Tiny Micropower, Low Voltage Dual Comparators

FEATURES

- **Low Supply Operation: 1.7V Minimum**
- **Low Supply Current: 30µA/Comparator Maximum**
- **Propagation Delay: 500ns Maximum (–40°C to 125°C)**
- 3.2MHz Toggle Frequency
- Input Voltage Range Extends 100mV Below Ground
- Internal Hysteresis: 4mV
- High Output Drive: TTL and CMOS Compatible
  Specified at ±15mA (–40°C to 125°C),
  Capacitive Load Handling to 10,000pF
- Specified for –40°C to 125°C Temperature Range
- Available in Low Profile (1mm) ThinSOT™ and 2mm × 2mm DFN Packages

APPLICATIONS

- Battery Powered Systems
- Window Comparators
- Threshold Detectors/Discriminators
- Clock Regeneration
- Automotive Sensing and Controls

DESCRIPTION

The LTC®6702 is an extremely small dual comparator designed to maximize battery life while providing both speed and low voltage operation in applications where board space is a premium.

These comparators operate on supplies between 1.7V and 5.5V, and have a maximum guaranteed propagation delay of 500ns while drawing only 30µA maximum quiescent current. Internal hysteresis desensitizes the LTC6702 to input noise and makes it easy to use, even with slow moving signals. CMOS inputs allow the use of large source impedances.

The LTC6702 is available in the 8-pin SOT-23 and the tiny 2mm × 2mm DFN package.

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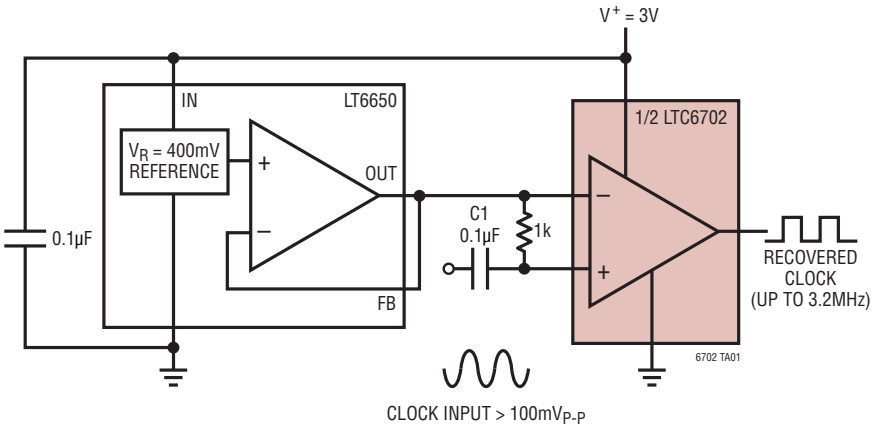
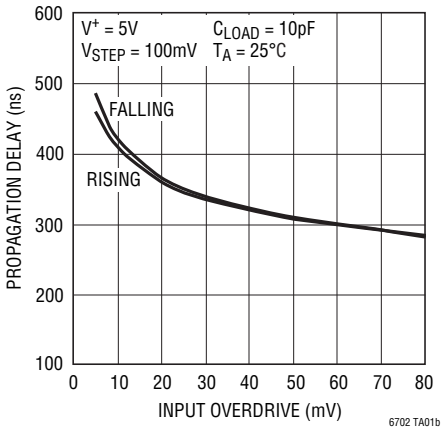
TYPICAL APPLICATION

Clock Regeneration Circuit



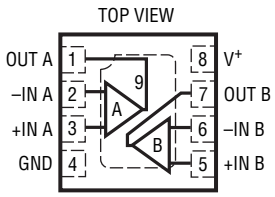
Propagation Delay vs Input Overdrive



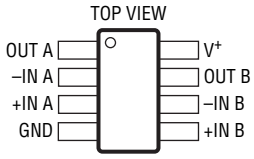
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V^+ to GND) 6V
Input Voltage 6V
Input Current ..... –10mA
Output Short-Circuit Duration (Note 2) ..... Indefinite
Operating Temperature Range (Note 3)
LTC6702C ..... –40°C to 85°C
LTC6702I ..... –40°C to 85°C
LTC6702H ..... –40°C to 125°C
Specified Temperature Range (Note 4)
LTC6702C ..... 0°C to 70°C
LTC6702I ..... –40°C to 85°C
LTC6702H ..... –40°C to 125°C
Junction Temperature ..... 150°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec)
TSOT Packages ..... 300°C

PIN CONFIGURATION



DC PACKAGE
8-LEAD (2mm × 2mm) PLASTIC DFN
T_{JMAX} = 150°C, θ_{JA} = 102°C/W
EXPOSED PAD (PIN 9) IS GND, MUST BE SOLDERED TO PCB



TS8 PACKAGE
8-LEAD PLASTIC TSOT-23
T_{JMAX} = 150°C, θ_{JA} = 130°C/W

ORDER INFORMATION

Lead Free Finish

TAPE AND REEL (MINI)	TAPE AND REEL	PART MARKING*	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE
LTC6702CDC#TRMPBF	LTC6702CDC#TRPBF	LCZJ	8-Lead (2mm × 2mm) Plastic DFN	0°C to 70°C
LTC6702IDC#TRMPBF	LTC6702IDC#TRPBF	LCZJ	8-Lead (2mm × 2mm) Plastic DFN	–40°C to 85°C
LTC6702HDC#TRMPBF	LTC6702HDC#TRPBF	LCZJ	8-Lead (2mm × 2mm) Plastic DFN	–40°C to 125°C
LTC6702CTS8#TRMPBF	LTC6702CTS8#TRPBF	LTCZK	8-Lead Plastic TSOT-23	0°C to 70°C
LTC6702ITS8#TRMPBF	LTC6702ITS8#TRPBF	LTCZK	8-Lead Plastic TSOT-23	–40°C to 85°C
LTC6702HTS8#TRMPBF	LTC6702HTS8#TRPBF	LTCZK	8-Lead Plastic TSOT-23	–40°C to 125°C

TRM = 500 pieces. *Temperature grades are identified by a label on the shipping container.

Consult LTC Marketing for parts specified with wider operating temperature ranges.
Consult LTC Marketing for information on lead based finish parts.

For more information on lead free part marking, go to: http://www.linear.com/leadfree/
For more information on tape and reel specifications, go to: http://www.linear.com/tapeandreel/

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full specified temperature range, otherwise specifications are at T_A = 25°C. V^+ = 3V, V_{CM} = 1.5V, C_{OUT} = 20pF, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V^+	Supply Voltage	Guaranteed by PSRR	●	1.7		5.5	V
I+	Supply Current per Comparator	V^+ = 3V	 ●		24	30 40	µA µA
		V^+ = 5V	 ●		25	32 42	µA µA
V_{OS}	Input Offset Voltage	(Note 5) LTC6702C/LTC6702I LTC6702H	 ● ●		1	3.5 5 6	mV mV mV
V_{HYST}	Input Hysteresis Voltage	(Note 5) LTC6702C/LTC6702I LTC6702H	 ● ●	2.5 1.6 1.6	4.3	6.2 7.2 8.2	mV mV mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 5)	●		6		µV/°C
I_{IN}	Input Leakage Current	 LTC6702C/LTC6702I LTC6702H	 ● ●		0.001	 1 10	nA nA nA
CMRR	Common Mode Rejection Ratio	V_{CM} = –0.1V to V_{DD} – 1.2V	 ●	58 56	70		dB dB
	Input Voltage Range	Guaranteed by CMRR	●	–0.1		V_{DD} – 1.2	V
PSRR	Power Supply Rejection Ratio	V^+ = 1.7V to 5.5V, V_{CM} = 0.5V	 ●	56 54	65		dB dB
V_{OL}	Output Swing Low	Overdrive = 20mV (Note 6) I_{SINK} = 100µA I_{SINK} = 15mA	 ● ●			 10 250	mV mV mV
V_{OH}	Output Swing High	Overdrive = 20mV (Note 6) I_{SOURCE} = 100µA I_{SOURCE} = 15mA	 ● ●			 10 350	mV mV mV
t_{PD}	Propagation Delay	(Note 7)	 ●		320	450 500	ns ns
Δt_{PD}	Differential Propagation Delay	Between Channels			4		ns
t_{SKEW}	Propagation Delay Skew	Between t_{PDLH}/t_{PDHL}			4		ns
t_r	Output Rise Time				11		ns
t_f	Output Fall Time				15		ns
f_{MAX}	Maximum Toggle Frequency				3.2		MHz
I_{SC}	Short-Circuit Current	V^+ = 5V			±250		mA

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: A heat sink may be required to keep the junction temperature below absolute maximum. This depends on the power supply voltage and how many comparators are shorted. The θ_{JA} specified for the DC and TS packages is with minimal PCB heat spreading metal. Using expanded metal area on all layers of a board reduces this value.

Note 3: The LTC6702C and LTC6702I are guaranteed functional over the temperature range of –40°C to 85°C. The LTC6702H is guaranteed functional over the operating temperature range of –40°C to 125°C.

Note 4: The LTC6702C is guaranteed to meet specified performance from 0°C to 70°C. The LTC6702C is designed, characterized and expected to meet specified performance from –40°C to 85°C but is not tested or QA sampled at these temperatures. The LTC6702I is guaranteed to meet specified performance from –40°C to 85°C. The LTC6702H is guaranteed to meet specified performance from –40°C to 125°C.

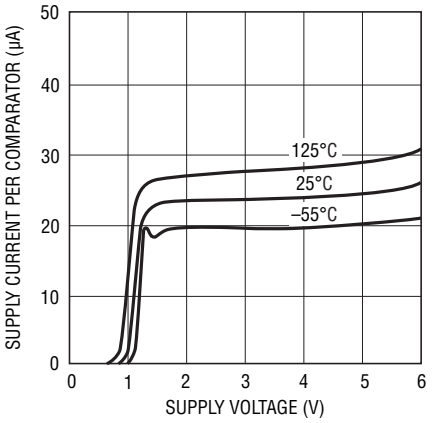
Note 5: The LTC6702 comparators include internal hysteresis. The offset voltage is defined as the average of the input voltages (trip points) required to change the output in each direction minus V_{CM}, while the hysteresis voltage is the difference of these trip points.

Note 6: Output voltage swings are measured between the output and power supply rails.

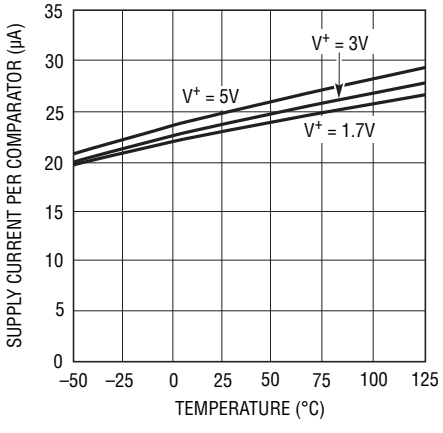
Note 7: Propagation delay is for 200mV steps, and 50mV of overdrive. Overdrive is measured relative to the positive and negative trip points.

TYPICAL PERFORMANCE CHARACTERISTICS

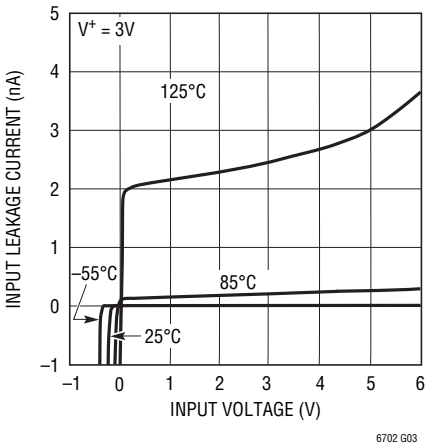
Supply Current vs Supply Voltage



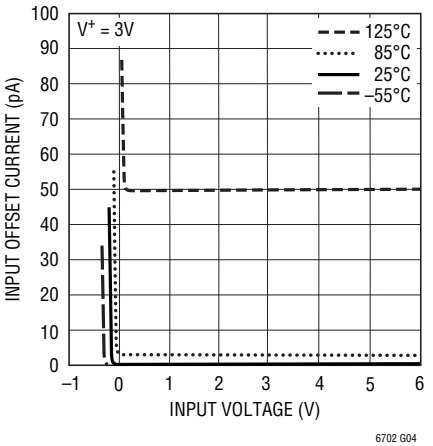
Supply Current vs Temperature



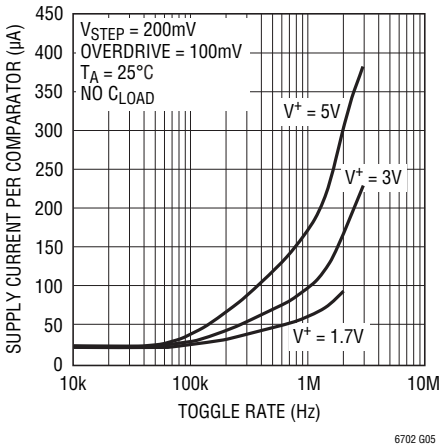
Input Leakage Current vs Input Voltage



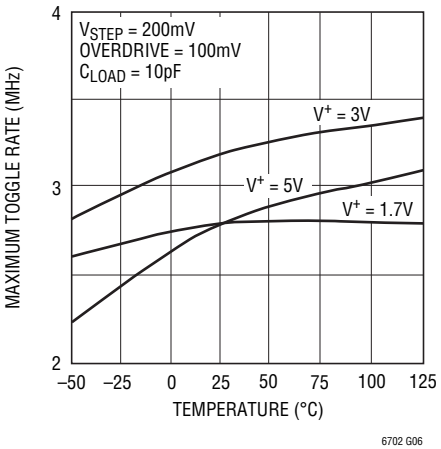
Input Offset Current vs Input Voltage



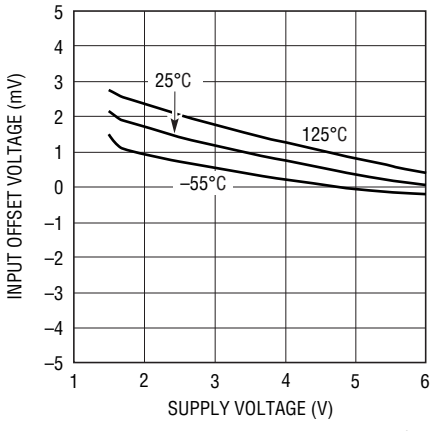
Supply Current vs Toggle Rate



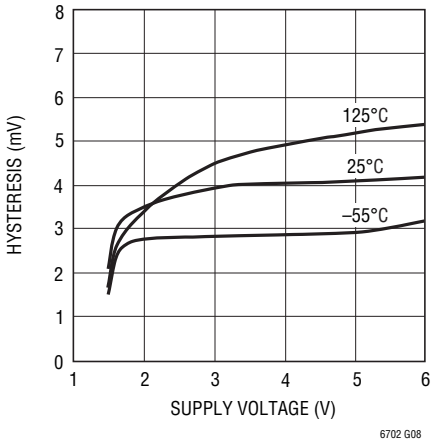
Maximum Toggle Rate vs Temperature



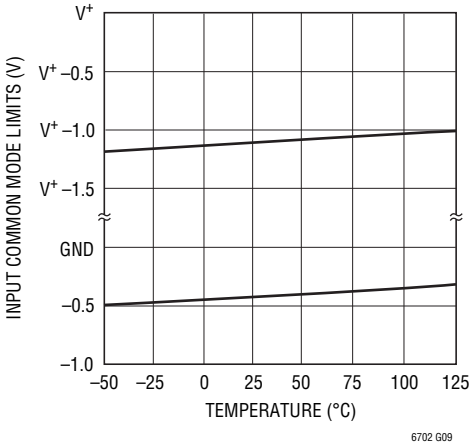
Input Offset Voltage vs Supply Voltage



Hysteresis vs Supply Voltage

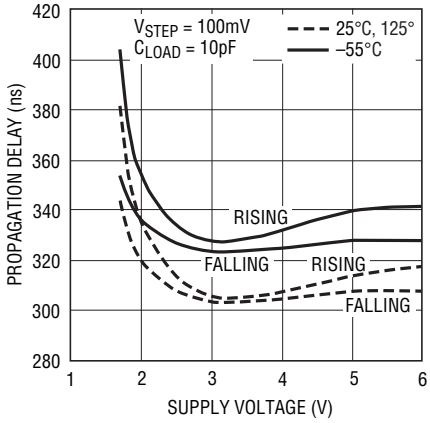


Input Common Mode Limits vs Temperature

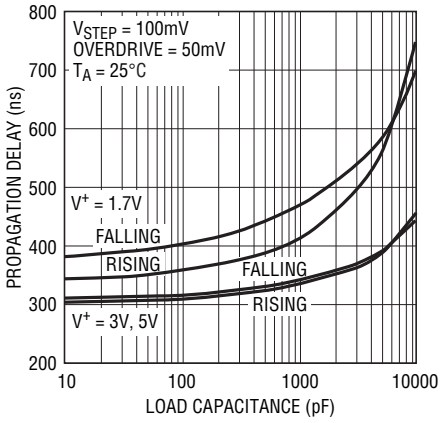


TYPICAL PERFORMANCE CHARACTERISTICS

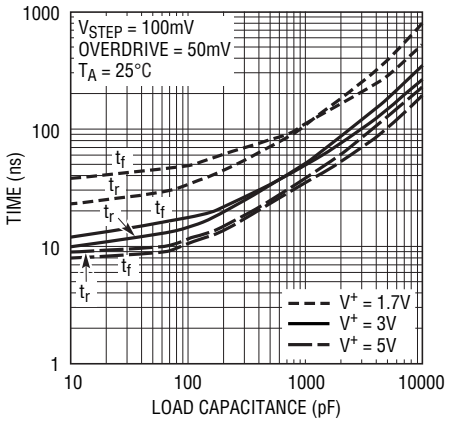
Propagation Delay vs Supply Voltage



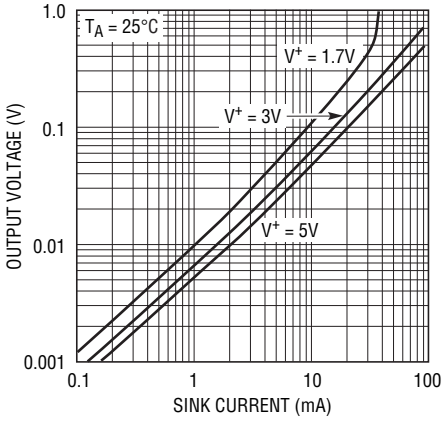
Propagation Delay vs Load Capacitance



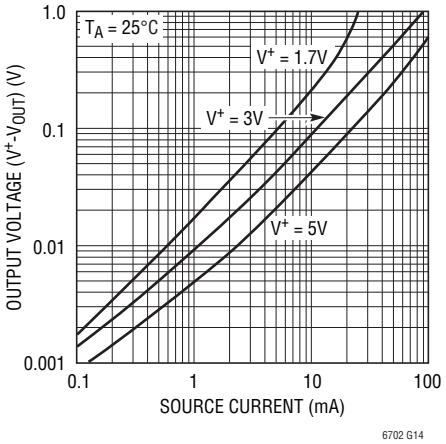
Output Rise and Fall Times vs Load Capacitance



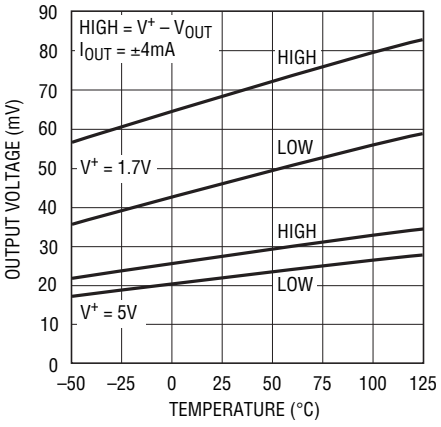
Output Low Voltage vs Load Current



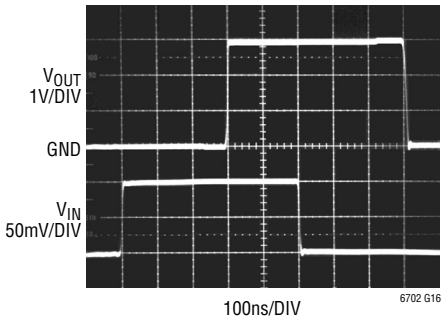
Output High Voltage vs Load Current



Output Voltage vs Temperature

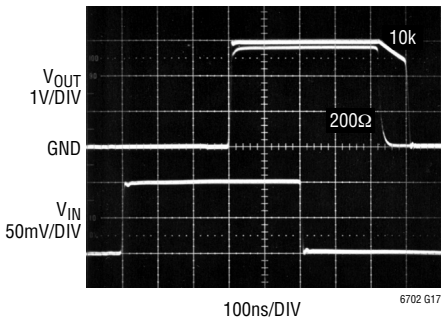


Propagation Delay



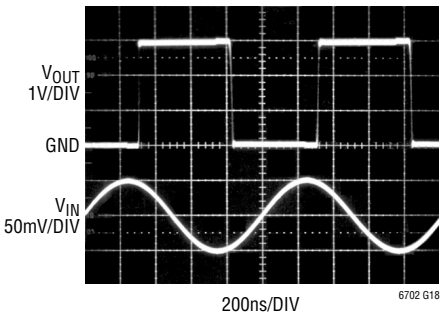
V+ = 3V
CL = 20pF
VCM = 500mV

Propagation Delay with Load



V+ = 3V VCM = 500mV
CL = 20pF RL = 10k, 200Ω

1MHz Sinusoid Response



V+ = 3V
CL = 20pF
VCM = 500mV

PIN FUNCTIONS

OUT A (Pin 1): Output of Comparator A.

–IN A (Pin 2): Inverting Input of Comparator A.

+IN A (Pin 3): Noninverting Input of Comparator A.

GND (Pin 4): Ground.

+IN B (Pin 5): Noninverting Input of Comparator B.

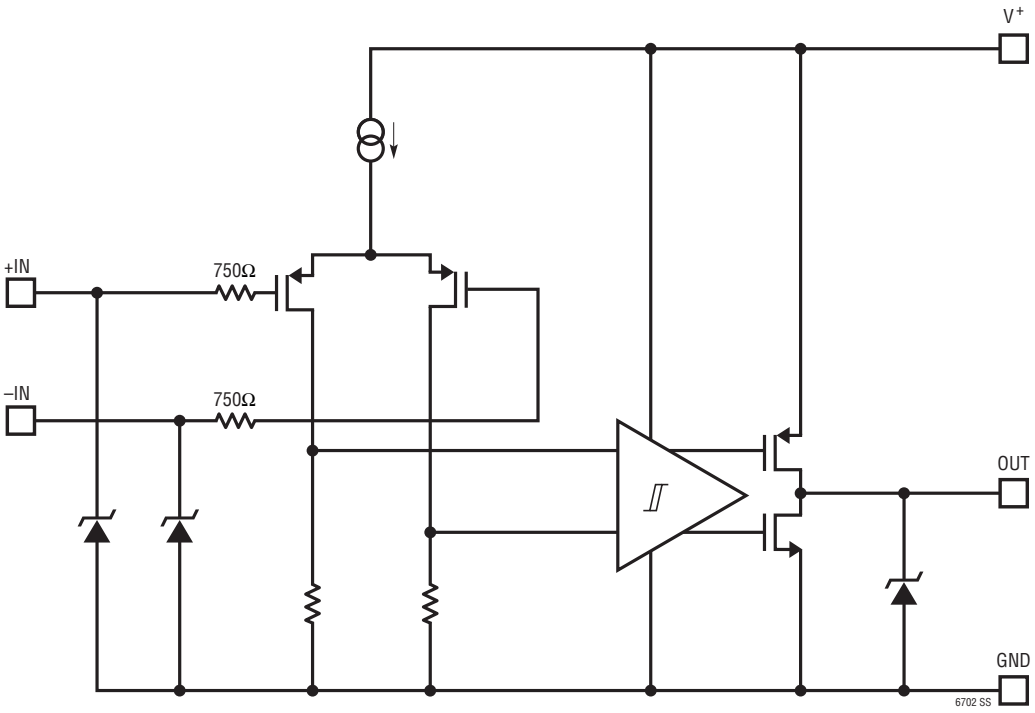
–IN B (Pin 6): Inverting Input of Comparator B.

OUT B (Pin 7): Output of Comparator B.

V⁺ (Pin 8): Positive Supply Voltage

Exposed Pad (Pin 9, DC Package Only): Ground. The Exposed Pad must be soldered to PCB.

SIMPLIFIED SCHEMATIC



APPLICATIONS INFORMATION

The LTC6702 device is a fast (500ns delay), low power, low voltage (1.7V to 5.5V supply) general purpose dual comparator. It provides rail-to-rail outputs able to interface to TTL/CMOS, draws low supply currents (30µA/comparator), and has internal hysteresis (approximately 4mV).

Hysteresis

Each comparator has built-in hysteresis to simplify designs, to insure stable operation in the presence of noise at the inputs, and to reject supply rail noise. The reference voltage applied to the input is not the exact switching threshold value due to the built-in hysteresis. Actual output switching typically occurs within ±2.2mV of the reference voltage, plus or minus the input offset voltage. External positive feedback circuitry can be employed to increase effective hysteresis if desired, as shown in Figure 1. This circuitry will provide an apparent effect on both the rising and falling input thresholds (the actual internal trip points remain unaffected). If an inverting configuration with hysteresis is needed, simply swap the V_{IN} and V_{REF} connections.

Unused Inputs

Any unused inputs should be connected in a way that fixes the output logic state high or low. One easy way to do this is to tie +IN to V^+ and –IN to GND.

Input Protection

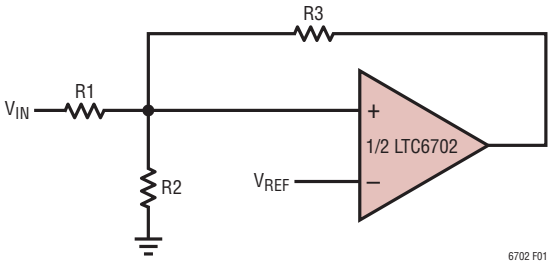
External input protection circuitry is only needed if currents would otherwise exceed the absolute maximum rating. Inputs driven further negative than 100mV below ground will not cause damage provided the current is limited to 10mA. ESD protection diodes are provided to prevent damage during handling.

Comparator Input

The allowable input voltage ranges from 100mV below GND to within 1.2V of the positive supply. The input may be forced below ground without causing an improper output, though some additional input current will begin to flow from the ESD input protection diode. The inputs can reach up to 6V independent of the V^+ supply voltage without causing additional input current or damage to the part. As long as one input is within the allowable input voltage range, the LTC6702 will continue to function normally.

Comparator Output

The comparator output is a push-pull CMOS stage guaranteed to swing to within 350mV of V^+ and 250mV of ground, over temperature when sourcing or sinking 15mA. No external pull-up/down resistor is required. To



$$\text{Additional Hysteresis} = \frac{R1}{R3} \bullet V^+$$

Trip Voltages:

$$V_{IN(L\rightarrow H)} = V_{REF} \bullet R1 \bullet \left(\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R3}\right)$$

$$V_{IN(H\rightarrow L)} = V_{REF} \bullet R1 \bullet \left(\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R3}\right)-\left(\frac{R1}{R3}\right) \bullet V^+$$

Example: Additional Hysteresis = 50mV, $V^+ = 5V$
R1 = 10k
R2 = 249k
R3 = 1M
FOR $V_{REF} = 0.5V$: V_{IN} (L → H) = 0.525V
V_{IN} (H → L) = 0.475V

Figure 1. Additional Hysteresis Circuit for Noninverting Configuration

APPLICATIONS INFORMATION

maintain micropower operation, the output stage uses a break-before-make circuit. The break interval of this circuit turns off both the pull-up and pull-down devices for tens of nanoseconds before activating the appropriate output transistor (depends on the output transition direction). Any load connected to the output will charge or discharge internal capacitance during this interval. This can create a soft corner during output transitions and also decrease the propagation delay. The Typical Performance Characteristics section shows this behavior under three load conditions: unloaded, 10k to ground and 200Ω to ground. Loads to V^+ have a similar affect when the output is transitioning from low to high.

Power Supplies

The comparator circuitry operates from a single 1.7V to 5.5V. A 0.1µF minimum bypass capacitor is required between the V^+ pin and GND. When the output is sinking at least 1mA, a 1µF bypass capacitor is recommended. Pulsing the V^+ supply to the comparators on and off may engage the ESD protection circuitry at the V^+ pin. If this occurs, current is pulled from the V^+ pin through the output stage. Using the recommended supply bypass capacitors with some series resistance in the V^+ supply line will help to prevent this action in pulsed supply applications.

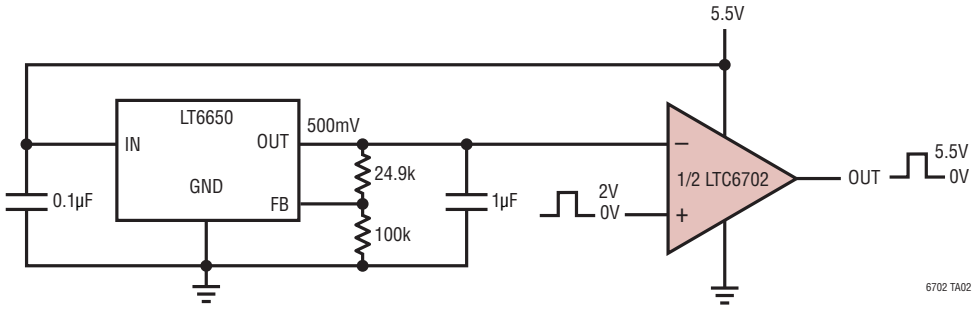
Level Translators

The level translators in the Typical Applications section show an adjustable high-precision voltage reference enabling the user to vary the threshold voltage. Simply adjusting the ratio of the two resistors changes the threshold voltage according to the following equation:

$$V_{THR} = 0.4\left(1+\frac{R_F}{R_G}\right)$$

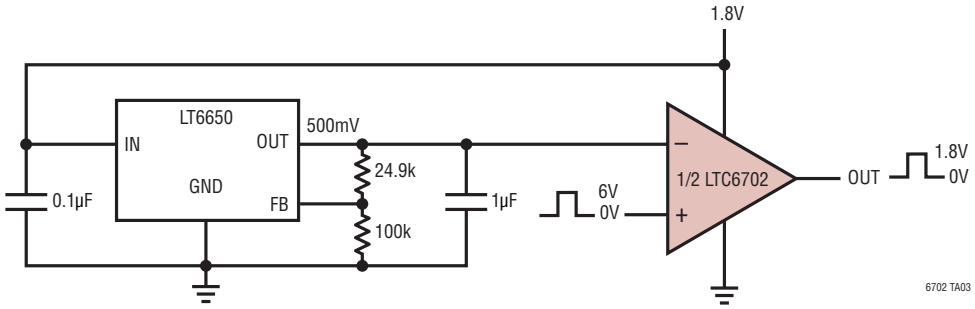
TYPICAL APPLICATIONS

Low to High Level Translator

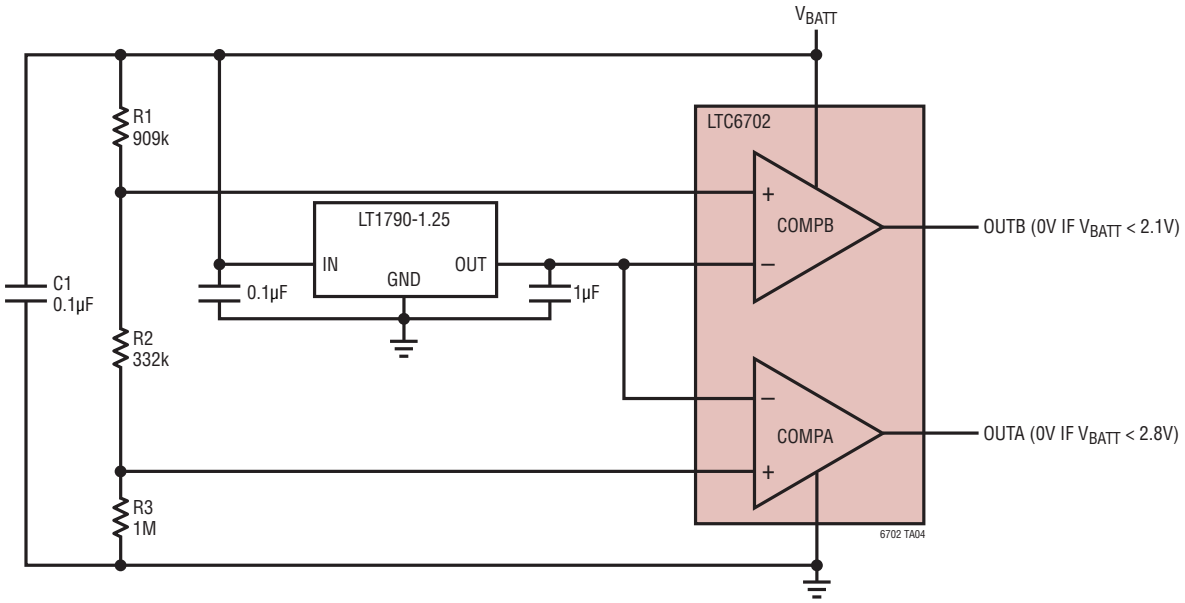


TYPICAL APPLICATIONS

High to Low Level Translator

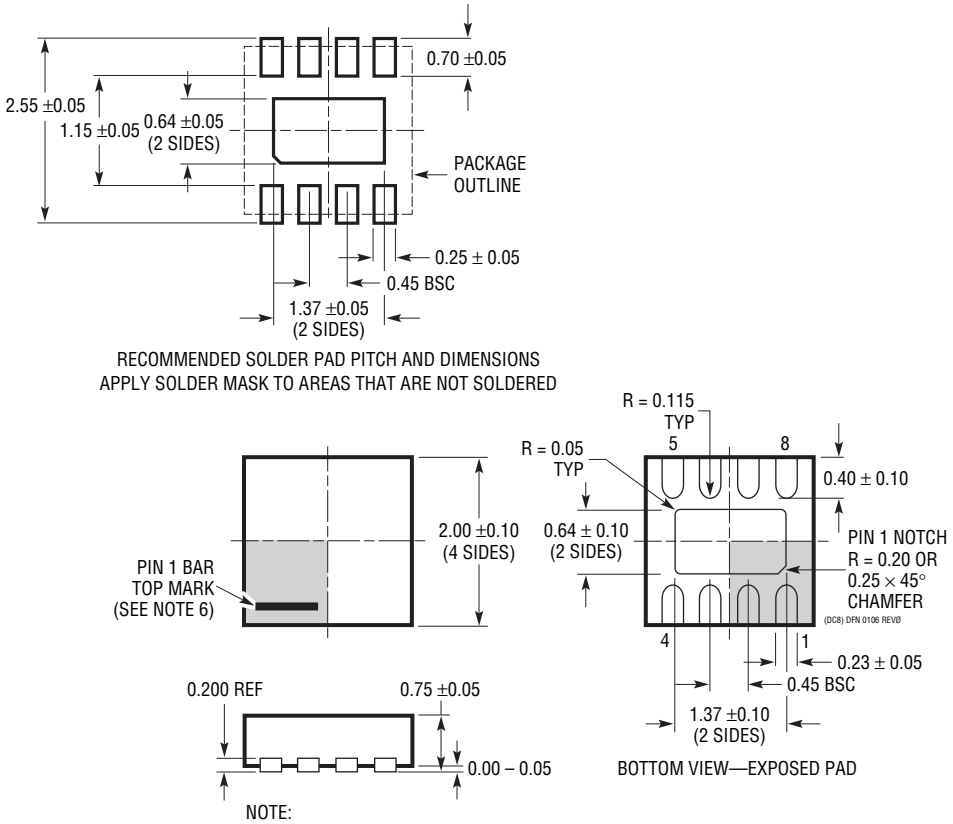


Micropower Battery Monitor with Fast Response



PACKAGE DESCRIPTION

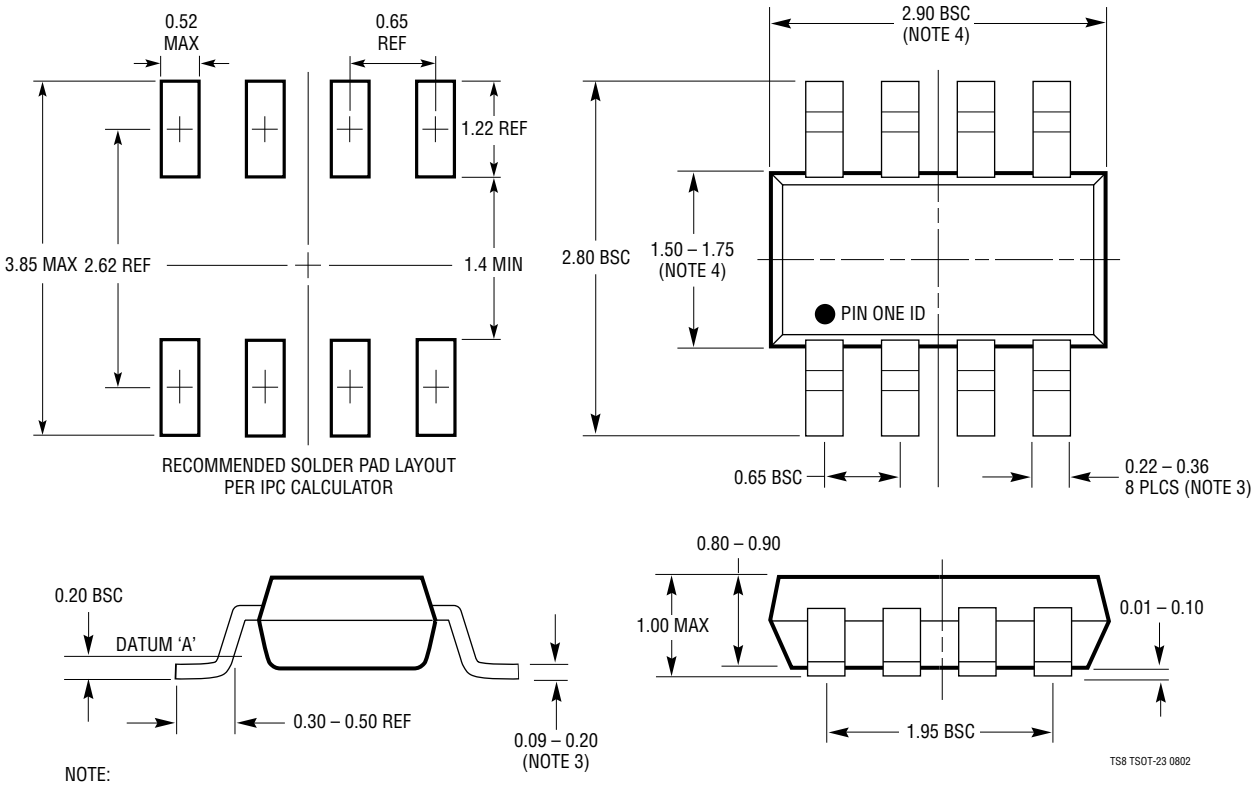
DC Package
8-Lead Plastic DFN (2mm × 2mm)
(Reference LTC DWG # 05-08-1719 Rev A)



NOTE:
1. DRAWING IS NOT A JEDEC PACKAGE OUTLINE
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

PACKAGE DESCRIPTION

TS8 Package
8-Lead Plastic TSOT-23
(Reference LTC DWG # 05-08-1637)

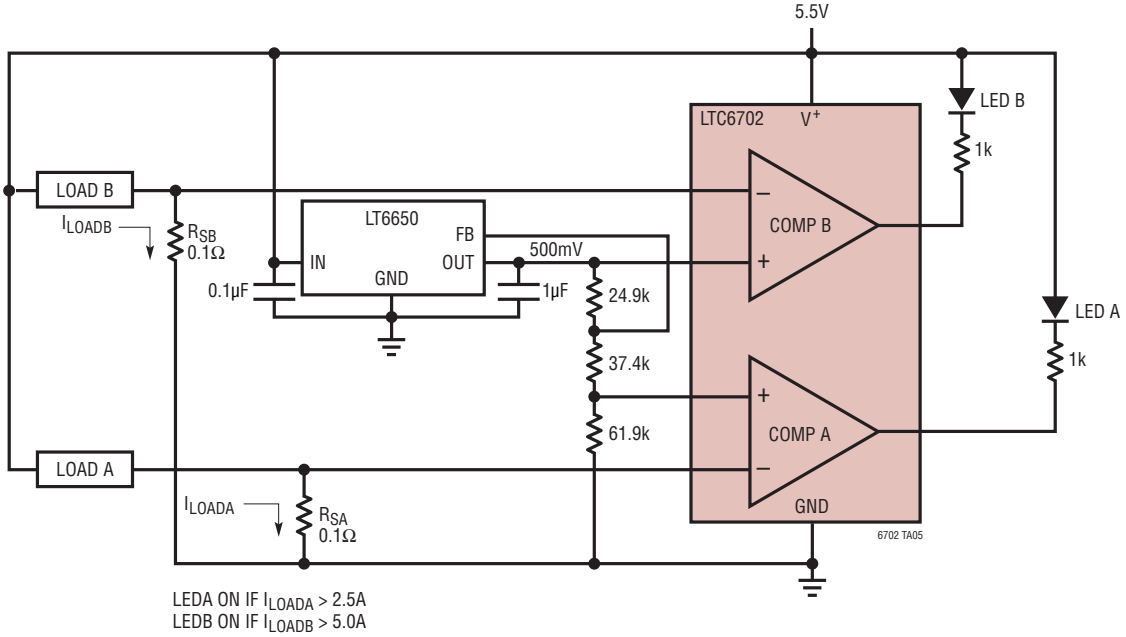


NOTE:
1. DIMENSIONS ARE IN MILLIMETERS
2. DRAWING NOT TO SCALE
3. DIMENSIONS ARE INCLUSIVE OF PLATING
4. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
5. MOLD FLASH SHALL NOT EXCEED 0.254mm
6. JEDEC PACKAGE REFERENCE IS MO-193

Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

TYPICAL APPLICATION

Dual Low Side Current Sense Alarm



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1441/LTC1442	Dual Ultralow Power Comparators with Reference	1.182V ±1% Reference, 8µs Propagation Delay, 5.7µA
LTC1541/LTC1542	Micropower Amplifier with Comparator and Reference	1.2V ±0.8% Reference, Amplifier Stable with 1000pF Load
LTC1842/LTC1843	Dual Ultralow Power Comparators with Reference	1.182V ±1% Reference, 4µs, 3.5µA, Open-Drain Out
LT6660	Tiny Micropower Precision Series References	0.2% Reference, 20ppm/°C Drift, 20mA Output, 2mm × 2mm DFN Package
LT6700-1/LT6700-2/ LT6700-3	Dual Comparators with 400mV Reference	1.4V to 18V Operating Range, 18µs Propagation Delay, SOT-23 Package
LT6703-2/LT6703-3	Tiny Single Comparator with 400mV Reference	1.4V to 18V Operating Range, 18µs Propagation Delay, 2mm × 2mm DFN Package

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LT 0609 REV A • PRINTED IN USA
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