1.1MHz, Precision, Rail-to-Rail I/O CMOS Operational Amplifier

FEATURES

- **HIGH GAIN BANDWIDTH:1.1MHz**
- **RAIL-TO-RAIL INPUT AND OUTPUT ±3mV Max Vos**
- **INPUT VOLTAGE RANGE: -0.2V to +5.7V with Vs = 5.5V**
- **SUPPLY RANGE: +2.3V to +5.5V**
- **SPECIFIED UP TO +125°C**
- **Micro SIZE PACKAGES: SOT23-5, SC70-5**

APPLICATIONS

- **SENSORS**
- **PHOTODIODE AMPLIFICATION**
- **ACTIVE FILTERS**
- **TEST EQUIPMENT**
- **DRIVING A/D CONVERTERS**

DESCRIPTION

The RS6331K, RS6332K, RS6334K families of products offer low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1.1MHz) and slew rate of 0.5V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The RS6331K, RS6332K and RS6334K has lower offset, which is guaranteed not upper than ±3mV at 25°C with Vs = 5V, V_{CM} = Vs/2.

The devices are ideal for sensor interfaces, active filters and portable applications. The RS6331K, RS6332K, RS6334K families of operational amplifiers are specified at the full temperature range of −40°C to +125°C under single or dual power supplies of 2.3V to 5.5V.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS6331K	SOT23-5	2.90mm×1.60mm
	SC70-5	2.10mm×1.25mm
	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm
RS6332K	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm
	TSSOP8	3.00mm×4.40mm
RS6334K	SOP14	8.65mm×3.90mm
	TSSOP14	5.00mm×4.40mm

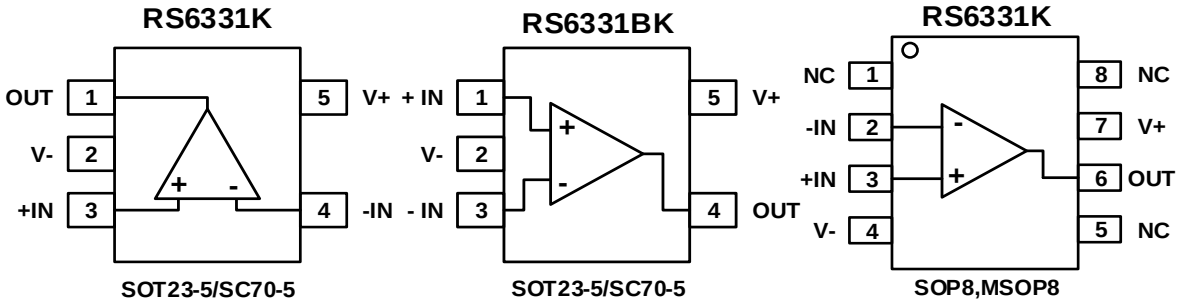
(1) For all available packages, see the orderable addendum at the end of the data sheet.

Revision History

Note: Page numbers for previous revisions may different from page numbers in the current version.

Version	Change Date	Change Item
C.1	2024/02/29	1. Update Package Qty on Page 2@RevB.5 2. Add the TAPE AND REEL INFORMATIOPN 3. Modify packaging naming

Pin Configuration and Functions (Top View)

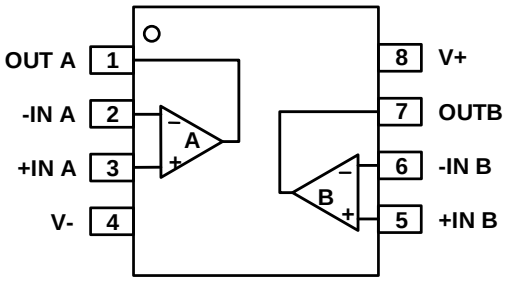


Pin Description

NAME	PIN			I/O	DESCRIPTION
	RS6331K	RS6331BK	RS6331K		
	SOT23-5/SC70-5	SOT23-5/SC70-5	SOP8/MSOP8		
-IN	4	3	2	I	Negative (inverting) input
+IN	3	1	3	I	Positive (noninverting) input
NC	-	-	1,5,8	-	No internal connection (can be left floating)
OUT	1	4	6	O	Output
V-	2	2	4	-	Negative (lowest) power supply
V+	5	5	7	-	Positive (highest) power supply

Pin Configuration and Functions (Top View)

RS6332K

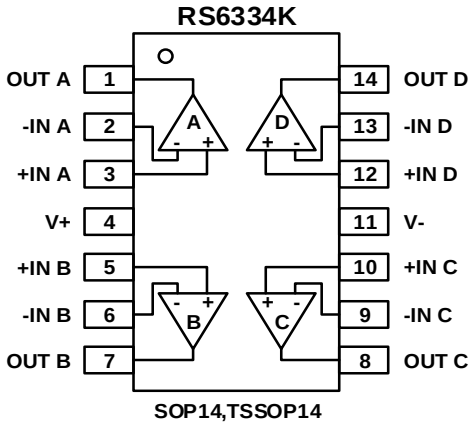


SOP8,MSOP8,TSSOP8

Pin Description

NAME	PIN	I/O	DESCRIPTION
	RS6332K		
	SOP8/MSOP8/TSSOP8		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
EnA	-	I	Enable pin, channel A. This pin turns the regulator on or off. Low = disabled, high = normal operation (pin must be driven)
EnB	-	I	Enable pin, channel B. This pin turns the regulator on or off. Low = disabled, high = normal operation (pin must be driven)
V-	4	-	Negative (lowest) power supply
V+	8	-	Positive (highest) power supply

Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN	I/O	DESCRIPTION
	SOP14/TSSOP14		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
-INC	9	I	Inverting input, channel C
+INC	10	I	Noninverting input, channel C
-IND	13	I	Inverting input, channel D
+IND	12	I	Noninverting input, channel D
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
OUTC	8	O	Output, channel C
OUTD	14	O	Output, channel D
V-	11	-	Negative (lowest) power supply
V+	4	-	Positive (highest) power supply

SPECIFICATIONS

Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Voltage	Supply, Vs=(V+) - (V-)		7	V
	Signal input pin (2)	(V-)-0.5	(V+) +0.5	
	Signal output pin (3)	(V-)-0.5	(V+) +0.5	
Current	Signal input pin (2)	-10	10	mA
	Signal output pin (3)	-200	200	mA
	Output short-circuit (4)	Continuous		
Temperature	Operating range, T_A	-40	125	°C
	Junction, T_J	-40	150	
	Storage, T_{stg}	-65	150	

(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 ±200mA or less.
(4) Short-circuit to ground, one amplifier per package.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	±3000	V
		Machine Model (MM)	±200	

Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage，Vs= (V+) - (V-)	Single-supply	2.3		5.5	V
	Dual-supply	±1.15		±2.75	

Thermal Information: RS6331K

THERMAL METRIC		RS6331K				UNIT
		5PINS		8PINS		
		SOT23-5	SC70-5	SOP8	MSOP8	
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	273.8	214.7	116	165	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	126.8	127.1	60	53	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	85.9	60.0	56	87	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	10.9	33.4	12.8	4.9	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	84.9	59.8	98.3	85	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	N/A	N/A	°C/W

Thermal Information: RS6332K

THERMAL METRIC		RS6332K			UNIT
		8PINS			
		SOP8	MSOP8	TSSOP8	
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	116	165	200.8	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	60	53	95.3	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	56	87	128.5	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	12.8	4.9	26.5	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	98.3	85	125.9	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	N/A	°C/W

Thermal Information: RS6334K

THERMAL METRIC		RS6334K		UNIT
		14PINS		
		SOP14	TSSOP14	
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	83.8	120.8	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	70.7	34.3	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	59.5	62.8	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	11.6	1	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	37.7	56.5	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	°C/W

PACKAGE/ORDERING INFORMATION

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking(1)	Package Qty
RS6331KXF	SOT23-5	5	1	-40°C ~125°C	6331K	Tape and Reel,3000
RS6331BKXF	SOT23-5	5	1	-40°C ~125°C	6331BK	Tape and Reel,3000
RS6331KXK	SOP8	8	1	-40°C ~125°C	RS6331K	Tape and Reel,4000
RS6331KXM	MSOP8	8	1	-40°C ~125°C	RS6331K	Tape and Reel,4000
RS6331KXC5	SC70-5 (2)	5	1	-40°C ~125°C	6331K	Tape and Reel,3000
RS6331BKXC5	SC70-5 (2)	5	1	-40°C ~125°C	6331BK	Tape and Reel,3000
RS6332KXK	SOP8	8	2	-40°C ~125°C	RS6332K	Tape and Reel,4000
RS6332KXM	MSOP8	8	2	-40°C ~125°C	RS6332K	Tape and Reel,4000
RS6332KXQ	TSSOP8	8	2	-40°C ~125°C	RS6332K	Tape and Reel,4000
RS6334KXP	SOP14	14	4	-40°C ~125°C	RS6334K	Tape and Reel,4000
RS6334KXQ	TSSOP14	14	4	-40°C ~125°C	RS6334K	Tape and Reel,4000

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) Equivalent to SOT353.

ELECTRICAL CHARACTERISTICS

(At T_A = +25°C, V_S=5V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER		CONDITIONS	T_J	RS6331K, RS6332K, RS6334K			
				MIN	TYP	MAX	UNIT
POWER SUPPLY							
V_S	Operating Voltage Range		25°C	2.3		5.5	V
IQ	Quiescent Current/Amplifier		25°C		80	140	uA
PSRR	Power-Supply Rejection Ratio	V_S=2.3V to 5.5V, V_{CM}=(V-)+0.5V	25°C	74	90		dB
			-40°C to 125°C	65			
INPUT							
V_{OS}	Input Offset Voltage	V_{CM}=0V to 3.5V	25°C	-3	±0.8	3	mV
V_{OS} T_C	Input Offset Voltage Average Drift		-40°C to 125°C		±2		uV/°C
IB	Input Bias Current		25°C		±1	±10	pA
I_{OS}	Input Offset Current		25°C		±1	±10	pA
V_{CM}	Common-Mode Voltage Range	V_S= 5.5V	25°C	-0.2		5.7	V
CMRR	Common-Mode Rejection Ratio	V_S= 5.5V, V_{CM} =-0.2V to 4V	25°C	74	90		dB
			-40°C to 125°C	68			
		V_S= 5.5V, V_{CM} =-0.2V to 5.7V	25°C	63	80		
			-40°C to 125°C	57			
OUTPUT							
A_{OL}	Open-Loop Voltage Gain	R_L=2KΩ, Vo= 0.15V to 4.85V	25°C	95	105		dB
			-40°C to 125°C	85			
		R_L=10KΩ, Vo= 0.05V to 4.95V	25°C	100	110		
			-40°C to 125°C	92			
	Output Swing From Rail	R_L=2KΩ	25°C		25		mV
		R_L=10KΩ			8		
I_{OUT}	Output Short-Circuit Current		25°C		120		mA
FREQUENCY RESPONSE							
SR	Slew Rate		25°C		0.5		V/us
GBP	Gain-Bandwidth Product		25°C		1.1		MHz
PM	Phase Margin		25°C		64		°
t_S	Setting Time,0.1%				1.3		us
	Overload Recovery Time	V_{IN}·Gain≥V_S			4		us
NOISE							
e_n	Input Voltage Noise Density	f = 1KHz	25°C		22		nV/√Hz
		f = 10KHz	25°C		20		nV/√Hz

TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to V_S/2, V_{OUT} = V_S/2, unless otherwise noted.

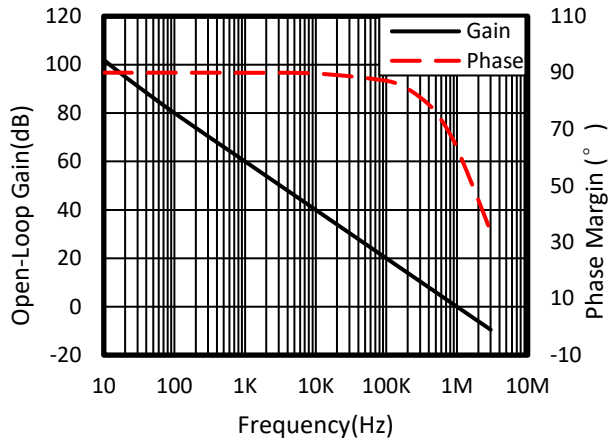


Figure 1. Open-Loop Gain and Phase vs Frequency

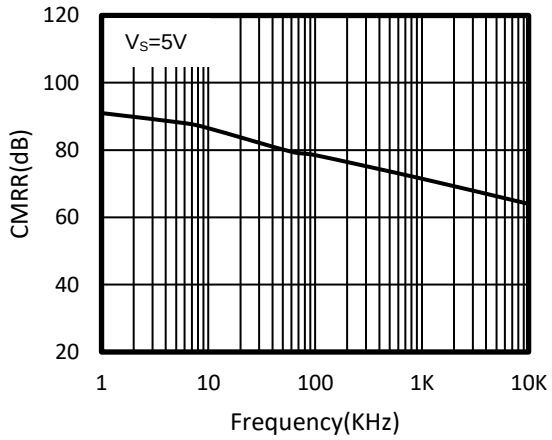


Figure 2. Common-Mode Rejection Ratio vs Frequency

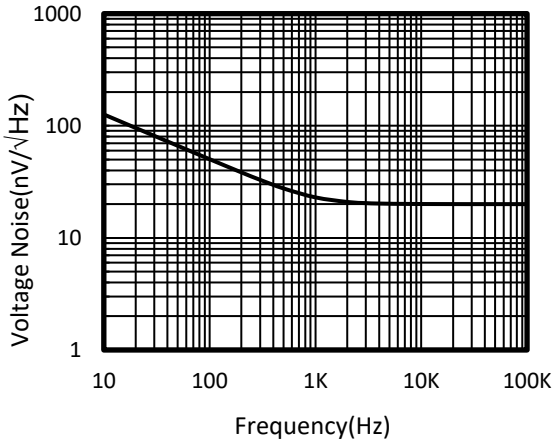


Figure 3. Input Voltage Noise Spectral Density vs Frequency

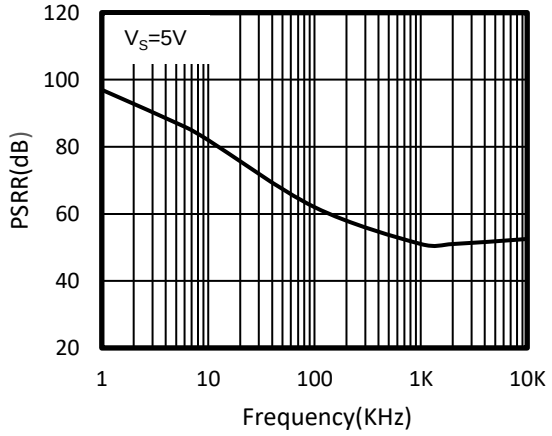


Figure 4. Power-Supply Rejection Ratio vs Frequency

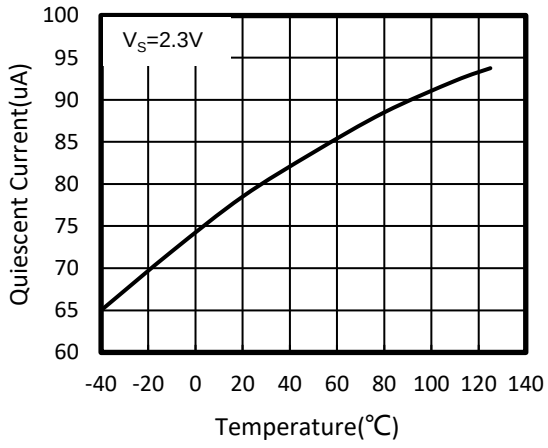


Figure 5. Quiescent Current vs Temperature

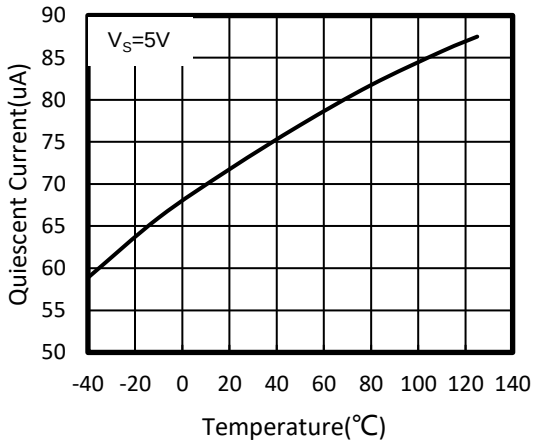


Figure 6. Quiescent Current vs Temperature

TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to V_S/2, V_{OUT} = V_S/2, unless otherwise noted.

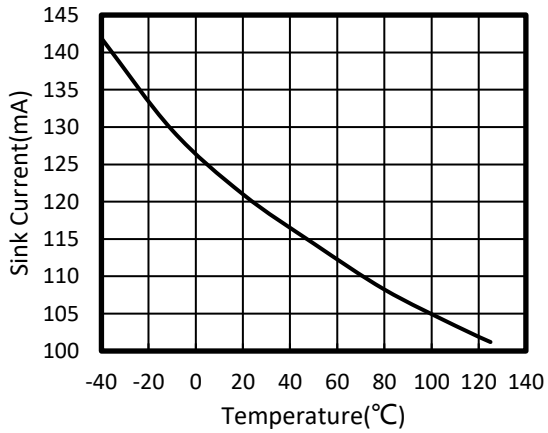


Figure 7. Sink Current vs Temperature

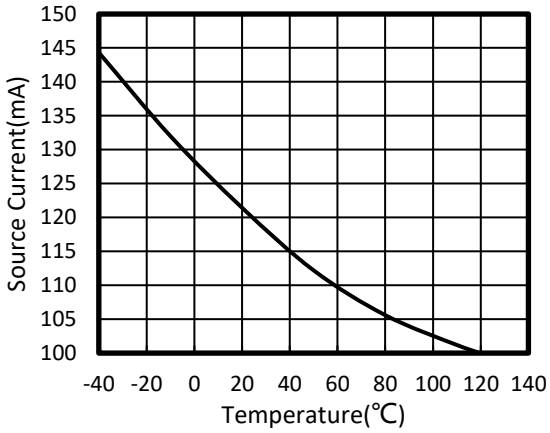


Figure 8. Source Current vs Temperature

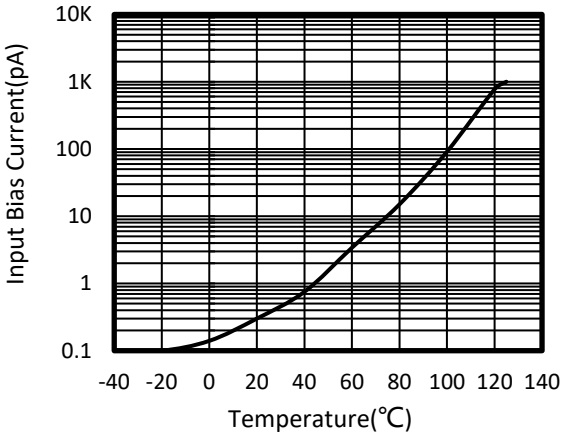


Figure 9. Input Bias Current vs Temperature

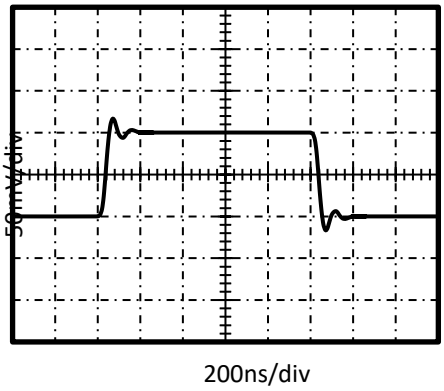


Figure 10. Small-Signal Step Response

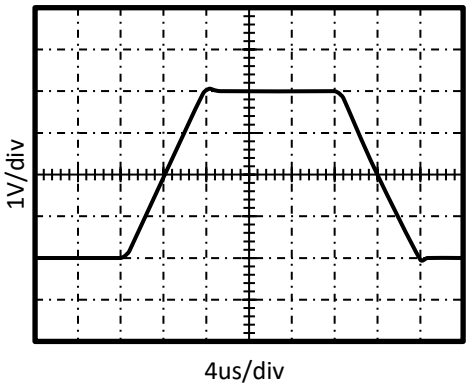


Figure 11. Large-Signal Step Response

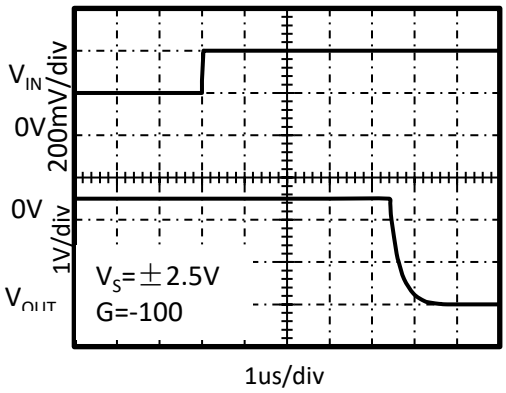


Figure 12. Positive Overvoltage Recovery

TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

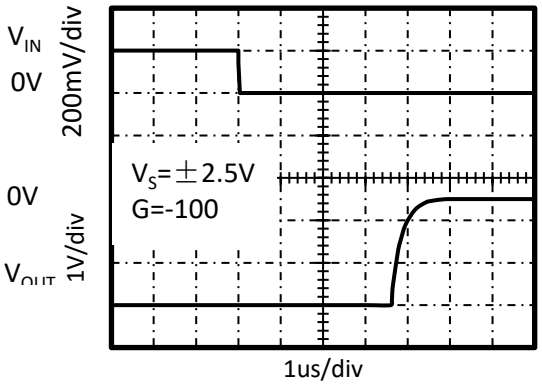


Figure 13. Negative Overvoltage Recovery

APPLICATION NOTES

The RS6331K, RS6332K, RS6334K are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.3V to 5.5V (±1.15V to ±2.75V). 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 0.1uF capacitor place closely across the supply pins.

LAYOUT GUIDELINS

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 0.1uF 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.

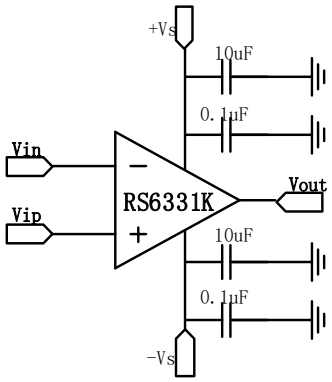


Figure 14. Amplifier with Bypass Capacitors

INSTRUMENTATION AMPLIFIER

In the three-op amp, instrumentation amplifier configuration shown in Figure15,

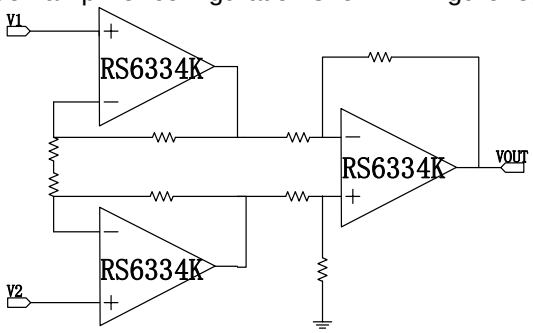
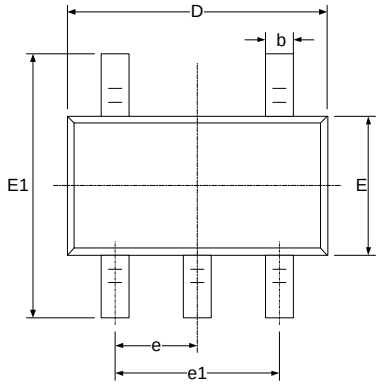
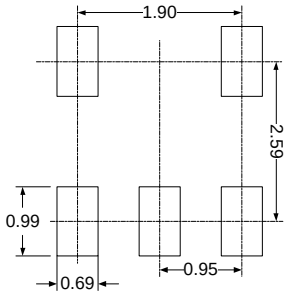


Figure 15. Amplifier instrumentation amplifier

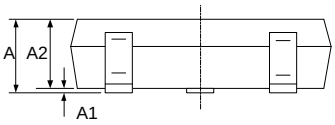
PACKAGE OUTLINE DIMENSIONS

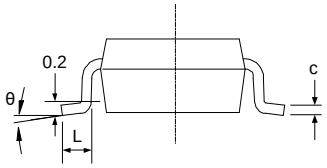
SOT23-5





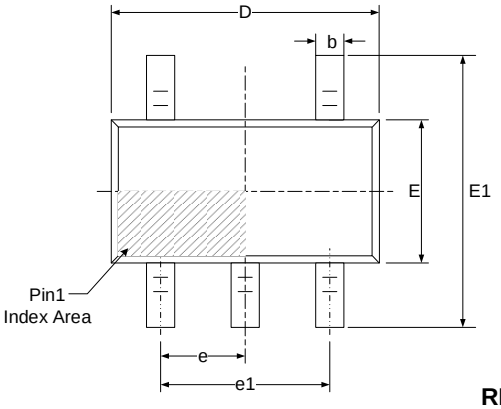
RECOMMENDED LAND PATTERN (Unit: mm)

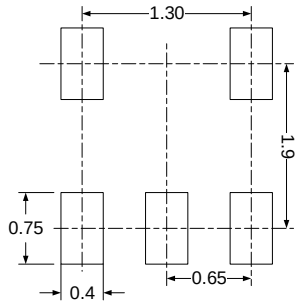




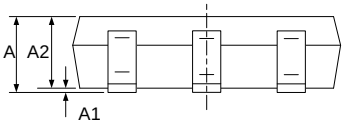
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

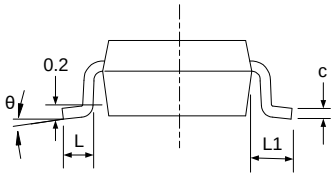
SC70-5





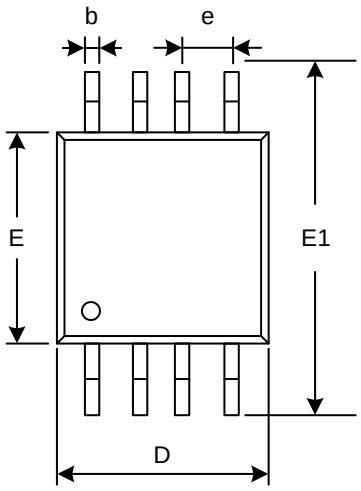
RECOMMENDED LAND PATTERN (Unit: mm)

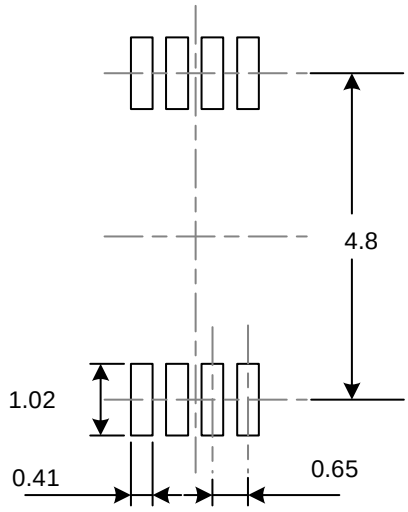




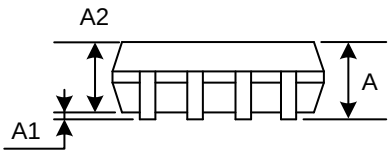
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650(BSC)		0.026(BSC)	
e1	1.300(BSC)		0.051(BSC)	
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

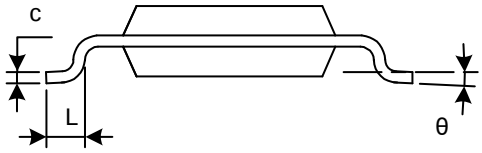
MSOP8





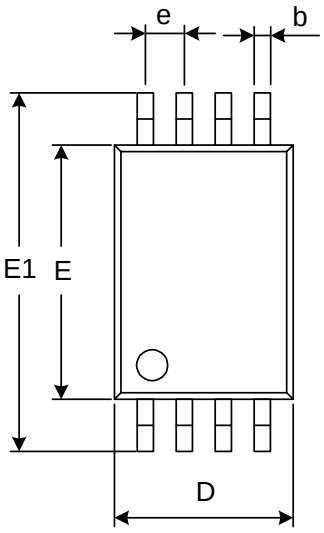
RECOMMENDED LAND PATTERN (Unit: mm)

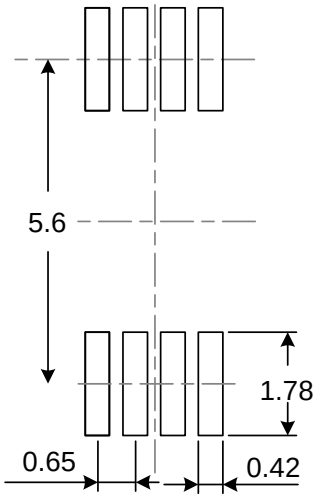




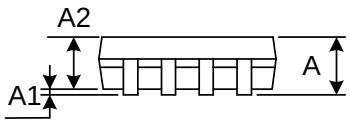
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187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

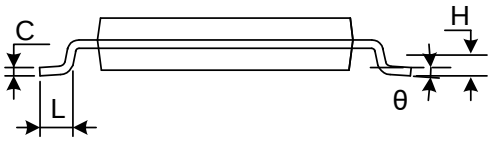
TSSOP8





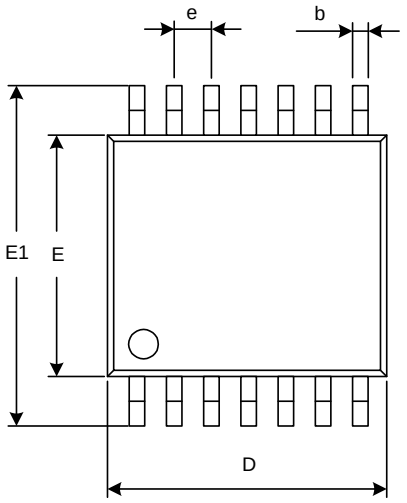
RECOMMENDED LAND PATTERN (Unit: mm)

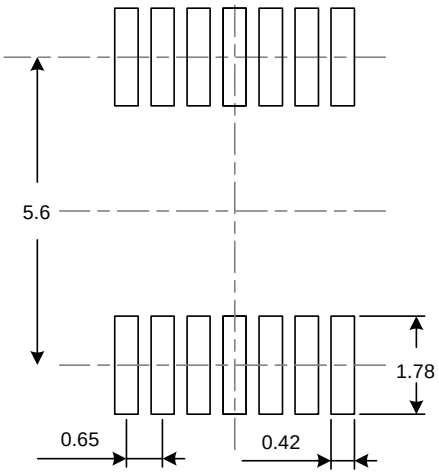




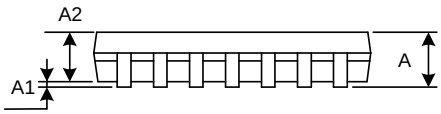
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

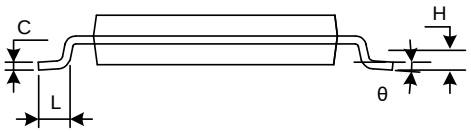
TSSOP14





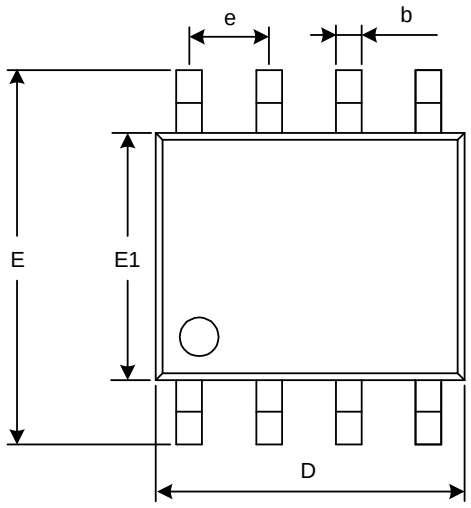
RECOMMENDED LAND PATTERN (Unit: mm)

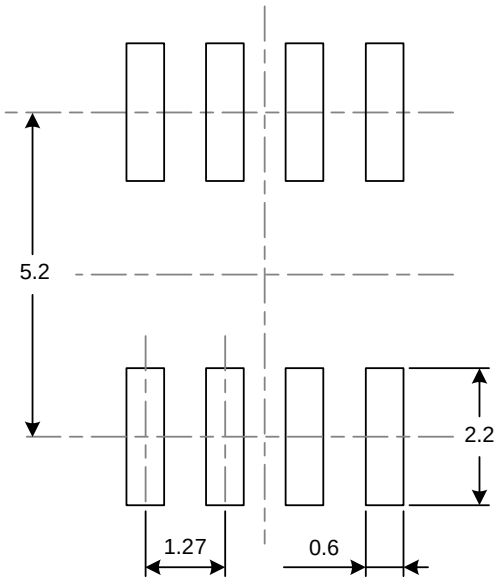




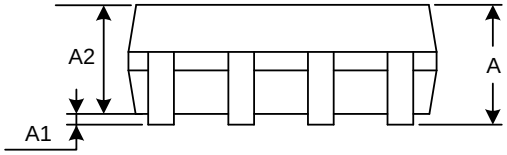
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

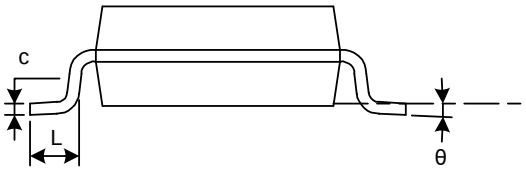
SOP8





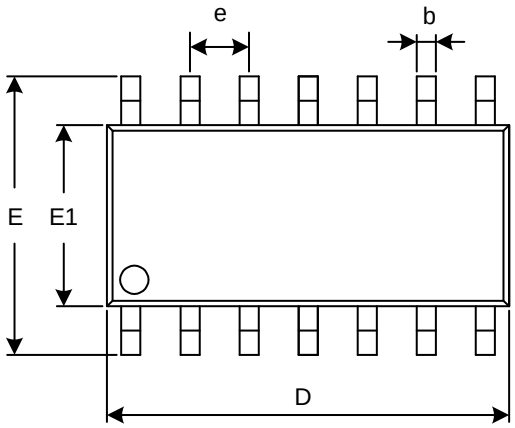
RECOMMENDED LAND PATTERN (Unit: mm)

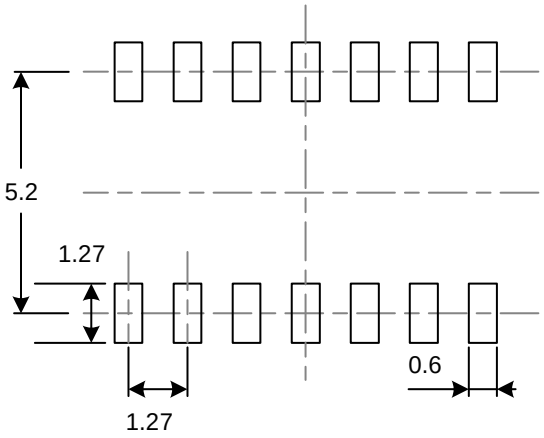




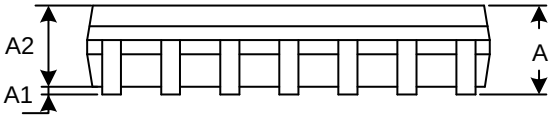
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

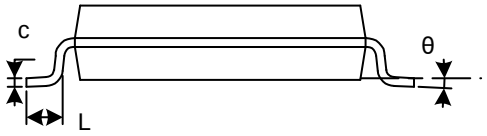
SOP14





RECOMMENDED LAND PATTERN (Unit: mm)



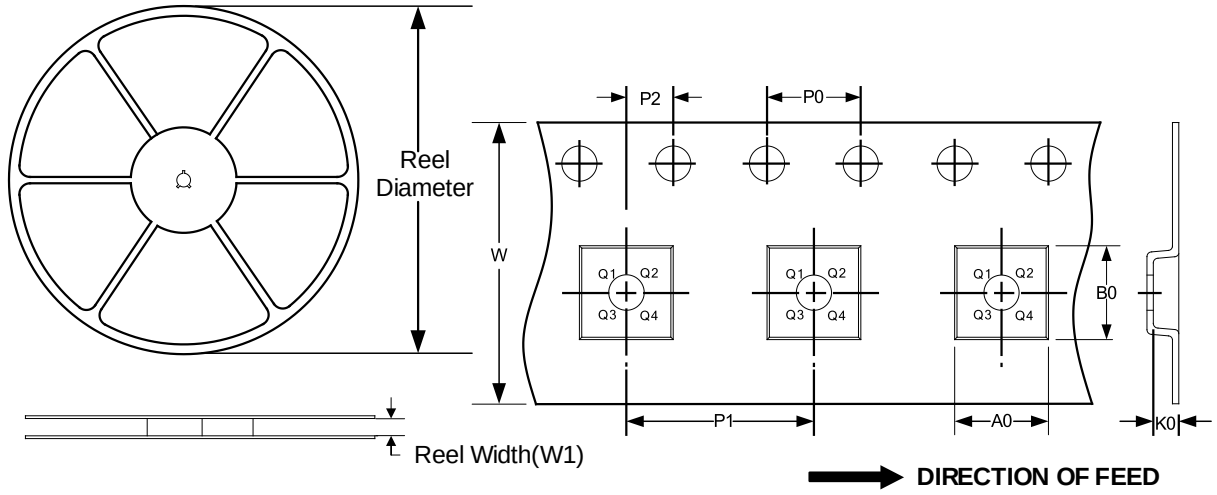


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



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(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SC70-5	7''	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3
SOP8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOP14	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
TSSOP8	13''	12.4	6.90	3.45	1.65	4.0	8.0	2.0	12.0	Q1