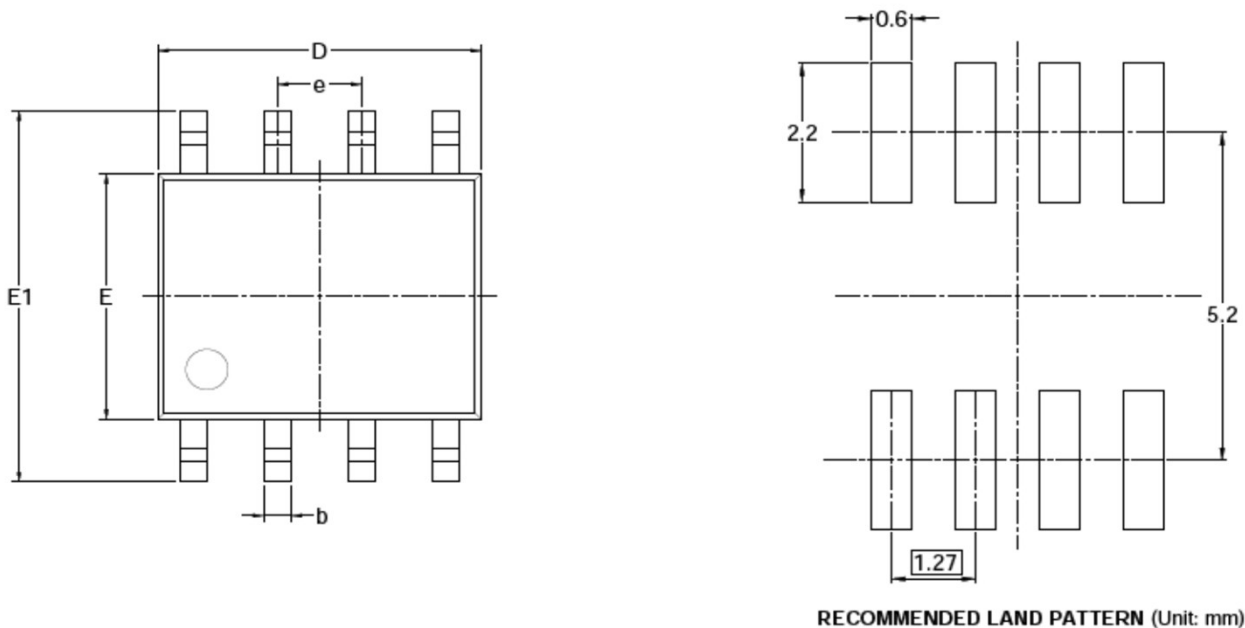
RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

NOTES:

1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier
Mechanical Dimensions(Con.)
M8: SOIC-8(SOP-8) Package


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	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

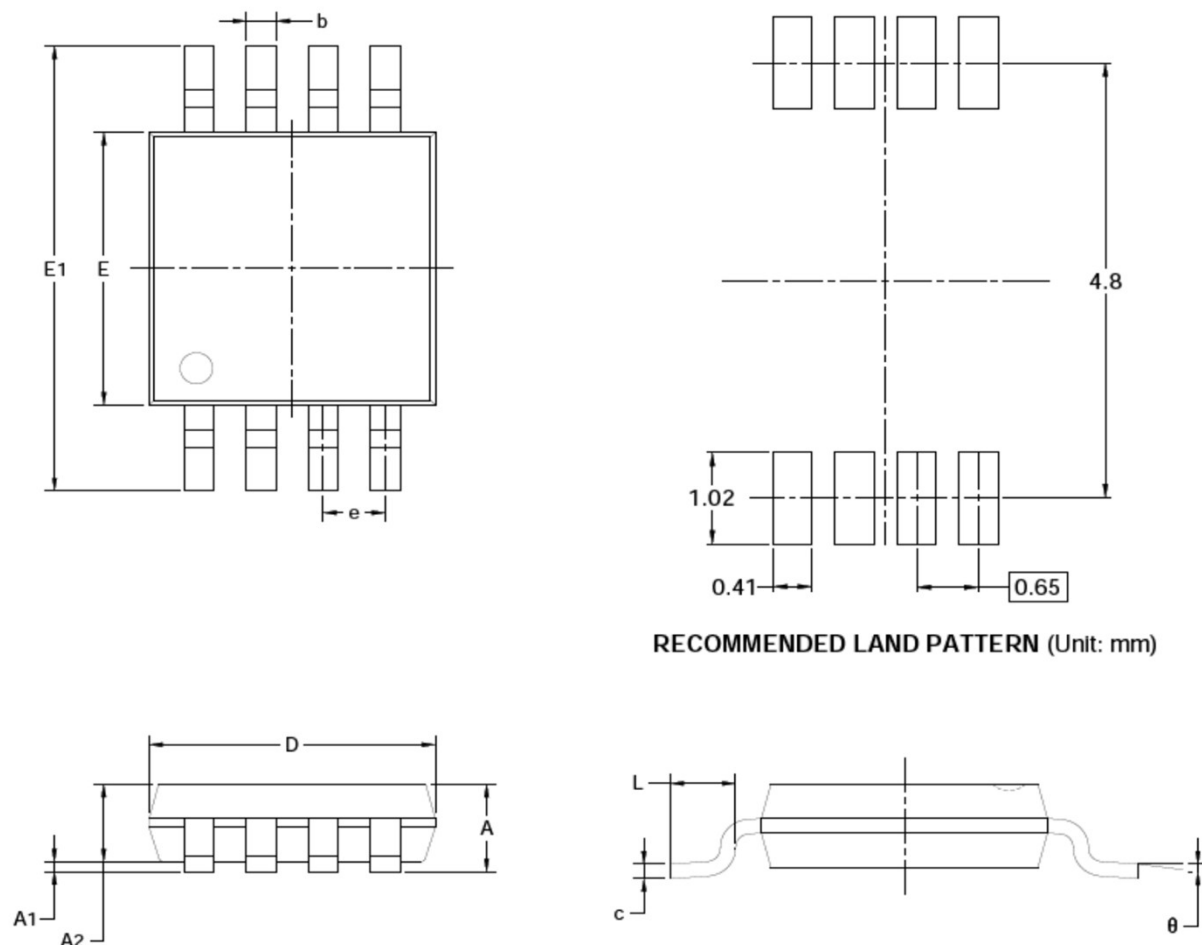
NOTES:

1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier

Mechanical Dimensions(Con.)

SM8: MSOP-8 Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

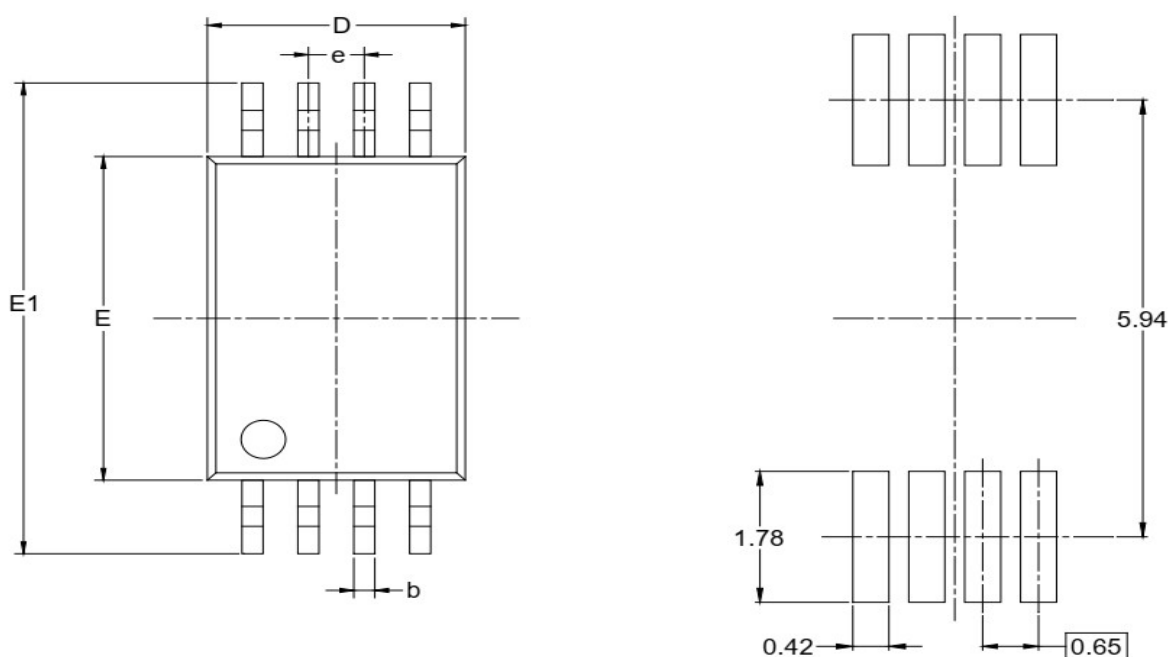
NOTES:

1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

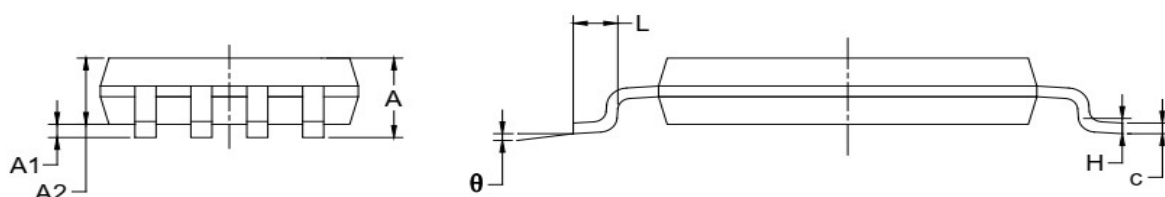
7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier

Mechanical Dimensions(Con.)

TS8: TSSOP-8 Package



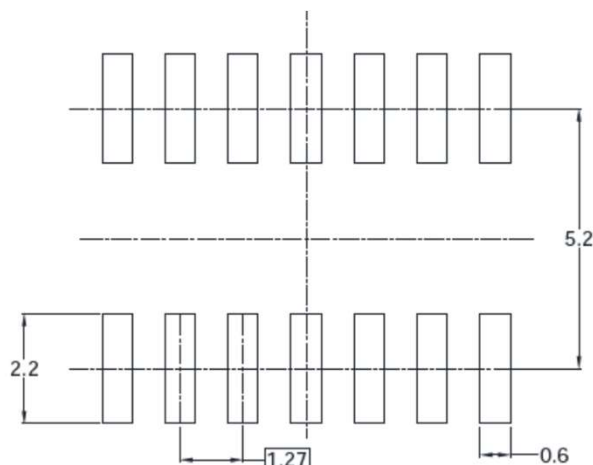
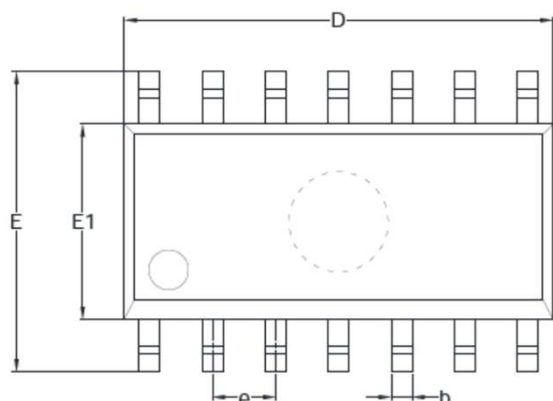
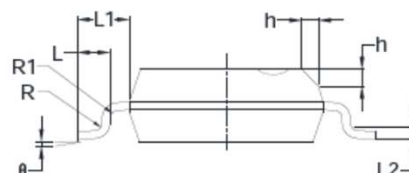
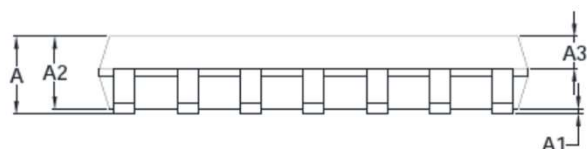
RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
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°

NOTES:

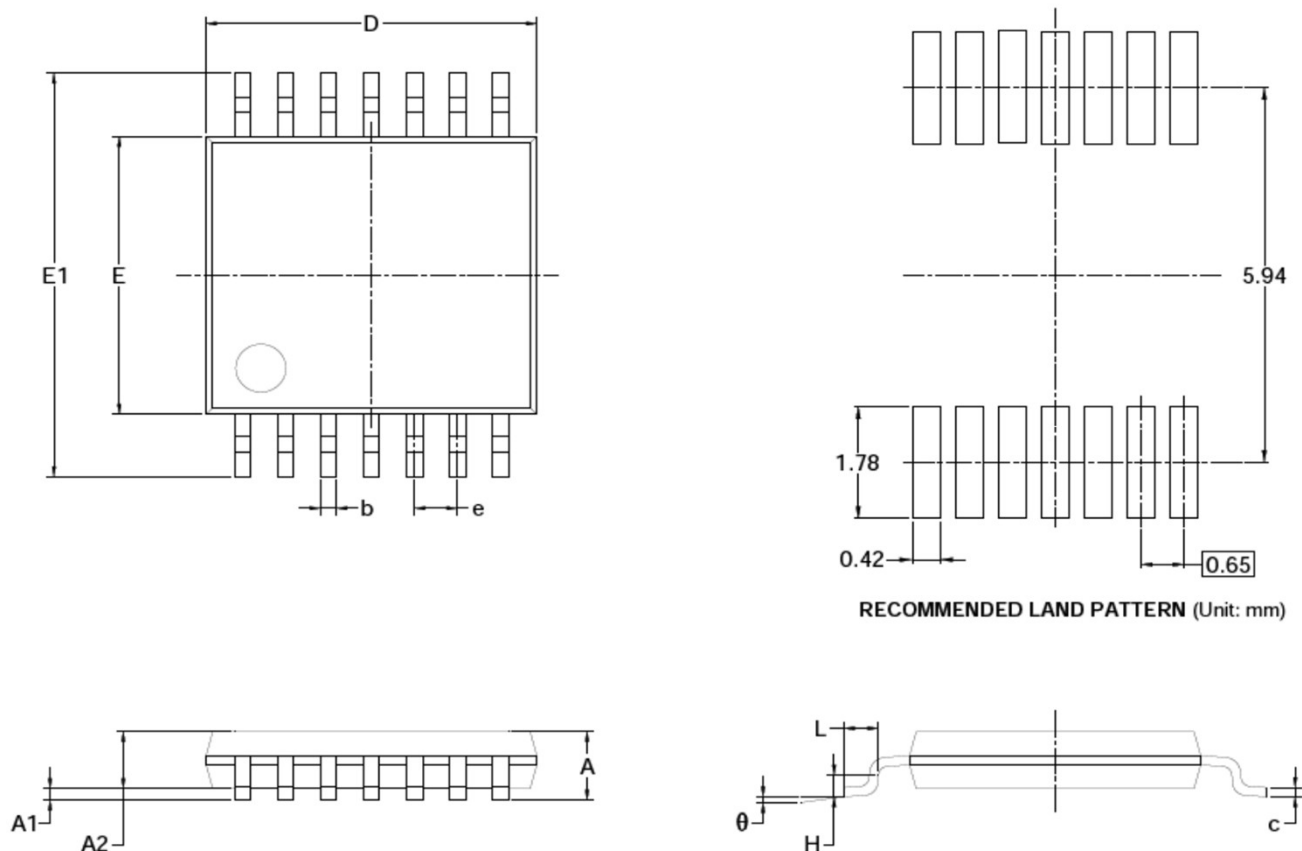
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier
Mechanical Dimensions(Con.)
M14: SOIC-14 Package

RECOMMENDED LAND PATTERN (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°

NOTES:

1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

7MHz, Low Noise Rail-to-Rail I/O CMOS Operational Amplifier
Mechanical Dimensions(Con.)
TS14: TSSOP-14 Package


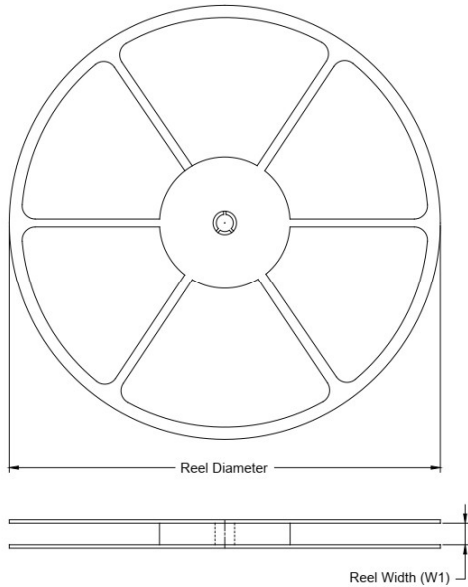
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500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

NOTES:

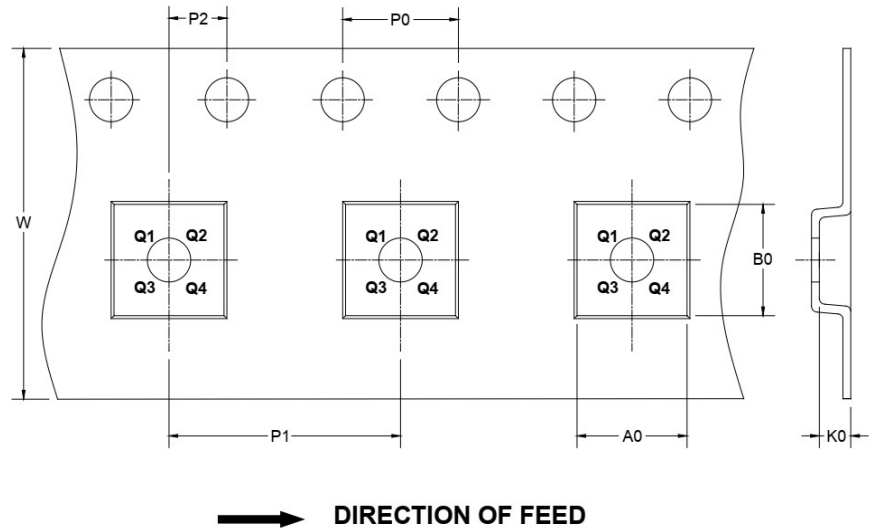
1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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
SOT-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOIC-8 (SOP-8)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
TSSOP-8	13"	12.4	6.90	3.45	1.65	4.0	8.0	2.0	12.0	Q1
SOIC-14 (SOP-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

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