CJOA204x Series Operational Amplifiers

1 Introduction

The CJOA204x family of single-, dual-, and quad-channel amplifiers features a maximized ratio of gain bandwidth (GBW) to supply current and is ideal for battery-powered applications such as portable instrumentations, portable medical equipments, wearable fitness devices, and wireless remote sensors. Featuring rail-to-rail input and output swings, 15 kHz bandwidth of combined with ultra-low supply current (typical 600 nA at 5.0 V per amplifier) and low noise (6.3 μV_{PP} at 0.1 to 10 Hz), the CJOA204x family is an excellent choice for precision, cost-optimized, "Always ON" sensing applications.

The robust design of the CJOA204x amplifiers provides ease-of-use to the circuit designer: integrated RF/EMI rejection filter, no phase reversal in overdrive conditions, and high electro-static discharge (ESD) protection (3kV HBM). The CJOA204x amplifiers are optimized for operation at voltages as low as +1.7 V (±0.85 V) and up to+5.5 V (±2.75 V) over the extended temperature range of -40°C to +85°C.

The CJOA2041 (single) is available in SOT23-5L packages. The CJOA2042 (dual) is offered in SOP8, and MSOP8 packages. The quad of CJOA2044 is offered in SOP14 and TSSOP14 packages.

2 Features

- Ultra-Low Power Preserves Battery Life
  600 nA Supply Current (Typically at 5 V) Per Amplifier
- Single 1.7 V to 5.5 V Supply Voltage Range
  Can be Powered From the Same 1.8V/2.5V/3.3V/5V System Rails
- 15 kHz GBW
- Low Input Offset Voltage: 0.6 mV
- Low Noise: 6.3 μV_{PP} at 0.1 to 10 Hz
- 1 pA Input Bias Current
- Rail-to-Rail Input and Output
- Extended Temperature Range:
  −40°C to +85°C

3 Applications

- Battery-Powered Instruments:
  Consumer, Industrial, Medical, Notebooks
- Wearable Fitness Devices
- Wireless Sensors:
  Home Security, Remote Sensing, Wireless Metering
- Sensor Signal Conditioning:
  Sensor Interfaces, Loop-Powered, Active Filters

4 Available Packages

PART NUMBER	PACKAGE
CJOA2041-M5N	SOT-23-5L
CJOA2042-PAN	SOP8
CJOA2042-PDN	MSOP8
CJOA2044-PHN	SOP14
CJOA2044-PIN	TSSOP14

5 Orderable Information

MODEL	DEVICE	PACKAGE	OP TEMP	ECO PLAN	MSL	PACKING OPTION	SORT
CJOA2041	CJOA2041-M5N	SOT-23-5L	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 3000 Units / Reel	Active
CJOA2042	CJOA2042-PAN	SOP8	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
	CJOA2042-PDN	MSOP8	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
CJOA2044	CJOA2044-PHN	SOP14	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 2500 Units / Reel	Active
	CJOA2044-PIN	TSSOP14	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 3000 Units / Reel	Active
Others	-	-	-	-	-	-	Customized

Note:

ECO PLAN: For the RoHS and Green certification standards of this product, please refer to the official report provided by JSCJ.

MSL: Moisture Sensitivity Level. Determined according to JEDEC industry standard classification.

SORT: Specifically defined as follows:

Active: Recommended for new products;

Customized: Products manufactured to meet the specific needs of customers;

Preview: The device has been released and has not been fully mass produced. The sample may or may not be available;

NoRD: It is not recommended to use the device for new design. The device is only produced for the needs of existing customers; Obsolete: The device has been discontinued.

6 Pin Configuration and Marking Information

6.1 Pin Configuration and Function

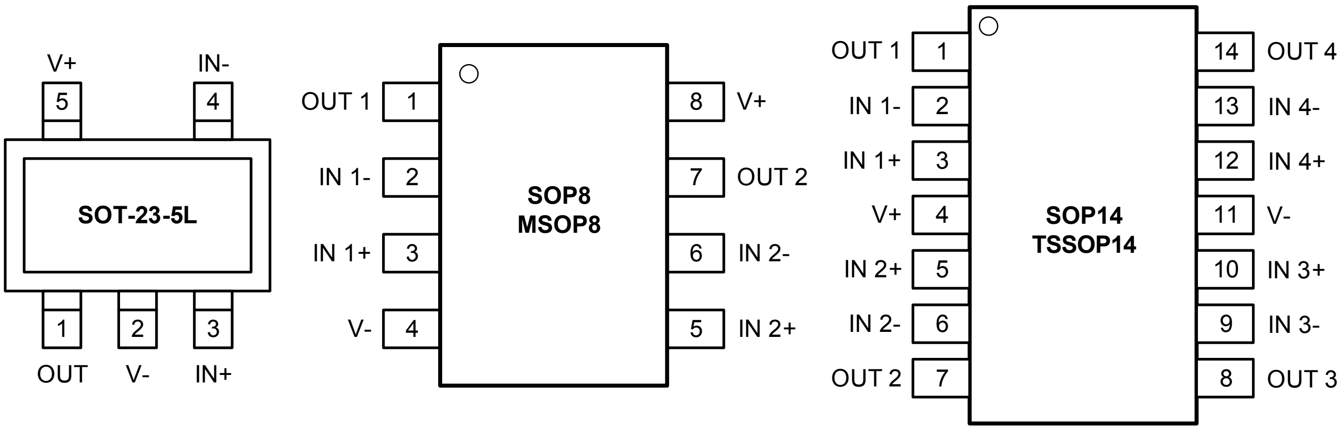
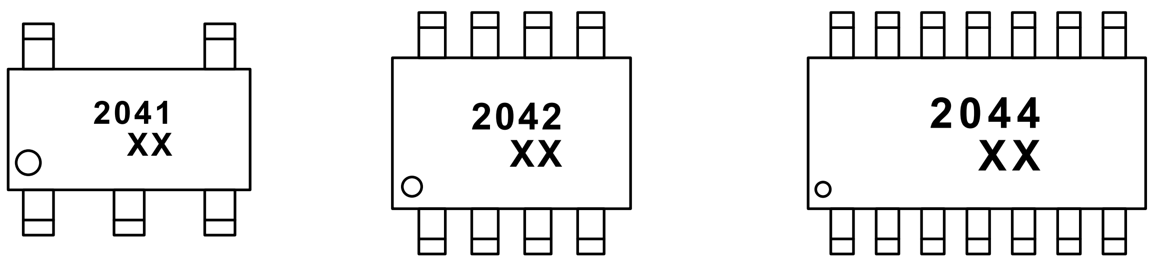


Figure 6-1. CJOA204x Pin Map

PIN NAME	CJOA2041 SOT-23-5L	CJOA2042 SOP8/MSOP8	CJOA2044 SOP14/ TSSOP14	I / O	DESCRIPTION
OUT 1	1	1	1	O	Output of the operational amplifier 1.
IN 1-	4	2	2	I	Negative input of the operational amplifier 1.
IN 1+	3	3	3	I	Positive input of the operational amplifier 1.
V+	5	8	4	-	Positive (highest) supply.
IN 2+	-	5	5	I	Positive input of the operational amplifier 2.
IN 2-	-	6	6	I	Negative input of the operational amplifier 2.
OUT 2	-	7	7	O	Output of the operational amplifier 2.
OUT 3	-	-	8	O	Output of the operational amplifier 3.
IN 3-	-	-	9	I	Negative input of the operational amplifier 3.
IN 3+	-	-	10	I	Positive input of the operational amplifier 3.
V-	2	4	11	-	Negative (lowest) supply or ground for single supply.
IN 4+	-	-	12	I	Positive input of the operational amplifier 4.
IN 4-	-	-	13	I	Negative input of the operational amplifier 4.
OUT 4	-	-	14	O	Output of the operational amplifier 4.

6.2 Marking Information



"**CJOA204x**": Device number.

"**XX**": Code, indicates weekly record information.

7 Specifications

7.1 Absolute Maximum Ratings

(over operating ambient temperature range, unless otherwise specified)[(1)]

CHARACTERISTIC		SYMBOL	VALUE	UNIT
Supply voltage[(V_+) - (V_-)]		V_S	10	V
Signal input pins	Voltage[(2)]		(V-)-0.5V ~ (V+)+0.5V	V
	Current[(2)]		±10	mA
Output short-circuit		T_{sc}	Continuous[(3)]	mA
Maximum junction temperature		$T_{J\ MAX}$	150	°C
Storage temperature		T_{stg}	-65 ~ 150	°C
Soldering temperature & time		T_{solder}	260°C, 10s	-

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.

(2) Input pins are diode-clamped to the power-supply rails. Current limit input signals that can swing more than 0.5V beyond the supply rails to 10mA or less.

(3) Short circuits from outputs to V_S can cause excessive heating and eventual destruction. A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

7.2 Recommend Operating Conditions

(over operating ambient temperature range, unless otherwise specified)

PARAMETER		SYMBOL	MIN.	NOM.	MAX.	UNIT
Power supply range	T_A = -40 ~ 85℃	V_S	1.7	-	5.5	V
Operating ambient temperature		T_A	-40	-	85	°C

7 Specifications

7.3 ESD Ratings

ESD RATINGS		VALUE	UNIT
Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(4)	3000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101(5)	2000	

(4) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(5) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

7.4 Thermal Information

THERMAL METRIC(6)	SYMBOL	CJOA156x Series		UNIT
Junction-to-ambient thermal resistance	$R_{\Theta JA}$	**SOT-23-5L**	**SOP8**	°C/W
		192.3	125.0	
		MSOP8	**SOP14**	
		201.6	115.7	
		TSSOP14	**-**	
		119.0	-	
Reference maximum power dissipation for continuous operation	$P_{D\ Ref}$	**SOT-23-5L**	**SOP8**	W
		0.65	1.00	
		MSOP8	**SOP14**	
		0.62	1.08	
		TSSOP14	**-**	
		1.05	-	

(6) T_A = 25°C, measured on evaluation board with 1oz. copper traces of minimum pad size, all device outputs were active.

7 Specifications

7.5 Electrical Characteristics

(V_S = 5.0V, T_A = +25°C, V_{CM} = V_S /2, V_O = V_S /2, and R_L = 10kΩ connected to V_S /2, unless otherwise noted. Boldface limits apply over the specified temperature range, T_A= -40 to +85 °C.

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
OFFSET VOLTAGE						
Input offset voltage	V_{OS}	-	-	±0.6	±3 .0	mV
Offset voltage drift	V_{OS} TC	T_A = −40 to +125 °C	-	±1	±3	nV/℃
Power supply rejection ratio	PSRR	V_S = 1.7 to 5.5 V, V_{CM} < (V+) − 2V	76	92	-	dB
		T_A = −40 to +125 ℃	72	-	-	
INPUT BIAS CURRENT						
Input bias current	I_B	-	-	1	-	pA
		T_A = +85 °C	-	150	-	
Input offset current	I_{OS}	-	-	5	-	pA
NOISE						
Input voltage noise	V_n	f = 0.1 to 10 Hz	-	6.3	-	μV_{PP}
Input voltage noise density	e_n	f = 1 kHz	-	177	-	nV/√Hz
		f = 100 Hz	-	184	-	
Input current noise density	I_n	f = 1 kHz	-	10	-	fA/√Hz
INPUT VOLTAGE						
Common-mode voltage range	V_{CM}	-	(V-) − 0.1	-	(V+) + 0.1	V
		T_A = −40 to +85 ℃	(V-)	-	(V+) +0.1	
Common-mode rejection ratio	CMRR	V_S = 5.5 V, V_{CM} = −0.1 to 5.5 V	67	84	-	dB
		V_{CM} = 0 to 5.3 V, T_A = −40 to +85℃	64	-	-	
		V_S = 1.8 V, V_{CM} = −0.1 to 1.8 V	65	79	-	
		V_{CM} = 0 to 1.6 V, T_A = −40 to +85℃	62	-	-	
INPUT IMPEDANCE						
Input resistance	R_{IN}	-	100	-	-	GΩ
Input capacitance	C_{IN}	Differential	-	2.0	-	pF
		Common mode	-	3.5	-	
OPEN-LOOP GAIN						
Open-loop voltage gain	A_{VOL}	R_L = 50 kΩ, V_O = 0.05 to 3.5 V	80	97	-	dB
		T_A = −40 to +85 ℃	75	-	-	
		R_L = 5 kΩ, V_O = 0.15 to 3.5 V	68	82	-	
		T_A = −40 to +85 ℃	64	-	-	
FREQUENCY RESPONSE						
Gain bandwidth product	GBW	-	-	15	-	kHz
Slew rate	SR	G = +1, C_L = 50 pF, V_O = 1.5 to 3.5 V	-	6	-	V/ms

7 Specifications

7.5 Electrical Characteristics (conitnued)

(V_S = 5.0V, T_A = +25°C, V_{CM} = V_S /2, V_O = V_S /2, and R_L = 10kΩ connected to V_S /2, unless otherwise noted. Boldface limits apply over the specified temperature range, T_A = -40 to +85 °C.

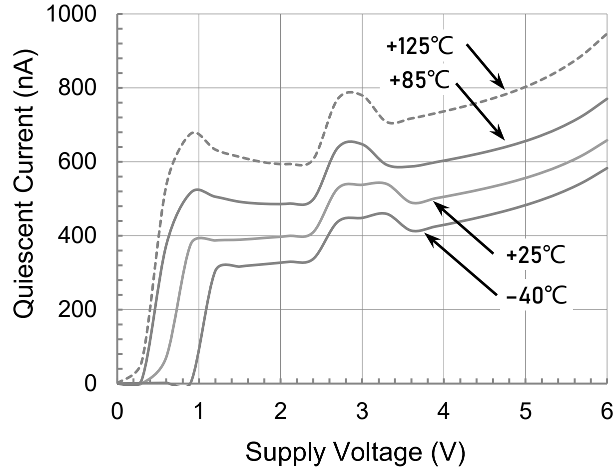
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
OUTPUT						
High output voltage swing	V_{OH}	R_L = 50 kΩ	(V+) –7	(V+) –4	-	mV
		R_L = 5 kΩ	(V+) –65	(V+) –40	-	
Low output voltage swing	V_{OL}	R_L = 50 kΩ	-	(V-) +3	(V-) +5	mV
		R_L = 5 kΩ	-	(V-) +27	(V-) +42	
Short-circuit current	I_{SC}	Source current through 10Ω	20	27	-	mA
		Sink current through 10Ω	-	-33	-25	
POWER SUPPLY						
Operating supply voltage	V_S	T_A = -40 to +85 ℃	1.7	-	5.5	V
Quiescent current (per amplifier)	I_Q	V_S = 1.8 V, T_A = +25 ℃	-	450	650	μA
		V_S = 5.0 V, T_A = +25 ℃	-	600	880	

7 Specifications

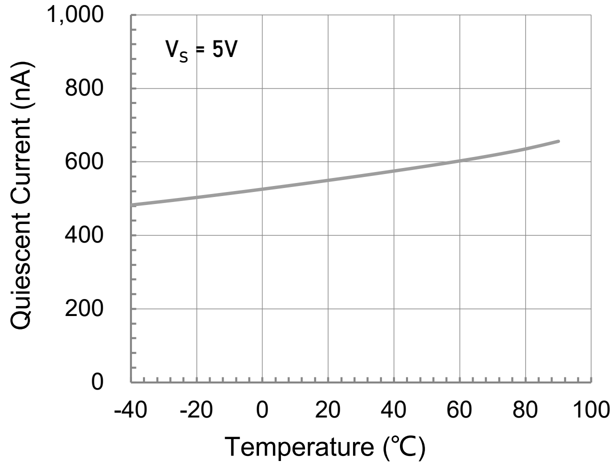
7.6 Typical Characteristics

At T_A = +25℃, V_{CM} = V_S /2, and R_L = 10kΩ connected to V_S /2, unless otherwise noted.

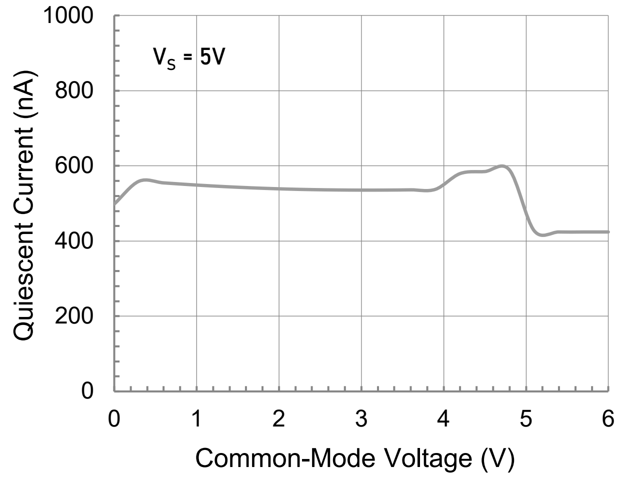
Quiescent Current vs. Supply Voltage



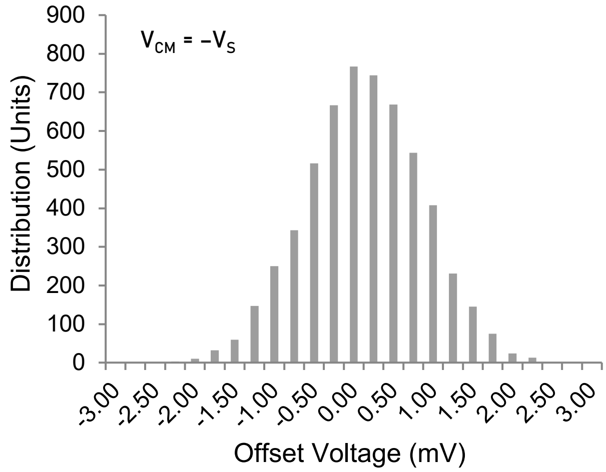
Quiescent Current vs. Temperature



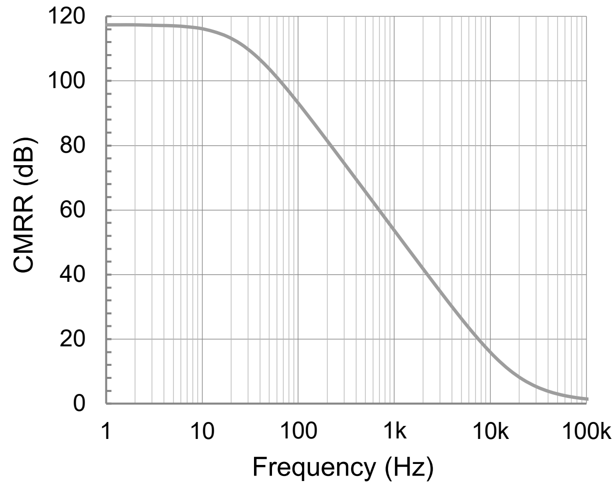
Quiescent Current vs. Input Common-Mode Voltage



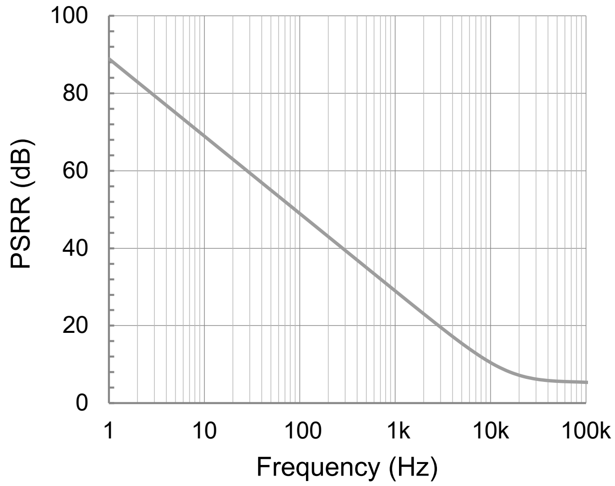
Offset Voltage Production Distribution



Common-mode Rejection Ratio vs. Frequency



Power Supply Rejection Ratio vs. Frequency

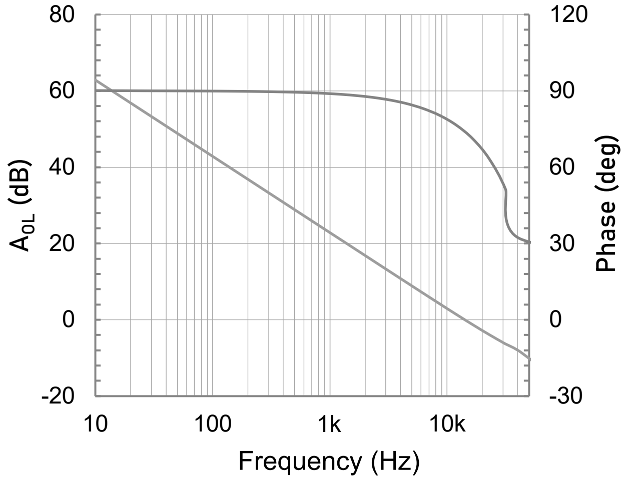


7 Specifications

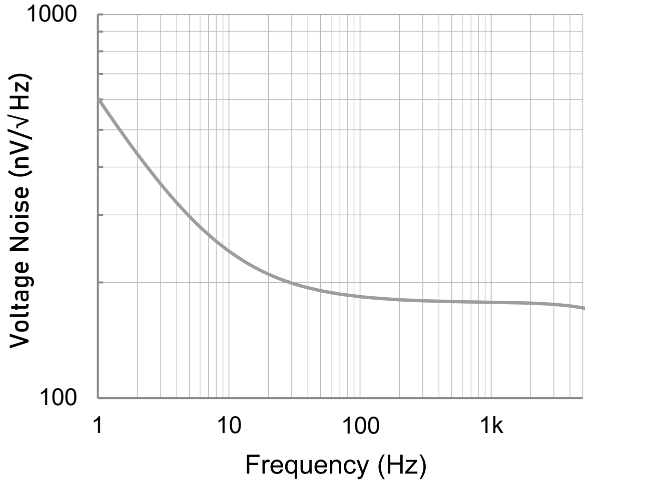
7.5 Typical Characteristics (continued)

At T_A = +25℃, V_{CM} = V_S /2, and R_L = 10kΩ connected to V_S /2, unless otherwise noted.

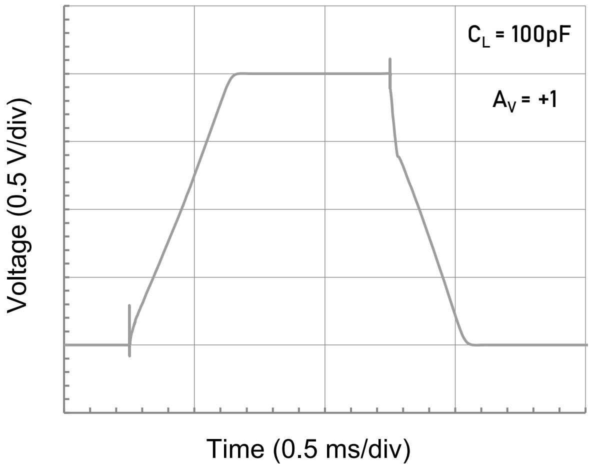
Open-loop Gain and Phase vs. Frequency



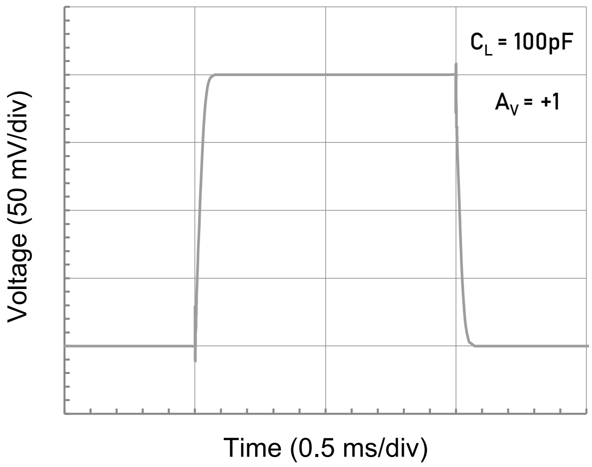
Input Voltage Noise Spectral Density vs. Frequency



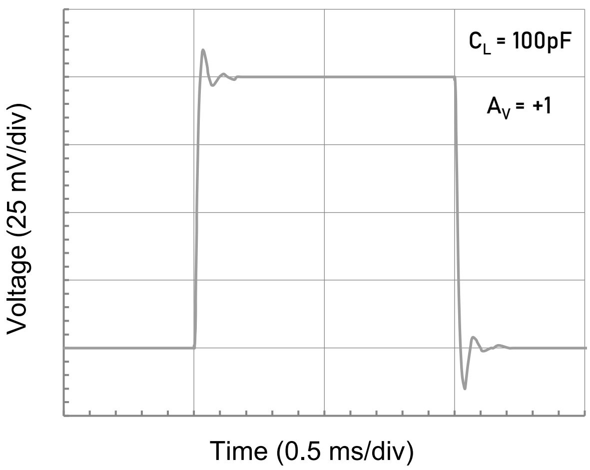
Large Signal Step Response (2V Step)



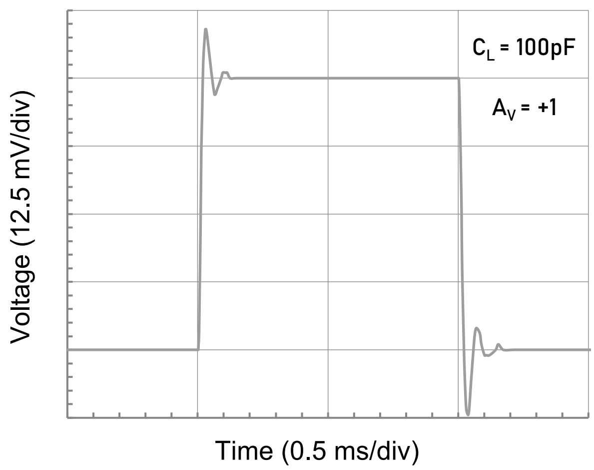
Small Signal Step Response (200mV Step)



Small Signal Step Response (100mV Step)



Small Signal Step Response (50mV Step)

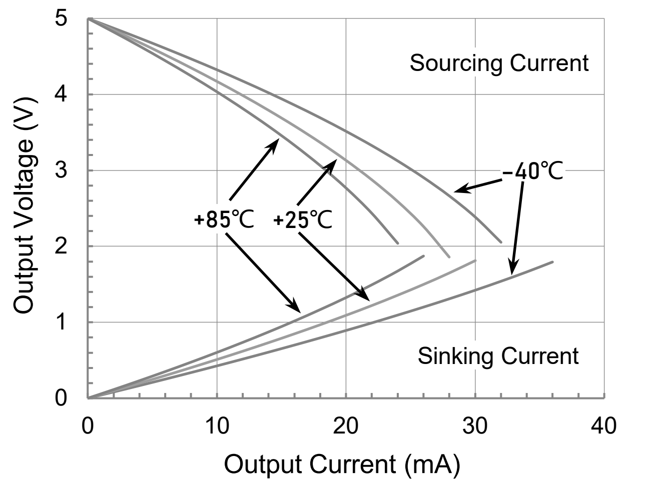


7 Specifications

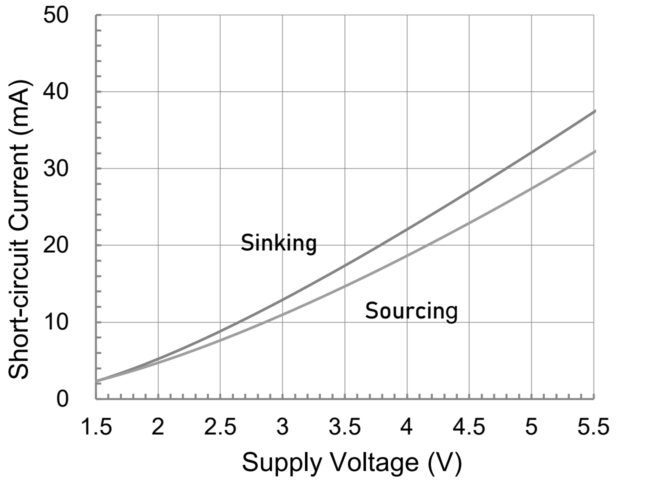
7.5 Typical Characteristics (continued)

At T_A = +25℃, V_{CM} = V_S /2, and R_L = 10kΩ connected to V_S /2, unless otherwise noted.

Output Voltage Swing vs. Output Current



Short-circuit Current vs. Supply Voltage



8 Detailed Description

8.1 Description

Featuring a maximized ratio of GBW-to-supply current, low operating supply voltage, low input bias current, and rail-to-rail inputs and outputs, the CJOA204x family is an excellent choice for precision or general-purpose, low-current, low-voltage, battery-powered applications. These CMOS operational amplifiers consume an ultra-low 600nA (typically at 5V supply voltage) supply current per amplifier. The CJOA204x family is unity-gain stable with a 15kHz GBW product, driving capacitive loads up to 250pF.

8.2 Feature Description

Rail-to-Rail Input

The input common-mode voltage range of the CJOA204x series extends 100mV beyond the negative and positive supply rails. This performance is achieved with a complementary input stage: an N-channel input differential pair in parallel with a P-channel differential pair. The N-channel pair is active for input voltages close to the positive rail, typically (V+) -1.4 V to the positive supply, whereas the P-channel pair is active for inputs from 100mV below the negative supply to approximately (V+) -1.4 V. There is a small transition region, typically (V+) -1.2 V to (V+) -1 V, in which both pairs are on. This 200mV transition region can vary up to 20mV with process variation. Thus, the transition region (both stages on) can range from (V+) -1.4 V to (V+) -1.2 V on the low end, up to (V+) -1 V to (V+) -0.8 V on the high end. Within this transition region, PSRR, CMRR, offset voltage, offset drift, and THD can be degraded compared to device operation outside this region.

The typical input bias current of the CJOA204x during normal operation is approximately 1pA. In overdriven conditions, the bias current can increase significantly. The most common cause of an overdriven condition occurs when the operational amplifier is outside of the linear range of operation. When the output of the operational amplifier is driven to one of the supply rails, the feedback loop requirements cannot be satisfied and a differential input voltage develops across the input pins. This differential input voltage results in activation of parasitic diodes inside the front-end input chopping switches that combine with electromagnetic interference (EMI) filter resistors to create the equivalent circuit. Notice that the input bias current remains within specification in the linear region.

Rail-to-Rail Output

Designed as a micro-power, low-noise operational amplifier, the CJOA204x delivers a robust output drive capability. A class AB output stage with common- source transistors is used to achieve full rail-to-rail output swing capability. For resistive loads up to 50kΩ， the output swings typically to within 4mV of either supply rail regardless of the power supply voltage applied. Different load conditions change the ability of the amplifier to swing close to the rails. For resistive loads up to 2kΩ, the output swings typically to within 40mV of the positive supply rail and within 27mV of the negative supply rail.

EMI Rejection Ratio

Circuit performance is often adversely affected by high frequency EMI. When the signal strength is low and transmission lines are long, an op-amp must accurately amplify the input signals. However, all op-amp pins — the non-inverting input, inverting input, positive supply, negative supply, and output pins — are susceptible to EMI signals. These high frequency signals are coupled into an op-amp by various means, such as conduction, near field radiation, or far field radiation. For example, wires and printed circuit board (PCB) traces can act as antennas and pick up high frequency EMI signals.

Amplifiers do not amplify EMI or RF signals due to their relatively low bandwidth. However, due to the nonlinearities of the input devices, op-amps can rectify these out of band signals. When these high frequency signals are rectified, they appear as a dc offset at the output.

The CJOA204x op-amps have integrated EMI filters at their input stage. A mathematical method of measuring EMIRR is defined as follows:

$$EMIRR = 20\ log(V_{IN\_PEAK}/\Delta V_{OS})$$

9 Application and Implementation

9.1 Typical Application Circuits

Input EMI Filter and Clamp Circuit

Figure 9-1 shows the input EMI filter and clamp circuit. The CJOA204x op-amps have internal ESD protection diodes (D1, D2, D3, and D4) that are connected between the inputs and each supply rail. These diodes protect the input transistors in the event of electrostatic discharge and are reverse biased during normal operation. This protection scheme allows voltages as high as approximately 500mV beyond the rails to be applied at the input of either terminal without causing permanent damage. These ESD protection current-steering diodes also provide in-circuit, input overdrive protection, as long as the current is limited to 10mA as stated in the Absolute Maximum Ratings.

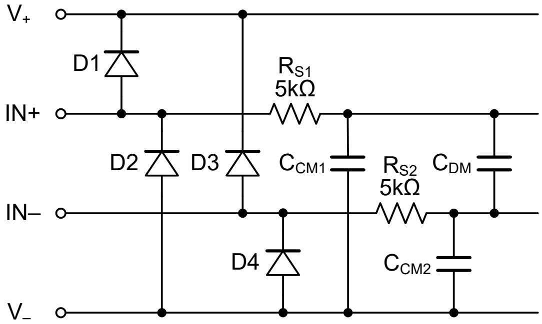


Figure 9-1. Input EMI Filter and Clamp Circuit

Operational amplifiers vary in susceptibility to EMI. If conducted EMI enters the operational amplifier, the dc offset at the amplifier output can shift from its nominal value when EMI is present. This shift is a result of signal rectification associated with the internal semiconductor junctions. Although all operational amplifier pin functions can be affected by EMI, the input pins are likely to be the most susceptible. The EMI filter of the CJOA204x family is composed of two 5kΩ input series resistors (R_{S1} and R_{S2}), two common-mode capacitors (C_{CM1} and C_{CM2}), and a differential capacitor (CDM). These RC networks set the -3dB low-pass cutoff frequencies at 35MHz for common-mode signals, and at 22MHz for differential signals.

Capacitive Load and Stability

The CJOA204x family of operational amplifiers can safely drive capacitive loads of up to 250pF in any configuration. As with most amplifiers, driving larger capacitive loads than specified may cause excessive overshoot and ringing, or even oscillation. A heavy capacitive load reduces the phase margin and causes the amplifier frequency response to peak. Peaking corresponds to overshooting or ringing in the time domain. Therefore, it is recommended that external compensation be used if the CJOA204x family requires greater capacitive-drive capability. This compensation is particularly important in the unity-gain configuration, which is the worst case for stability.

A quick and easy way to stabilize the op-amp for capacitive load drive is by adding a series resistor, R_{ISO}, between the amplifier output terminal and the load capacitance, as shown in Figure 9-2. R_{ISO} isolates the amplifier output and feedback network from the capacitive load. The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. Note that this method results in a loss of gain accuracy because R_{ISO} forms a voltage divider with the R_L. In unity gain applications with relatively small RL (approximately 5 kΩ), the capacitive load can be increased up to 100pF.

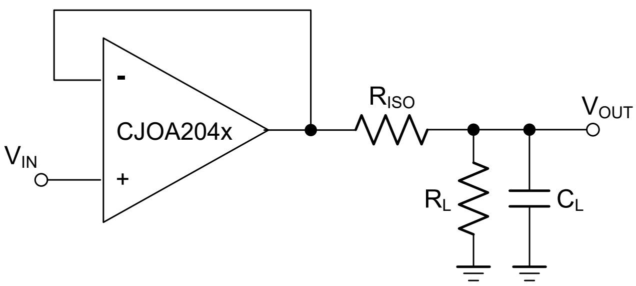


Figure 9-2. Indirectly Driving Heavy Capacitive Load

9 Application and Implementation

9.1 Typical Application Circuits (continued)

Capacitive Load and Stability (continued)

An improvement circuit is shown in Figure 9-3. It provides DC accuracy as well as AC stability. The RF provides the DC accuracy by connecting the inverting signal with the output.

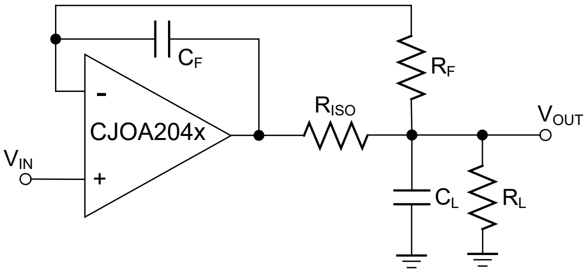


Figure 9-3. Indirectly Driving Heavy Capacitive Load with DC Accuracy

The C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

For no-buffer configuration, there are two others ways to increase the phase margin: (a) by increasing the amplifier's gain, or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

Input-to-Output Coupling

To minimize capacitive coupling, the input and output signal traces should not be parallel. This helps reduce unwanted positive feedback

Differential Amplifier

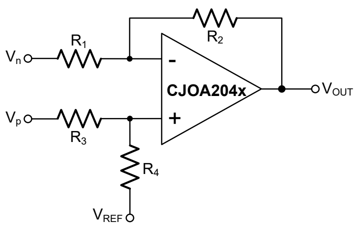


Figure 9-4. Differential Amplifier

The circuit shown in Figure 9-4 performs the difference function. If the resistors ratios are equal $R_4/R_3 = R_2/R_1$, then:

$$V_{OUT} = (V_p - V_n) \times R_2/R_1 + V_{REF}$$

Portable Gas Meter

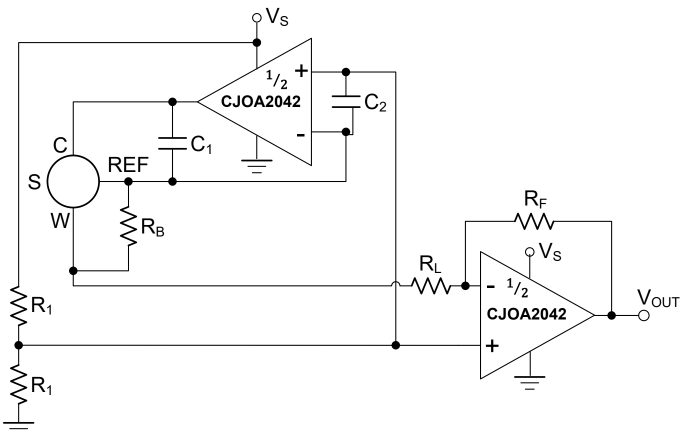
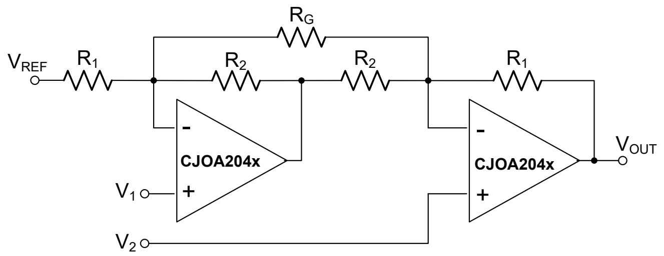


Figure 9-5. Portable Gas Meter Application

9 Application and Implementation

9.1 Typical Application Circuits (continued)

Instrumentation Amplifier



$$V_{OUT} = (V1 - V2)\left(1 + \frac{R_1}{R_2} + \frac{2R_1}{R_G}\right) + V_{REF}$$

Figure 9-6. Instrumentation Amplifier

The CJOA204x family is well suited for conditioning sensor signals in battery-powered applications. Figure 9-6 shows a two op-amp instrumentation amplifier, using the CJOA204x op-amps. The circuit works well for applications requiring rejection of common-mode noise at higher gains. The reference voltage (V_{REF}) is supplied by a low-impedance source. In single voltage supply applications, the V_{REF} is typically $V_S/2$.

Battery Monitoring

The low operating voltage and quiescent current of the CJOA204x family make it an excellent choice for battery monitoring applications, as shown in Figure 9-7. In this circuit, V_{STATUS} is high as long as the battery voltage remains above 2V (V_{REF} = 1.2V). A low-power reference is used to set the trip point. Resistor values are selected as follows:

1. RF Selecting: Select R_F such that the current through R_F is approximately 1000x larger than the maximum bias current over temperature:

$$R_F = V_{REF} \div (1000 \times I_{BMAX}) = 1.2V \div (1000 \times 100\ pA) = 12M\Omega\ \approx 10M\Omega$$

2. Choose the hysteresis voltage, V_{HYST}. For battery monitoring applications, 50mV is adequate.

3. Calculate R1 as follows:

$$R_1 = R_F \times (V_{HYST} \div V_{BATT}) \approx 10M\Omega \times (50\text{mV} \div 2.4\text{V}) = 210\text{k}\Omega$$

4. Select a threshold voltage for V_{IN} rising (V_{TS}) = 2.0V.

5. Calculate R_2 as follows:

$$R_2 = 1 \div [V_{TS} \div (V_{REF} \times R_1) - 1 \div R_1 - 1 \div R_F] = 1 \div [2V \div (1.2V \times 210\text{k}\Omega) - 1 \div 210\text{k}\Omega - 1 \div 10\text{M}\Omega] = 325\text{k}\Omega$$

6. Calculate R_{BIAS}: The minimum supply voltage for this circuit is 1.8V. Providing 5μA of supply current assures proper operation. Therefore:

$$R_{BIAS} = (V_{BATTMIN} - V_{REF}) \div I_{BIAS} = (1.8V \div 1.2V) \div 5\mu A = 120\ \text{k}\Omega$$

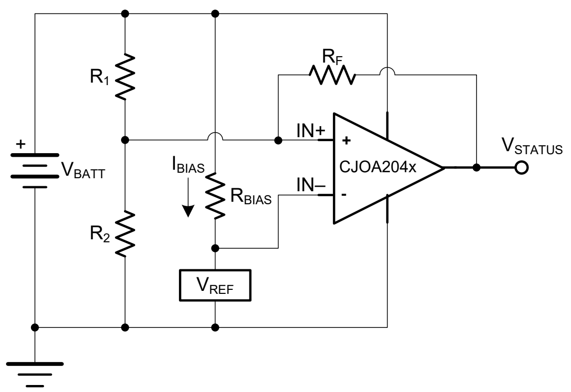


Figure 9-7. Battery Monitor

9 Application and Implementation

9.2 Power Supply Recommendations

Operating Voltage

The CJOA204x family is fully specified and ensured for operation at voltages as low as +1.7 V (± 0.85 V) and up to +5.5 V (± 2.75 V). In addition, many specifications apply from －40℃ to +85℃ . Parameters that vary significantly with operating voltages or temperature are illustrated in the Typical Characteristics graphs.

9.3 Layout Guidelines

Maximizing Performance through Proper Layout

To achieve the maximum performance of the extremely high input impedance and low offset voltage of the CJOA204x op-amps, care is needed in laying out the circuit board. The PCB surface must remain clean and free of moisture to avoid leakage currents between adjacent traces. Surface coating of the circuit board reduces surface moisture and provides a humidity barrier, reducing parasitic resistance on the board. The use of guard rings around the amplifier inputs further reduces leakage currents. Figure 9-8 shows proper guard ring configuration and the top view of a surface-mount layout. The guard ring does not need to be a specific width, but it should form a continuous loop around both inputs. By setting the guard ring voltage equal to the voltage at the non-inverting input, parasitic capacitance is minimized as well. For further reduction of leakage currents, components can be mounted to the PCB using Teflon standoff insulators.

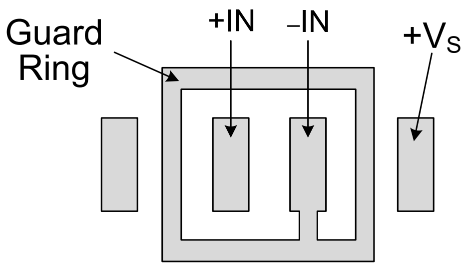


Figure 9-8. Use a guard ring around sensitive pins

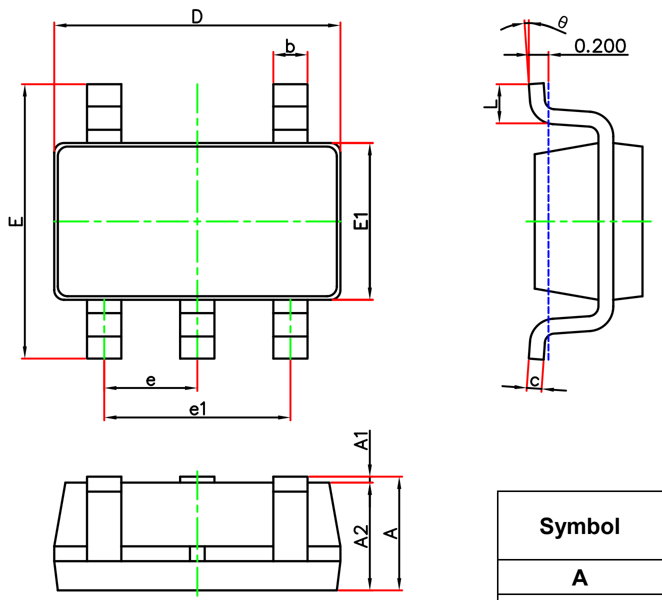
Other potential sources of offset error are thermoelectric voltages on the circuit board. This voltage, also called Seebeck voltage, occurs at the junction of two dissimilar metals and is proportional to the temperature of the junction. The most common metallic junctions on a circuit board are solder-to- board trace and solder-to-component lead. If the temperature of the PCB at one end of the component is different from the temperature at the other end, the resulting Seebeck voltages are not equal, resulting in a thermal voltage error.

This thermocouple error can be reduced by using dummy components to match the thermoelectric error source. Placing the dummy component as close as possible to its partner ensures both Seebeck voltages are equal, thus canceling the thermocouple error. Maintaining a constant ambient temperature on the circuit board further reduces this error. The use of a ground plane helps distribute heat throughout the board and reduces EMI noise pickup.

10 Mechanical Information

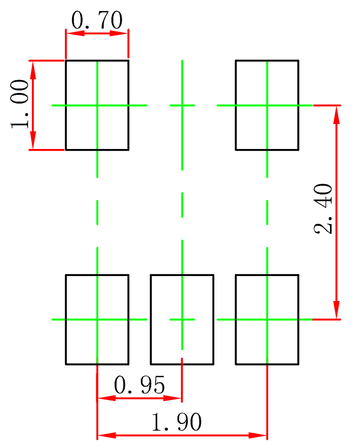
10.1 SOT-23-5L Mechanical Information

SOT-23-5L Outline Dimensions



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	1.000	1.200	0.039	0.047
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	2.600	3.000	0.102	0.118
E1	1.500	1.700	0.059	0.067
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°

SOT-23-5L Suggested Pad Layout



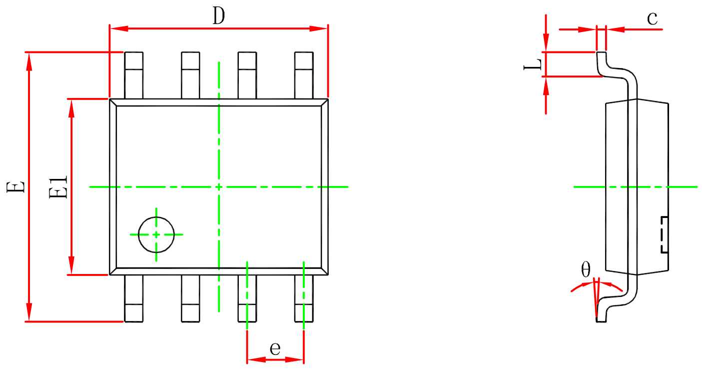
Note:

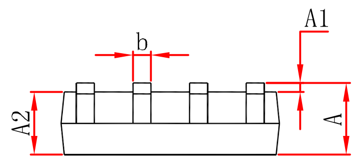
1. Controlling dimension: in millimeters.
2. General tolerance: ±0.05mm.
3. The pad layout is for reference purpose only.

10 Mechanical Information

10.2 SOP8 Mechanical Information

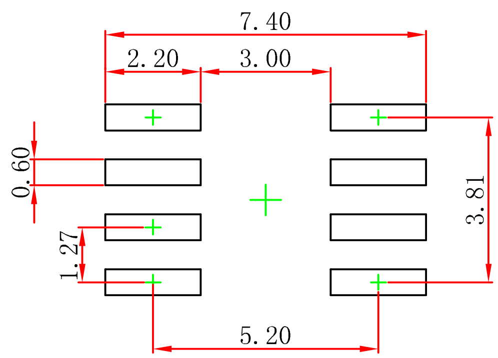
Outline Dimensions





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.450	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	4.700	5.100	0.185	0.201
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°

SOP8 Suggest Pad Layout



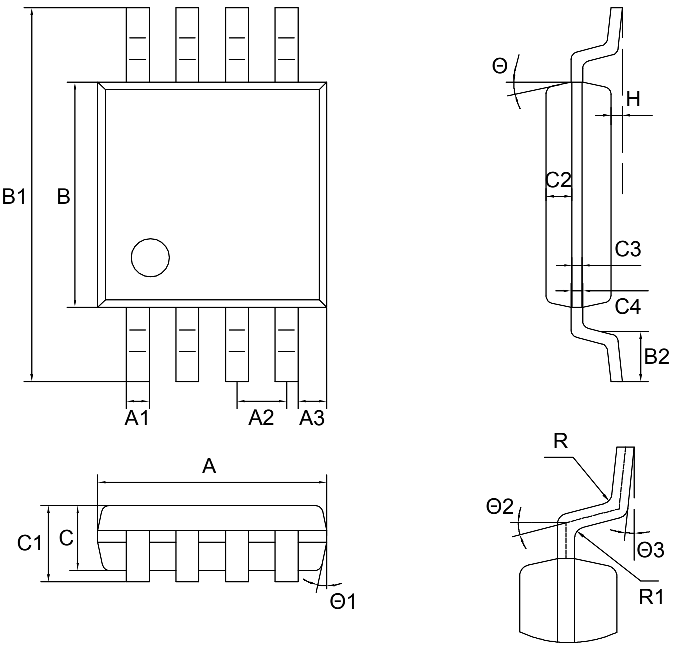
NOTE:

1. Controlling dimension: in millimeters.
2. General tolerance: ±0.05mm.
3. The pad layout is for reference purposes only.

10 Mechanical Information

10.3 MSOP8 Mechanical Information

Outline Dimensions

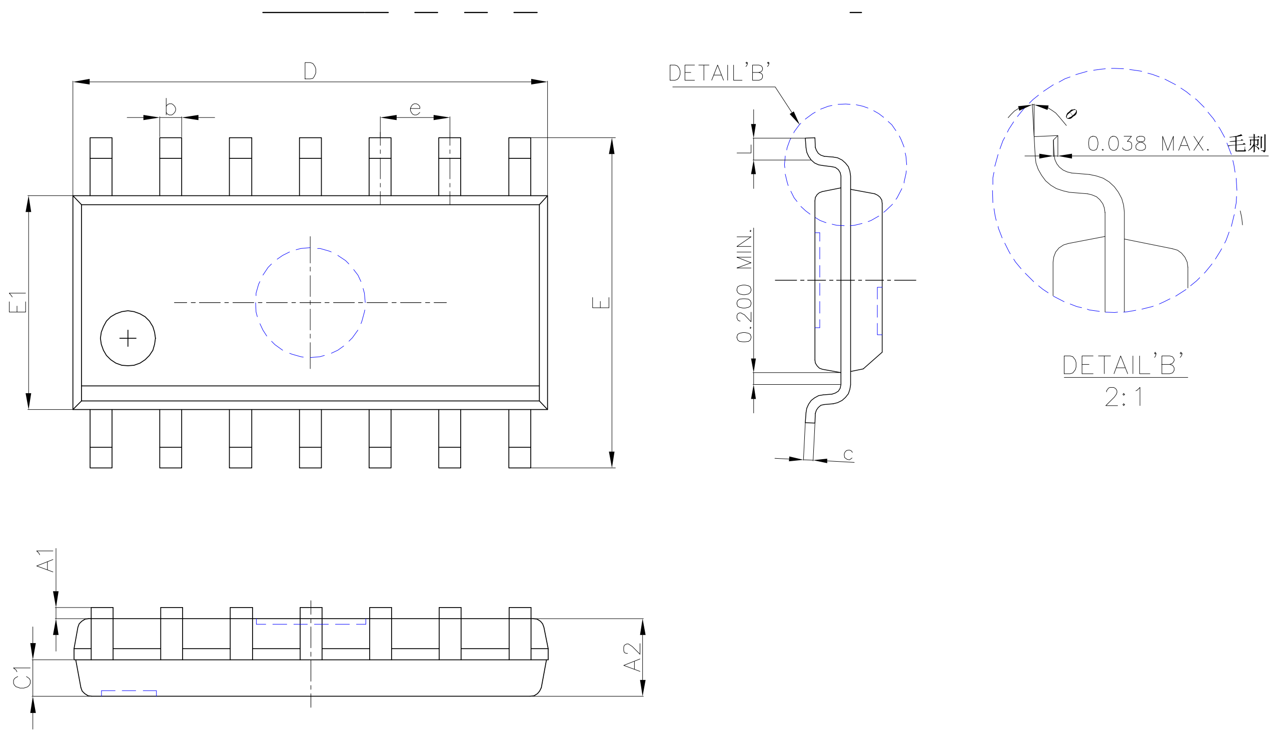


SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	2.900	3.000	3.100	0.114	0.118	0.122
A1	0.280	-	0.350	0.011	-	0.014
A2	0.650 TYP.			0.026 TYP.		
A3	0.375 TYP.			0.015 TYP.		
B	2.900	3.000	3.100	0.114	0.118	0.122
B1	4.700	-	5.100	0.185	-	0.201
B2	0.450	0.600	0.750	0.018	0.024	0.030
C	0.750	0.850	0.950	0.030	0.033	0.037
C1	-	-	1.100	-	-	0.043
C2	0.328 TYP.			0.013 TYP.		
C3	0.152 TYP.			0.006 TYP.		
C4	0.150	-	0.230	0.006	-	0.009
H	0.000	-	0.090	0.000	-	0.004
Θ	-	12°	-	-	12°	-
Θ1	-	12°	-	-	12°	-
Θ2	-	14°	-	-	14°	-
Θ3	0°	-	6°	0°	-	6°
R	0.150 TYP.			0.006 TYP.		
R1	0.150 TYP.			0.006 TYP.		

10 Mechanical Information

10.4 SOP14 Mechanical Information

Outline Dimensions

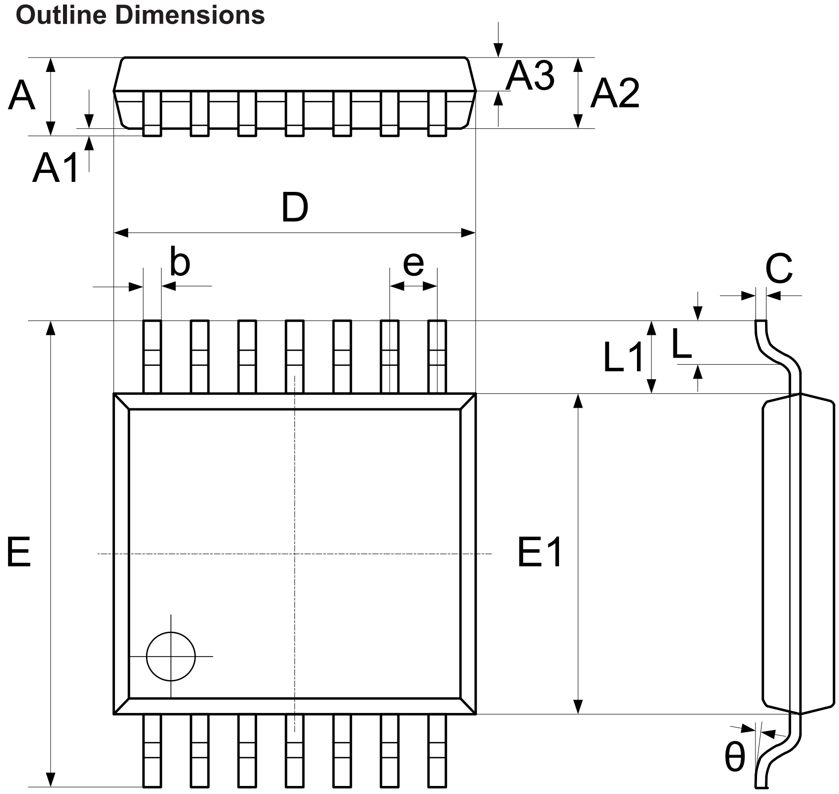


SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
D	8.630	8.730	8.830	0.340	0.344	0.348
b	0.406 Typ.			0.016 Typ.		
e	1.270 Typ.			0.050 Typ.		
E1	3.850	3.950	4.050	0.152	0.155	0.159
E	5.840	6.040	6.240	0.230	0.238	0.246
A2	1.350	1.450	1.550	0.053	0.057	0.061
C1	0.550	0.650	0.750	0.022	0.026	0.030
A1	0.100	0.200	0.300	0.004	0.008	0.012
c	0.203 Typ.			0.008 Typ.		
L	0.350	0.550	0.750	0.014	0.022	0.030
θ	0°	2°	8°	0°	2°	8°

10 Mechanical Information

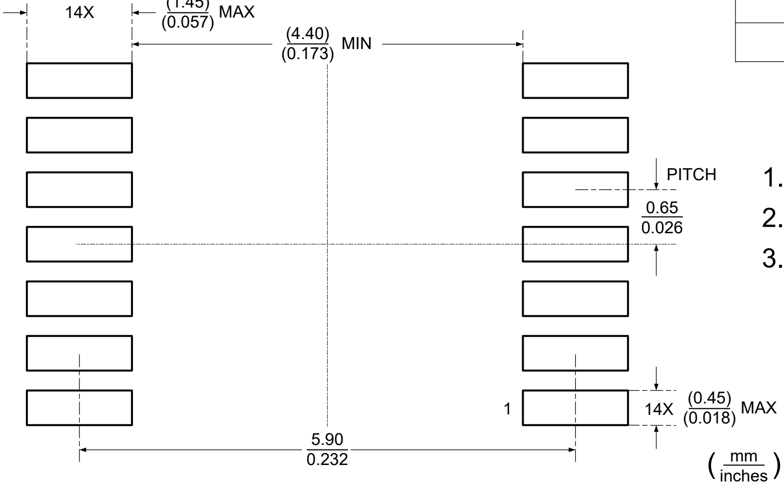
10.5 TSSOP14 Mechanical Information

Outline Dimensions



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	0.900	1.050	0.035	0.041
A3	0.390	0.490	0.015	0.019
b	0.200	0.290	0.008	0.011
C	0.130	0.180	0.005	0.007
D	4.860	5.060	0.191	0.199
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 TYP.		0.026 TYP.	
L1	1.000 REF.		0.039 REF.	
L	0.450	0.750	0.018	0.030
θ	0°	8°	0°	8°

TSSOP14 Suggest Pad Layout



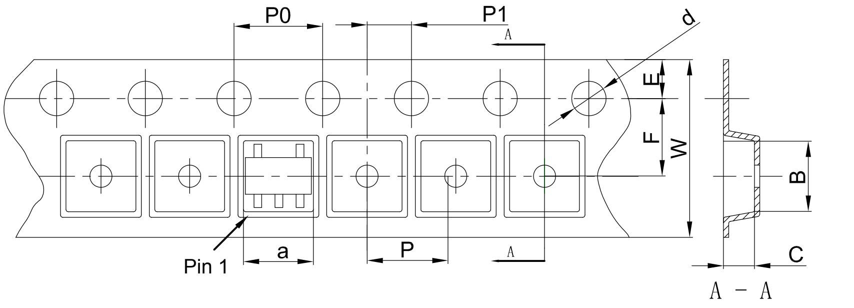
NOTE:

1. Controlling dimension: in millimeters.
2. General tolerance: ±0.05mm.
3. The pad layout is for reference purposes only.

11 Packaging Information

11.1 SOT-23-5L Tape and Reel Information

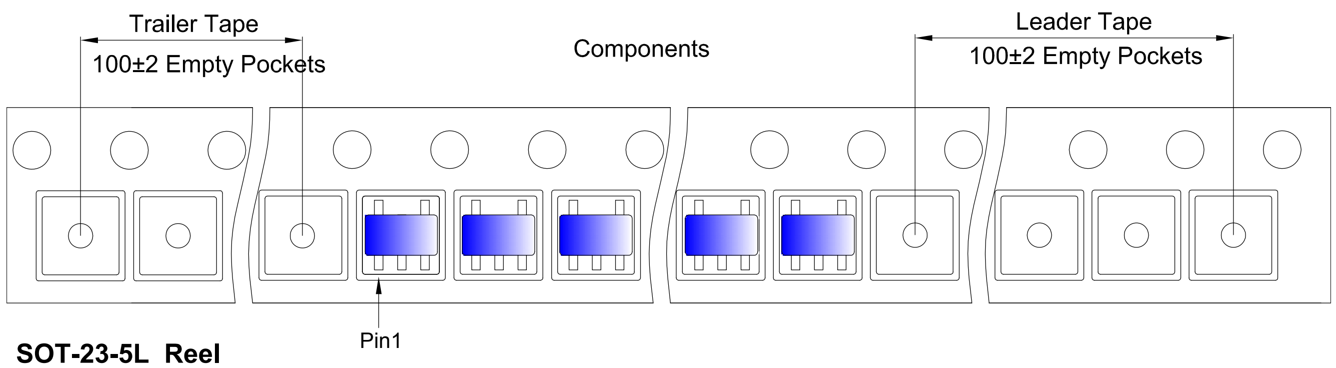
SOT-23-5L Tape and Reel Information



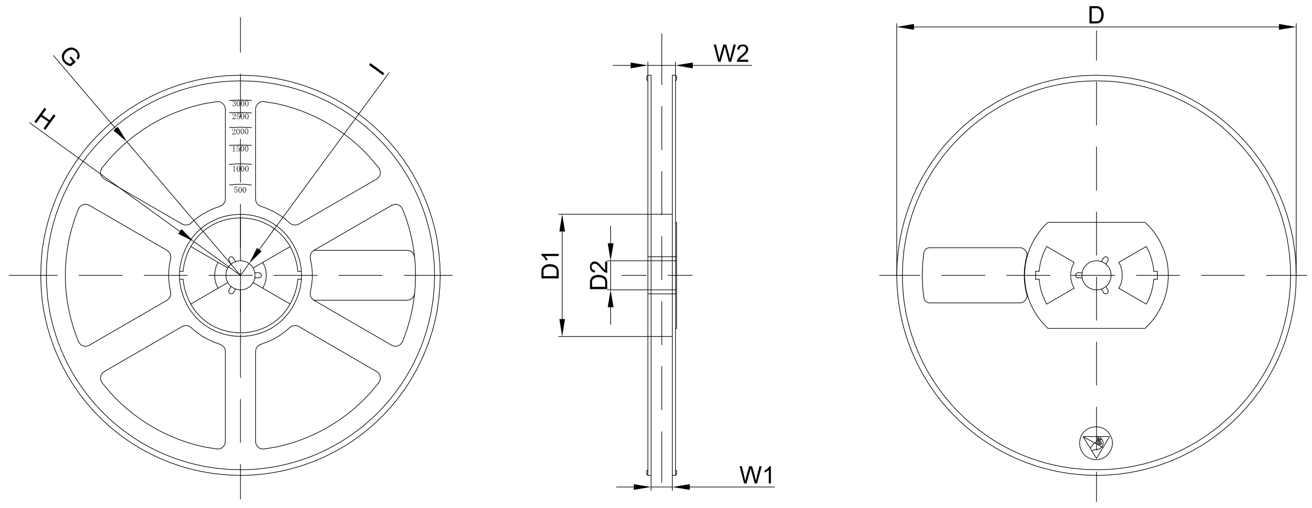
Packaging Description:
SOT-23-5L parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 3,000 units per 7" or 18.0cm diameter reel. The reels are clear in color and is made of polystyrene plastic (anti-static coated).

Dimensions are in millimeter										
Pkg type	a	B	C	d	E	F	P0	P	P1	W
SOT-23-5L	3.17	3.23	1.37	Ø1.55	1.75	3.50	4.00	4.00	2.00	8.00

SOT-23-5L Tape Leader and Trailer



SOT-23-5L Reel



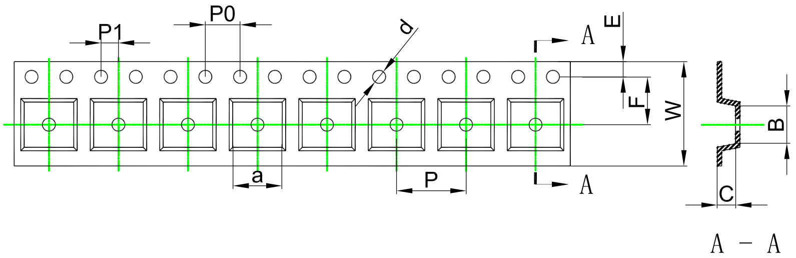
Dimensions are in millimeter								
Reel Option	D	D1	D2	G	H	I	W1	W2
7"Dia	Ø180.00	60.00	13.00	R78.00	R25.60	R6.50	9.50	13.10

REEL	Reel Size	Box	Box Size(mm)	Carton	Carton Size(mm)	G.W.(kg)
3000 pcs	7 inch	30,000 pcs	203×203×195	120,000 pcs	438×438×220	

11 Packaging Information

11.2 SOP8 Tape and Reel Information

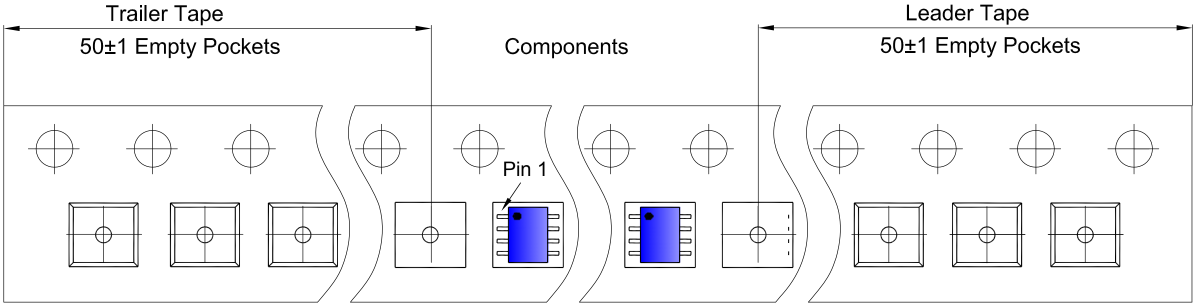
Embossed Carrier Tape



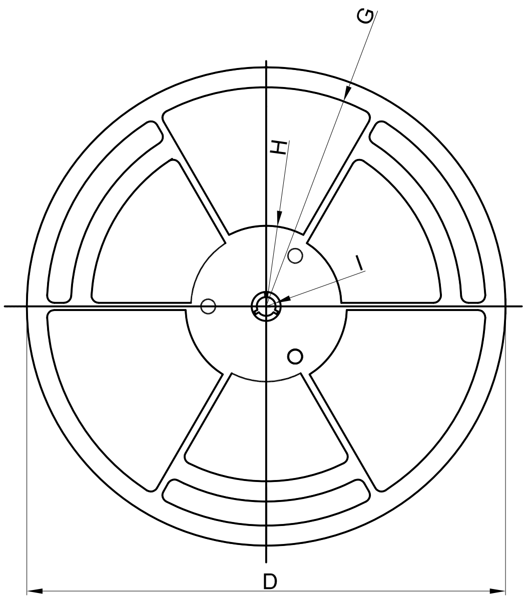
Packaging Description:
SOP8 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 2,500 units per 13" or 33cm diameter reel. The reels are clear in color and is made of polystyrene plastic (anti-static coated).
ALL DIM IN mm

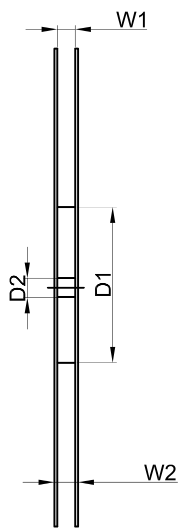
Dimensions are in millimeter										
Pkg type	a	B	C	d	E	F	P0	P	P1	W
SOP8	6.40	5.40	2.10	Ø1.50	1.75	5.50	4.00	8.00	2.00	12.00

Tape Leader and Trailer



Reel





Dimensions are in millimeter								
Reel Option	D	D1	D2	G	H	I	W1	W2
13"Dia	Ø330.00	100.00	13.00	R151.00	R56.00	R6.50	12.40	17.60

REEL	Reel Size	Box	Box Size(mm)	Carton	Carton Size(mm)	G.W.(kg)
4,000 pcs	13 inch	8,000 pcs	360×360×65	64,000 pcs	565×380×390	

12 Notes and Revision History

12.1 Associated Product Family and Others

To view other products of the same type or IC products of other types, click the official website of JSCJ -- https: ***www.jscj-elec.com*** for more details.

12.2 Notes

Electrostatic Discharge Caution

This IC may be damaged by ESD. Relevant personnel shall comply with correct installation and use specifications to avoid ESD damage to the IC. If appropriate measures are not taken to prevent ESD damage, the hazards caused by ESD include but are not limited to degradation of integrated circuit performance or complete damage of integrated circuit. For some precision integrated circuits, a very small parameter change may cause the whole device to be inconsistent with its published specifications.

12.3 Revision History

October 2024: released CJOA204x Series rev - 1.0.

DISCLAIMER

IMPORTANT NOTICE, PLEASE READ CAREFULLY

The information in this data sheet is intended to describe the operation and characteristics of our products. JSCJ has the right to make any modification, enhancement, improvement, correction or other changes to any content in this data sheet, including but not limited to specification parameters, circuit design and application information, without prior notice.

Any person who purchases or uses JSCJ products for design shall: 1. Select products suitable for circuit application and design; 2. Design, verify and test the rationality of circuit design; 3. Procedures to ensure that the design complies with relevant laws and regulations and the requirements of such laws and regulations. JSCJ makes no warranty or representation as to the accuracy or completeness of the information contained in this data sheet and assumes no responsibility for the application or use of any of the products described in this data sheet.

Without the written consent of JSCJ, this product shall not be used in occasions requiring high quality or high reliability, including but not limited to the following occasions: medical equipment, military facilities and aerospace. JSCJ shall not be responsible for casualties or property losses caused by abnormal use or application of this product.

Official Website: www.jscj-elec.com