250MHz, High Slew Rate, RRO, CMOS Amplifiers

CJOA665x Series CMOS Amplifiers

1 Introduction

The CJOA665x family is true single-supply voltage feedback operational amplifiers feature high speed performance with 250MHz of small signal bandwidth and 190V/μs slew rate. The products are specified for +3.3V, +5V, and ±5V supplies, input common mode voltage range extends to 0.1V below V- and 1V from V+, and output voltage range extends to power rail, allowing wide dynamic range especially desirable in low voltage applications. The CJOA665x also offer excellent signal quality of low distortion and fast settling time (13.5ns to 0.1%), which make them ideal as buffers to single-supply ADCs.

Operating on supplies from +3.3V to +12.6V and dual supplies up to ±6.3V, the CJOA665x are ideal for a wide range of applications, from battery-operated systems with large bandwidth requirements to high speed systems where component density requires lower power dissipation. The single version CJOA6651 device is available in micro-size SOT23-5L package. The dual CJOA6652 device is offered in SOP8 and MSOP8 packages. The quad CJOA6654 device is offered in SOP14 package.

2 Features

- High Speed and Fast Settling on ±5V
- 250MHz, -3dB bandwidth (G = +1)
- 190V/μs slew rate
- 13.5ns settling time to 0.1%
- Fully specified at +3.3V, +5V, and ±5V Supplies
- Input Common Mode Voltage 0.1V Beyond V-, 1V from V+
- Output Voltage Swing from -4.6V to +4.2V (±5V power supply)
- Output Short Circuit Current 210mA
- Linear Output Current ±130mA
- Operating Temperature Range -40°C to +125°C

3 Applications

- Photodiode Amplification
- Video Buffer
- Active Filters
- Driving A/D Converters
- Motor Phase Current Sense
- Portable Equipment
- Battery-Powered Instrumentation

4 Available Packages

PART NUMBER	PACKAGE
CJOA6651-M5N	SOT-23-5L
CJOA6652-PAN	SOP8
CJOA6652-PDN	MSOP8
CJOA6654-PHN	SOP14

5 Orderable Information

MODEL	DEVICE	PACKAGE	OP TEMP	ECO PLAN	MSL	PACKING OPTION	SORT
CJOA6651	CJOA6651-M5N	SOT-23-5L	-40 ~ 125°C	RoHS & Green	Level 3 168 HR	Tape and Reel 3000 Units / Reel	Active
CJOA6652	CJOA6652-PAN	SOP8	-40 ~ 125°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
	CJOA6652-PDN	MSOP8	-40 ~ 125°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
CJOA6654	CJOA6654-PHN	SOP14	-40 ~ 125°C	RoHS & Green	Level 3 168 HR	Tape and Reel 2500 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 SZCJ

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

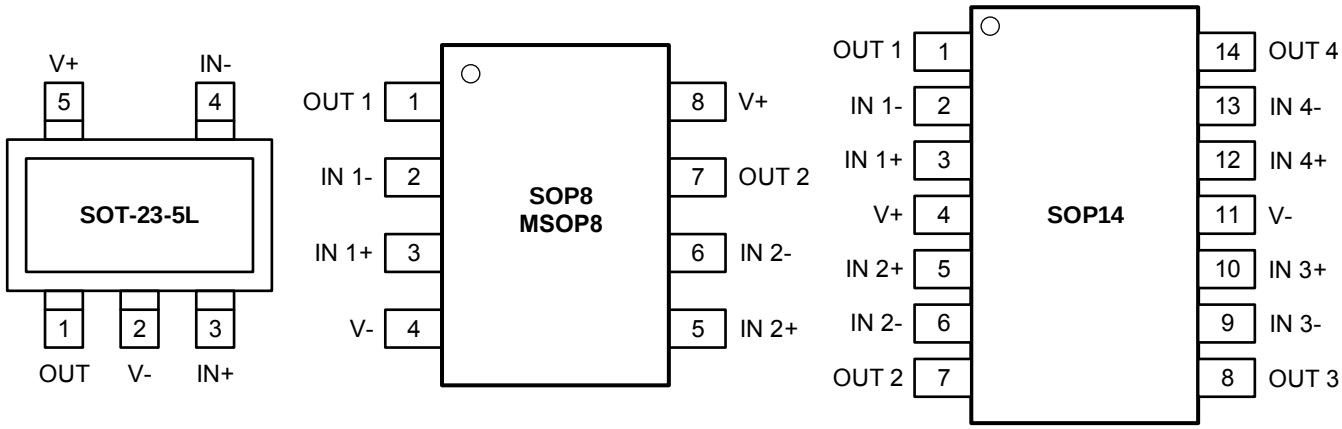
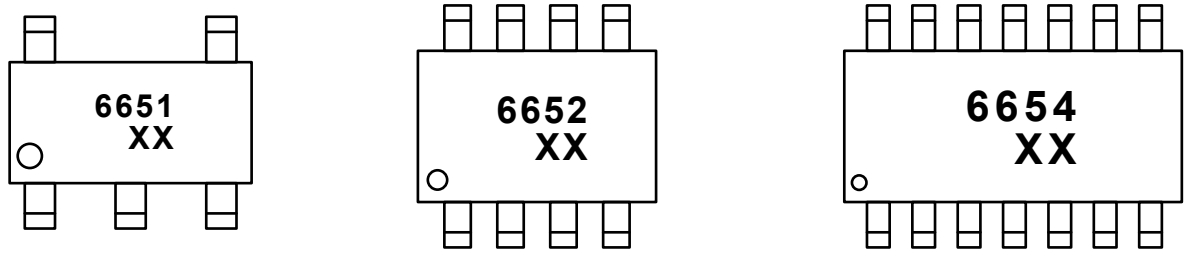


Figure 6-1. CJOA665x Pin Map

PIN NAME	CJOA6651 SOT-23-5L	CJOA6652 SOP8/MSOP8	CJOA6654 SOP14	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



"**665x**": 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	13.2	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 ~ 125°C	V_S	3.3	-	12.6	V
Operating ambient temperature		T_A	-40	-	125	°C

7 Specifications

7.3 ESD Ratings

ESD RATINGS		VALUE	UNIT
Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(4)	8000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101(5)	1000	

(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	SOT-23-5L	SOP8	MSOP8	SOP14	UNIT
Junction-to-ambient thermal resistance	$R_{\Theta JA}$	192.3	125.0	201.6	115.7	°C/W
Reference maximum power dissipation (continuous)	$P_{D\ Ref}$	0.65	1.00	0.62	1.08	W

(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

Unless otherwise noted. V_S = ±5V, V_{CM} = 0V, A_V = +1, and R_F = 20Ω; A_V ≥ +2, R_F = 470Ω and R_L = 100Ω.

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC PERFORMANCE						
Input Offset Voltage	V_{OS}	-	-	±2	±12	mV
Input Offset Voltage vs. Temperature	dV_{OS}/dT	T_A = −40 to +125℃	-	4	-	μV/℃
Input Bias Current	I_B	-	-	3	-	pA
Input Offset Current	I_{OS}	-	-	0.5	-	pA
Open-loop voltage gain	A_{VOL}	R_L = 100Ω, V_O = 4V_{PP}	-	80	100	dB
INPUT CHARACTERISTICS						
Input Common Mode Voltage Range	V_{CM}	-	(V-)-0.1	-	(V+)-1	V
Common Mode Rejection Rate	CMRR	G = +100, V_{CM} = -4.7V to +3.5V	60	80	108	dB
NOISE and DISTORTION PERFORMANCE						
Input Voltage Noise Density	e_n	F ≥ 1MHz	-	1	-	nV/√Hz
DYNAMIC PERFORMANCE						
-3dB Small-Signal Bandwidth	f_{-3dB}	G = +1, V_{OUT} = 0.2V_{PP}, R_F = 20Ω, R_L = 150Ω	-	250	-	MHz
		G = +1, V_{OUT} = 0.2V_{PP}, R_F = 20Ω, R_L = 1kΩ	-	300	-	
		G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L=150Ω	-	90	-	
		G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L = 1kΩ	-	110	-	
Gain-Bandwidth Product	GBP	G = +10, R_L = 150Ω	-	13	-	MHz
		G = +10, R_L = 1kΩ	-	13.5	-	
Bandwidth for 0.1dB Flatness	$f_{0.1dB}$	G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L=150Ω	-	10.6	-	MHz
Slew Rate	SR	G = +1, V_{IN} = 2V_{PP}	-	180/190	-	V/μs
Rise Time	T_r	G = +1, V_{IN} = 0.2V Step	-	2	-	ns
Fall Time	T_f	G = +1, V_{IN} = 0.2V Step	-	1.5	-	ns
Settling Time to 0.1%	T_s	G = -1, R_F = 402Ω, V_{OUT} = 2V Step	-	14	-	ns
OUTPUT CHARACTERISTICS						
High Output Voltage Swing	V_{OH}	No Load	(V+)-95	(V+)-50	-	mV
		R_L = 100Ω	(V+)-750	(V+)-550	-	
Low Output Voltage Swing	V_{OL}	No Load	-	(V-)+10	(V-)+40	mV
		R_L = 100Ω	-	(V-)+300	(V-)+450	
Short-circuit Current	I_{source}	Open loop, V_{IN} = ±200mV, no load	-	190	-	mA
	I_{sink}		-	210	-	
POWER SUPPLY						
Quiescent Current (Per amplifier)	I_Q	-	-	7.4	9	mA

7 Specifications

7.5 Electrical Characteristics (conitnued)

Unless otherwise noted. V_S = ±2.5V, V_{CM} = 0V, A_V = +1, and R_F = 20Ω; A_V ≥ +2, R_F = 470Ω and R_L = 100Ω.

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC PERFORMANCE						
Input Offset Voltage	V_{OS}	-	-	±1.8	±12	mV
Input Offset Voltage vs. Temperature	dV_{OS}/dT	T_A = −40 to +125 ℃	-	4	-	μV/℃
Input Bias Current	I_B	-	-	0.5	-	pA
Input Offset Current	I_{OS}	-	-	0.2	-	pA
Open-loop voltage gain	A_{VOL}	R_L = 100Ω, V_O = 3.3V_{PP}	-	80	100	dB
INPUT CHARACTERISTICS						
Input Common Mode Voltage Range	V_{CM}	-	(V-)-0.1	-	(V+)-1	V
Common Mode Rejection Rate	CMRR	G = +100, V_{CM} = -2.2V to +1V	60	80	108	dB
NOISE and DISTORTION PERFORMANCE						
Input Voltage Noise Density	e_n	F ≥ 1MHz	-	1	-	nV/√Hz
Differential Gain	DG	G = +2, R_L = 150Ω	-	0.05	-	%
Differential Phase	DP	G = +2, R_L = 150Ω	-	0.05	-	%
DYNAMIC PERFORMANCE						
-3dB Small-Signal Bandwidth	f_{-3dB}	G = +1, V_{OUT} = 0.2V_{PP}, R_F = 20Ω, R_L = 150Ω	-	200	-	MHz
		G = +1, V_{OUT} = 0.2V_{PP}, R_F = 20Ω, R_L = 1kΩ	-	240	-	
		G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L=150Ω	-	85	-	
		G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L = 1kΩ	-	110	-	
Gain-Bandwidth Product	GBP	G = +10, R_L = 150Ω	-	12	-	MHz
		G = +10, R_L = 1kΩ	-	12.5	-	
Bandwidth for 0.1dB Flatness	$f_{0.1dB}$	G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L=150Ω	-	8	-	MHz
Slew Rate	SR	G = +1, V_{IN} = 2V_{PP}	-	160/180	-	V/μs
Rise Time	T_r	G = +1, V_{IN} = 0.2V Step	-	2.2	-	ns
Fall Time	T_f	G = +1, V_{IN} = 0.2V Step	-	1.8	-	ns
Settling Time to 0.1%	T_s	G = -1, R_F = 402Ω, V_{OUT} = 2V Step	-	13.5	-	ns
OUTPUT CHARACTERISTICS						
High Output Voltage Swing	V_{OH}	No Load	(V+)-80	(V+)-40	-	mV
		R_L = 100Ω	(V+)-450	(V+)-350	-	
Low Output Voltage Swing	V_{OL}	No Load	-	(V-)+5	(V-)+20	mV
		R_L = 100Ω	-	(V-)+100	(V-)+250	
Short-circuit Current	I_{source}	Open loop, V_{IN} = ±200mV	-	120	-	mA
	I_{sink}		-	140	-	
POWER SUPPLY						
Quiescent Current (Per amplifier)	I_Q	-	-	6.7	8	mA

7 Specifications

7.5 Electrical Characteristics (conitnued)

Unless otherwise noted. V_S = ±1.65V, V_{CM} = 0V, A_V = +1, and R_F = 20Ω; A_V ≥ +2, R_F = 470Ω and R_L = 100Ω.

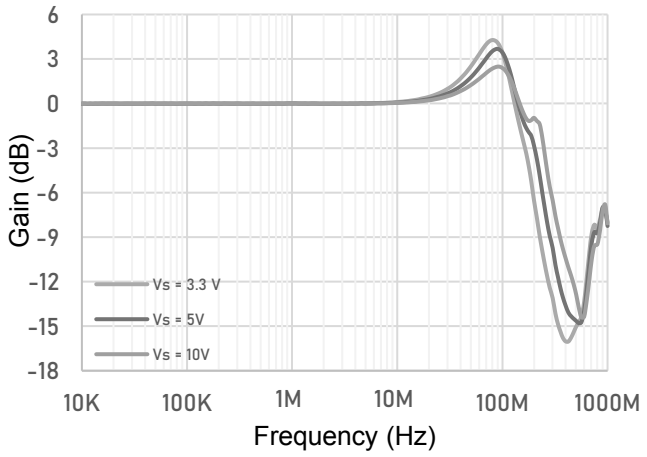
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC PERFORMANCE						
Input Offset Voltage	V_{OS}	-	-	±1.5	±12	mV
Input Offset Voltage vs. Temperature	dV_{OS}/dT	T_A = −40 to +125 ℃	-	3	-	μV/℃
Input Bias Current	I_B	-	-	0.6	-	pA
Input Offset Current	I_{OS}	-	-	0.6	-	pA
Open-loop voltage gain	A_{VOL}	R_L = 100Ω, V_O = 3.3V_{PP}	-	70	80	dB
INPUT CHARACTERISTICS						
Input Common Mode Voltage Range	V_{CM}	-	(V-)-0.1	-	(V+)-1	V
Common Mode Rejection Rate	CMRR	G = +100, V_{CM} = -2.2V to +1V	55	60	90	dB
NOISE and DISTORTION PERFORMANCE						
Input Voltage Noise Density	e_n	F ≥ 1MHz	-	1	-	nV/√Hz
DYNAMIC PERFORMANCE						
-3dB Small-Signal Bandwidth	f_{-3dB}	G = +1, V_{OUT} = 0.2V_{PP}, R_F = 20Ω, R_L = 150Ω	-	160	-	MHz
		G = +1, V_{OUT} = 0.2V_{PP}, R_F = 20Ω, R_L = 1kΩ	-	200	-	
		G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L=150Ω	-	80	-	
		G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L = 1kΩ	-	105	-	
Gain-Bandwidth Product	GBP	G = +10, R_L = 150Ω	-	12	-	MHz
		G = +10, R_L = 1kΩ	-	12.5	-	
Bandwidth for 0.1dB Flatness	$f_{0.1dB}$	G = +2, V_{OUT} = 0.2V_{PP}, R_F = 470Ω, R_L=150Ω	-	7	-	MHz
Slew Rate	SR	G = +1, V_{IN} = 2V_{PP}	-	150/170	-	V/μs
Rise Time	T_r	G = +1, V_{IN} = 0.2V Step	-	4	-	ns
Fall Time	T_f	G = +1, V_{IN} = 0.2V Step	-	4	-	ns
Settling Time to 0.1%	T_s	G = -1, R_F = 402Ω, V_{OUT} = 2V Step	-	16.5	-	ns
OUTPUT CHARACTERISTICS						
High Output Voltage Swing	V_{OH}	No Load	(V+)-50	(V+)-30	-	mV
		R_L = 100Ω	(V+)-350	(V+)-300	-	
Low Output Voltage Swing	V_{OL}	No Load	-	(V-)+3	(V-)+5	mV
		R_L = 100Ω	-	(V-)+180	(V-)+200	
Short-circuit Current	I_{source}	Open loop, V_{IN} = ±200mV	-	70	-	mA
	I_{sink}		-	90	-	
POWER SUPPLY						
Quiescent Current (Per amplifier)	I_Q	-	-	6.3	7	mA

7 Specifications

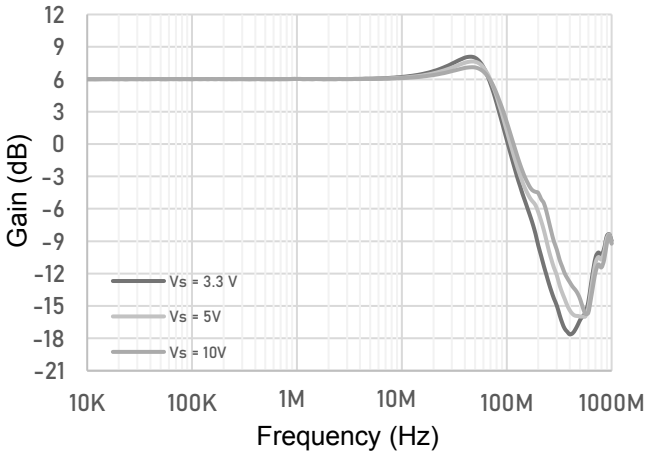
7.6 Typical Characteristics

(T_A = 25°C, V_S = ±5V, R_F = 20Ω for G = +1, R_F = 470Ω for G = +2, G = +10, and R_L = 100Ω, unless otherwise noted.)

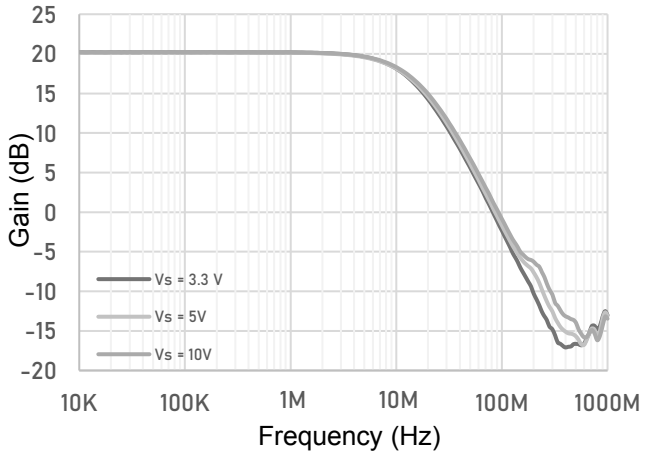
Closed-loop Bandwidth (G = +1)



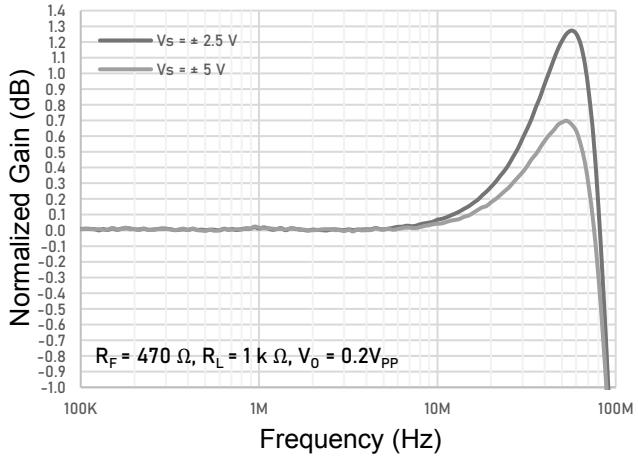
Closed-loop Bandwidth (G = +2)



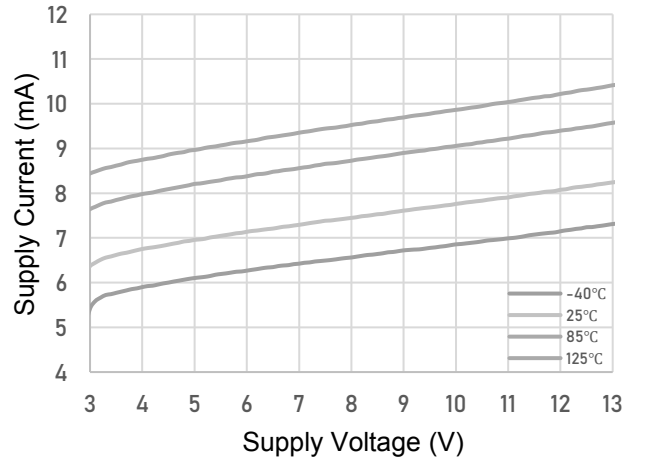
Closed-loop Bandwidth (G = + 10)



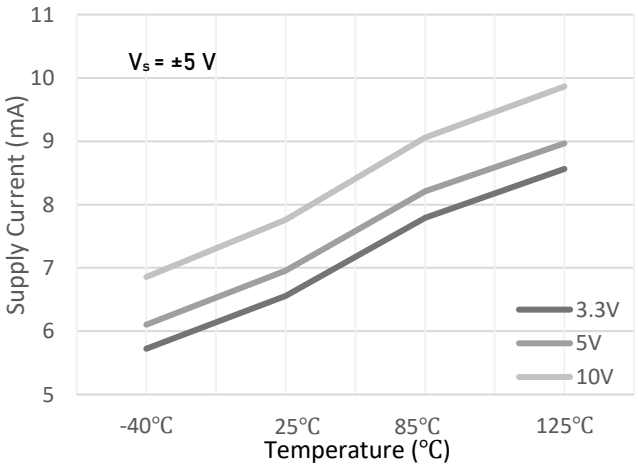
0.1 dB Gain Flatness (G= +2)



Supply Current per Channel vs. Supply Voltage



Supply Current per Channel vs. Temperature

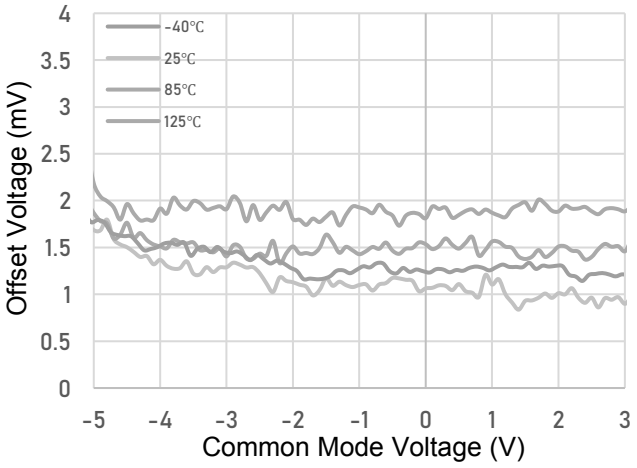


7 Specifications

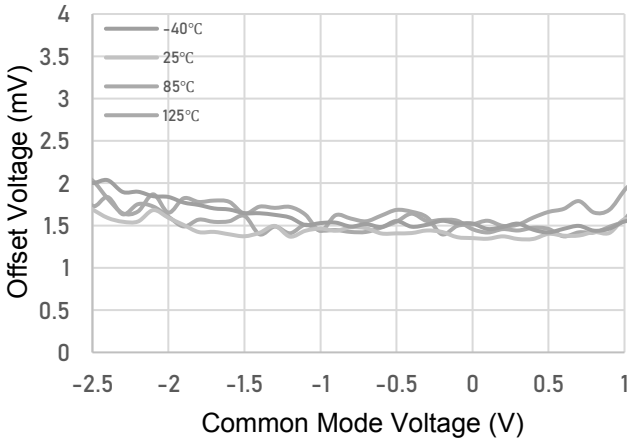
7.6 Typical Characteristics

(T_A = 25°C, V_S = ±5V, R_F = 20Ω for G = +1, R_F = 470Ω for G = +2, G = +10, and R_L = 100Ω, unless otherwise noted.)

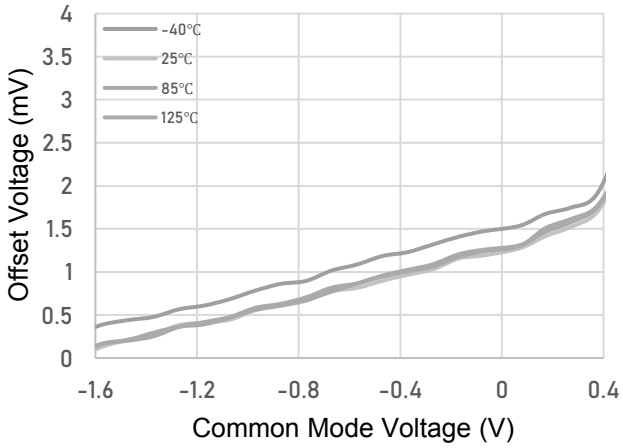
Offset Voltage vs. Common Mode Voltage (Vs = ±5V)



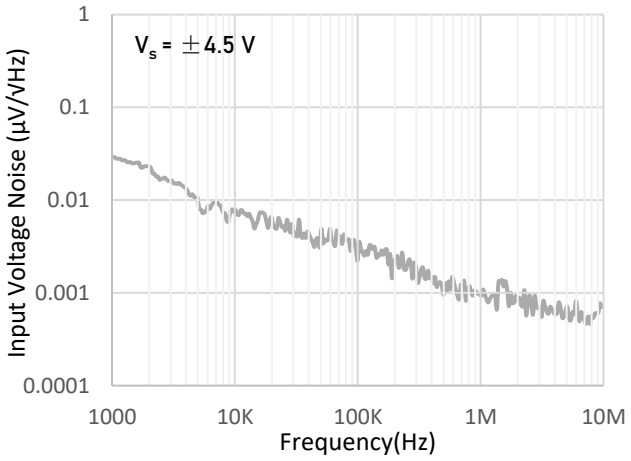
Offset Voltage vs. Common Mode Voltage (Vs = ±2.5V)



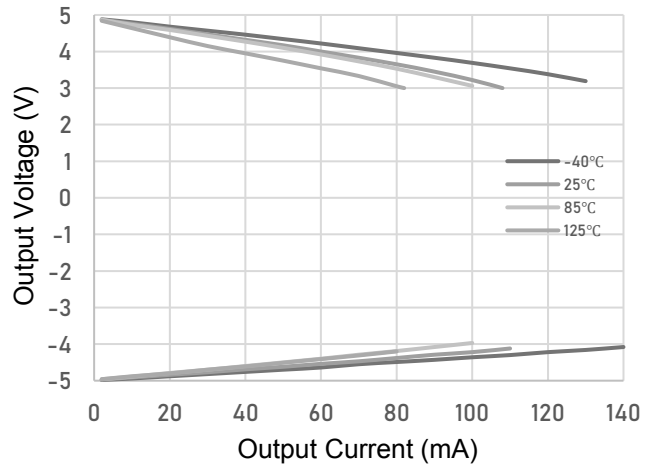
Offset Voltage vs. Common Mode Voltage (Vs = ±1.65V)



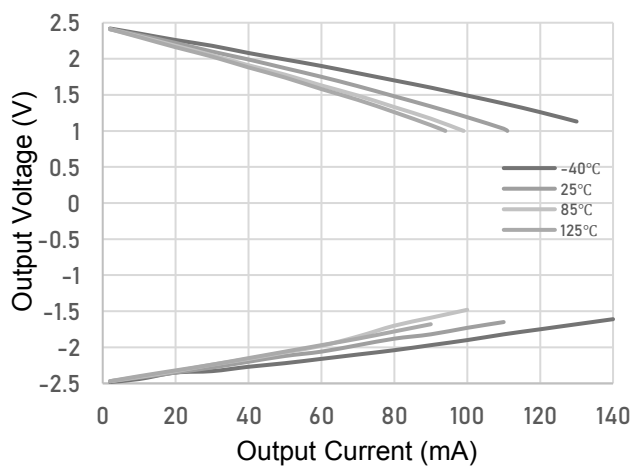
Input Voltage Noise vs. Frequency



Output Voltage vs. Output Current (Vs = ±5V)



Output Voltage vs. Output Current (Vs = ±2.5V)

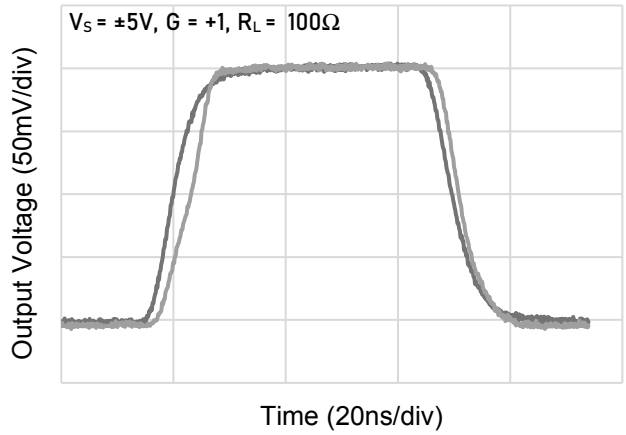


7 Specifications

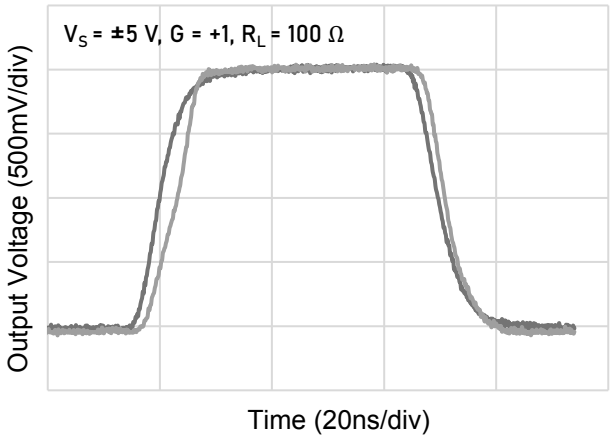
7.6 Typical Characteristics

(T_A = 25°C, V_S = ±5V, R_F = 20Ω for G = +1, R_F = 470Ω for G = +2, G = +10, and R_L = 100Ω, unless otherwise noted.)

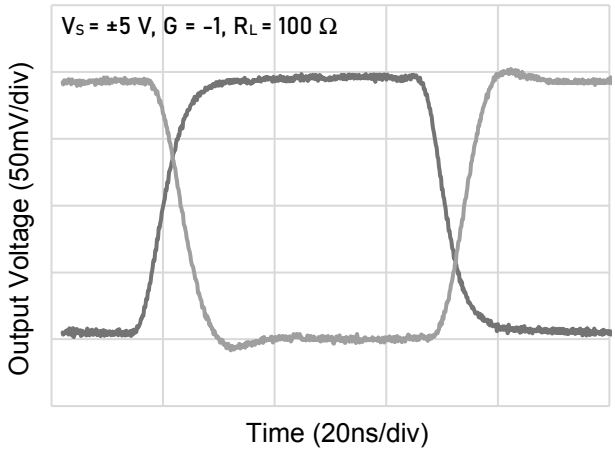
Non-Inverting Small-Signal Step Response



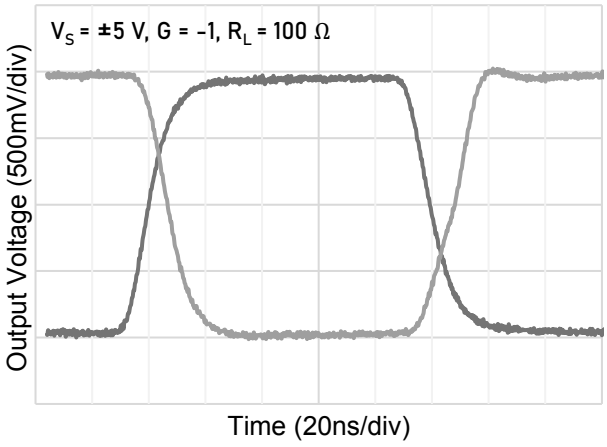
Non-Inverting Large-Signal Step Response



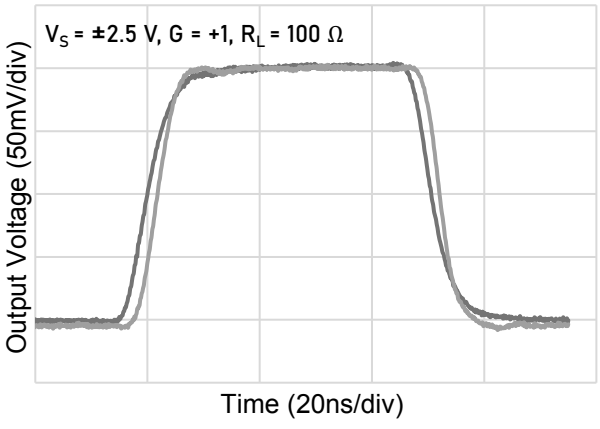
Inverting Small-Signal Step Response



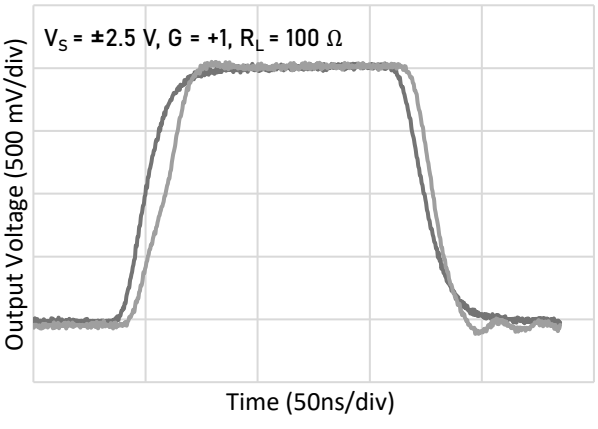
Inverting Large-Signal Step Response



Non-Inverting Small-Signal Step Response



Non-Inverting Large-Signal Step Response

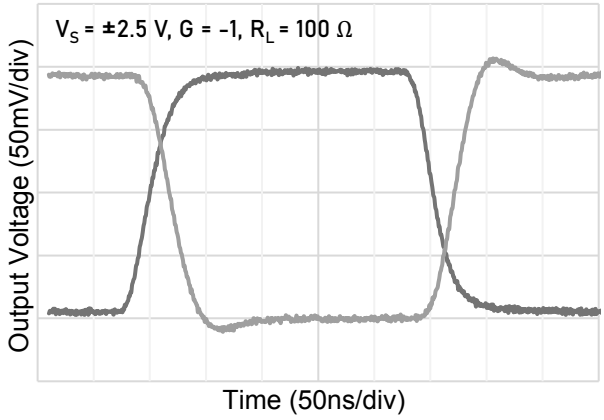


7 Specifications

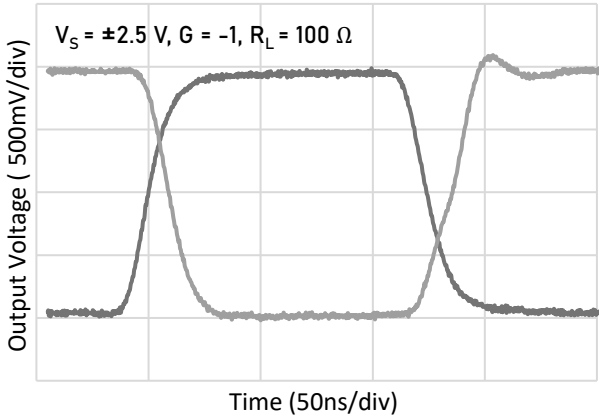
7.6 Typical Characteristics

(T_A = 25°C, V_S = ±5V, R_F = 20Ω for G = +1, R_F = 470Ω for G = +2, G = +10, and R_L = 100Ω, unless otherwise noted.)

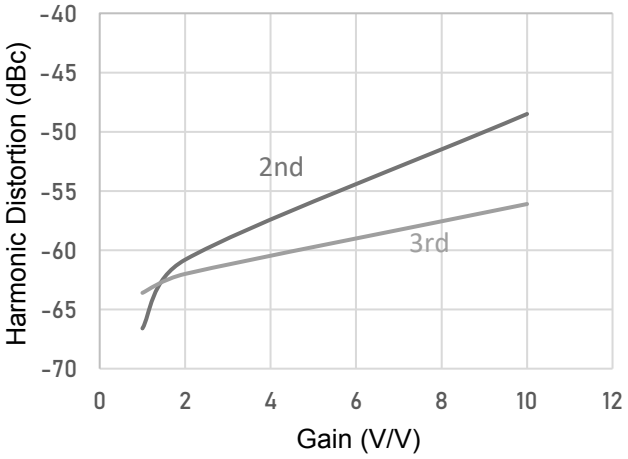
Inverting Small-Signal Step Response



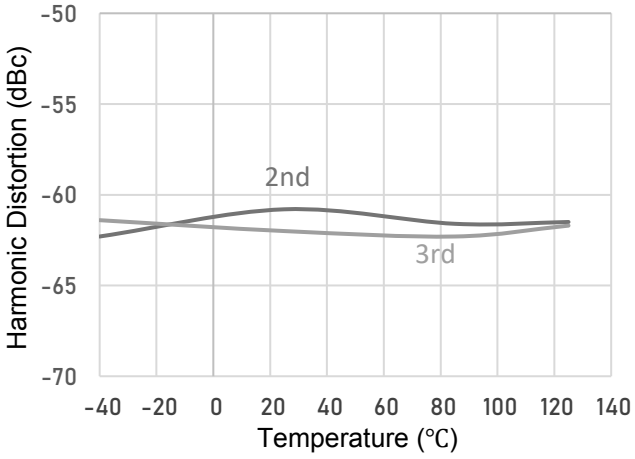
Inverting Large-Signal Step Response



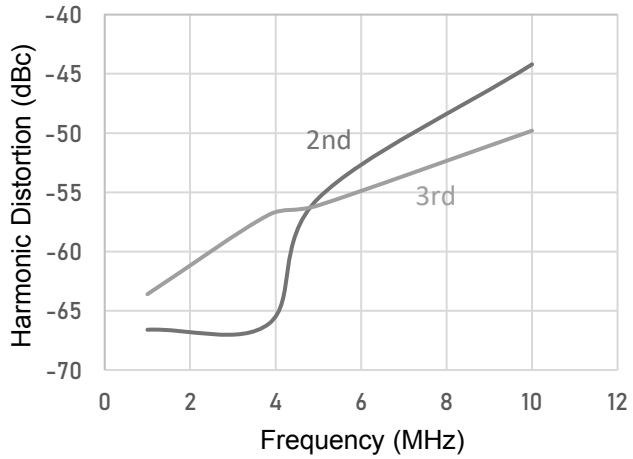
Harmonic Distortion vs. Gain
Vs=±2.5V, f = 1MHz, Vo = 2Vpp



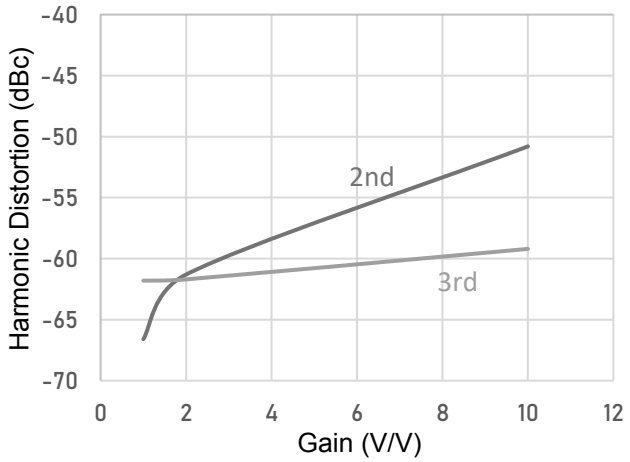
Harmonic Distortion vs. Temperature
Vs=±2.5V, f = 1MHz, Vo = 2Vpp



Harmonic Distortion vs. Frequency
Vs=±2.5V, G = +1, Vo = 2Vpp



Harmonic Distortion vs. Gain
Vs=±5V, f = 1MHz, Vo = 2Vpp

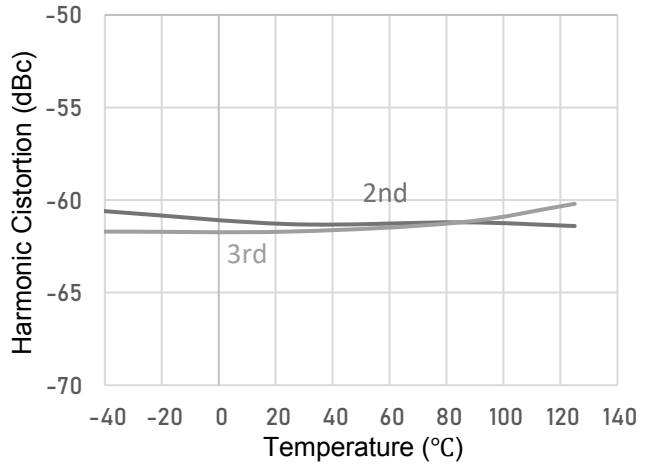


7 Specifications

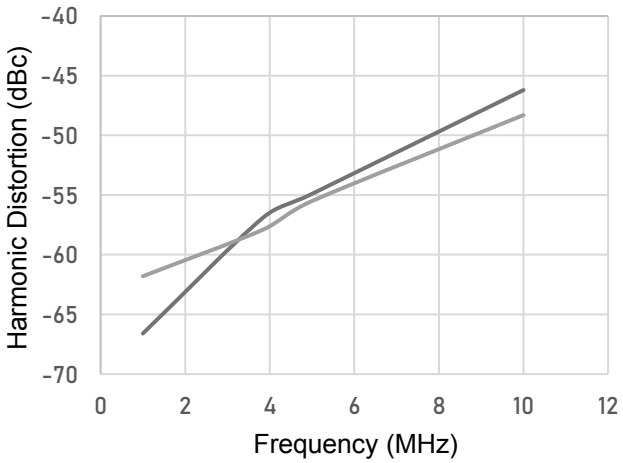
7.5 Typical Characteristics (continued)

(T_A = 25°C, V_S = ±5V, R_F = 20Ω for G = +1, R_F = 470Ω for G = +2, G = +10, and R_L = 100Ω, unless otherwise noted.)

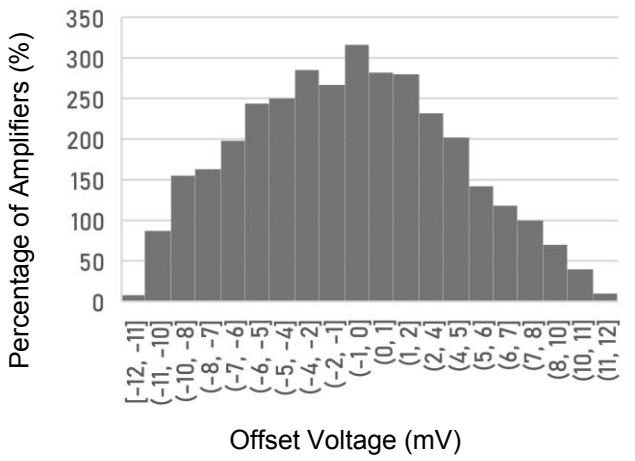
Harmonic Distortion vs. Temperature
Vs=±5V, f = 1MHz, V_O = 2Vpp



Harmonic Distortion vs. Temperature
Vs=±5V, G = +1, V_O = 2Vpp



Offset Voltage Production Distribution



8 Detailed Description

8.1 Description

The CJOA665x is a family of High speed, high slew rate, rail-to-rail output operational amplifiers specifically designed for high-speed applications. These devices operate from 3.3V to 12.6V at the temperature range of –40°C to +125°C, are unity-gain stable, and suitable for a wide range of general-purpose applications. The output stage is capable of driving heavy loads with 130mA linear output current. The input common-mode voltage range includes from (V-) -0.1V to (V+)-1V, and allows the CJOA665x family to be used in virtually any single supply application. Rail-to-rail output swing significantly increases dynamic range, especially in low-supply applications, and makes them ideal for driving sampling analog-to-digital converters (ADCs).

The CJOA665x features 250MHz bandwidth and 190V/μs slew rate, providing good ac performance at same time. DC applications are also well served with low input bias current, and an input offset voltage of ±2mV typically. The typical offset voltage drift is 4μV/°C, over the full temperature range the input offset voltage changes only 660μV.

8.2 Feature Description

Rail-to-Rail Output

Designed as a high speed, high slew rate, low-noise operational amplifier, the CJOA665x 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 100Ω, the output swings typically to within 750mV of 10V supply rail. Different load conditions change the ability of the amplifier to swing close to the rails. For in open load, the output swings typically to within 95mV of the positive supply rail and within 40mV of the negative supply rail.

9 Application and Implementation

9.1 Typical Application Circuits

Capacitive Load and Stability

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 CJOA665x op-amps must drive a heavy capacitive load. 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 9-1. 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.

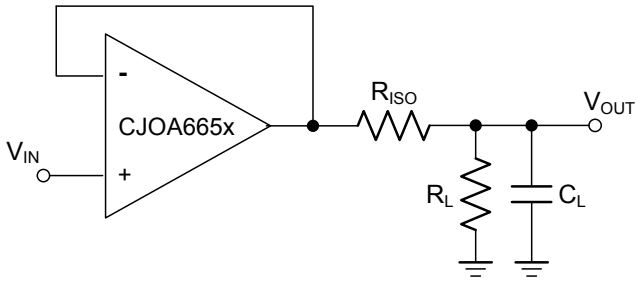


Figure 9-1. Indirectly Driving Heavy Capacitive Load

An improvement circuit is shown in Figure 9-2. It provides DC accuracy as well as AC stability. The R_F provides the DC accuracy by connecting the inverting signal with the output.

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 other 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.

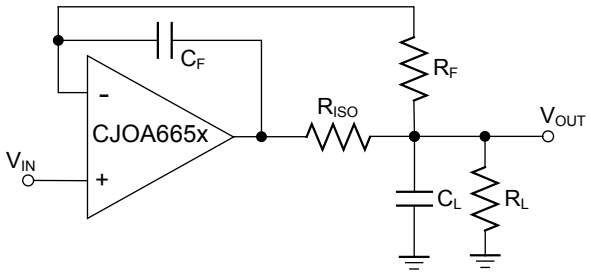


Figure 9-2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

9 Application and Implementation

9.1 Typical Application Circuits (continued)

Active filter

The CJOA665x family is well-suited for active filter applications that require a wide bandwidth, fast slew rate, single-supply operational amplifier. Figure 9-3 shows a 500kHz, second-order, low-pass filter using the multiple-feedback (MFB) topology. The components have been selected to provide a maximally-flat Butterworth response. Beyond the cut-off frequency, roll-off is –40dB/dec. The Butterworth response is ideal for applications that require predictable gain characteristics, such as the anti-aliasing filter used in front of an ADC.

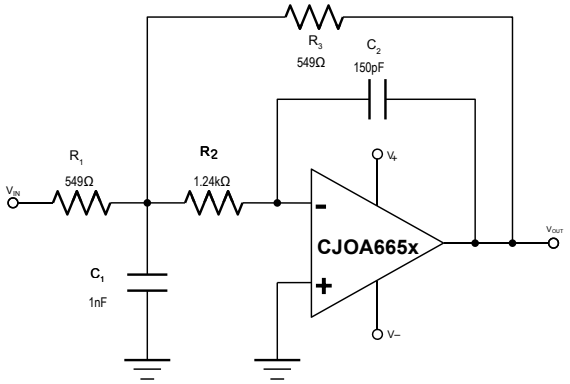


Figure 9-3. Second-Order, Butterworth, 500kHz Low-Pass Filter

One point to observe when considering the MFB filter is that the output is inverted, relative to the input. If this inversion is not required, or not desired, a non- inverting output can be achieved through one of these options:

1. adding an inverting amplifier;
2. adding an additional second-order MFB stage;
3. using a non-inverting filter topology, such as the Sallen-KeKeyy (shown in Figure 9-4).

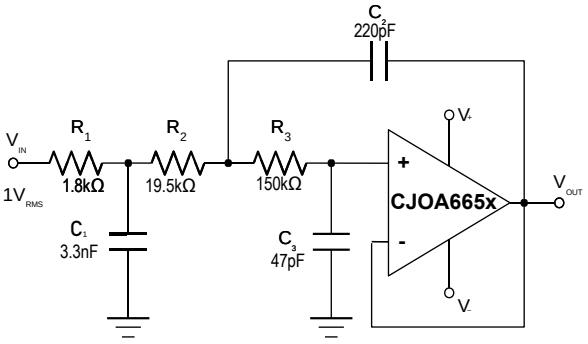


Figure 9-4. Configured as a Three-Pole, 20kHz, Sallen-Key Filter

9 Application and Implementation

9.1 Typical Application Circuits (continued)

Differential Amplifier

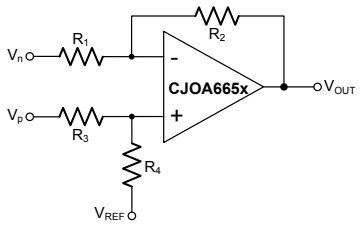


Figure 9-5. Differential Amplifier

The circuit shown in Figure 9-5 performs the difference function. If the resistors ratios are equal $R_4/R_3 = R_2/R_1$, then:

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

9.2 Power Supply Recommendations

Operating Voltage

The LTA605x family is optimized for operation at voltages as low as +3.3V (±1.65V) and up to +12.6V (±6.3V). In addition, many specifications apply from –40°C to +125°C. 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 CJOA665x 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 9-6 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.

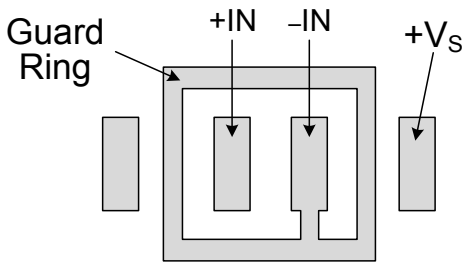


Figure 9-6. Use a guard ring around sensitive pins

9 Application and Implementation

9.3 Layout Guidelines (continued)

Maximizing Performance through Proper Layout (continued)

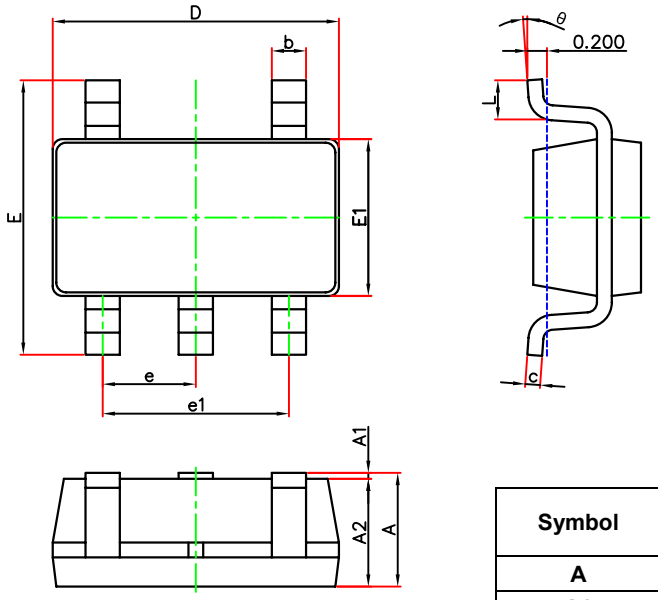
Other potential sources of offset error are thermoelectric voltages on the circuit board. This voltage, also called Seebeck voltage, occurs at the junction of two dissimilar metals and is proportional to the temperature of the junction. The most common metallic junctions on a circuit board are solder-to- 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

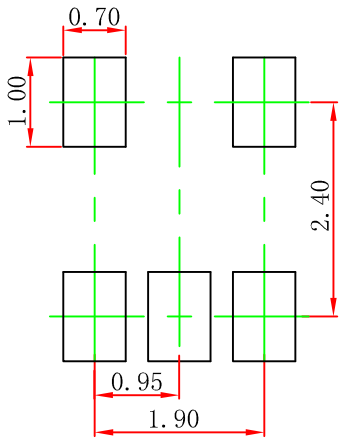
10.1 SOT-23-5L Mechanical Information

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



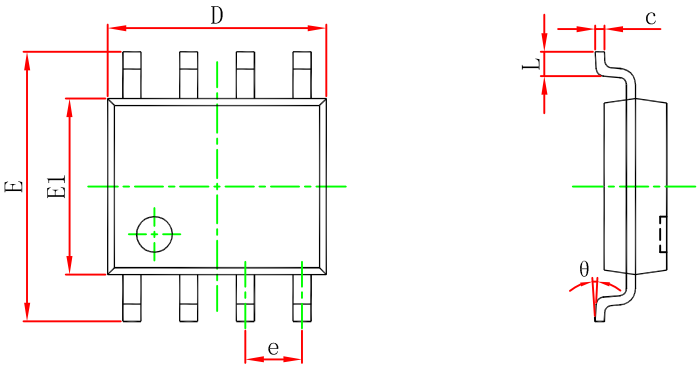
Note:

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

10 Mechanical Information

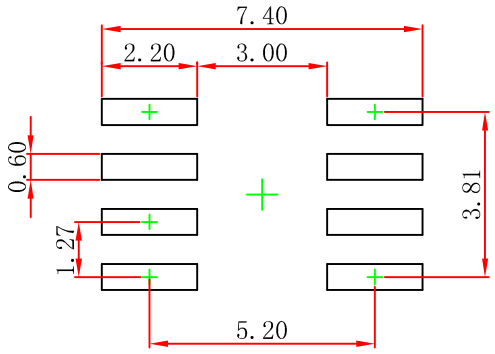
10.2 SOP8 Mechanical Information

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



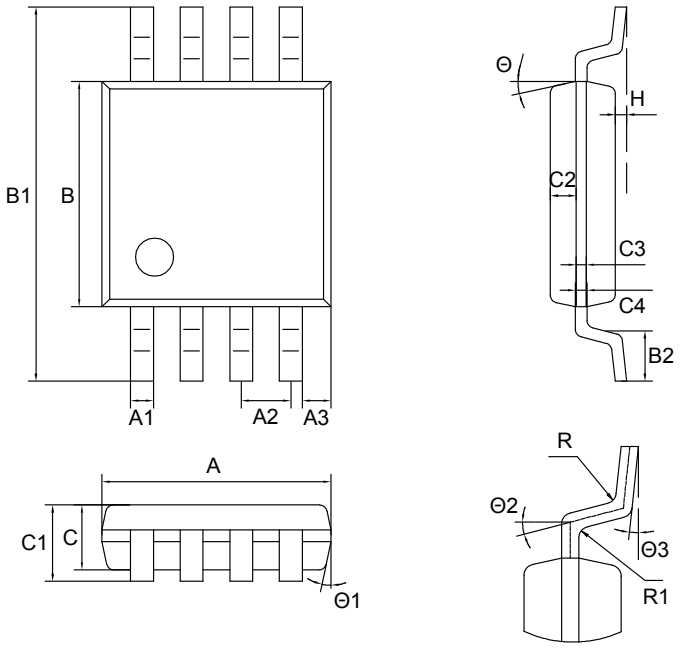
NOTE:

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

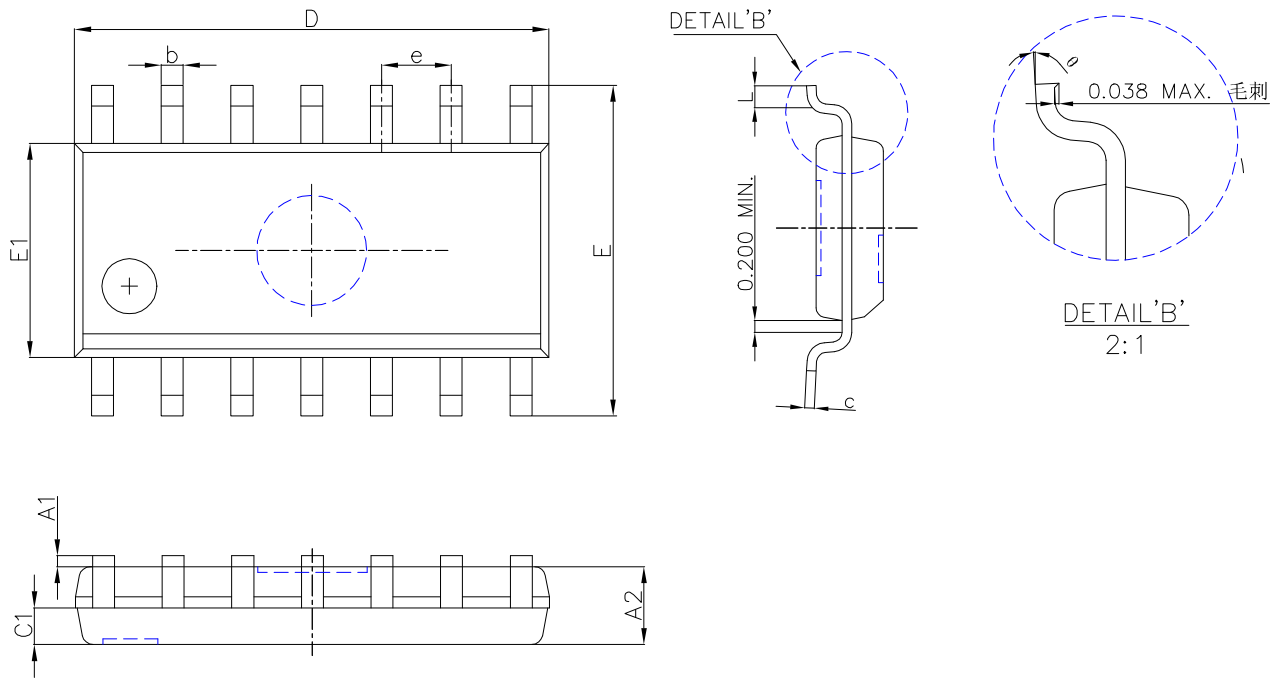


SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	2.900	3.000	3.100	0.114	0.118	0.122
A1	0.280	-	0.350	0.011	-	0.014
A2	0.650 TYP.			0.026 TYP.		
A3	0.375 TYP.			0.015 TYP.		
B	2.900	3.000	3.100	0.114	0.118	0.122
B1	4.700	-	5.100	0.185	-	0.201
B2	0.450	0.600	0.750	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

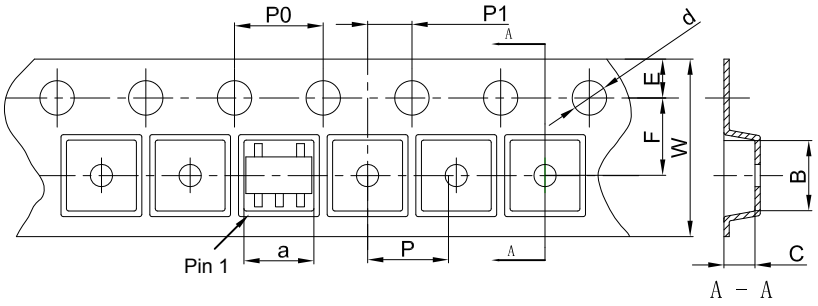


SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
D	8.630	8.730	8.830	0.340	0.344	0.348
b	0.406 Typ.			0.016 Typ.		
e	1.270 Typ.			0.050 Typ.		
E1	3.850	3.950	4.050	0.152	0.155	0.159
E	5.840	6.040	6.240	0.230	0.238	0.246
A2	1.350	1.450	1.550	0.053	0.057	0.061
C1	0.550	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°

11 Packaging Information

11.1 SOT-23-5L Tape and Reel Information

SOT-23-5L Tape and Reel Information

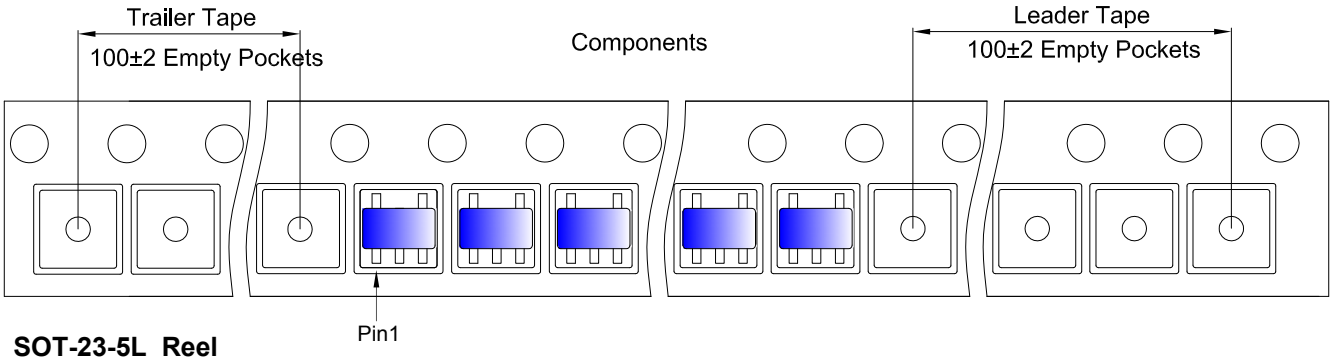


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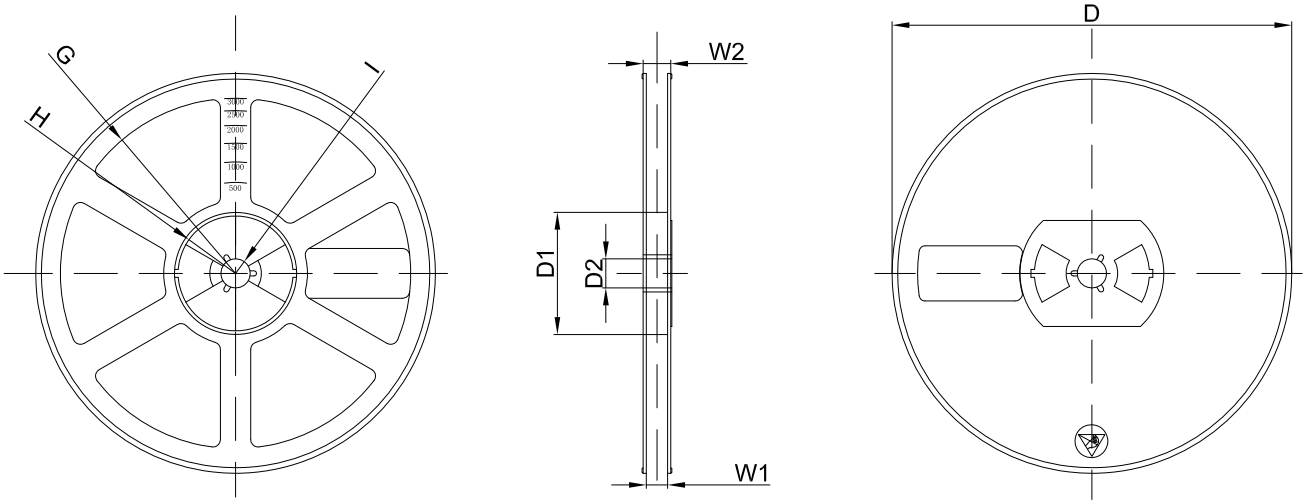
SOT-23-5L parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts 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



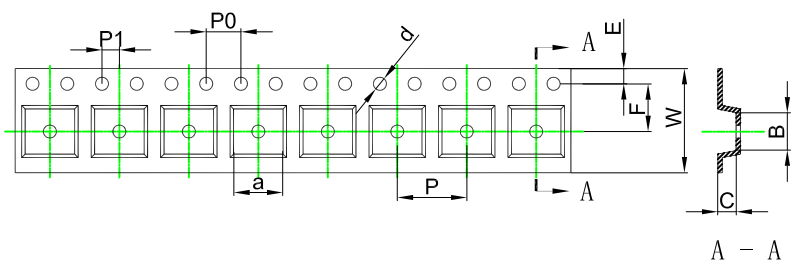
Dimensions are in millimeter								
Reel Option	D	D1	D2	G	H	I	W1	W2
7"Dia	Ø180.00	60.00	13.00	R78.00	R25.60	R6.50	9.50	13.10

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



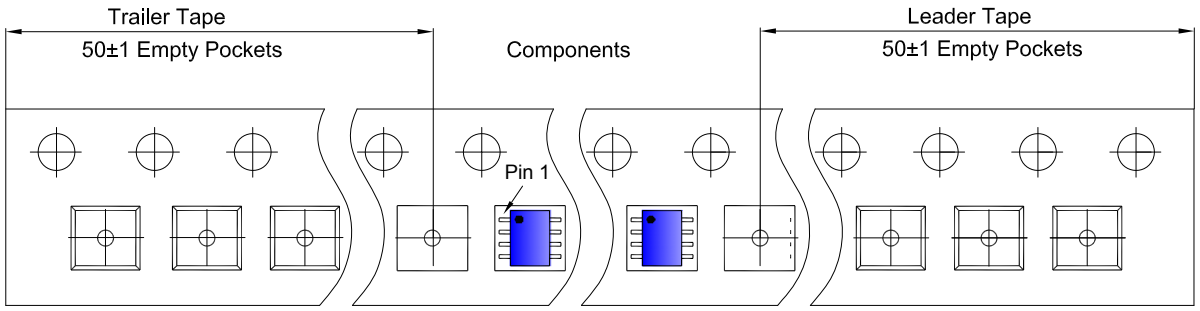
Packaging Description:

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).

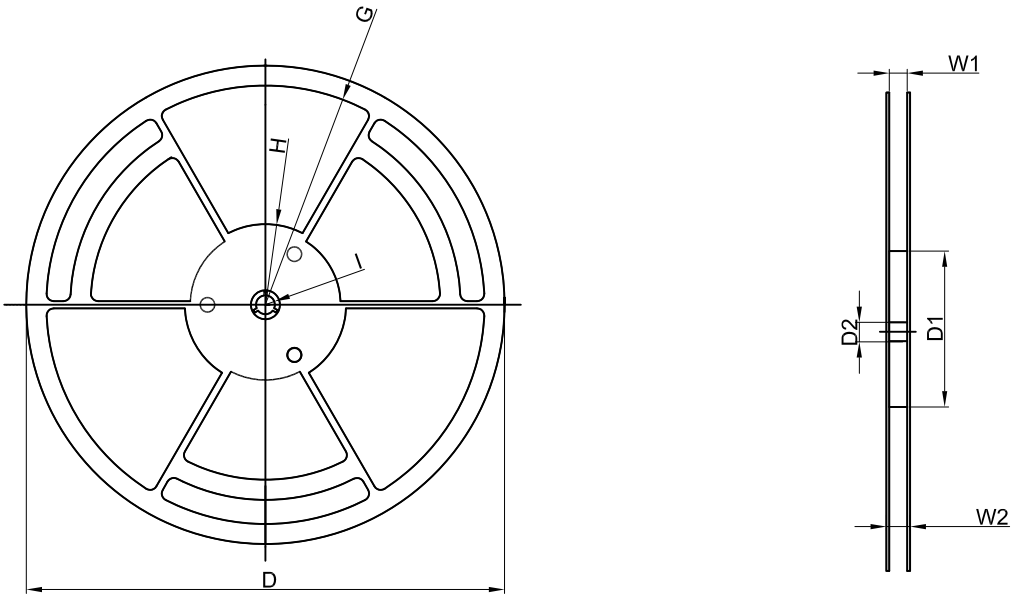
ALL DIM IN mm

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 SZCJ -- https: ***www.szcjsemi.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

December 2024: released CJOA665x 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. SZCJ 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 SZCJ 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. SZCJ 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 SZCJ , 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. SZCJ shall not be responsible for casualties or property losses caused by abnormal use or application of this product.

Official Website: www.szcjsemi.com

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