LTA8161 LTA8162

45V, High-precision, low-noise, rail-to-rail, zero-drift operational amplifier

General Description

The LTA8161 (single-channel) and LTA8162 (dual-channel) are high-voltage, high-precision, low-noise, and low-power operational amplifiers with extremely high input impedance. Their output swing can be as small as 15mV within the power supply rails. The input common-mode voltage range includes the negative power supply rail. Additionally, these amplifiers employ offset compensation technology, resulting in an exceptionally low offset voltage (typical value of ±8μV), which remains nearly constant regardless of temperature and time variations.

It supports both single and dual power supply configurations. When powered by a single supply, the voltage range is +4V to +45V; with dual supplies, the voltage range is ±2V to ±22.5V.

The main package types of LTA8161 are SOT23-5L, MSOP-8L and SOIC-8L. For LTA8162, it could support MSOP-8L and SOIC-8L. All package types operate within a temperature range of -40℃ to 125℃.

Features and Benefits

- Low Offset Voltage: ±8μV (typical)
- Zero Drift: 0.03μV/℃
- Low Noise: 9nV/√Hz
- 0.1Hz to 10Hz Noise: 250nV$_{P-P}$
- High DC Accuracy:
  - -Open-loop Gain: 140 dB
  - -Power Supply Rejection Ratio (PSRR): 135dB
  - -Common-mode Rejection Ratio (CMRR): 130 dB
- Gain-bandwidth Product: 2MHz
- Quiescent Current: 340μA (typical)
- Operating Power Supply Range: ±2V to ±22.5V
- Output Rail-to-rail
- The input can reach the negative power rail

Applications

- Bridge amplifier
- Stress gauge
- Sensor applications
- Temperature measurement
- Electronic scale
- Medical equipment
- Resistance thermometer

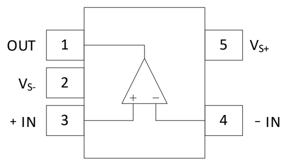
Table of Content

Ordering Information

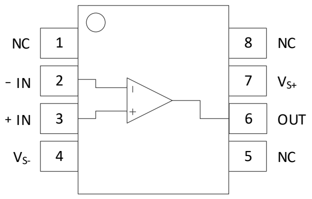
Part Number	Package Type	Package Size	Package Quantity	ECO Class	Mark Code
LTA8161XT5/R6	SOT23-5L	2.92 mm * 1.60 mm	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	Z61
LTA8161XS8/R8	SOIC-8L	4.90 mm * 3.92 mm	Tape and Reel, 4 000	Green (RoHS & no Sb/Br)	ZHV61
LTA8161XV8/R6	MSOP-8L	3.00 mm * 3.00 mm	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	ZHV61
LTA8162XS8/R8	SOIC-8L	4.90 mm * 3.92 mm	Tape and Reel, 4 000	Green (RoHS & no Sb/Br)	ZHV62
LTA8162XV8/R6	MSOP-8L	3.00 mm * 3.00 mm	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	ZHV62

Pin Configuration (Top View)

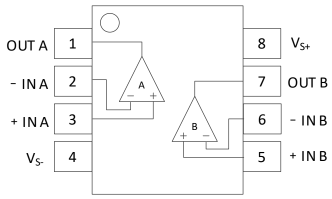
LTA8161
SOT23-5L



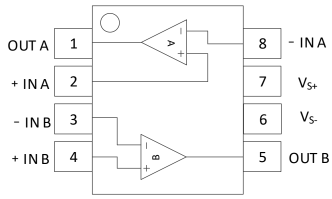
LTA8161
MSOP-8L/SOIC-8L



LTA8162
SOIC-8L



LTA8162
MSOP-8L



PIN Name	Description
OUT A	Amplifier output A.
-IN A	Inverting input of the amplifier A.
+IN A	Non-inverting input of the amplifier A.
Vs-	Negative power supply. It is normally tied to ground. It can also be tied to a voltage other than ground as long as the voltage between V_{S+} and V_{S-} is from 4 V to 45 V.
+IN B	Non-inverting input of the amplifier B.
-IN B	Inverting input of the amplifier B.
OUT B	Amplifier output B.
Vs+	Positive power supply. The voltage is from 4 V to 45 V. Split supplies are possible as long as the voltage between V_{S+} and V_{S-} is from 4 V to 45 V.
NC	No Connection

Limiting Value

Parameter	Absolute Maximum Rating
Supply Voltage, V_{S+} to V_{S-}	50 V (±25V)
Signal Input Terminals: Voltage	V_{S-} – 0.3 to V_{S+} + 0.3
Signal Input Terminals: Current	±10 mA
Signal Differential Input Voltage	±0.7 V
Storage Temperature Range, T_{stg}	-65 ℃ to +150 ℃
Junction Temperature, T_J	150 ℃
Operation Temperature T_{JL}	-55 ℃ to +150 ℃

Note:

1. Exceeding these 'absolute maximum ratings' may cause permanent damage to the equipment. These pressure levels are only for hardware specific functional operations and do not include other recommended working conditions beyond these indications. Long term exposure to absolute maximum rated conditions may affect the reliability of the device.
2. The input terminal is clamped to the power rail by a diode.
3. The provided components must not exceed the maximum junction temperature (T_J) at any time

Thermal Information

Thermal Metric		Package	Level	Unit
$θ_{JA}$	Package Thermal Resistance	SOIC-8L	125	°C/W
		MSOP-8L	216	
		SOT23-5L	190	

ESD Ratings

		Value	Unit
$V_{(ESD)}$	HBM	±2	kV
	CDM	±1	

Electrical Characteristics

Unless otherwise noted, T_A=25℃, V_S = ±18.0 V, V_{CM}=V_S/2， V_O=V_S/2， R_L=10kΩ， connect to V_S/2，

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
DC PERFORMANCE						
Input Offset Voltage	V_{OS}		-20	±8	+20	µV
Input Offset Voltage vs Temperature	dV_{os} / dT	T_A=-40℃ to + 125℃		0.03		µV/℃
Input Bias Current	I_B	V_{CM} = V_S/2		±180		pA
		T_A=-40℃ to + 125℃				
Input Offset Current	I_{OS}			±340		pA
Large voltage gain	A_{VOL}	V_{S-}+0.5V<V_O<V_{S+}-0.5V	130	140		dB
		T_A=-40℃ to + 125℃	125			
NOISE and DISTORTION PERFORMANCE						
Input voltage noise	V_n	f = 0.1 Hz to 10 Hz		250		nV_{P-P}
Input Voltage Noise Density	e_N	f = 1kHz		9		nV/√Hz
INPUT CHARACTERISTICS						
Input Common Mode Voltage Range	V_{CM}	T_A = −40℃ to +125℃	V_{S-}−0.1		V_{S+}-1.5	V
Common Mode Rejection Rate	CMRR	V_{S-}<V_{CM}<V_{S+}-1.5	120	130		dB
		T_A = −40℃ to +125℃	115			
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	GBP			2		MHz
Slew Rate	SR	G = +1		0.8		V/µs
Overload recovery time	t_{OR}	V_{IN} × Gain = V_S		3		µs
OUTPUT CHARACTERISTICS						
High Output Voltage Swing	V_{OH}	R_L = 10 kΩ	(V_{S+})-200	(V_{S+})-170		mV
		T_A = −40℃ to +125℃	(V_{S+})-280			
Low Output Voltage Swing	V_{OL}	R_L = 10 kΩ		(V_{S-})+150	(V_{S-})+190	mV
		T_A = −40℃ to +125℃			(V_{S-})+260	
Short-circuit Current	I_{source}			18		mA
	I_{sink}			16		
POWER SUPPLY						
Operating Supply Voltage	Vs	T_A = -40 to +125 ℃	4		45	V
Power Supply Rejection Ratio	PSRR	V_S = 4V to 45V,	120	135		dB
		T_A = −40℃ to +125℃	115			
Quiescent Current	I_Q			340	480	µA
		T_A = −40℃ to +125℃			550	

Typical Characteristics

Unless otherwise noted, T_A=25℃, V_S = ±18.0 V, V_{CM}=V_S/2, V_O=V_S/2, R_L=10kΩ, connect to V_S/2.

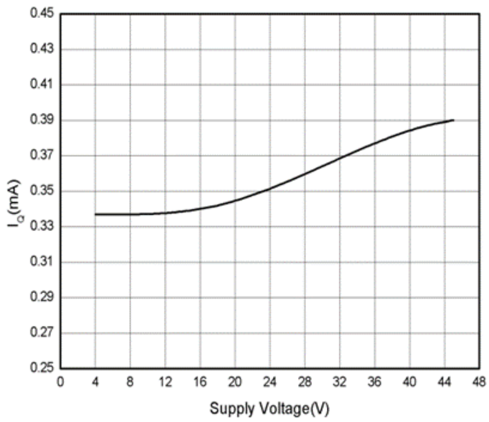


Figure 1. Quiescent Current vs Supply Voltage

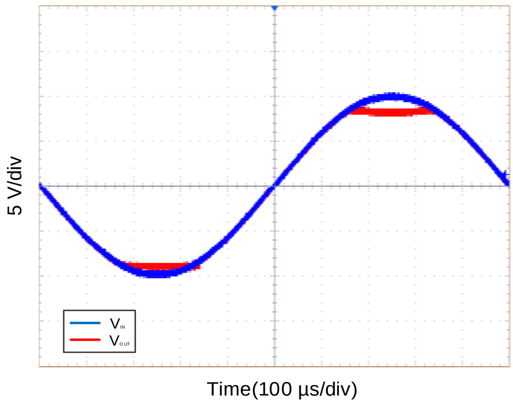


Figure 2. No phase reversal

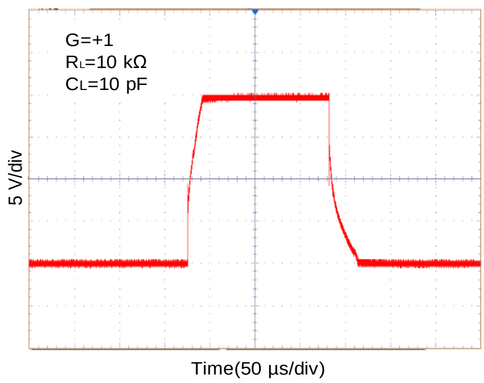


Figure 3. Large signal step response

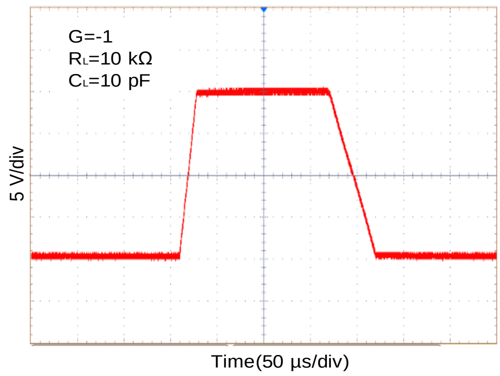


Figure 4. Large signal step response

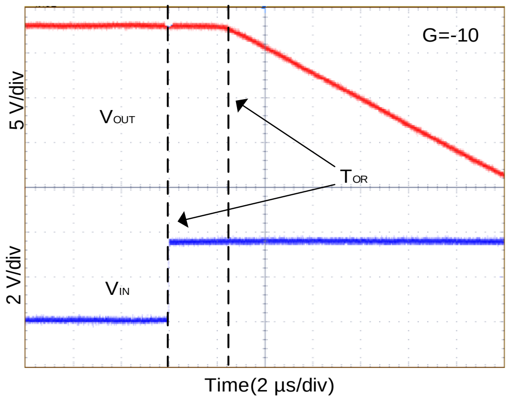


Figure 5. Positive overload recovery

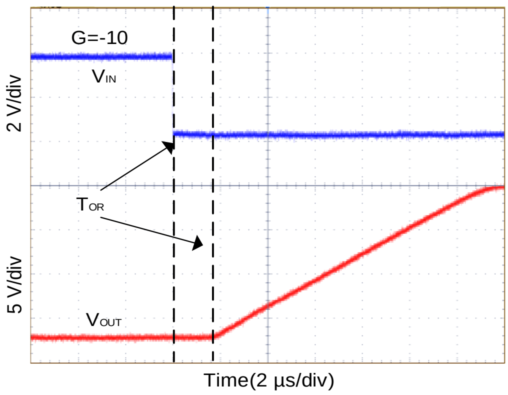


Figure 6. Negative overload recovery

Typical Characteristics

Unless otherwise noted, T_A=25℃, V_S = 5.0 V, V_{CM}=V_S/2, V_O=V_S/2, R_L=10kΩ, connect to V_S/2

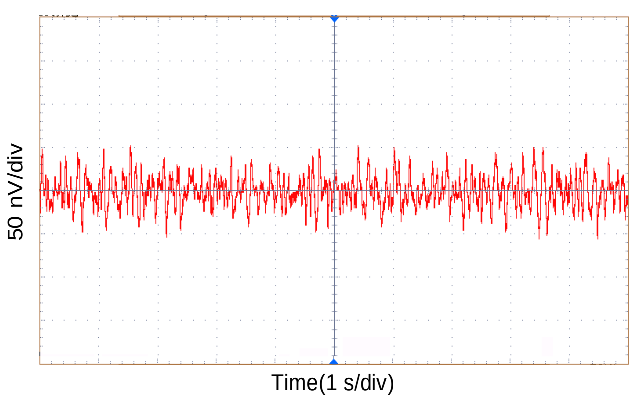


Figure 7. 0.1Hz to 10Hz noise

Application Notes

Job Characteristics

The specified power supply voltage for the LTA816x series is 4V to 45V (± 2V to ± 22.5V). The specified working temperature is -40 ℃ to +125 ℃. The parameters related to power supply voltage and temperature can refer to the classical characteristics section.

Phase reversal protection

The LTA816x series has phase protection function. When the input voltage of a typical operational amplifier exceeds the input range of its common mode input voltage, the phase of its output terminal will reverse. This situation usually occurs in noninverting circuit scenarios, where when the input voltage exceeds the specified common mode voltage range, the output will flip and reach the power rail.
As shown in Figure 8, the LTA816x series solves this problem by limiting its output to the power rail.

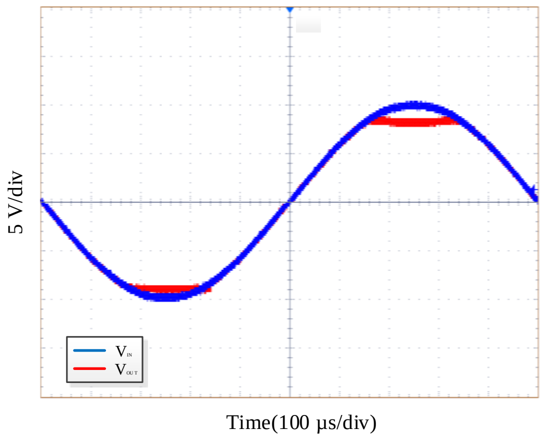


Figure 8. Phase Reversal Test Diagram

Capacitive load and stability

The LTA816x series can directly drive 1nF with unity gain without generating oscillations. Unit gain follower (buffer) is the most sensitive circuit to capacitive loads. Directly driving capacitive loads can reduce the phase margin of operational amplifiers, leading to output ringing or even oscillation. In applications that require a large capacitive load driving force, an isolation resistor R_{ISO} needs to be added at the output end and the capacitive load end. The isolation resistor R_{ISO} and capacitive load C_L will add a zero point, thereby improving stability. The larger the value of R_{ISO}, the more stable its output. But this processing method will reduce the accuracy of the gain, as R_{ISO} and load resistor R_L form a voltage divider network.

A more excellent circuit is shown in Figure 9. This circuit not only has good stability, but also high DC accuracy. Using an RF resistor to connect the inverting terminal to the output can effectively improve DC accuracy. C_F and R_{ISO} are used to compensate for the loss of phase margin. By using a high pass component, the output signal is fed back to the inverting input terminal to ensure the phase margin of the overall feedback loop.

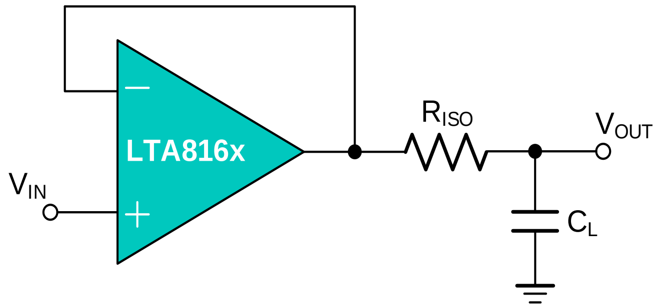


Figure 9. Indirectly driving heavy capacitive overload

There are two other ways to increase phase margin for circuits without buffers:

1) Increase the gain of the operational amplifier,

2) Prevent a capacitor connected in parallel with the feedback resistor from compensating for parasitic capacitance at the inverting input terminal.

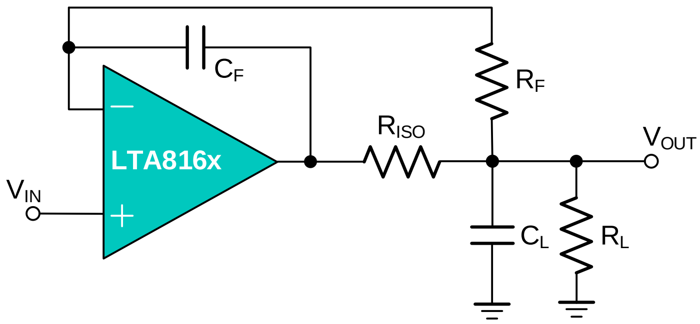


Figure 10. Directly driving capacitive loads with high DC accuracy

Clock feedthrough with input bias current

The LTA816x series uses switches internally to correct the inherent offset and drift of operational amplifiers. But the internal switch will cause a certain sudden change in the input bias current at the moment of switch switching. These pulses have a very short duration and are not amplified by an amplifier, but they can be coupled to the output through a feedback network. The most effective way to prevent this phenomenon is to use a low-pass filter, such as an RC network.

Layout Guide

In order to achieve optimal device performance, the following layout principles should be followed when designing a printed circuit board (PCB).

A. Divide the ground into two parts: digital ground and analog ground, and plan the path of current return to the ground reasonably to avoid the return of digital signals leading to analog signals. If a multi-layer PCB board is used, setting one layer as the ground not only helps with heat dissipation but also effectively reduces EMI noise.

B. In order to minimize the size of parasitic capacitance and Seebeck effect as much as possible, external devices (such as feedback resistors) should be placed as close to the device as possible.

C. The input signal wires should be as short as possible and should be kept away from power lines or other digital signal lines.

D. A low ESR, 0.1 μ F ceramic bypass capacitor should be connected between each power pin and ground, and placed as close as possible to the device. In the case of a single power supply, use a capacitor to connect between V+ and ground.

E. Consider adding a low resistance, driven protective ring around the critical wiring. Protecting can significantly reduce the leakage current of different potentials nearby.

Low side current detecting

As shown in Figure 11, the operational amplifier constitutes the low side current detecting circuit. The load current (I_{LOAD}) is amplified by LTA816x due to the voltage difference generated by resistor R_{SHUNT}. Under the condition of constant power supply voltage, the output voltage range can be changed by changing the resistor R_{SHUNT} and closed-loop amplification factor.

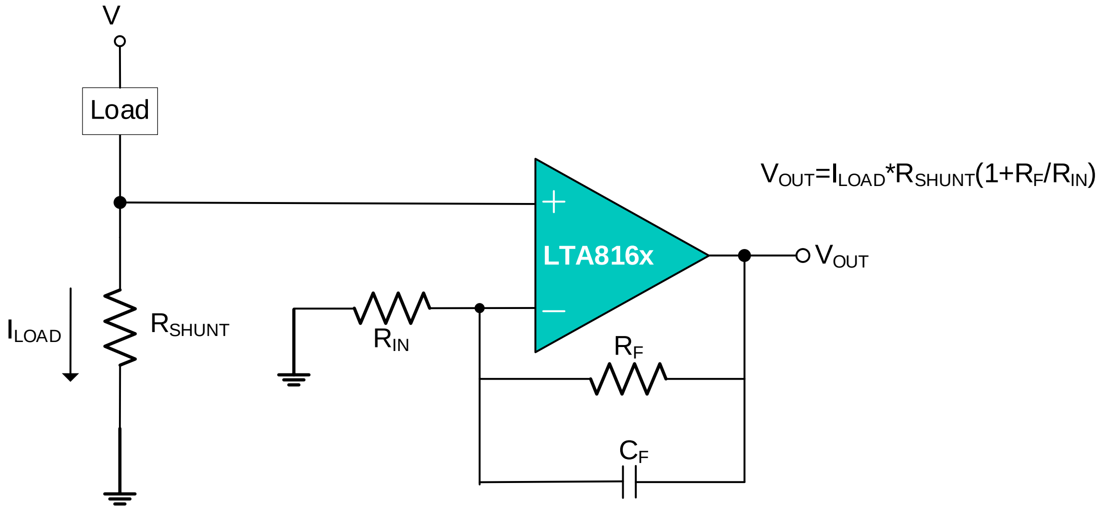


Figure 11. Low side current detecting

Bridge amplifier

As shown in Figure 12, the LTA816x series forms a bridge amplifier.

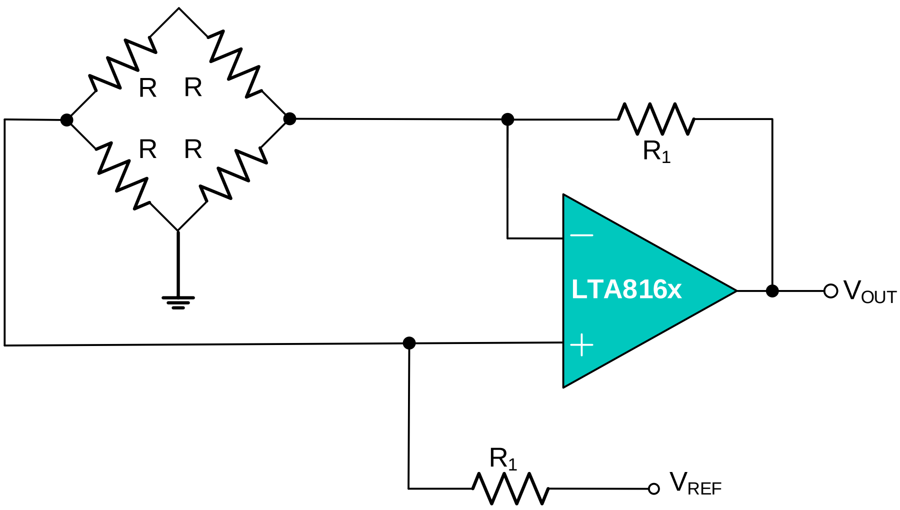


Figure 12. Bridge amplifier

Programmable voltage source

As shown in Figure 13, the LTA816x series DAC、The power amplifier constitutes a high-precision programmable power supply. An amplifier circuit was constructed using capacitors and resistors to amplify the output voltage of the DAC by a factor of 1+R4/R1. In situations where the input voltage variation range is wide, LTA816x has the characteristics of high precision and low drift.

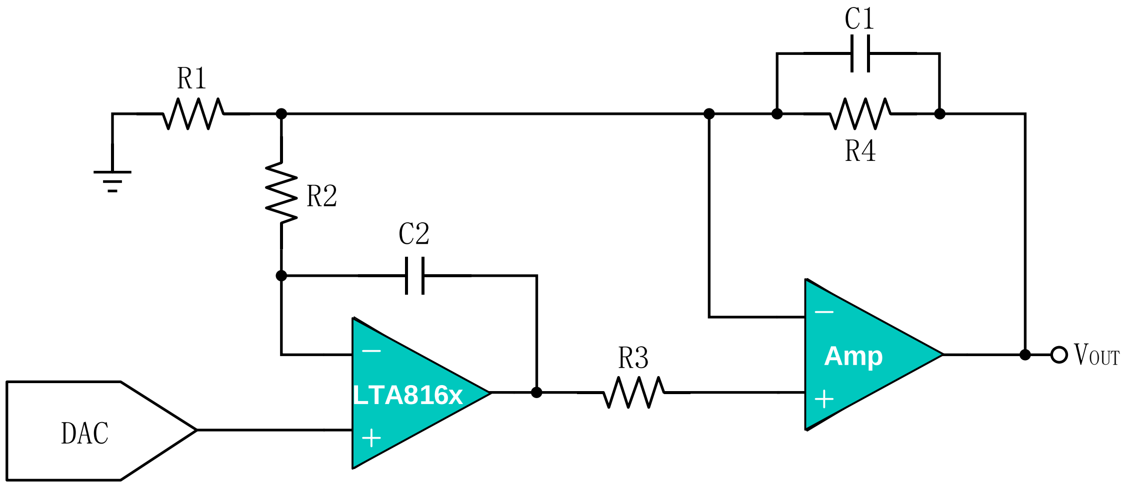
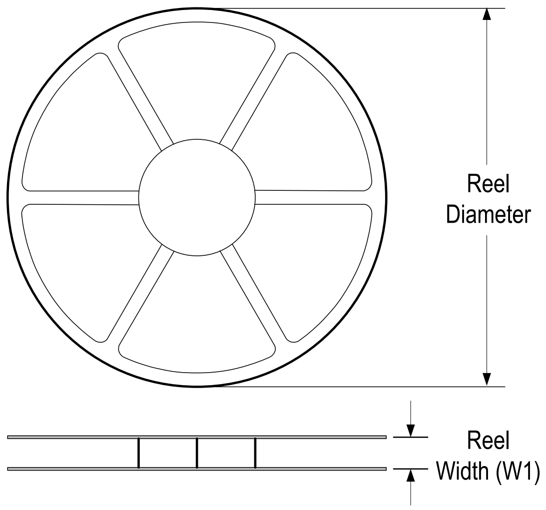


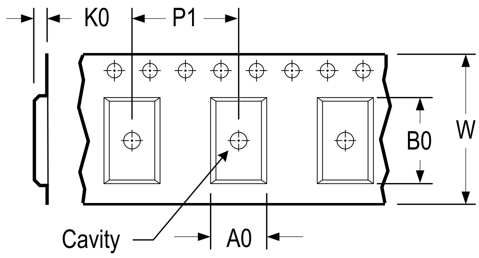
Figure 13. Programmable voltage source

Tape and Reel Information

REEL DIMENSIONS

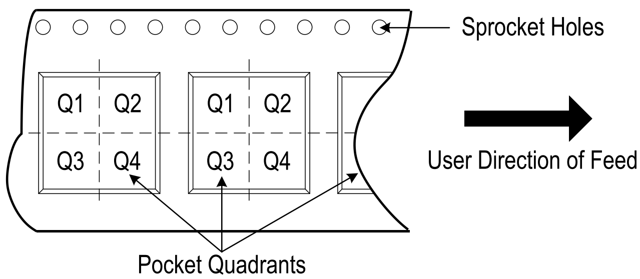


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIETATION IN TAPE

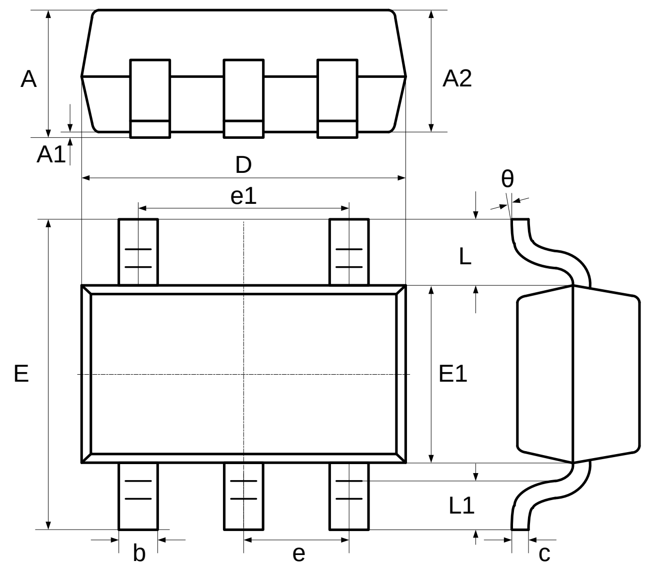


* All dimensions are nominal

Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin 1 Quadrant
LTA8161XT5/R6	SOT23	5	3 000	178	9.5	3.3	3.2	1.5	4.0	8.0	Q3
LTA8161XS8/R8	SOIC	8	4 000	330	12.5	6.6	5.3	2.0	8.0	12.0	Q1
LTA8161XV8/R6	MSOP	8	3 000	330	12.5	5.0	3.5	2.0	8.0	12.0	Q1
LTA8162XS8/R8	SOIC	8	4 000	330	12.5	6.6	5.3	2.0	8.0	12.0	Q1
LTA8162XV8/R6	MSOP	8	3 000	330	12.5	5.0	3.5	2.0	8.0	12.0	Q1

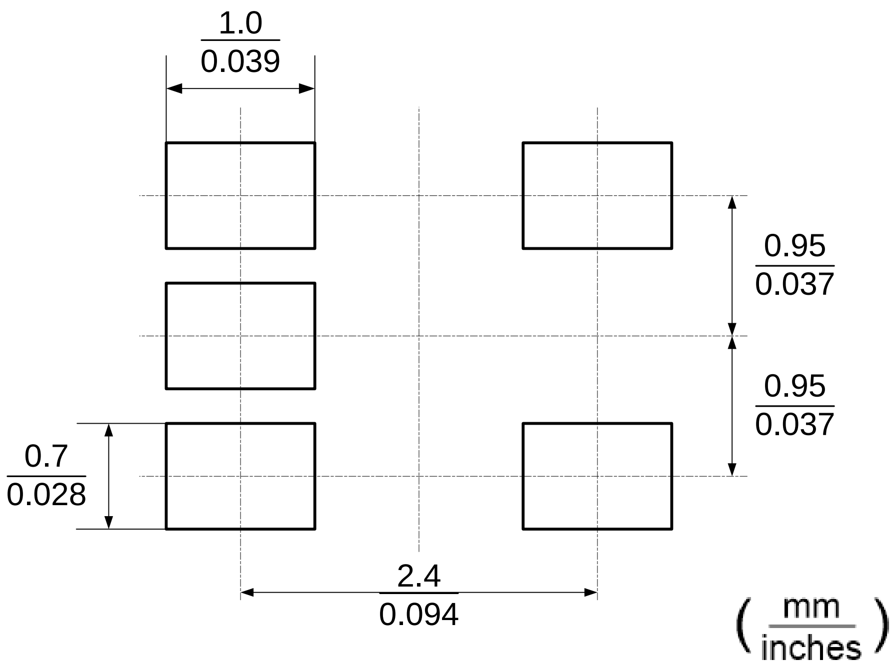
Package Outlines

DIMENSIONS, SOT23-5L



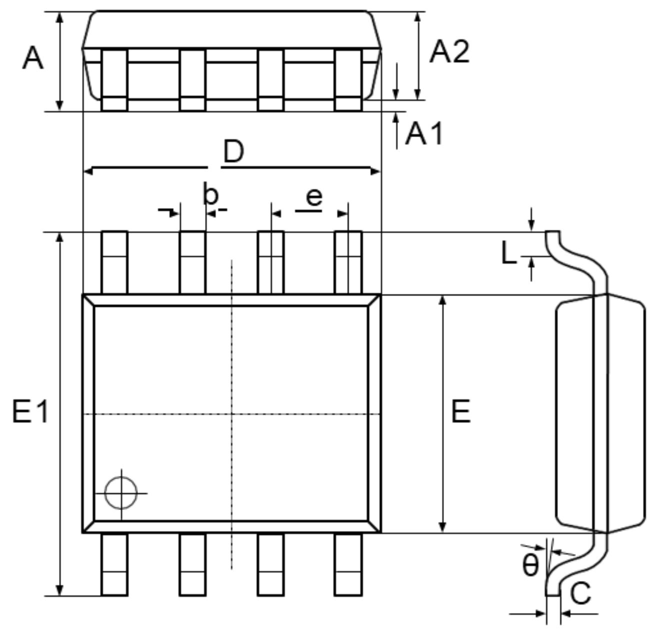
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	-	1.25	-	0.049
A1	0.04	0.10	0.002	0.004
A2	1.00	1.20	0.039	0.047
b	0.33	0.41	0.013	0.016
c	0.15	0.19	0.006	0.007
D	2.820	3.02	0.111	0.119
E1	1.50	1.70	0.059	0.067
E	2.60	3.00	0.102	0.118
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.60 REF		0.024 REF	
L1	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

RECOMMENDED SOLDERING FOOTPRINT, SOT23-5L



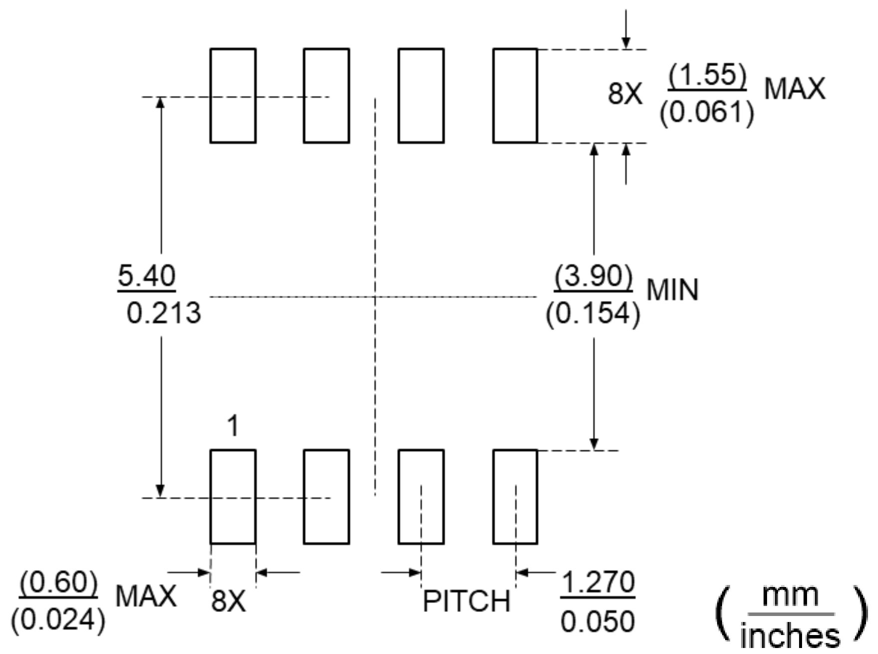
Package Outlines (Cont.)

DIMENSIONS, SOIC-8L



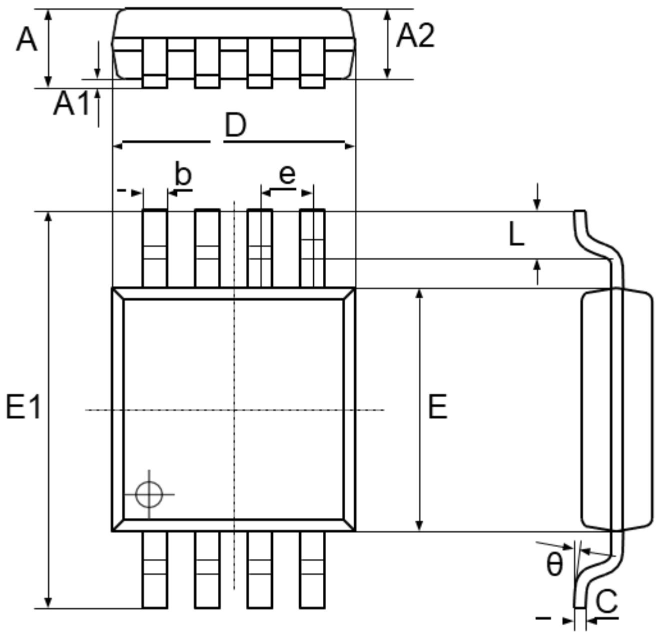
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.370	1.670	0.054	0.066
A1	0.070	0.170	0.003	0.007
A2	1.300	1.500	0.051	0.059
b	0.306	0.506	0.012	0.020
C	0.203 TYP.		0.008 TYP.	
D	4.700	5.100	0.185	0.201
E	3.820	4.020	0.150	0.158
E1	5.800	6.200	0.228	0.244
e	1.270 TYP.		0.050 TYP.	
L	0.450	0.750	0.018	0.030
θ	0°	8°	0°	8°

RECOMMENDED SOLDERING FOOTPRINT, SOIC-8L



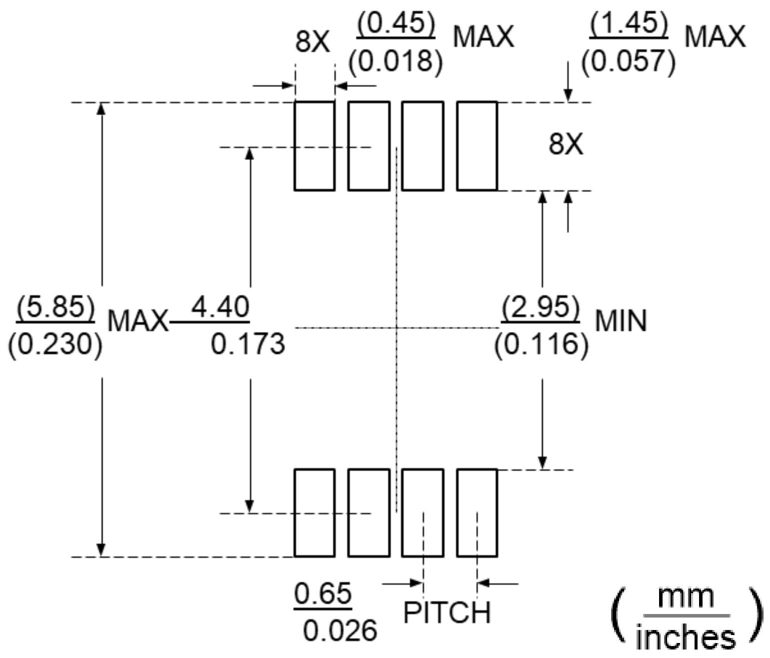
Package Outlines (Cont.)

DIMENSIONS, MSOP-8L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.031	0.043
A1	0.050	0.150	0.002	0.006
A2	0.750	0.950	0.030	0.037
b	0.290	0.380	0.011	0.015
C	0.150	0.200	0.006	0.008
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
e	0.650 TYP.		0.026 TYP.	
L	0.400	0.700	0.016	0.028
θ	0°	8°	0°	8°

RECOMMENDED SOLDERING FOOTPRINT, MSOP-8L



Important Notice

Linearin is a global fabless semiconductor company specializing in advanced high-performance high-quality analog/mixed-signal IC products and sensor solutions. The company is devoted to the innovation of high performance, analog-intensive sensor front-end products and modular sensor solutions, applied in multi-market of medical & wearable devices, smart home, sensing of IoT, intelligent industrial & smart factory (industry 4.0), and automotives. Linearin's product families include widely-used standard catalog products, solution-based application specific standard products (ASSPs) and sensor modules that help customers achieve faster time-to-market products. Go to http://www.linearin.com for a complete list of Linearin product families.

For additional product information, or full datasheet, please contact with the Linearin's Sales Department or Representatives.