50MHz, Rail-to-Rail Output CMOS Operational Amplifier

FEATURES

- **HIGH GAIN BANDWIDTH: 50MHz**
- **RAIL-TO-RAIL OUTPUT**
  ±1.5mV TYP V_{OS}
- **INPUT VOLTAGE RANGE: -0.2V to +3.9V with Vs = 5V**
- **SUPPLY RANGE: +2.5V to +5.5V**
- **SPECIFIED UP TO +125°C**
- **Micro SIZE PACKAGES: SOT23-5**

APPLICATIONS

- **AUDIO ADC INPUT BUFFERS**
- **PHOTODIODE PREAMP**
- **HIGH-DENSITY SYSTEMS**
- **PORTABLE SYSTEMS**
- **DRIVING A/D CONVERTERS**

DESCRIPTION

The RS870X families of voltage-feedback (VFB) products offer low voltage operation, negative-rail input, rail-to-rail output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (50MHz) and slew rate of 75V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

These amplifiers set an industry-leading power-to-performance ratio for rail-to-rail amplifiers. The RS870X families of operational amplifiers are specified at the full temperature range of -40°C to +125°C under single or dual power supplies of 2.5V to 5.5V.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS8701	SOT23-5	2.90mm×1.60mm
	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm
RS8702	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm
	DFN3X3-8	3.00mm×3.00mm
	TSSOP8	3.00mm×4.40mm
RS8704	SOP14	8.65mm×3.90mm
	TSSOP14	5.00mm×4.40mm

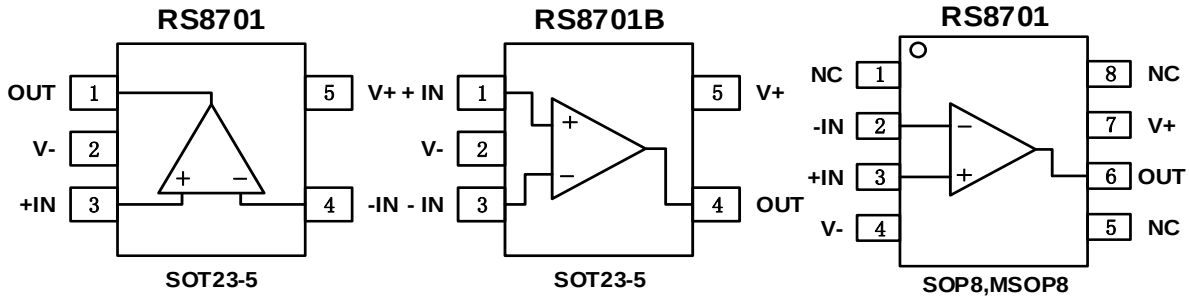
(1) For all available packages, see the orderable addendum at the end of the data sheet.

Revision History

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

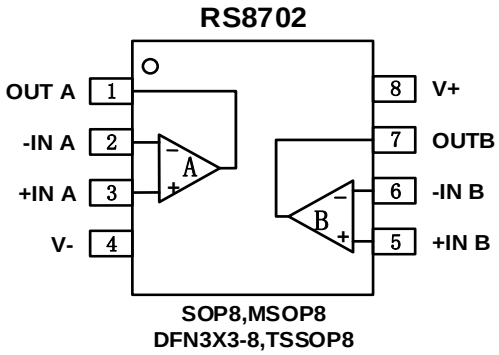
Version	Change Date	Change Item
C.1	2024/03/04	1. Added the TAPE AND REEL INFORMATION 2. Update Package Qty on Page 2@RevB.2 3. Modify packaging naming

Pin Configuration and Functions (Top View)



Pin Description

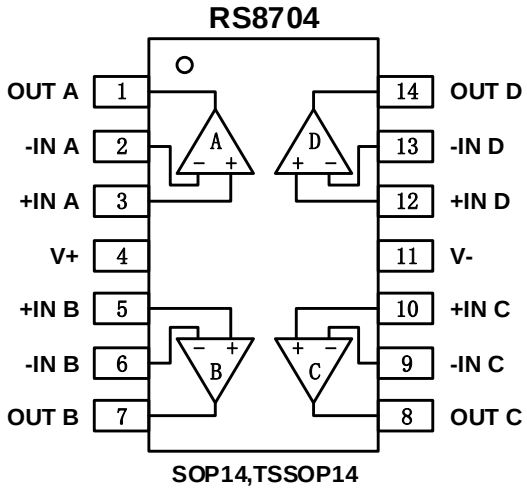
NAME	PIN			I/O	DESCRIPTION
	RS8701	RS8701B	RS8701		
	SOT23-5	SOT23-5	SOP8/MSOP8		
-IN	4	3	2	I	Negative (inverting) input
+IN	3	1	3	I	Positive (noninverting) input
NC	-	-	1,5,8	-	No internal connection (can be left floating)
OUT	1	4	6	O	Output
V-	2	2	4	-	Negative (lowest) power supply
V+	5	5	7	-	Positive (highest) power supply



Pin Description

NAME	PIN	I/O	DESCRIPTION
	SOP8/MSOP8/DFN3X3-8/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
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)	-150	150	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 ±150mA or less.
(4) Short-circuit to ground, one amplifier per package.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	±5000	V
		Machine Model (MM)	±400	

Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage，V_S= (V+) - (V-)	Single-supply	2.5		5.5	V
	Dual-supply	±1.25		±2.75	

Thermal Information: RS8701

THERMAL METRIC		RS8701			UNIT
		5PINS	8PINS		
		SOT23-5	SOP8	MSOP8	
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	273.8	116	165	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	126.8	60	53	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	85.9	56	87	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	10.9	12.8	4.9	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	84.9	98.3	85	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	N/A	°C/W

Thermal Information: RS8702

THERMAL METRIC		RS8702				UNIT
		8PINS				
		SOP8	MSOP8	DFN3X3-8	TSSOP8	
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	116	165	66.9	200.8	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	60	53	54.5	95.4	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	56	87	40.4	128.6	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	12.8	4.9	1.9	27.2	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	98.3	85	40.4	127.2	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	10.8	N/A	°C/W

Thermal Information: RS8704

THERMAL METRIC		RS8704		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
RS8701XF	SOT23-5	5	1	-40°C ~125°C	8701	Tape and Reel,3000
RS8701BXF	SOT23-5	5	1	-40°C ~125°C	8701B	Tape and Reel,3000
RS8701XK	SOP8	8	1	-40°C ~125°C	RS8701	Tape and Reel,4000
RS8701XM	MSOP8	8	1	-40°C ~125°C	RS8701	Tape and Reel,4000
RS8702XK	SOP8	8	2	-40°C ~125°C	RS8702	Tape and Reel,4000
RS8702XM	MSOP8	8	2	-40°C ~125°C	RS8702	Tape and Reel,4000
RS8702XT	DFN3X3-8	8	2	-40°C ~125°C	RS8702	Tape and Reel,5000
RS8702XQ	TSSOP8	8	2	-40°C ~125°C	RS8702	Tape and Reel,4000
RS8704XP	SOP14	14	4	-40°C ~125°C	RS8704	Tape and Reel,4000
RS8704XQ	TSSOP14	14	4	-40°C ~125°C	RS8704	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.

ELECTRICAL CHARACTERISTICS

(At T_A = +25°C, V_S = 5V, G = +2, R_F = 1KΩ, and R_L = 1KΩ connected to V_S/2, V_{IN_CM} =Vs/2, unless otherwise noted.)

PARAMETER		CONDITIONS	RS8701, RS8702, RS8704			
			MIN	TYP	MAX	UINTS
POWER SUPPLY						
V_S	Operating Voltage Range		2.5		5.5	V
I_Q	Quiescent Current/Amplifier			3.2	4.0	mA
PSRR	Power-Supply Rejection Ratio	V_S=2.5V to 5.5V, V_{CM}=(V-)+0.5V	70	88		dB
INPUT						
V_{OS}	Input Offset Voltage	V_{CM}=Vs/2		±1.5	±7.5	mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	V_{CM}=Vs/2, -40°C ≤ T_A ≤125°C		4		μV/°C
IB	Input Bias Current			1	10	pA
I_{OS}	Input Offset Current			1	10	pA
V_{CM}	Common-Mode Voltage Range	V_S= 5V	-0.2		3.9	V
CMRR	Common-Mode Rejection Ratio	V_S= 5.5V, V_{CM}=-0.2V to 3.5V	66	85		dB
OUTPUT						
AOL	Open-Loop Voltage Gain	V_S=5.0V, R_L=1KΩ, V_O=Vs-0.2V	95	110		dB
		V_S=5.0V, R_L=150Ω, V_O=Vs-0.3V	78	85		dB
	Output Swing From Rail	R_L=1KΩ		23		mV
I_{OUT}	Output Current Source			90		mA
I_{OUT}	Output Current Sink			125		mA
FREQUENCY RESPONSE						
GBP	Gain-Bandwidth Product			50		MHz
PM	Phase Margin			63		°
SR	Slew Rate			75		V/us
NOISE						
en	Input Voltage Noise Density	f = 100 KHz		15.5		nV/$\sqrt{\text{HZ}}$
en	Input Voltage Noise Density	f = 1 MHz		8.5		nV/$\sqrt{\text{HZ}}$

TYPICAL CHARACTERISTICS

At T_A = +25°C, V_S = 5V, G = +2, R_F = 1KΩ, and R_L = 1KΩ connected to V_S/2, V_{IN_CM} =Vs/2, unless otherwise noted

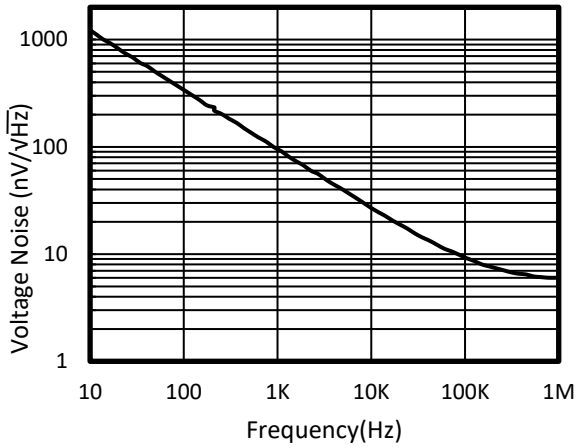


Figure 1. INPUT VOLTAGE NOISE SPECTRAL DENSITY vs FREQUENCY

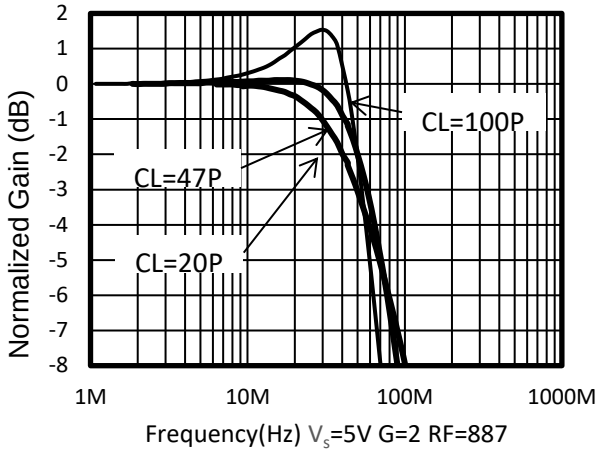


Figure 2. FREQUENCY RESPONSE FOR VARIOUS CL WITH RL=600Ω

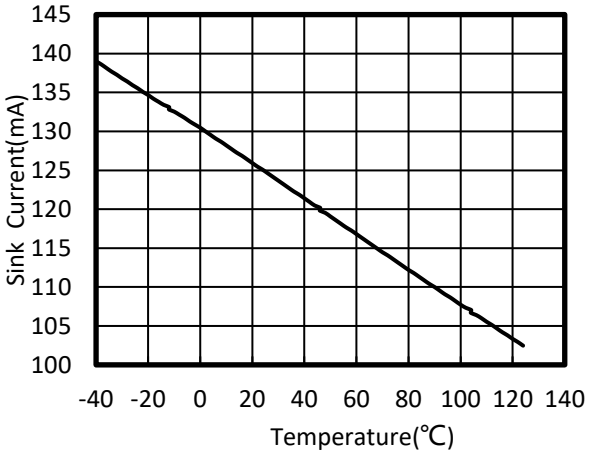


Figure 3. SINK CURRENT vs TEMPERATURE

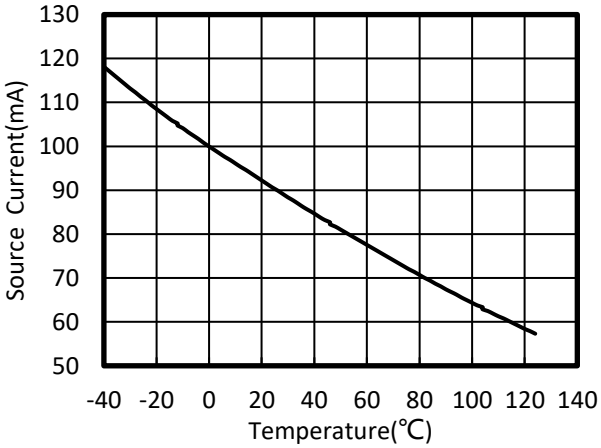


Figure 4. SOURCE CURRENT vs TEMPERATURE

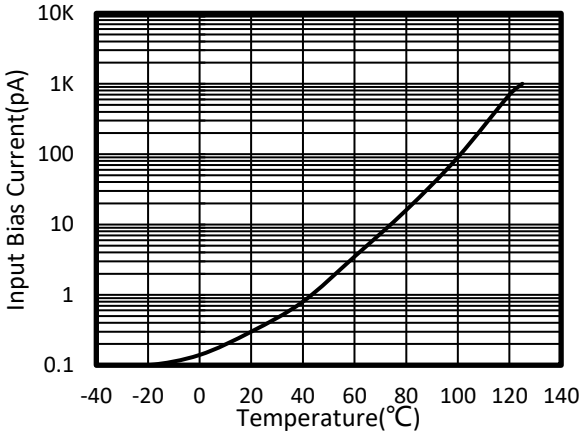


Figure 5. INPUT BIAS CURRENT vs TEMPERATURE

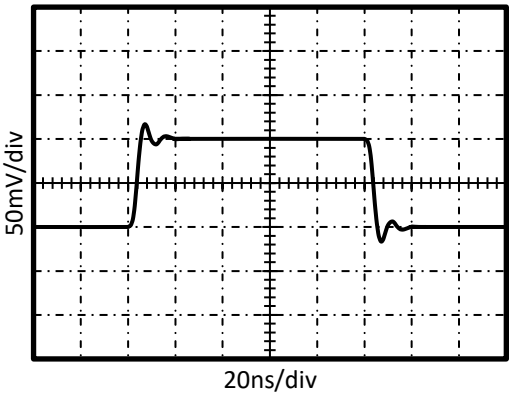


Figure 6. SMALL−SIGNAL STEP RESPONSE

TYPICAL CHARACTERISTICS

At T_A = +25°C, V_S = 5V, G = +2, R_F = 1KΩ, and R_L = 1KΩ connected to V_S/2, V_{IN_CM} =Vs/2, unless otherwise noted

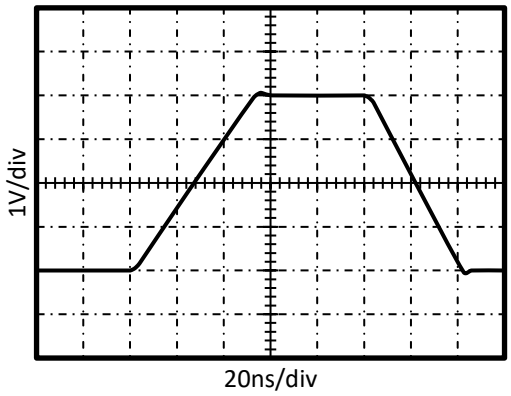


Figure 7. LARGE−SIGNAL STEP RESPONSE

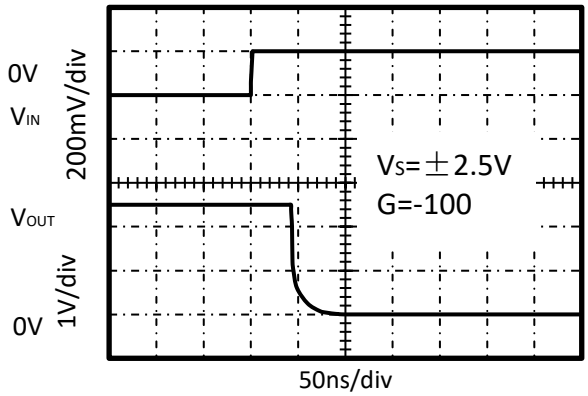


Figure 8. POSITIVE OVERLOAD RECOVERY

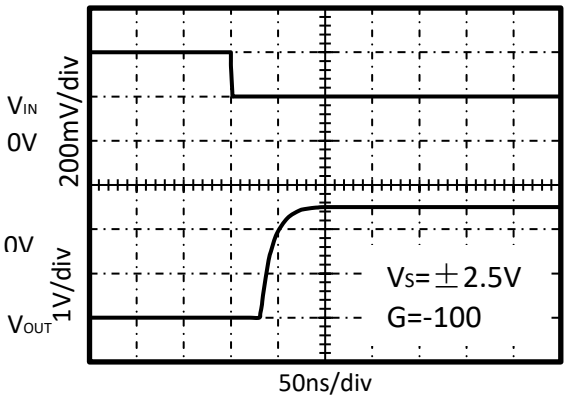


Figure 9. NEGATIVE OVERLOAD RECOVERY

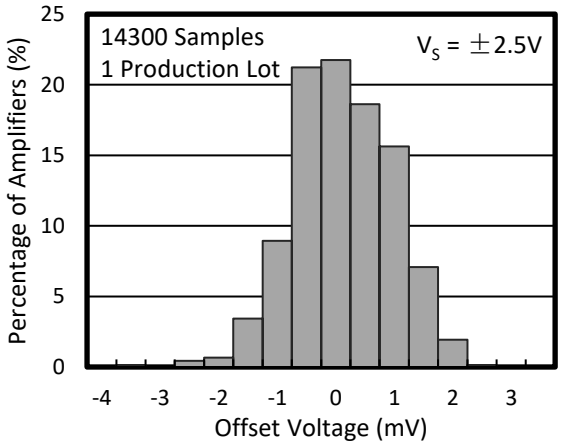


Figure 10. OFFSET VOLTAGE PRODUCTION DISTRIBUTION

APPLICATION NOTES

The RS8701, RS8702, RS8704 are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V (±1.25V 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

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 0.1uF 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.

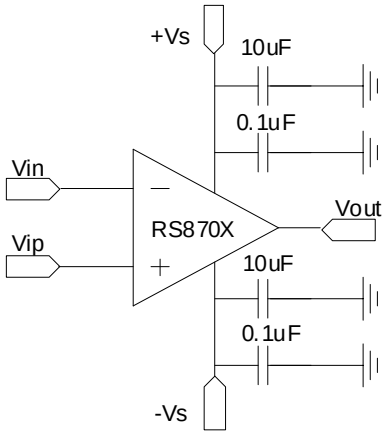


Figure 11. Amplifier with Bypass Capacitors

INSTRUMENTATION AMPLIFIER

In the three-op amp, instrumentation amplifier configuration shown in Figure 12,

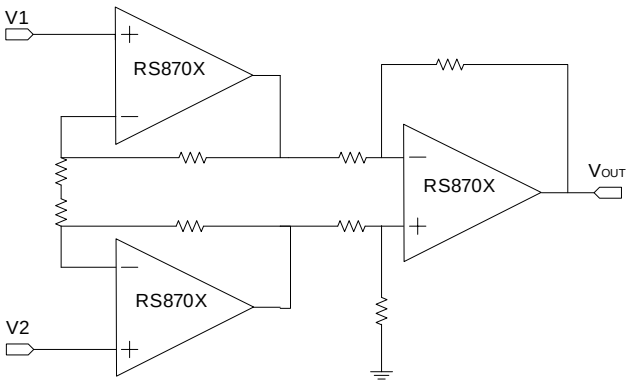
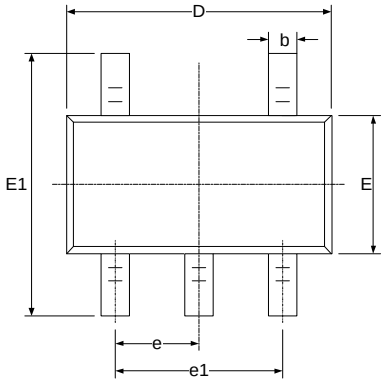
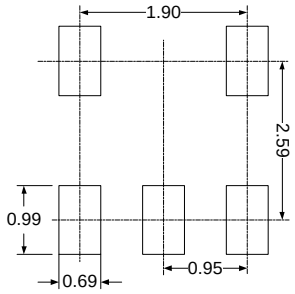


Figure 12. Amplifier instrumentation amplifier

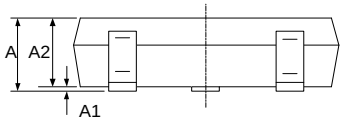
PACKAGE OUTLINE DIMENSIONS

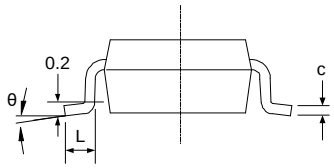
SOT23-5





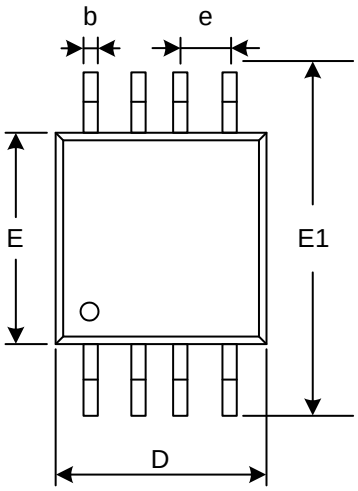
RECOMMENDED LAND PATTERN (Unit: mm)

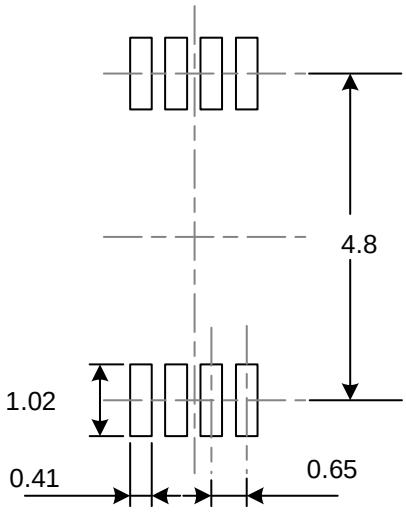




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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

MSOP8





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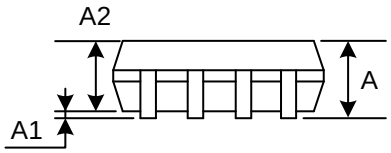
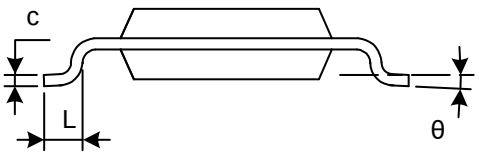
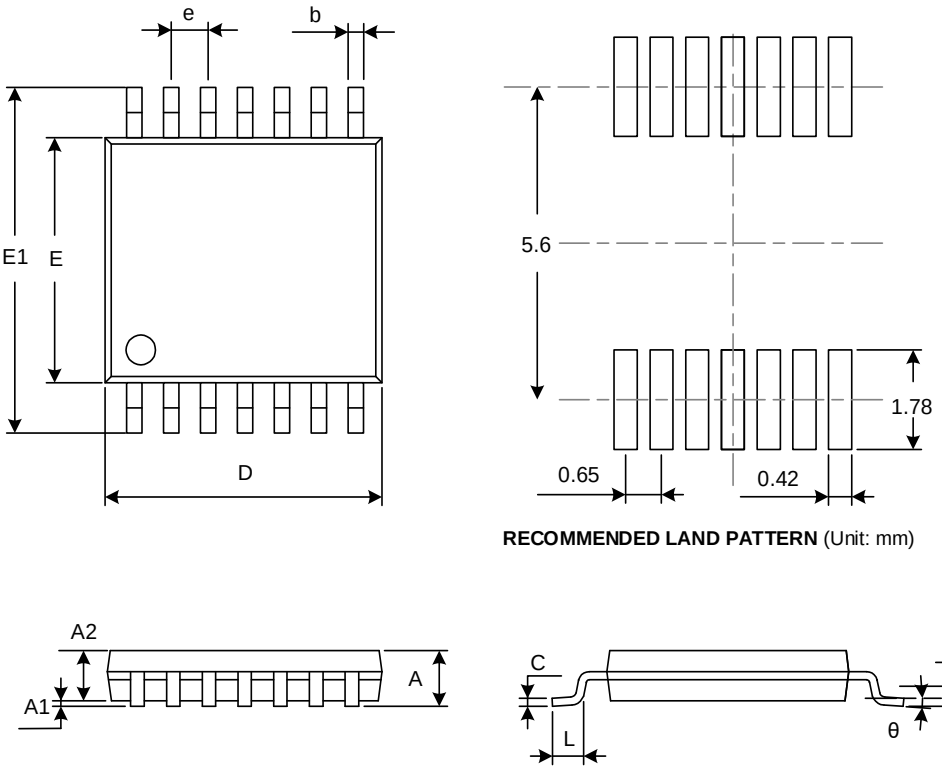




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187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

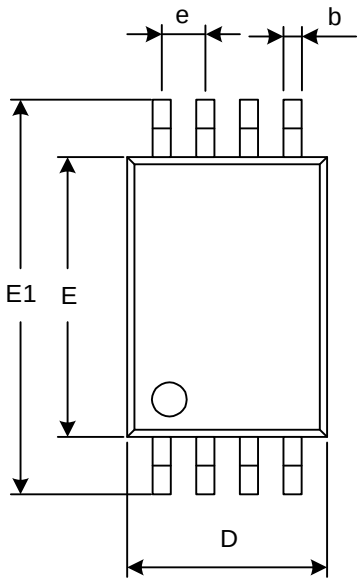
TSSOP14

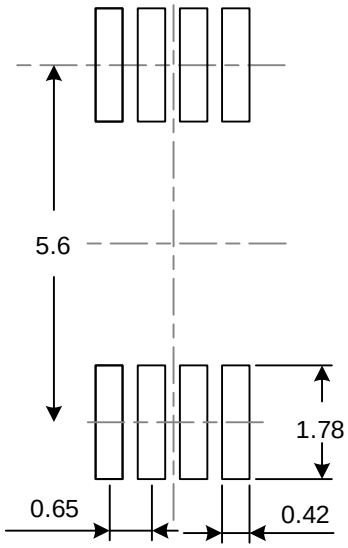


RECOMMENDED LAND PATTERN (Unit: mm)

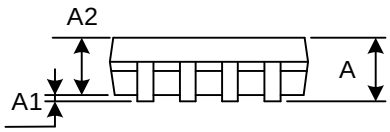
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L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

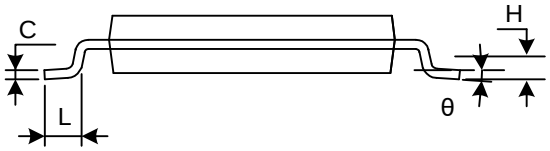
TSSOP8





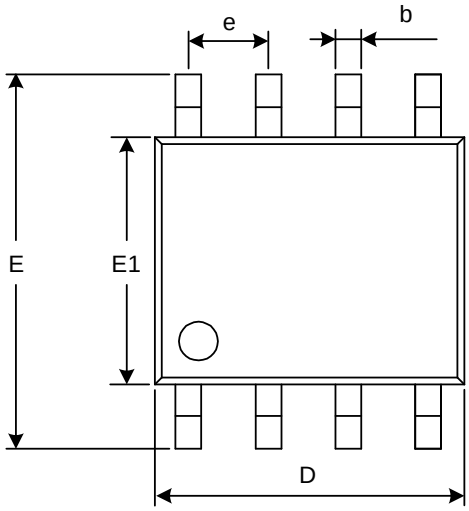
RECOMMENDED LAND PATTERN (Unit: mm)

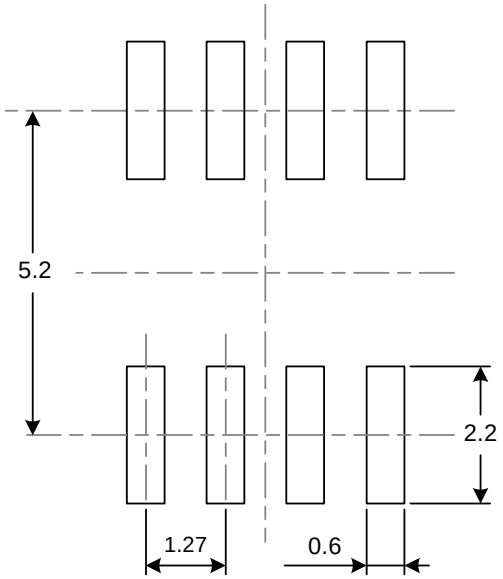




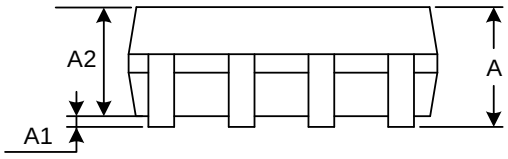
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L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

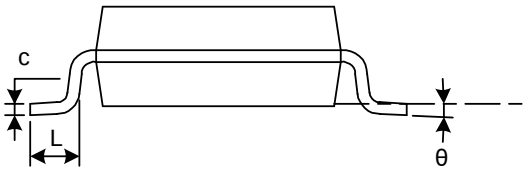
SOP8





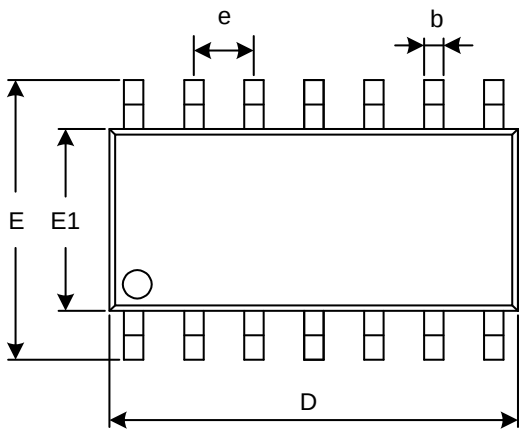
RECOMMENDED LAND PATTERN (Unit: mm)

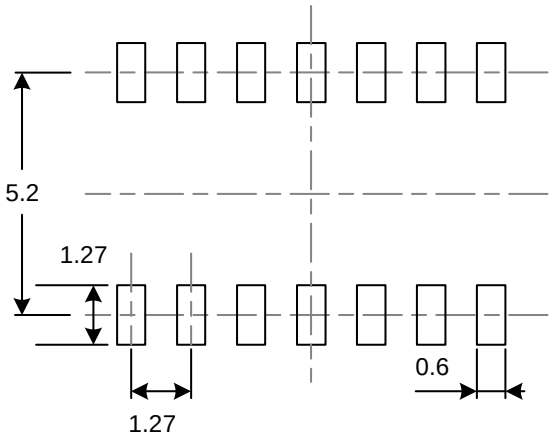




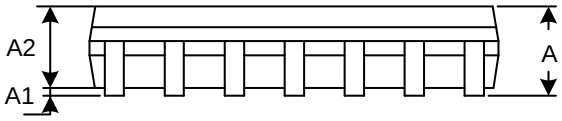
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150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

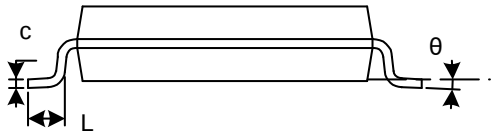
SOP14





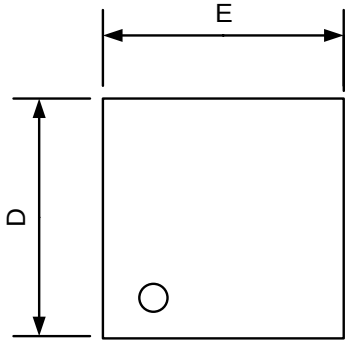
RECOMMENDED LAND PATTERN (Unit: mm)



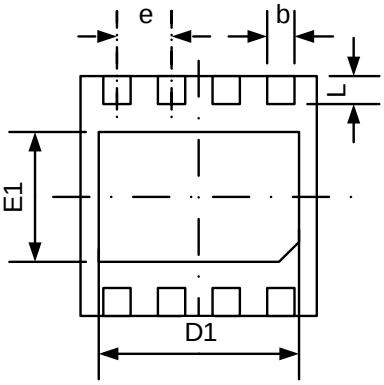


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150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

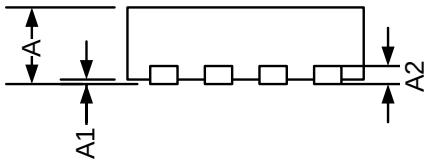
DFN3X3-8



TOP VIEW



BOTTOM VIEW



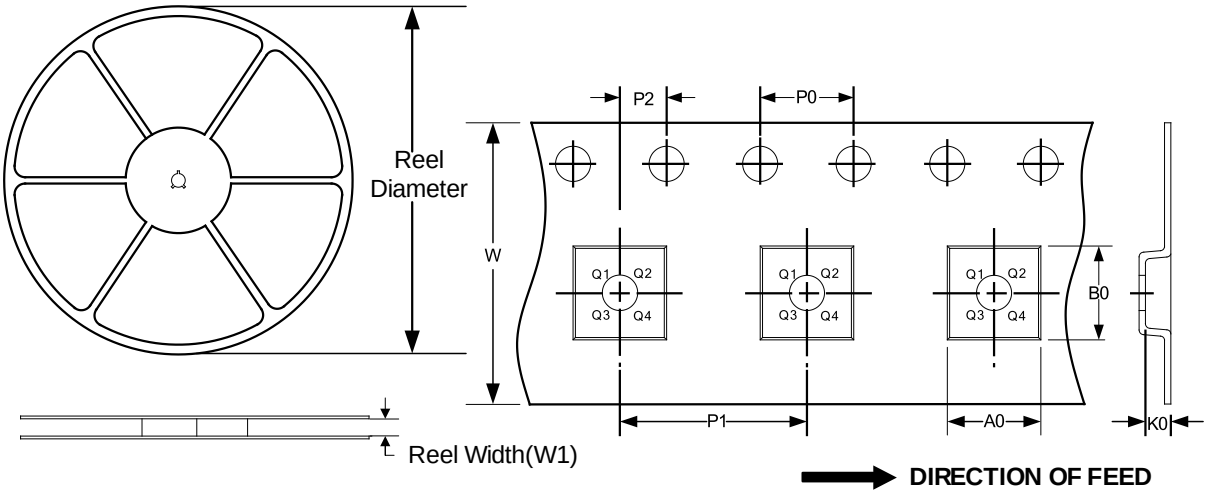
SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203		0.008	
b	0.300	0.400	0.012	0.016
D	2.900	3.100	0.114	0.122
D1	2.510	2.610	0.099	0.103
E	2.900	3.100	0.114	0.122
E1	1.550	1.650	0.061	0.065
e	0.650 TYP		0.026 TYP	
L	0.350	0.450	0.014	0.018

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
MSOP8	13''	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
TSSOP14	13''	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOP8	13''	12.4	6.40	5.40	2.10	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
DFN3X3-8	13''	12.4	3.35	3.35	1.13	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