Features

- **900 nA Maximum Supply Current**
- **Ultra-low Single-Supply Operation Down to +1.8V**
- **Ground-Sensing Input Common-Mode Range**
- **Outputs Swing Rail-to-Rail**
- **Offset Voltage: 0.6 mV Maximum**
- **Ultra-low V_{OS} TC: 0.4 μV/℃**
- **Ultra-low Input Bias Current: 1 fA Typical**
- **Stable 18 kHz GBWP with 10 mV/μs Slew Rate**
- **High 120 dB Open-Loop Voltage Gain**
- **Unity Gain Stable**
- **Outputs Source and Sink 20mA of Load Current**
- **No Phase Reversal for Overdriven Inputs**
- **Shutdown Pin Feature (XPT2291E)**
- **–40°C to 125°C Operation Range**
- **Robust 8kV – HBM and 2kV – CDM ESD Rating**
- **Green, SC70/SOT23 Small Size Package**

Applications

- Current Sensing
- Threshold Detectors/Discriminators
- Low Power Filters
- Wireless Remote Sensors, Active RFID Readers
- Environment/Gas/Oxygen Sensors
- Handsets and Mobile Accessories
- Battery or Solar Powered Devices
- Sensor Network Powered by Energy Scavenging

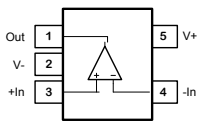
Description

The XPT2291(E) is a high precision,ultra-low power... CMOS op-amp featuring a maximum supply current of 900 nA with an ultra-low typical input bias current of 1 fA. Analog trim and calibration routine reduce input offset voltage to below 600 μV, and the precision temperature compensation technique makes offset voltage temperature drift at 0.4 μV/°C, which allowing use of the XPT2291(E) in systems with high gain without creating excessively large output offset errors.

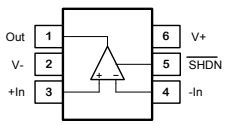
The XPT2291(E) is unity gain stable with a constant 18 kHz GBWP, 10 mV/μs slew rate, which make them appropriate for low frequency applications, such as battery current monitoring and sensor conditioning. The XPT2291(E) can operate from a single-supply voltage of +1.8V to +6.0V or a dual-supply voltage of ±0.9V to ±3.0V. Beyond the rails input makes it very prominent in low voltage (< 3V) rail-to-rail input applications.

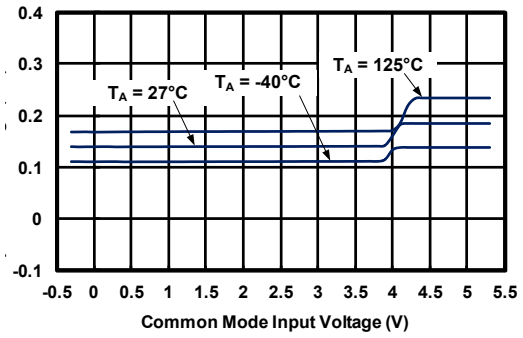
The combined features make the XPT2291(E) an ideal choice for battery-powered applications because it minimize errors due to power supply voltage variations over the lifetime of the battery and maintain high CMRR even for a rail-to-rail input op-amp. Mobile accessories, wireless remote sensing, backup battery sensors, and single-Li+ or 2-cell NiCd/Alkaline battery powered systems can benefit from the features of the XPT2291(E) op-amp.

XPT2291
5-Pin SC70/SOT23
(-C and -T Suffixes)

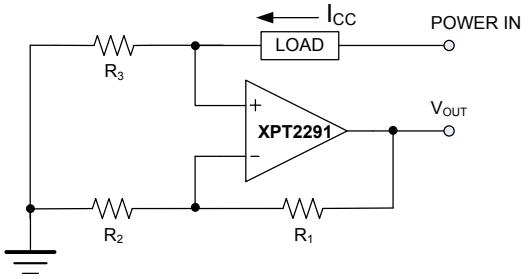


XPT2291E
6-Pin SC70/SOT23
(-C and -T Suffixes)





Ground-Sensing Input Common-Mode Range



XPT2291 in Low Side Battery Current Sensor

Order Information

Model Name	Order Number	Package	Transport Media, Quantity	Marking Information
XPT2291	XPT2291-CR	5-Pin SC70	Tape and Reel, 3,000	B2CYW (1)
	XPT2291-TR	5-Pin SOT23	Tape and Reel, 3,000	B2TYW (1)
XPT2291E	XPT2291E-CR	6-Pin SC70	Tape and Reel, 3,000	B2MYW (1)
	XPT2291E-TR	6-Pin SOT23	Tape and Reel, 3,000	B2NYW (1)

Note (1): 'YW' is date coding scheme. 'Y' stands for calendar year, and 'W' stands for single workweek coding scheme.

Absolute Maximum Ratings Note 1

Supply Voltage: $V^+ - V^-$.....6.0V
Input Voltage..... V^- – 0.3 to V^+ + 0.3
Input Current: +IN, –IN, SHDN Note 2..... ±10mA
SHDN Pin Voltage……V^- to V^+
Output Current: OUT..... ±20mA

Output Short-Circuit Duration Note 3..... Indefinite
Operating Temperature Range.....–40°C to 125°C
Maximum Junction Temperature..... 150°C
Storage Temperature Range..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 260°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 500mV beyond the power supply, the input current should be limited to less than 10mA.

Note 3: 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.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	MIL-STD-883H Method 3015.8	8	kV
CDM	Charged Device Model ESD	JEDEC-EIA/JESD22-C101E	2	kV

Pin Functions

–IN: Inverting Input of the Amplifier. Voltage range of this pin can go from V^- – 0.3V to V^+ + 0.3V.

+IN: Non-Inverting Input of Amplifier. This pin has the same voltage range as –IN.

V+ or $+V_S$: Positive Power Supply. Typically the voltage is from 1.8V to 5.5V. Split supplies are possible as long as the voltage between V+ and V– is between 1.8V and 5.5V. A bypass capacitor of 0.1 µF as close to the part as possible should be used between power supply pins or between supply pins and ground.

V^- or ^-V_S: 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^+ and V^- is from 1.8V to 5.5V. If it is not connected to ground, bypass it with a capacitor of 0.1 µF as close to the part as possible.

SHDN: Active **Low** Shutdown. Shutdown threshold is **1.0V** above negative supply rail. If unconnected, the amplifier is automatically enabled.

OUT: Amplifier Output. The voltage range extends to within milli-volts of each supply rail.

Operation

The XPT2291(E) input signal range extends beyond the negative and positive power supplies. The output can even extend all the way to the negative supply. The input stage is comprised of two CMOS differential amplifiers, a PMOS stage and NMOS stage that are active over different ranges of common mode input voltage. The Class-AB control buffer and output bias stage uses a proprietary compensation technique to take full advantage of the process technology to drive very high capacitive loads. This is evident from the transient over shoot measurement plots in the Typical Performance Characteristics.

Applications Information

Low Supply Voltage and Low Power Consumption

The XPT2291(E) of operational amplifier can operate with power supply voltages from 1.8V to 6.0V. Each amplifier draws only 700 nA quiescent current. The low supply voltage capability and low supply current are ideal for portable applications demanding HIGH CAPACITIVE LOAD DRIVING CAPABILITY and CONSTANT WIDE BANDWIDTH. The XPT2291(E) is optimized for industrial precision and wide bandwidth low power applications. They have an industry leading high GBWP to power ratio and are unity gain stable for 1,000 nF capacitive load. When the load capacitance increases, the increased capacitance at the output pushed the non-dominant pole to lower frequency in the open loop frequency response, lowering the phase and gain margin. Higher gain configurations tend to have better capacitive drive capability than lower gain configurations due to lower closed loop bandwidth and hence higher phase margin.

Low Input Referred Noise

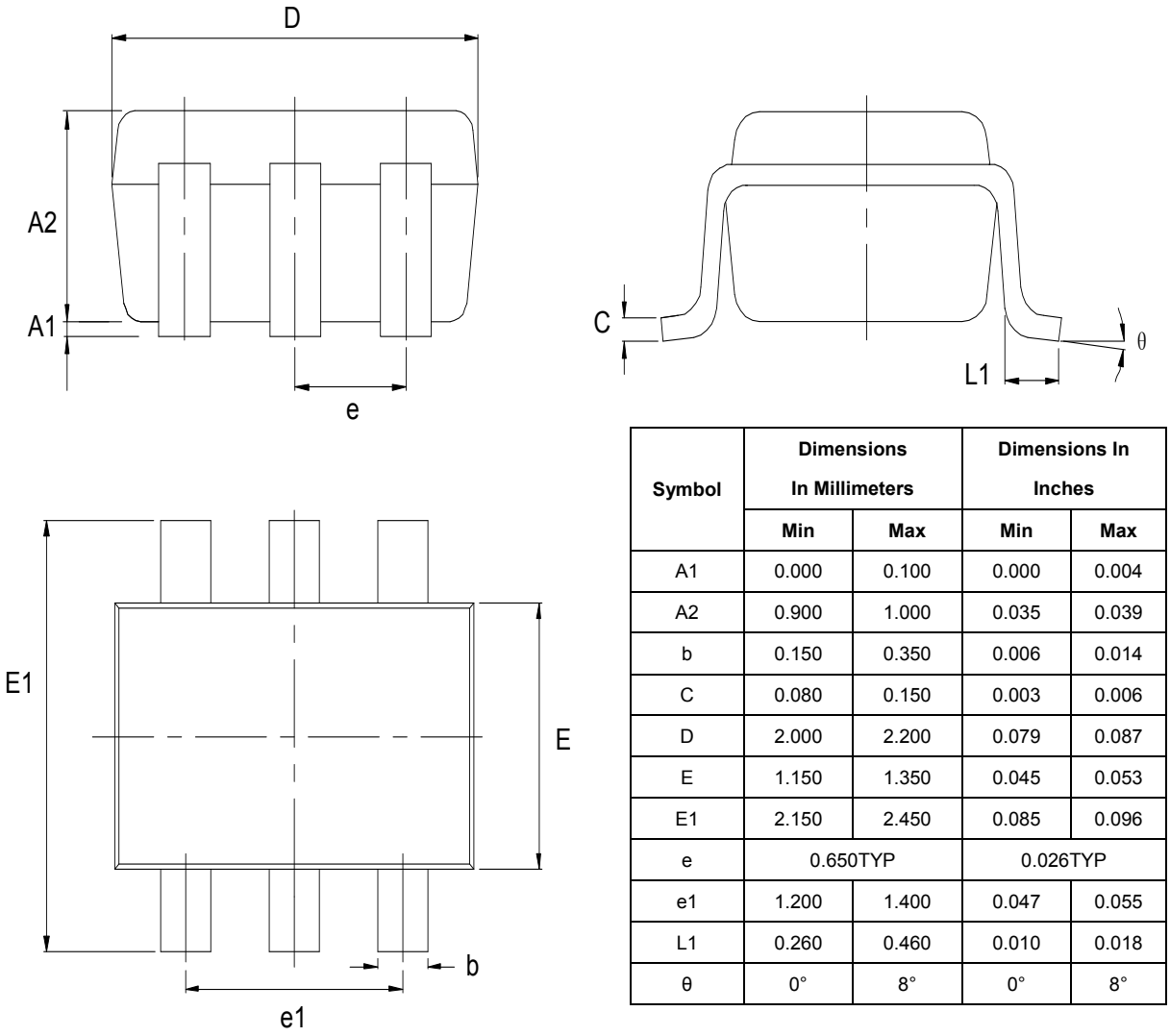
The XPT2291(E) provides a low input referred noise density of 170 nV/ √ Hz at 1 kHz. The voltage noise will grow slowly with the frequency in wideband range, and the input voltage noise is typically 6.5 μV_{P-P} at the frequency of 0.1 Hz to 10 Hz.

Low Input Offset Voltage

The XPT2291(E) has a low offset voltage of 600 µV maximum which is essential for precision applications. The offset voltage is trimmed with a proprietary trim algorithm to ensure low offset voltage for precision signal processing requirement.

Package Outline Dimensions

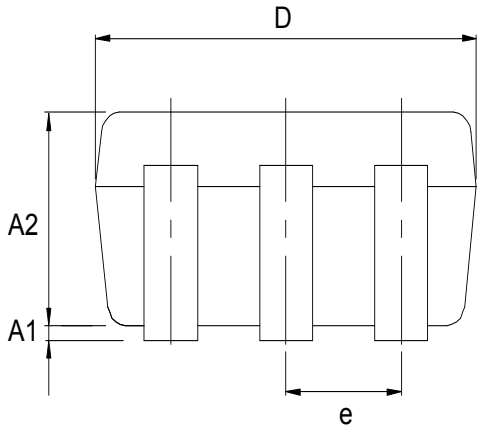
SC-70-5 / SC-70-6 (SOT353 / SOT363)

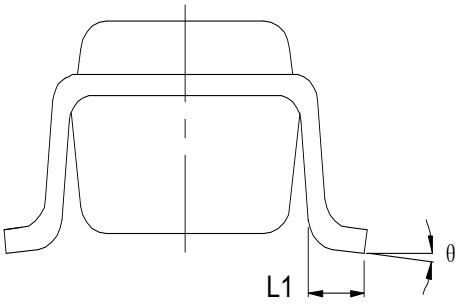


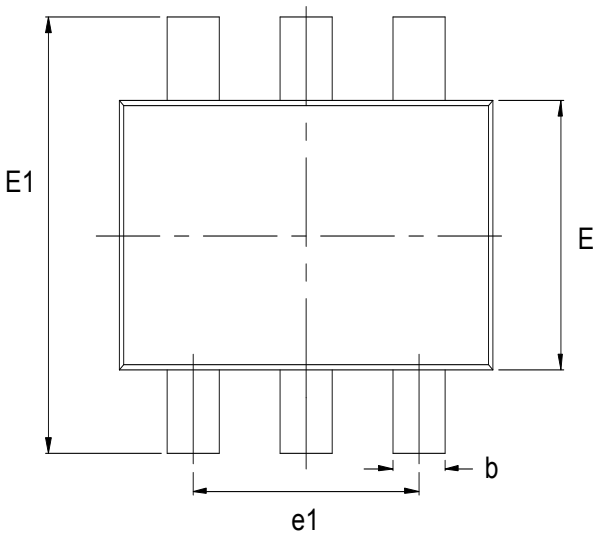
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
e1	1.200	1.400	0.047	0.055
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

Package Outline Dimensions

SOT23-5 / SOT23-6







Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L1	0.300	0.460	0.012	0.024
θ	0°	8°	0°	8°