Micropower, Regulated 3.3V Charge Pump in a 5-Pin SOT-23 Package

FEATURES

- **Ultralow Power: I_{CC} = 6μA Typ**
- **Short-Circuit/Thermal Protected**
- 3.3V ±4% Regulated Output
- V_{IN} Range: 2V to 4.4V
- **Output Current: 8mA ($V_{IN} \geq 2V$)**
  15mA ($V_{IN} \geq 2.5V$)
- No Inductors
- **Ultrasmall Application Circuit (0.045in^2)**
- 700kHz Switching Frequency
- Available in 5-Pin SOT-23

APPLICATIONS

- Cellular Telephones
- Battery-Operated Equipment
- Local Power Supplies
- Handheld Instruments
- PCMCIA Supplies

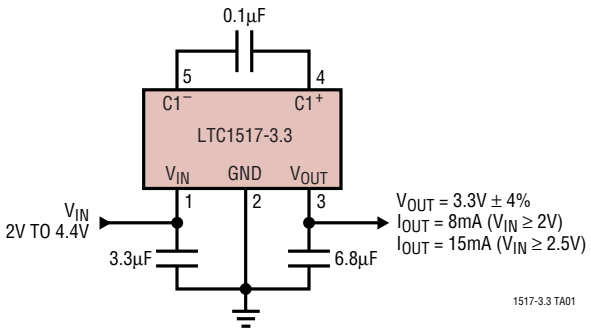
DESCRIPTION

The LTC®1517-3.3 is a micropower charge pump DC/DC converter that produces a regulated 3.3V output. The input voltage range is 2V to 4.4V, allowing a single cell lithium battery to produce a regulated 3.3V output over the entire life of the battery. Extremely low operating current (typically 6μA with no load) and low external parts count (one 0.1μF flying capacitor and two small bypass capacitors at V_{IN} and V_{OUT}) make the part ideally suited for small, light load battery-powered applications. The total printed circuit board area of the application circuit shown below is only 0.045in^2.

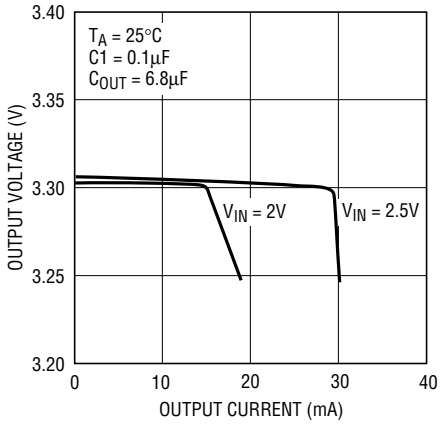
The part operates as a Burst Mode™ switched-capacitor voltage doubler to produce a regulated output. The part has thermal shutdown capability and can survive a continuous short circuit from V_{OUT} to GND. The device is available in a 5-pin SOT-23 package.

LT, LTC and LT are registered trademarks of Linear Technology Corporation.
Burst Mode is a trademark of Linear Technology Corporation.

TYPICAL APPLICATION



Typical Output Voltage vs Output Current

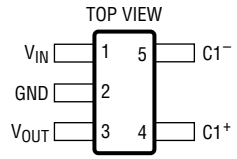


ABSOLUTE MAXIMUM RATINGS

(Note 1)

V_{IN} to GND ..... –0.3V to 6V
V_{OUT} to GND ..... –0.3V to 6V
V_{OUT} Short-Circuit Duration ..... Indefinite
Operating Temperature Range:
Commercial ..... 0°C to 70°C
Extended ..... –40°C to 85°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PACKAGE/ORDER INFORMATION



S5 PACKAGE
5-LEAD PLASTIC SOT-23

T_{JMAX} = 125°C, θ_{JA} = 256°C/W

ORDER PART NUMBER
LTC1517CS5-3.3 LTC1517ES5-3.3
S5 PART MARKING
LTEF LTTE

Consult factory for Industrial and Military grade parts.

ELECTRICAL CHARACTERISTICS

V_{IN} = 2V to 4.4V, C1 = 0.1µF, C_{IN} = 3.3µF, C_{OUT} = 6.8µF, T_{MIN} to T_{MAX}, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{IN}	Operating Input Voltage		●	2.0		4.4	V
V_{OUT}	Output Voltage	2V ≤ V_{IN} ≤ 4.4V, I_{OUT} ≤ 8mA	●	3.17	3.3	3.43	V
		2.5V ≤ V_{IN} ≤ 4.4V, I_{OUT} ≤ 15mA	●	3.17	3.3	3.43	V
I_{CC}	Input Supply Current	2V ≤ V_{IN} ≤ 4.4V, I_{OUT} = 0	●		6	15	µA
	V_{OUT} Ripple	V_{IN} = 2.5V, I_{OUT} = 15mA, C_{OUT} = 6.8µF			50		mV_{P-P}
f_{OSC}	Oscillator Frequency				700		kHz
t_{ON}	V_{OUT} Turn-On Time	V_{IN} = 2.5V			1		ms
I_{SC}	Output Short-Circuit Current	V_{IN} = 3V			60		mA

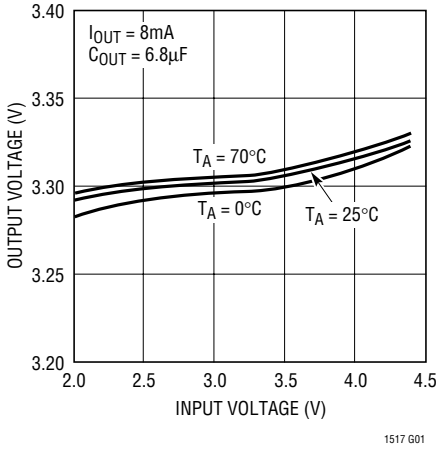
The ● denotes specifications that apply over the full operating temperature range.

Note 1: Absolute Maximum Ratings are those values beyond which the life of the device may be impaired.

Note 2: Extended grade parts are 100% tested at T_A = 25°C. Performance at –40°C and 85°C is assured by design, characterization and correlation with statistical process controls.

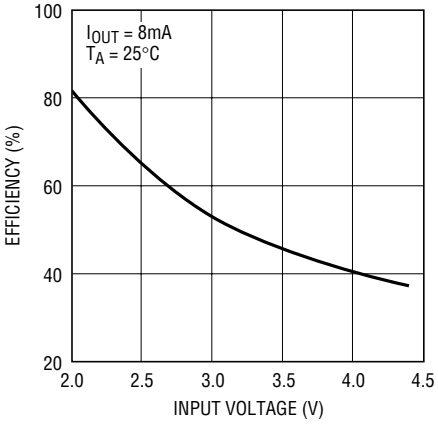
TYPICAL PERFORMANCE CHARACTERISTICS

Output Voltage vs Input Voltage



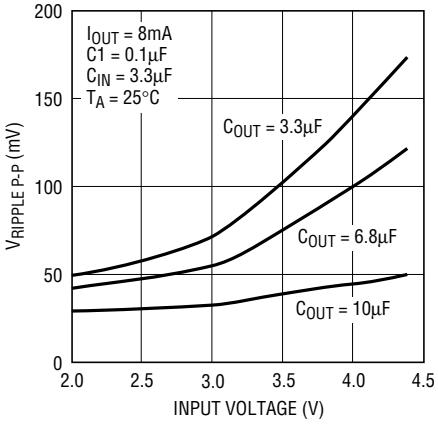
1517 G01

Efficiency vs Input Voltage



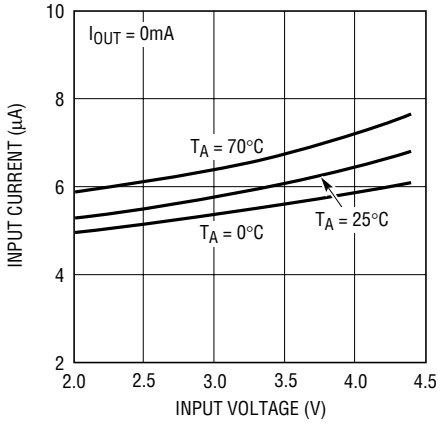
1517 G02

Output Ripple vs Input Voltage



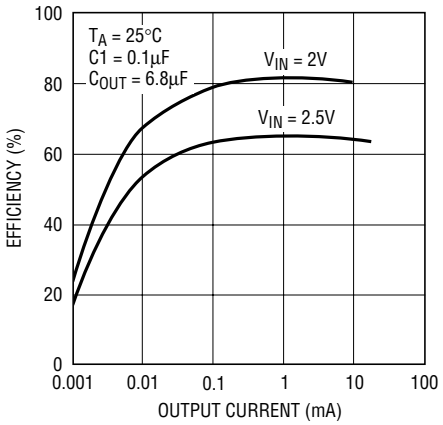
1517 G03

No Load Input Current vs Input Voltage



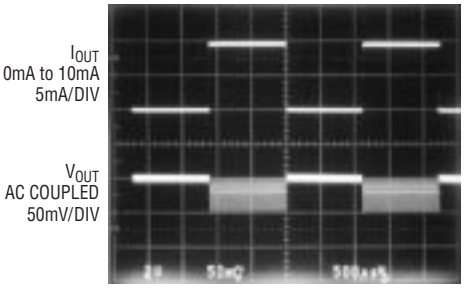
1517 G04

Typical Efficiency vs Output Current



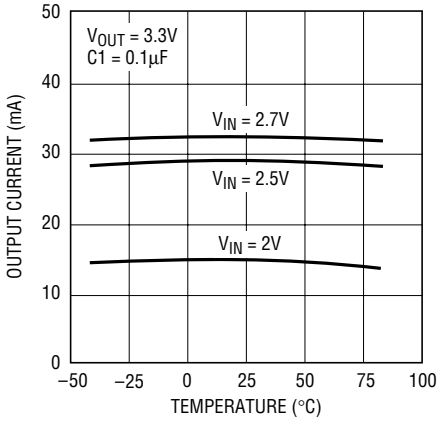
1517 TA02

Load Transient Response



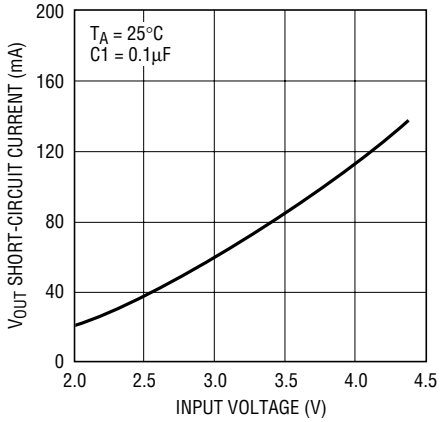
1517 G06

Typical Output Current vs Temperature



1517 G09

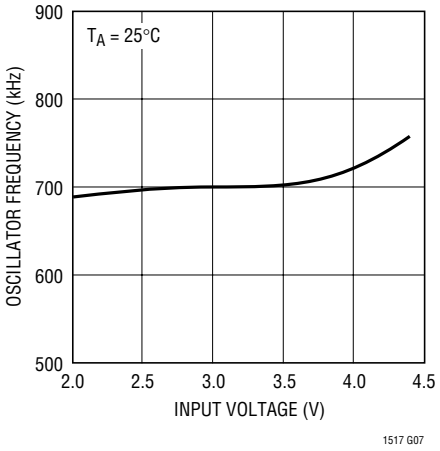
V_{OUT} Short-Circuit Current vs Input Voltage



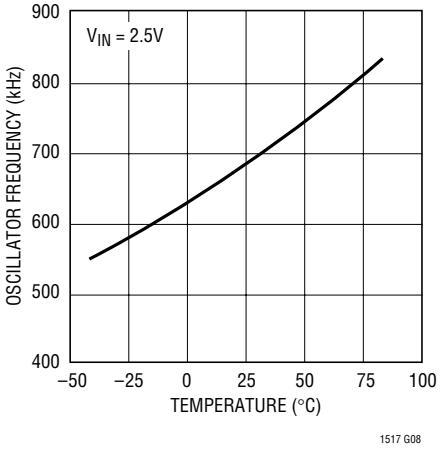
1517 G10

TYPICAL PERFORMANCE CHARACTERISTICS

Oscillator Frequency vs Input Voltage



Oscillator Frequency vs Temperature



PIN FUNCTIONS

V_{IN} (Pin 1): Charge Pump Input Voltage. May be between 2V and 4.4V. V_{IN} should be bypassed with a ≥3.3µF low ESR capacitor as close as possible to the pin for best performance.

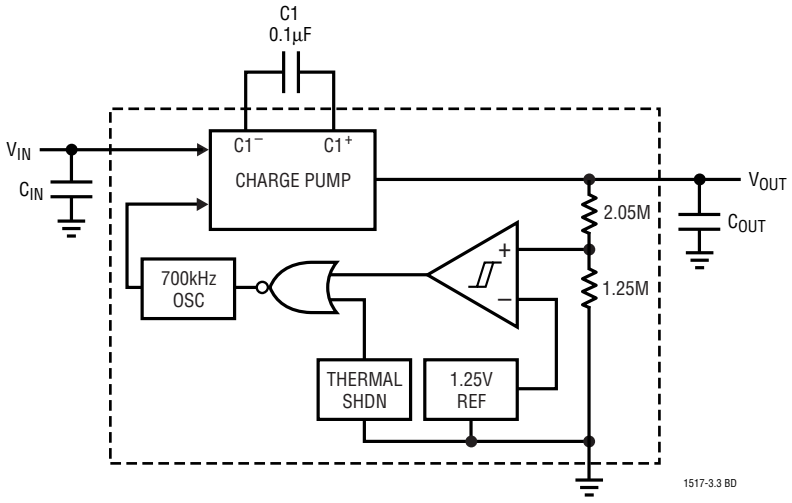
GND (Pin 2): Ground. Should be tied to a ground plane for best performance.

V_{OUT} (Pin 3): Regulated Output Voltage. V_{OUT} should be bypassed with a ≥3.3µF low ESR capacitor as close as possible to the pin for best performance.

C1⁺ (Pin 4): Charge Pump Flying Capacitor Positive Terminal.

C1⁻ (Pin 5): Charge Pump Flying Capacitor Negative Terminal.

SIMPLIFIED BLOCK DIAGRAM



APPLICATIONS INFORMATION

Operation

The LTC1517-3.3 uses a switched-capacitor charge pump to boost V_{IN} to a 3.3V ±4% regulated output. The part achieves regulation by sensing the output voltage through an internal resistor divider and enabling the charge pump when the divided output droops below the comparator's lower trip point (set by V_{REF}). When the charge pump is enabled, a 2-phase nonoverlapping clock controls the internal charge pump switches. Flying capacitor C1 is charged to V_{IN} on phase one of the clock. On phase two of the clock, C1 is stacked in series with V_{IN} and connected to V_{OUT} through an internal switch. This sequence of charging and discharging the flying capacitor occurs at a free running frequency of 700kHz (typ) and continues until the divided output voltage reaches the upper trip point of the comparator. Once the output is back in regulation, the charge pump is disabled. This method of bursting the charge pump on and off enables the LTC1517-3.3 to achieve high efficiency at extremely low output loads.

Capacitor Selection

For best performance, it is recommended that low ESR capacitors be used for both C_{IN} and C_{OUT} to reduce noise and ripple. The C_{IN} and C_{OUT} capacitors should be either ceramic or tantalum and should be 3.3µF or greater. Ceramic capacitors will provide the smallest size for a given capacitance. If the input source impedance is very low (< 0.5Ω), C_{IN} may not be needed. Ceramic capacitors are recommended for the flying capacitor C1 with values of 0.1µF or 0.22µF. Smaller value flying capacitors may be used in low I_{OUT} applications.

Output Ripple

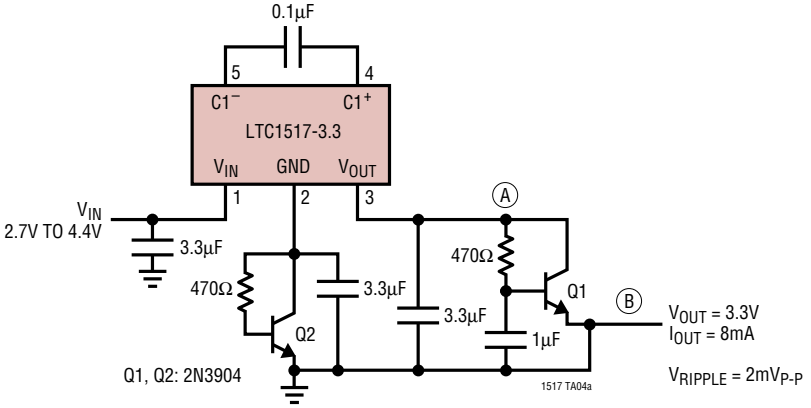
Normal LTC1517-3.3 operation produces voltage ripple on the V_{OUT} pin. Output voltage ripple is required for the parts to regulate. Low frequency ripple exists due to the hysteresis in the sense comparator and propagation delays in the charge pump enable/disable circuits. High frequency ripple is also present mainly from the ESR (equivalent series resistance) in the output capacitor. Typical output ripple with V_{IN} = 2.5V under maximum load is 75mV peak-to-peak with a low ESR 3.3µF output capacitor (minimum recommended C_{OUT}). For applications requiring V_{IN} to exceed 3.3V or for applications requiring less than 75mV of peak-to-peak ripple, a 6.8µF to 10µF C_{OUT} capacitor is recommended. Slight further decreases in output ripple can be achieved by using C_{OUT} capacitors larger than 10µF.

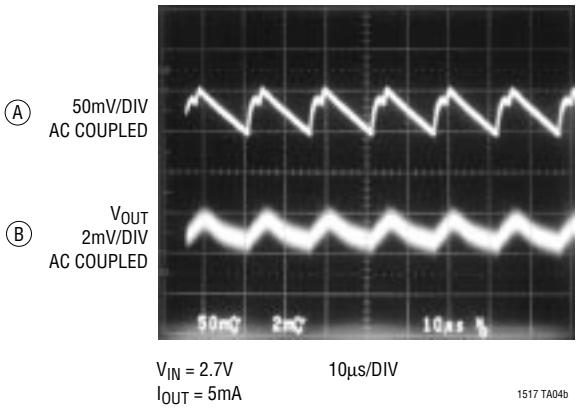
Short-Circuit/Thermal Protection

During short-circuit conditions, the LTC1517-3.3 will draw between 20mA and 150mA from V_{IN}, causing a rise in junction temperature. On-chip thermal shutdown circuitry disables the charge pump once the junction temperature exceeds approximately 160°C. The charge pump is reenabled once the junction temperature drops to approximately 145°C. The LTC1517-3.3 will cycle in and out of thermal shutdown indefinitely without latchup or damage until the V_{OUT} short is removed.

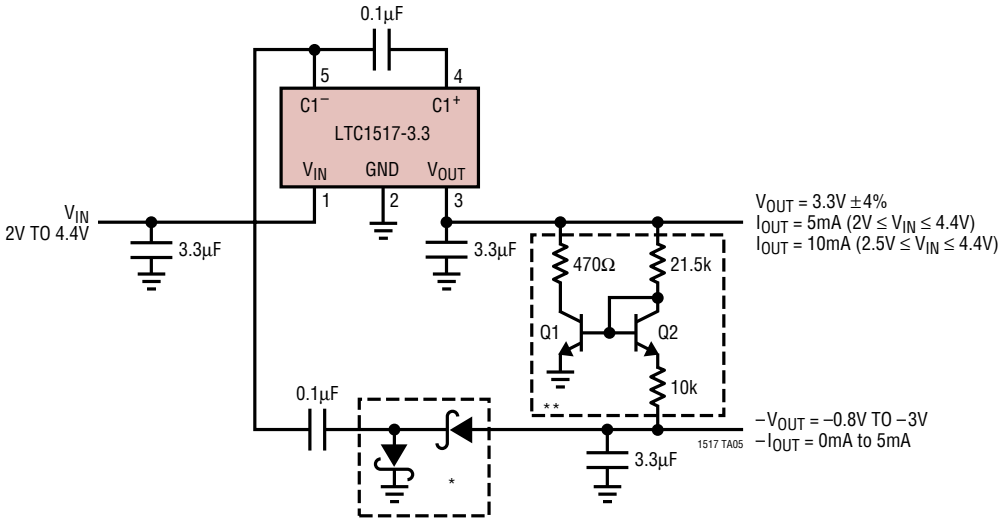
TYPICAL APPLICATIONS

Low Noise Boosted 3.3V Supply





Generating 3.3V and a Negative Supply

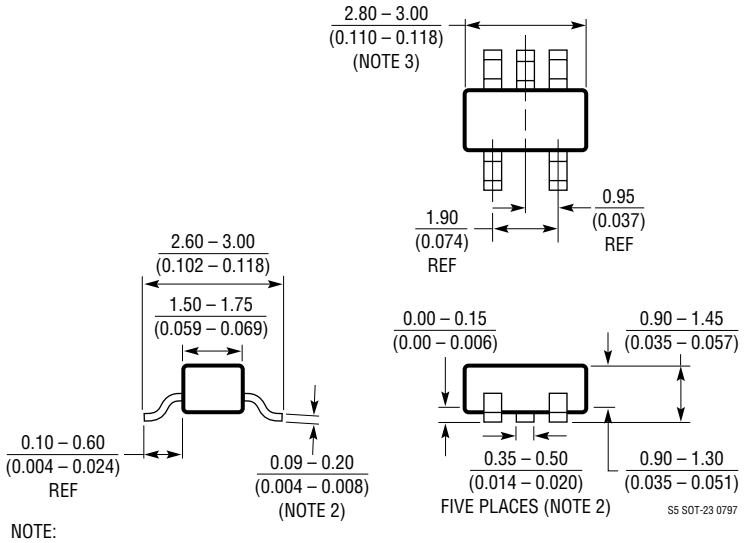


*CENTRAL SEMICONDUCTOR CMPSH-35 DUAL SCHOTTKY
**OPTIONAL CIRCUITRY FOR MAINTAINING –V_{OUT} WITH LOW V_{OUT} LOADS
Q1, Q2: 2N3904

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

S5 Package
5-Lead Plastic SOT-23
(LTC DWG # 05-08-1633)

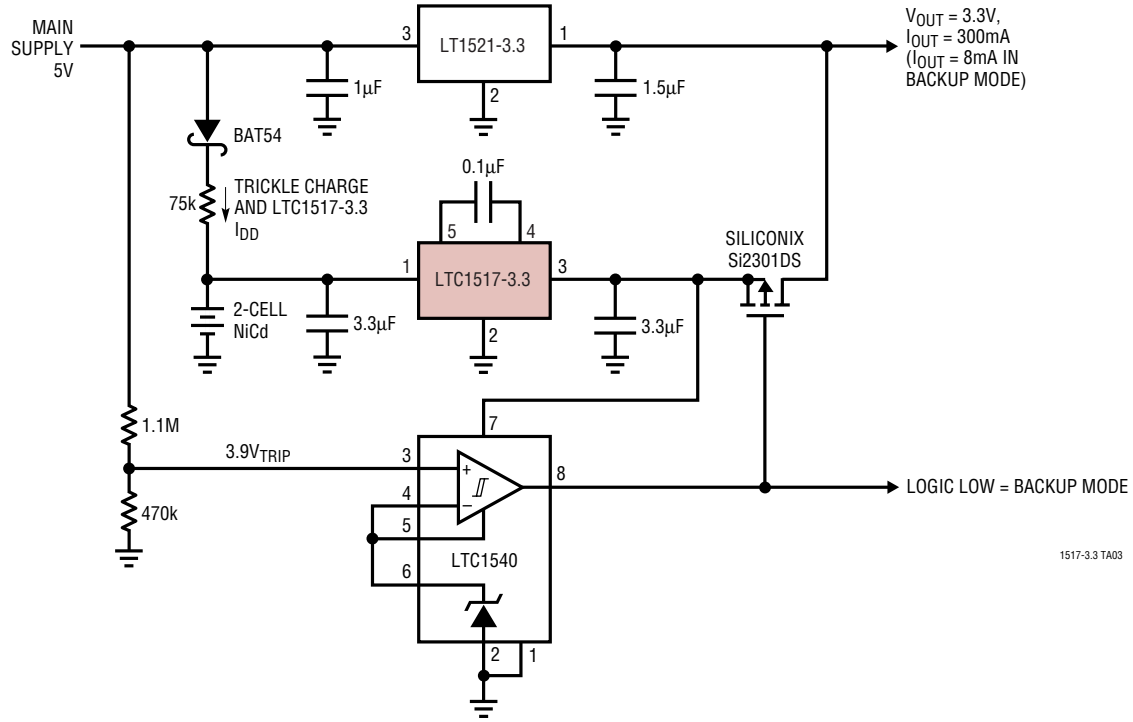


NOTE:
1. DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONS ARE INCLUSIVE OF PLATING
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
4. MOLD FLASH SHALL NOT EXCEED 0.254mm
5. PACKAGE EIAJ REFERENCE IS SC-74A (EIAJ)

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TYPICAL APPLICATION

Low Power Battery Backup Supply with Autoswitchover and No Reverse Current



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1514-X	Step-Up/Step-Down Switched-Capacitor DC/DC Converter with Low Battery Comparator	3.3V or 5V Output up to 50mA
LTC1515	Step-Up/Step-Down Switched-Capacitor DC/DC Converter with POR	Fixed or Adjustable Output up to 50mA
LTC1516	Micropower Regulated 5V Charge Pump DC/DC Converter	20mA for $V_{IN} \geq 2V$, 50mA for $V_{IN} \geq 3V$
LTC1517-5	Micropower Regulated 5V Charge Pump in a 5-Pin SOT-23 Package	I_{OUT} up to 20mA
LTC1522	Micropower Regulated 5V Charge Pump DC/DC Converter	Same as LTC1517-5 with Shutdown

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