

FEATURES

- Generates Low Noise Bias Voltage from Single Cell Li-Ion Battery
- Output Current: Up to 40mA
- Low Output Ripple and Noise: <500 μ V_{P-P}
- Boost Regulator
 - 2.2MHz Operation
 - 300mA Power Switch
 - Integrated Schottky Diode
- Low Dropout Linear Regulator
 - Low Noise: <120 μ V_{RMS} (10Hz to 100kHz)
 - 0.1% Load Regulation
- Short-Circuit and Thermal Protection
- Load Disconnect in Shutdown
- Available in 2mm × 2mm DFN Package

APPLICATIONS

- Sensor Bias
- Op Amp Supply

DESCRIPTION

The **LT[®]3048-15** generates a low noise, low ripple bias supply from an input voltage of 2.7V to 4.8V.

The LT3048-15 includes a boost regulator and a LDO linear regulator. The boost regulator provides power to the linear regulator.

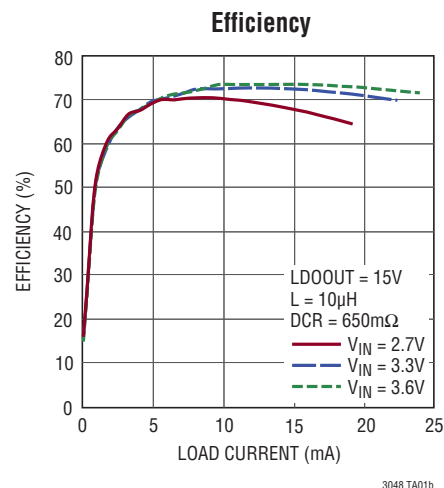
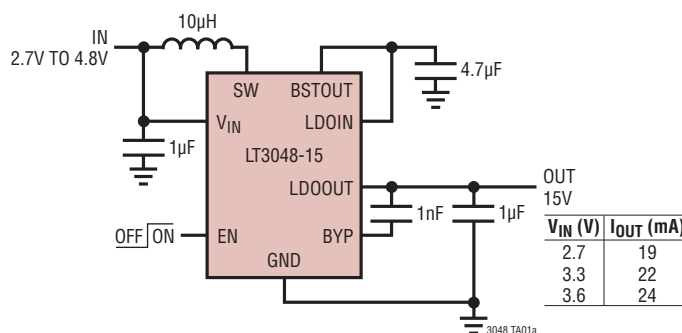
The boost regulator output voltage is regulated to 1.1V above the LDO output, optimizing LDO ripple rejection and transient response. Fixed frequency operation and current mode control allow the use of very small inductors and results in low, predictable output ripple.

The linear regulator in the LT3048-15 generates a fixed 15V output. High power supply ripple rejection combined with a low noise internal reference results in less than 500 μ V_{P-P} output ripple and noise.

The LT3048-15 is available in a 8-lead 2mm × 2mm DFN package.

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TYPICAL APPLICATION



LT3048-15

ABSOLUTE MAXIMUM RATINGS

(Note 1)

V_{IN}	6V
SW	25V
BSTOUT	23V
LDOIN	22V
LDOOUT	22V
BYP	$\pm 0.3V$
EN	6V

Operating Junction Temperature Range (Note 2)

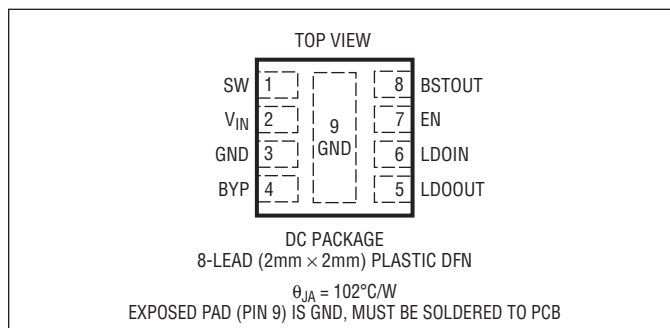
LT3048E-15..... $-40^{\circ}C$ to $125^{\circ}C$

LT3048I-15..... $-40^{\circ}C$ to $125^{\circ}C$

Maximum Junction Temperature $125^{\circ}C$

Storage Temperature Range $-65^{\circ}C$ to $150^{\circ}C$

PIN CONFIGURATION



ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PART MARKING	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT3048EDC-15#PBF	LT3048EDC-15#TRPBF	LGKK	8-Lead (2mm $\times$ 2mm) Plastic DFN	$-40^{\circ}C$ to $125^{\circ}C$
LT3048IDC-15#PBF	LT3048IDC-15#TRPBF	LGKK	8-Lead (2mm $\times$ 2mm) Plastic DFN	$-40^{\circ}C$ to $125^{\circ}C$

Consult LTC Marketing for parts specified with wider operating temperature ranges.

Consult LTC Marketing for information on nonstandard 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

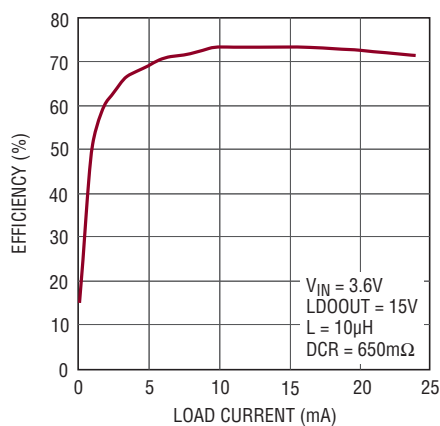
The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_{IN} = 3.6\text{V}$, $\text{EN}/\text{UVLO} = 3\text{V}$, unless otherwise noted.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{IN} Operating Range			2.7		4.8	V
Boost Regulator						
BSTOUT-LDOOUT Regulation Voltage		●	1	1.1	1.2	V
BSTOUT- V_{IN} Regulation Voltage	LDOOUT = 0V			1		V
V_{IN} Quiescent Current	Not Switching $\text{EN} \leq 0.4\text{V}$			475 0.1	600 1	μA μA
Switching Frequency		●	1.7 1.6	2.2 2.2	2.7 2.8	MHz MHz
Maximum Duty Cycle			86	90		%
Switch Current Limit			300	400	500	mA
Switch V_{CESAT}	$I_{\text{SW}} = 200\text{mA}$			220		mV
Diode Forward Drop	$I_{\text{DIODE}} = 100\text{mA}$			0.84		V
EN Voltage High			1.25			V
EN Voltage Low					0.4	V
LDO Linear Regulator						
LDOIN Quiescent Current				14	20	μA
LDOOUT Regulation Voltage	$I_{\text{LOAD}} = 100\mu\text{A}$ $I_{\text{LOAD}} = 100\mu\text{A}$ to 40mA	●	14.775 14.625	15 15	15.225 15.375	V V
LDOOUT Load Regulation	$\Delta I_{\text{LOAD}} = 1\text{mA}$ to 40mA			10	30	mV
LDOOUT Voltage Noise	$C_{\text{OUT}} = 1\mu\text{F}$, $C_{\text{BYP}} = 0\text{nF}$, BW = 10Hz to 100kHz $C_{\text{OUT}} = 1\mu\text{F}$, $C_{\text{BYP}} = 1\text{nF}$, BW = 10Hz to 100kHz			450 120		μV_{RMS} μV_{RMS}
Ripple Rejection	$f_{\text{RIPPLE}} = 2.2\text{MHz}$			20		dB
Current Limit	LDOOUT = 15V	●	45	80		mA

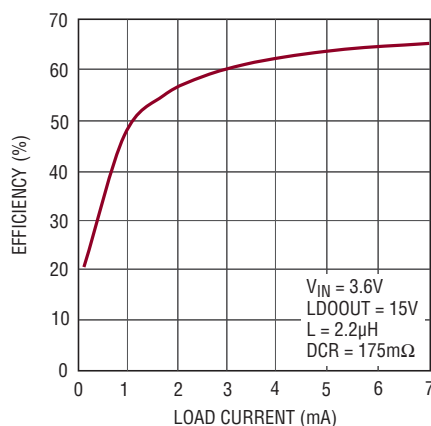
Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The LT3048E-15 is guaranteed to meet performance specifications from 0°C to 125°C junction temperature. Specifications over the -40°C to 125°C operating junction temperature range are assured by design, characterization and correlation with statistical process controls. The LT3048I-15 is guaranteed over the full -40°C to 125°C operating junction temperature range. High junction temperatures degrade operating lifetimes. Operating lifetime is derated at junction temperatures greater than 125°C .

TYPICAL PERFORMANCE CHARACTERISTICS

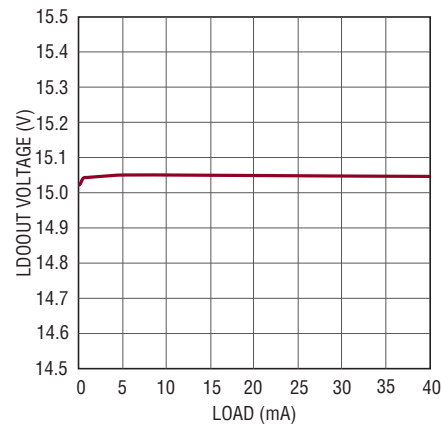
Efficiency (10 μ H)

3048 G01

Efficiency (2.2 μ H)

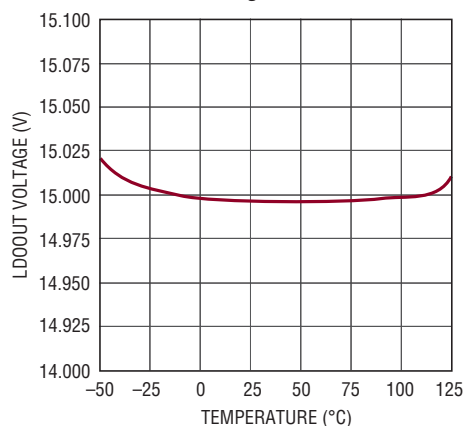
3048 G02

LD00OUT Load Regulation



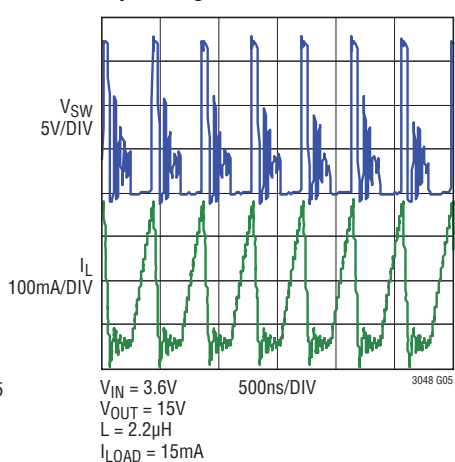
3048 G03

LD00OUT Voltage



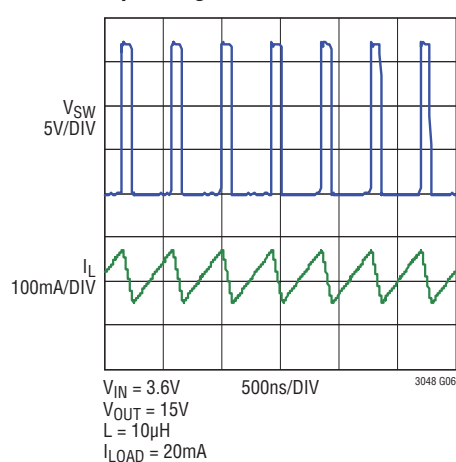
3048 G04

Operating Waveforms: DCM



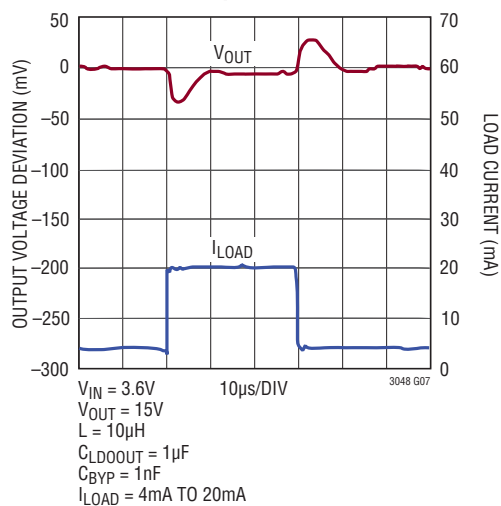
3048 G05

Operating Waveforms: CCM



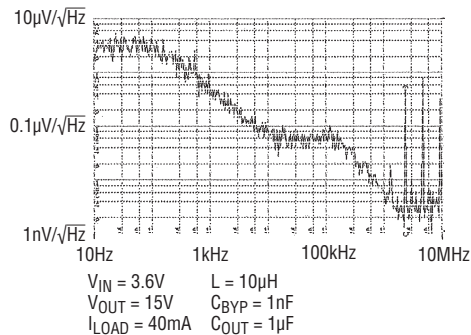
3048 G06

Transient Response

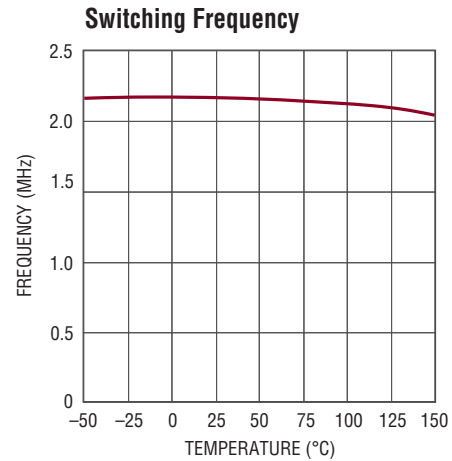
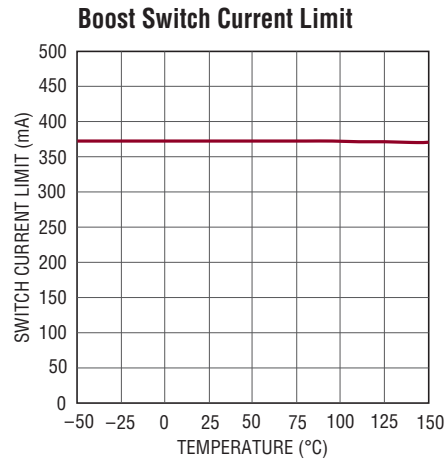
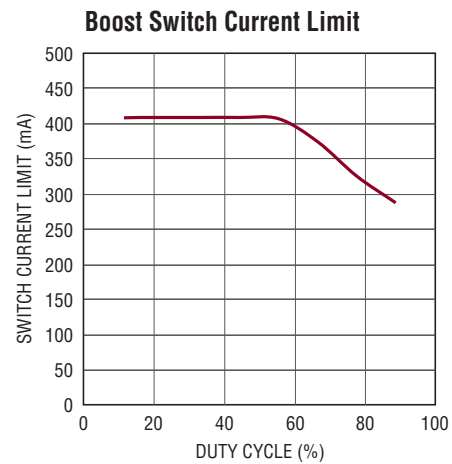
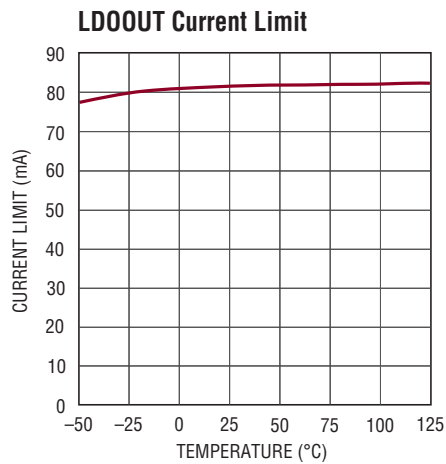


3048 G07

LD00OUT Noise



TYPICAL PERFORMANCE CHARACTERISTICS



PIN FUNCTIONS

SW (Pin 1): Boost Regulator Switch Node. This is the collector of the internal power transistor and the anode of the internal Schottky diode.

V_{IN} (Pin 2): Input Supply. Provides operating current to the boost regulator. Bypass to ground.

GND (Pin 3): Ground. This pin must be soldered to PCB ground. The exposed pad must also be soldered to PCB ground.

BYP (Pin 4): Bypass. Add an optional capacitor from LDOOUT to BYP to reduce noise at LDOOUT; otherwise leave BYP unconnected. A capacitor also soft-starts the linear regulator.

LDOOUT (Pin 5): LDO Linear Regulator Output. This pin is regulated to 15V. Bypass to ground with a minimum of 1 μ F.

LDOIN (Pin 6): LDO Linear Regulator Input. Normally connected to BSTOUT. Bypass to ground.

EN (Pin 7): Enable. Logic input to enable the boost and linear regulator.

BSTOUT (Pin 8): Boost Regulator Output. This pin is connected to the internal Schottky diode and is regulated to 1.1V above LDOOUT. Bypass to ground.

GND (Exposed Pad Pin 9): The internal boost power switch is connected to the exposed pad. Tie to ground.

BLOCK DIAGRAM

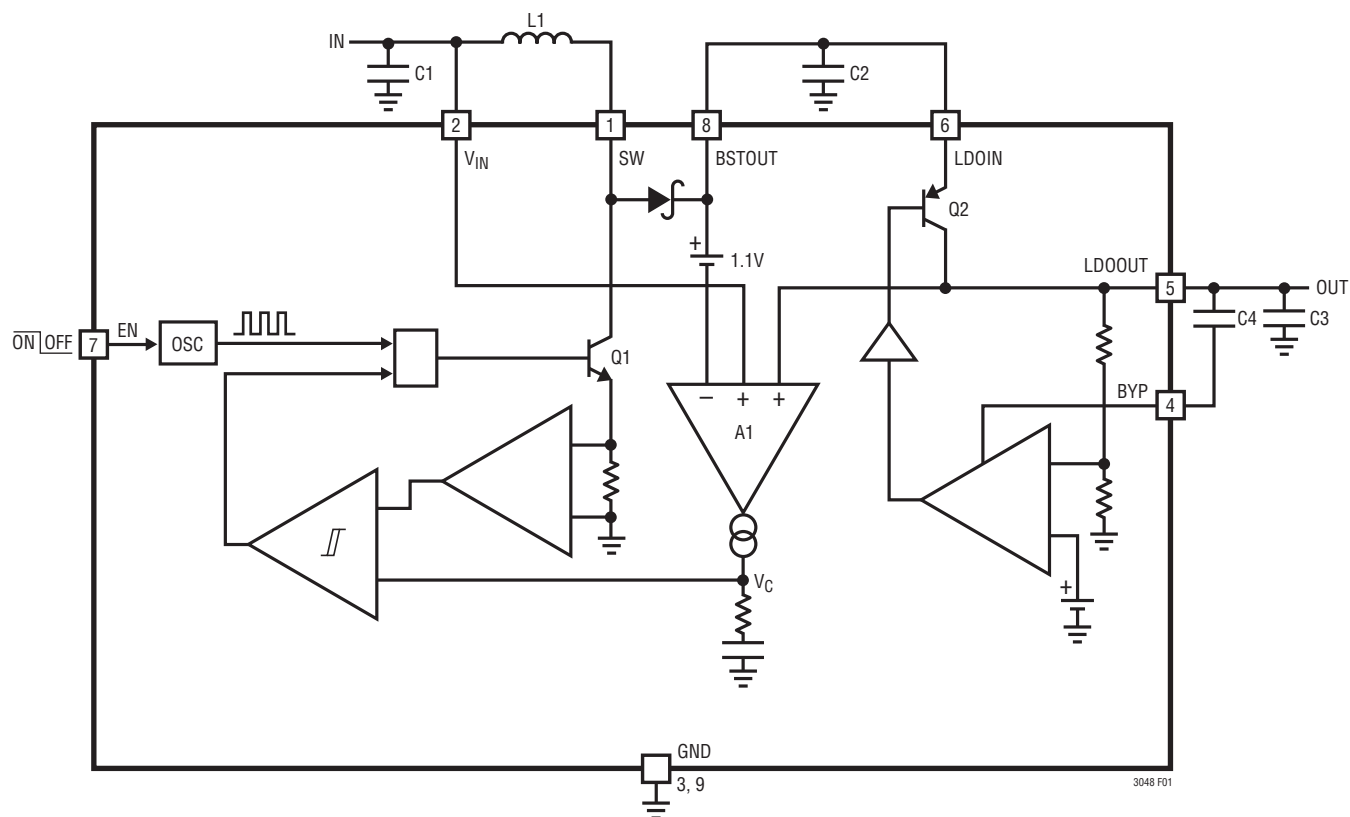


Figure 1. LT3048-15 Block Diagram

OPERATION

The LT3048-15 combines a boost regulator with a low dropout linear regulator to produce a 15V output from a lower input voltage. With EN below 0.4V, all circuits are turned off, Q2 disconnects the load from the input, and current consumption is less than 1 μ A. Driving EN high enables the oscillator and all bias circuits including voltage reference and regulation amplifiers.

The boost regulator uses peak current mode operation, providing cycle-by-cycle current regulation and limiting, fast transient response, and good stability. The error amplifier, A1, regulates BSTOUT (and LDOIN) to 1.1V above LDOOUT or V_{IN} , whichever is higher.

Regulating 1.1V between LDOIN and LDOOUT allows the linear regulator to provide good transient response and ripple rejection, while maintaining good efficiency. This regulation loop also minimizes total power dissipation in fault conditions. If the output is overloaded, the linear regulator will enter current limit, LDOOUT voltage will decrease. By reducing the boost regulator output voltage, the voltage across Q2 will be reduced, limiting dissipation in Q2. Thermal shutdown provides additional protection.

APPLICATIONS INFORMATION

Capacitor Selection

A 4.7 μ F ceramic capacitor should be sufficient for the boost regulator output bypass. Low ESR (equivalent series resistance) ceramic capacitors should be used at the outputs of the regulator to minimize the output ripple voltage. Use only X5R or X7R dielectrics, as these materials retain their capacitance over wider voltage and temperature ranges better than other dielectrics.

Table 1. Ceramic Capacitor Manufacturers

MANUFACTURER	PHONE	WEB
Taiyo Yuden	(408) 573-4150	www.t-yuden.com
AVX	(803) 448-9411	www.avxcorp.com
Murata	(714) 852-2001	www.murata.com

Table 2. Inductor Manufacturers

VENDOR	URL
Coilcraft	www.coilcraft.com
Sumida	www.sumida.com
Toko	www.toko.com
Würth Elektronik	www.we-online.com

Inductor Selection

A 10 μ H inductor will suffice for most LT3048-15 applications, a 2.2 μ H inductor can be used if the load current is below 15mA. The inductor's RMS current rating must be greater than the maximum input current. To keep efficiency high, the DCR (series resistance) should be minimized. Table 2 lists several vendors.

APPLICATIONS INFORMATION

Reducing Output Noise With A Bypass Capacitor

The LT3048-15 relies on the power supply rejection of the linear regulator to reduce switching regulator noise at LDOOUT. The linear regulator also contributes thermal noise to the output. The thermal noise can be reduced, and transient response improved, by adding a capacitor between LDOOUT and BYP. A typical value is 1nF. This capacitor increases start-up time of the regulator.

Recommended PCB Layout

Figure 2 shows the recommended layout for LT3048-15 circuits. Most important is careful placement of the BSTOUT bypass capacitor C2. High frequency AC current flows in a loop formed by C2, internal power transistor Q1 and boost diode D2. Keep this loop small. Also be sure to place an unbroken ground plane below this loop, on the highest copper layer below the surface. This prevents the AC loop from coupling to LDOOUT and other nearby circuitry. Keep the SW node as small as possible.

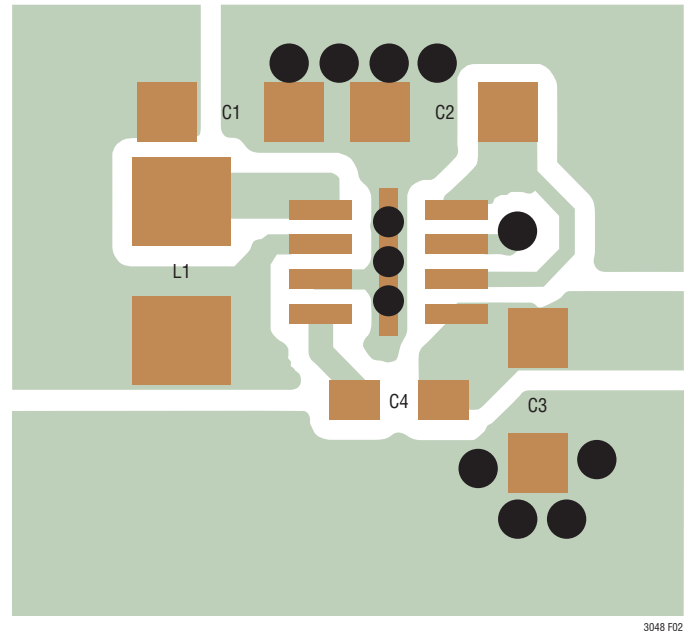


Figure 2. Recommended PCB Layout

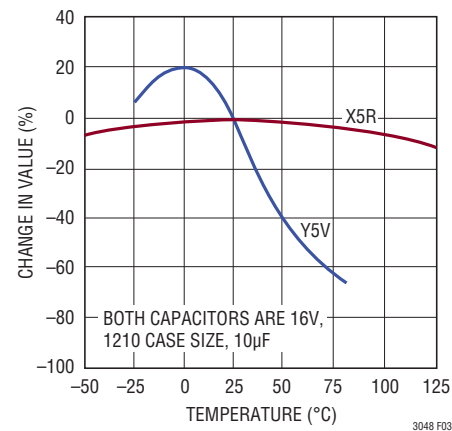


Figure 3. Ceramic Capacitor Temperature Characteristics

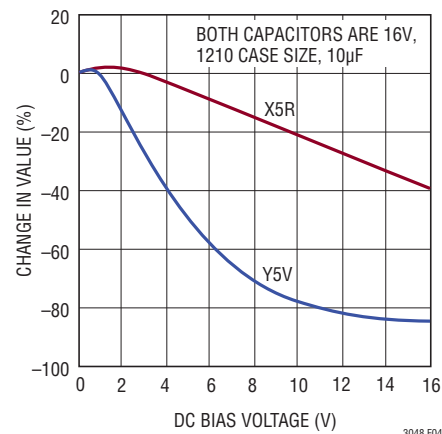


Figure 4. Ceramic Capacitor DC Bias Characteristics

LDO Stability and Output Capacitance

The LT3048-15 linear regulator requires an output capacitor for stability. It is designed to be stable with most low ESR capacitors (typically ceramic, tantalum or low ESR electrolytic). A minimum output capacitor of 1µF with an ESR of 1Ω or less is recommended to prevent oscillations. Larger values of output capacitance decrease peak deviations and provide improved transient response for larger load current changes. Bypass capacitors, used to decouple individual components powered by the LT3048-15, increase the effective output capacitor value.

Give consideration to the use of ceramic capacitors as they are manufactured with a variety of dielectrics, each with different behavior across temperature and applied voltage. The most common dielectrics used are specified with EIA codes of Z5U, Y5V, X5R and X7R. Typical voltage and temperature coefficients are shown in Figures 3 and 4. The X5R and X7R dielectrics have more stable characteristics and are most suitable for use as the output capacitor. The X7R type has better stability across temperature, while the X5R is less expensive and is available in higher values. Care still must be exercised when using X5R and X7R capacitors; the codes only specify operating

APPLICATIONS INFORMATION

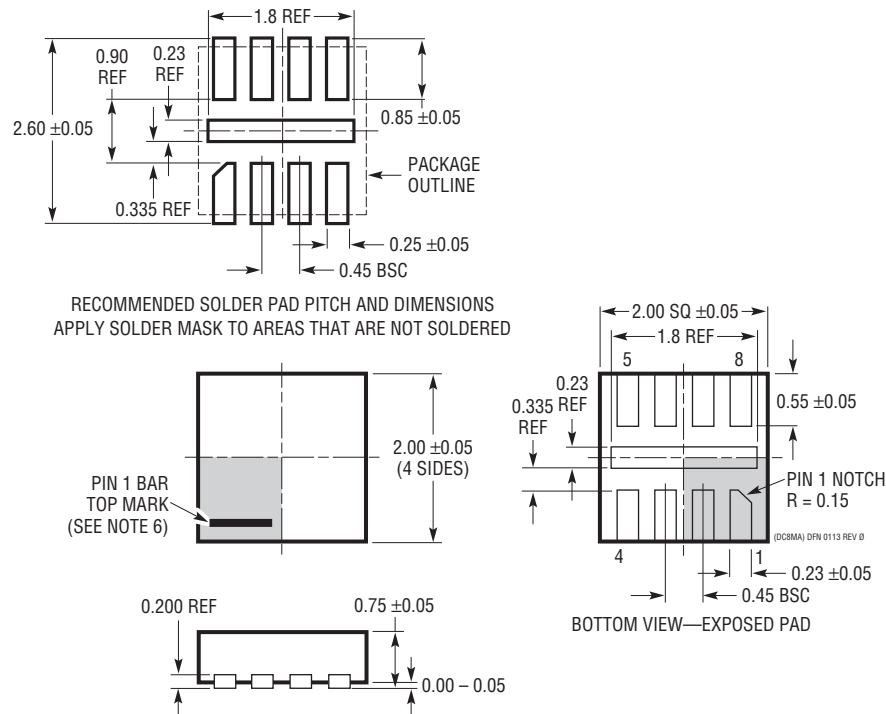
temperature range and maximum capacitance change over temperature. Capacitance change due to DC bias with X5R and X7R capacitors can be significant enough to drop capacitor values below appropriate levels. Capacitor DC bias characteristics tend to improve as case size increases, but expected capacitance at operating voltage should be verified.

Voltage and temperature coefficients are not the only sources of problems. Some ceramic capacitors have a piezoelectric response. A piezoelectric device generates voltage across its terminals due to mechanical stress. In a ceramic capacitor, the stress can be induced by vibrations in the system or thermal transients.

PACKAGE DESCRIPTION

Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

DC8 Package 8-Lead Plastic DFN (2mm × 2mm) (Reference LTC DWG # 05-08-1939 Rev 0) Exposed Pad Variation AA

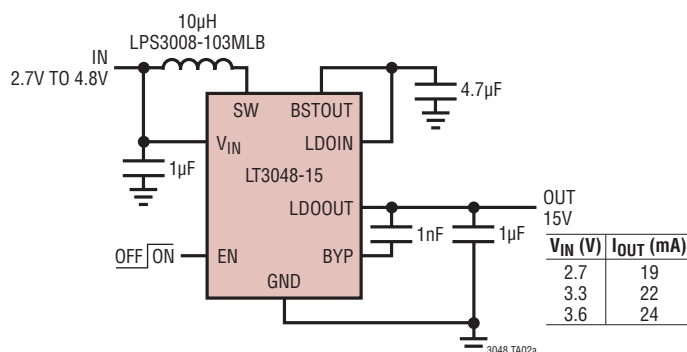


NOTE:

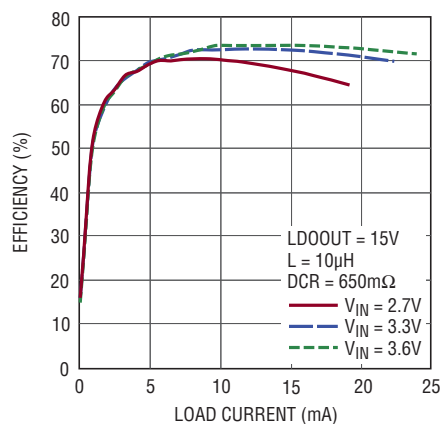
1. DRAWING IS NOT A JEDEC PACKAGE OUTLINE
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY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

TYPICAL APPLICATIONS

High I_{OUT} with 10 μ H Inductor

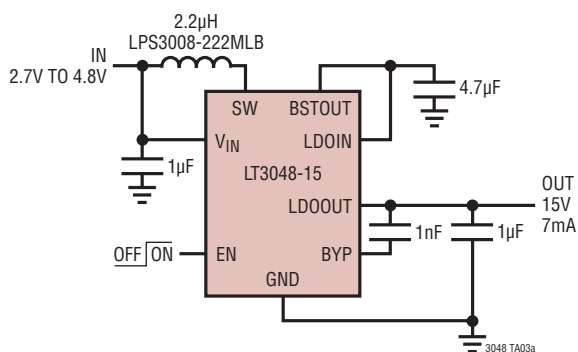


Efficiency

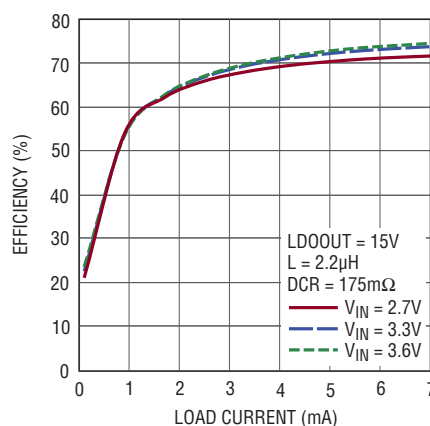


3048 TA02b

Low I_{OUT} with Small 2.2 μ H Inductor



Efficiency (2.2 μ H)



3048 TA03b

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT3460	300mA, 38V I_{SW} , 1.3MHz, High Efficiency Step-Up DC/DC Converter	V_{IN} : 2.5V to 16V, $V_{OUT(MAX)}$ = 38V, I_Q = 2.8mA, I_{SD} < 1 μ A, ThinSOT™ Package
LT3461/LT3461A	300mA, 38V I_{SW} , 1.3MHz, High Efficiency Step-Up DC/DC Converters	V_{IN} : 2.5V to 16V, $V_{OUT(MAX)}$ = 36V, I_Q = 2mA, I_{SD} < 1 μ A, SC70, ThinSOT Packages
LT3464	120mA, 38V I_{SW} , High Efficiency Step-Up DC/DC Converter with Integrated Schottky, Output Disconnect	V_{IN} : 2.3V to 10V, $V_{OUT(MAX)}$ = 34V, I_Q = 25mA, I_{SD} < 1 μ A, ThinSOT Package
LT1613	550mA I_{SW} , 1.4MHz, High Efficiency Step-Up DC/DC Converter	V_{IN} : 0.9V to 10V, $V_{OUT(MAX)}$ = 34V, I_Q = 3mA, I_{SD} < 1 μ A, ThinSOT Package
LT1761	20V, 100mA (I_{OUT}) Low Noise LDO	V_{IN} : 1.8V to 20V, $V_{OUT(MIN)}$ = 1.22V, I_Q = 20 μ A, I_{SD} < 1 μ A, ThinSOT Package
LT3009	20V, 20mA (I_{OUT}) Low Noise LDO	V_{IN} : 1.6V to 20V, $V_{OUT(MIN)}$ = 0.6V, I_Q = 3 μ A, I_{SD} < 1 μ A, SC70, 2mm $\times$ 2mm DFN-6 Packages