LINEAR TECHNOLOGY

LTC3401

1A, 3MHz Micropower Synchronous Boost Converter

September 2000

FEATURES

- **Synchronous Rectification: Up to 97% Efficiency**
- **1A Switch Current Rating**
- **Fixed Frequency Operation Up to 3MHz**
- **Wide Input Range: 0.5V to 5V (Operating)**
- **Very Low Quiescent Current: 38μA (Burst Mode™ Operation)**
- 2.6V to 5V Adjustable Output Voltage
- 0.85V (Typ) Start-Up Voltage
- No External Schottky Diode Required
- Synchronizable Switching Frequency
- Burst Mode Enable Control
- Antiringing Control Reduces Switching Noise
- PGOOD Output
- OPTI-LOOP™ Compensation
- Very Low Shutdown Current: < 1μA
- Small 10-Pin MSOP Package

APPLICATIONS

- Pagers
- Handheld Instruments
- Cordless Phones
- Wireless Handsets
- GPS Receivers
- Battery Backup

DESCRIPTION

The LTC®3401 is a high efficiency, fixed frequency, step-up DC/DC converter that operates from an input voltage below 1V. The device includes a 0.16Ω N-channel MOSFET switch and a 0.18Ω P-channel synchronous rectifier. Switching frequencies up to 3MHz are programmed with an external timing resistor and the oscillator can be synchronized to an external clock. An external Schottky diode is optional but will slightly improve efficiency.

Quiescent current is only 38μA in Burst Mode operation, maximizing battery life in portable applications. Burst Mode operation is user controlled and can be enabled by driving the MODE/SYNC pin high. If the MODE/SYNC pin has either a clock or is driven low, then fixed frequency switching is enabled.

Other features include a 1μA shutdown, antiringing control, open-drain power good output, thermal shutdown and current limit. The LTC3401 is available in the 10-lead thermally enhanced MSOP package. Higher current applications should use the 2A rated LTC3402 synchronous boost converter.

LT, LTC and LT are registered trademarks of Linear Technology Corporation.
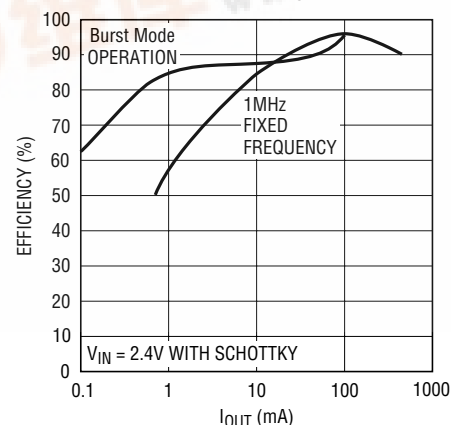*Burst Mode and OPTI-LOOP are trademarks of Linear Technology Corporation.*

TYPICAL APPLICATION
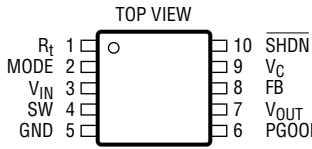
2-Cell to 3.3V at 500mA Step-Up Converter

C1, C2: AVX TPS SERIES
L1: SUMIDA CD43-4R7M
f_{OSC} = 1MHz
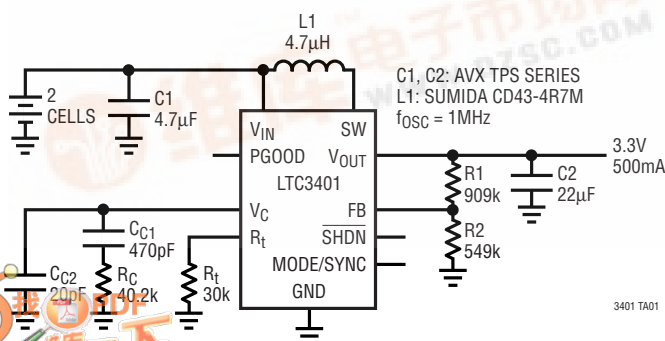
3401 TA01

Efficiency

3401 TA02

LTC3401

ABSOLUTE MAXIMUM RATINGS

(Note 1)

V_{IN}, V_{OUT} Voltages .... −0.5V to 6V
SW Voltage .... −0.5V to 6V
V_C, R_t, FB, MODE,
$\overline{SHDN}$ Voltages .... −0.5V to (V_{OUT} + 0.3V)
PGOOD Voltage .... −0.5V to 6V
Operating Temperature Range (Note 2) .. −40°C to 85°C
Storage Temperature Range .... −65°C to 125°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION

TOP VIEW

```
       ┌─────────┐
Rt   1 │  ○      │ 10  SHDN
MODE 2 │         │ 9   VC
VIN  3 │         │ 8   FB
SW   4 │         │ 7   VOUT
GND  5 │         │ 6   PGOOD
       └─────────┘
```

MS10 PACKAGE
10-LEAD PLASTIC MSOP

T_{JMAX} = 125°C
θ_{JA} = 160°C/W 1 LAYER BOARD
θ_{JA} = 120°C/W 4 LAYER BOARD

ORDER PART NUMBER
LTC3401EMS

MS10 PART MARKING
LTPG

Consult factory for Industrial and Military grade parts.

ELECTRICAL CHARACTERISTICS

The ● denotes specifications that apply over the full operating temperature range, otherwise specifications are at T_A = 25°C.
V_{IN} = 1.2V, V_{OUT} = 3.3V unless otherwise noted.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Minimum Start-Up Voltage	I_{LOAD} < 1mA			0.85	1.0	V
Minimum Operating Voltage	(Note 4)	●			0.5	V
Output Voltage Adjust Range		●	2.6		5	V
Feedback Voltage		●	1.22	1.25	1.28	V
Feedback Input Current	V_{FB} = 1.25V			1	50	nA
Quiescent Current—Burst Mode Operation	V_C = 0V, MODE/SYNC = 3.3V (Note 3)			38	65	μA
Quiescent Current—$\overline{SHDN}$	$\overline{SHDN}$ = 0V, Not Including Switch Leakage			0.1	1	μA
Quiescent Current—Active	V_C = 0V, MODE/SYNC = 0V, R_t = 300k (Note 3)			440	800	μA
NMOS Switch Leakage				0.1	5	μA
PMOS Switch Leakage				0.1	10	μA
NMOS Switch On Resistance				0.16		Ω
PMOS Switch On Resistance				0.18		Ω
NMOS Current Limit		●	1	1.6		A
NMOS Burst Current Limit				0.66		A
Maximum Duty Cycle	R_t = 15k	●	80	85		%
Minimum Duty Cycle		●			0	%
Frequency Accuracy	R_t = 15k	●	1.6	2	2.4	MHz
MODE/SYNC Input High			1.4			V
MODE/SYNC Input Low					0.4	V
MODE/SYNC Input Current	$V_{MODE/SYNC}$ = 5.5V			0.01	1	μA
Error Amp Transconductance	ΔI = −5μA to 5μA, V_C = V_{FB}			85		μmhos
PGOOD Threshold	Referenced to Feedback Voltage		−6	−9	−12	%

ELECTRICAL CHARACTERISTICS

The ● denotes specifications that apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{IN} = 1.2V, V_{OUT} = 3.3V unless otherwise noted.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
PGOOD Low Voltage	I_{PGOOD} = 1mA			0.1	0.2	V
	V_{OUT} = 1V, I_{PGOOD} = 20μA			0.1	0.4	V
PGOOD Leakage	V_{PGOOD} = 5.5V			0.01	1	μA
$\overline{SHDN}$ Input High	$V_{\overline{SHDN}}$ = V_{IN} = V_{OUT}		1			V
$\overline{SHDN}$ Input Low					0.4	V
$\overline{SHDN}$ Input Current	$V_{\overline{SHDN}}$ = 5.5V			0.01	1	μA
Thermal Shutdown				170		°C

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

Note 2: The LTC3401 is guaranteed to meet performance specifications from 0°C to 70°C. Specifications over the –40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

Note 3: Current is measured into the V_{OUT} since the supply current is bootstrapped to the output pin and in the application will reflect to the input supply by (V_{OUT}/V_{IN}) • Efficiency. The outputs are not switching.
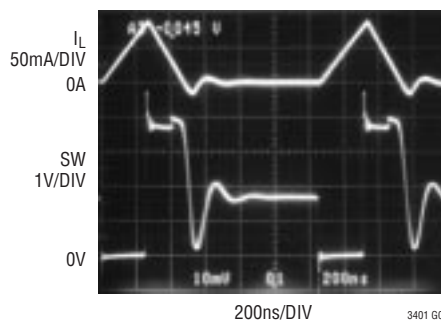
Note 4: Once the output is started, the IC is not dependant upon the V_{IN} supply.
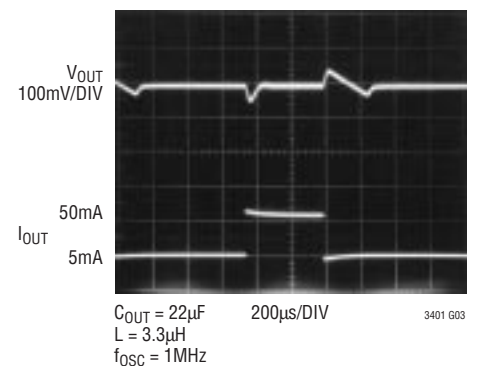
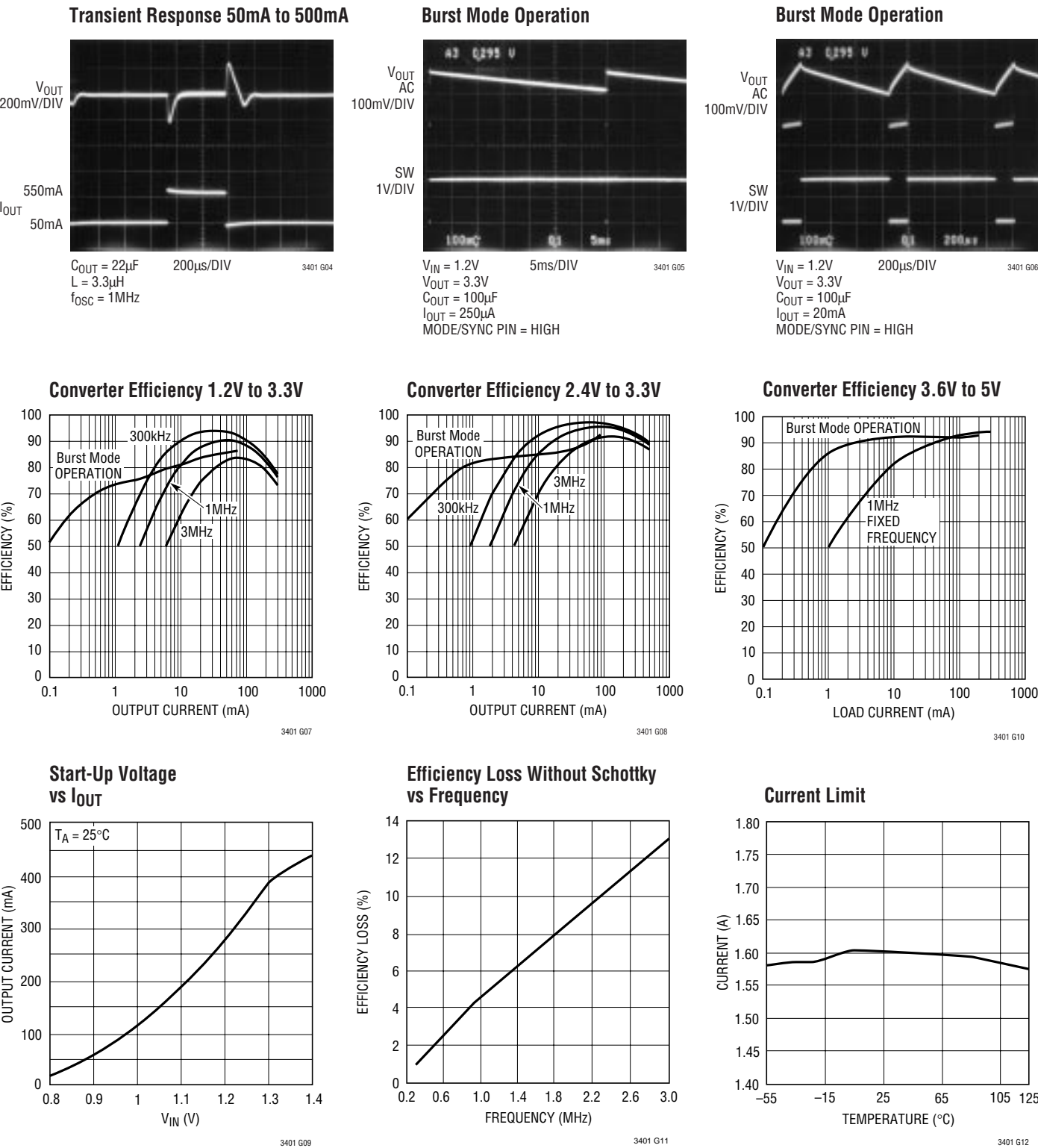# TYPICAL PERFORMANCE CHARACTERISTICS

Switching Waveform on SW Pin

50ns/DIV   3401 G01
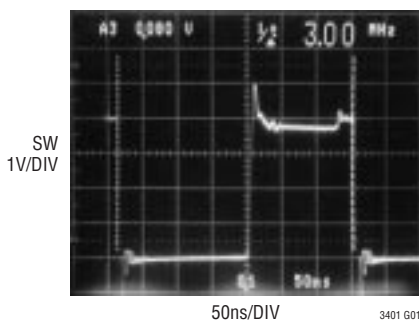
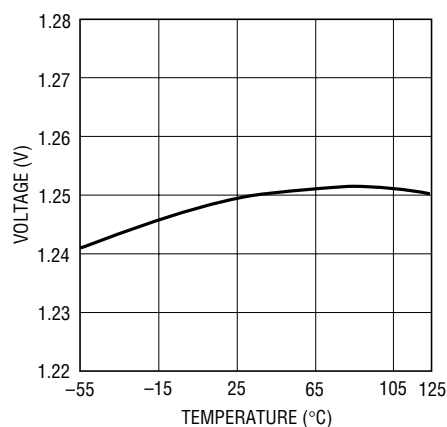**SW Pin and Inductor Current (I_C) in Discontinuous Mode. Ringing Control Circuitry Eliminates High Frequency Ringing**

200ns/DIV   3401 G02

Transient Response 5mA to 50mA

C_{OUT} = 22μF   200μs/DIV   3401 G03
L = 3.3μH
f_{OSC} = 1MHz

LTC3401

TYPICAL PERFORMANCE CHARACTERISTICS

Transient Response 50mA to 500mA

C_{OUT} = 22μF
L = 3.3μH
f_{OSC} = 1MHz

3401 G04

Burst Mode Operation

V_{IN} = 1.2V
V_{OUT} = 3.3V
C_{OUT} = 100μF
I_{OUT} = 250μA
MODE/SYNC PIN = HIGH

3401 G05

Burst Mode Operation

V_{IN} = 1.2V
V_{OUT} = 3.3V
C_{OUT} = 100μF
I_{OUT} = 20mA
MODE/SYNC PIN = HIGH

3401 G06

Converter Efficiency 1.2V to 3.3V

3401 G07

Converter Efficiency 2.4V to 3.3V

3401 G08

Converter Efficiency 3.6V to 5V

3401 G10

Start-Up Voltage vs I_{OUT}

3401 G09

Efficiency Loss Without Schottky vs Frequency
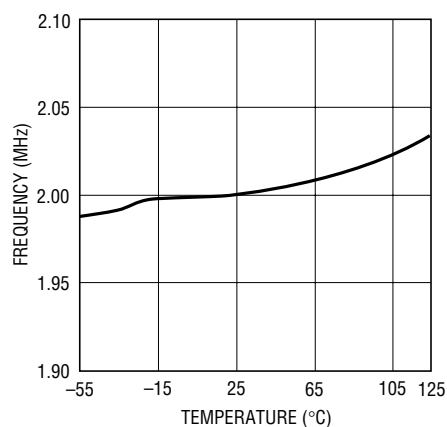

3401 G11

Current Limit

3401 G12

TYPICAL PERFORMANCE CHARACTERISTICS

EA FB Voltage

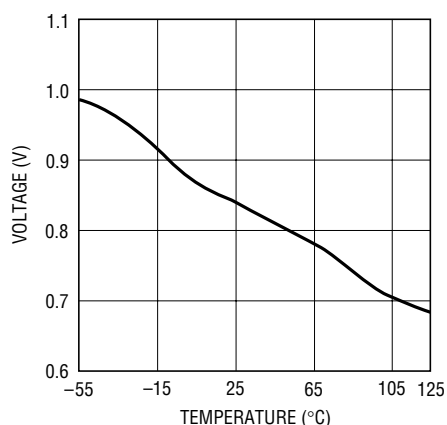3401 G13

Oscillator Frequency Accuracy

3401 G14

NMOS $R_{DS(ON)}$

$V_{OUT} = 3.3V$
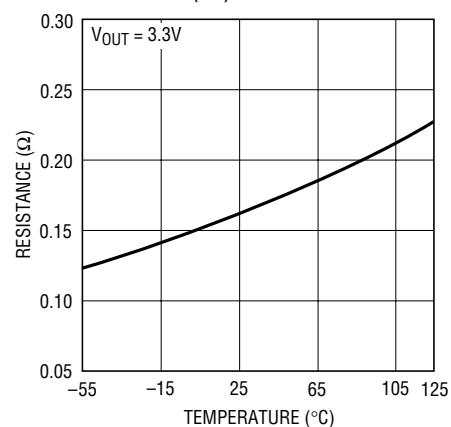
3401 G22

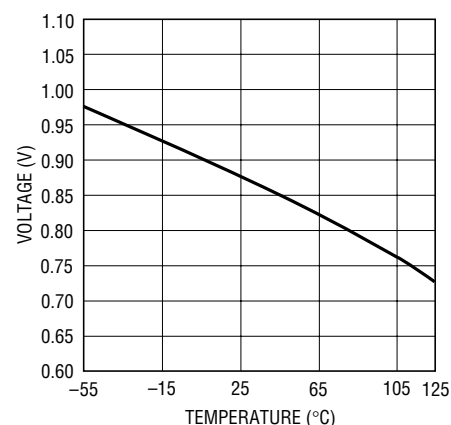**PMOS $R_{DS(ON)}$**

$V_{OUT} = 3.3V$
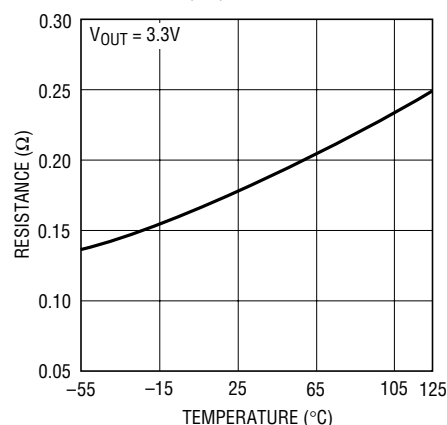
3401 G16

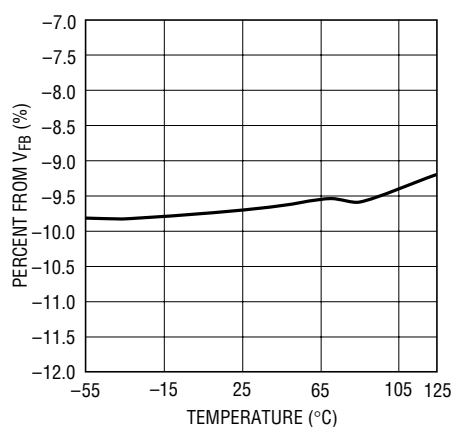**Start-Up Voltage**

3401 G17

Shutdown Threshold
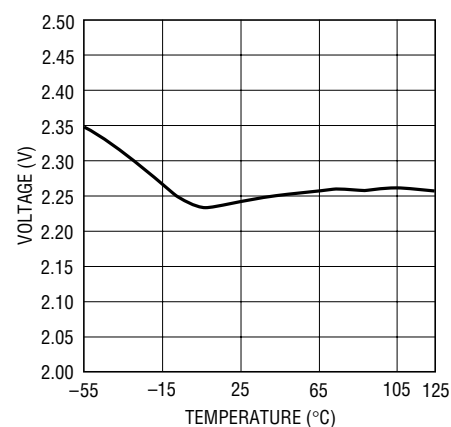

3401 G18

PGOOD Threshold

3401 G19

Burst Mode Operation Current
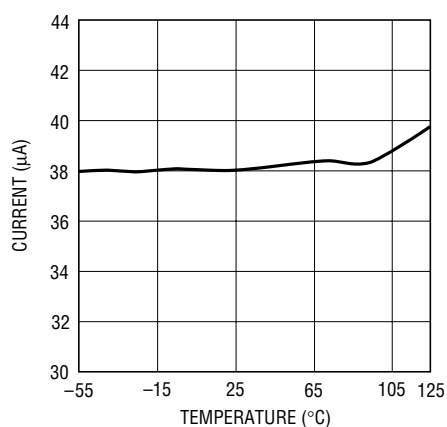
3401 G20

V_{OUT} Turn-Off Voltage

3401 G21

LTC3401

PIN FUNCTIONS

R$_t$ (Pin 1): Timing Resistor to Program the Oscillator Frequency.

$$f_{OSC} = \frac{3 \cdot 10^{10}}{R_t} \, Hz$$

MODE/SYNC (Pin 2): Burst Mode Select and Oscillator Synchronization.

MODE/SYNC = High. Enable Burst Mode operation. The inductor peak inductor current will be 1/3 the current limit value and return to zero current on each cycle. During Burst Mode operation the operation is variable frequency, providing a significant efficiency improvement at light loads. It is recommended the Burst Mode operation only be entered once the part has started up.

MODE/SYNC = Low. Disable Burst Mode operation and maintain low noise, constant frequency operation.

MODE/SYNC = External CLK. Synchronization of the internal oscillator and Burst Mode operation disable. A clock pulse width of 100ns to 2µs is required to synchronize.

V$_{IN}$ (Pin 3): Input Supply Pin.

SW (Pin 4): Switch Pin. Connect inductor and optional Schottky diode here. Minimize trace length to keep EMI and high ringing down. For discontinuous inductor current, a controlled impedance is placed from SW to V$_{IN}$ from the IC to eliminate high frequency ringing due to the resonant tank of the inductor and SW node capacitance, therefore reducing EMI radiation.

GND (Pin 5): Signal and Power Ground for the IC.

PGOOD (Pin 6): Power Good Comparator Output. This open-drain output is low when V$_{FB}$ < −9% from its regulation voltage.

V$_{OUT}$ (Pin 7): Output of the Synchronous Rectifier and Bootstrapped Power Source for the IC.

FB (Pin 8): Feedback Pin. Connect resistor divider tap here. The output voltage can be adjusted from 2.6V to 5V. The feedback reference voltage is typically 1.25V.

V$_C$ (Pin 9): Error Amp Output. A frequency compensation network is connected to this pin to compensate the loop. See the section "Compensating the Feedback Loop" for guidelines.

$\overline{SHDN}$ (Pin 10): Shutdown. Grounding this pin shuts down the IC. Tie to >1V to enable. A 1MΩ to V$_{IN}$ is sufficient. An additional resistor to V$_{OUT}$ (5MΩ) will allow the IC to operate lower once started.

BLOCK DIAGRAM

3401 BD
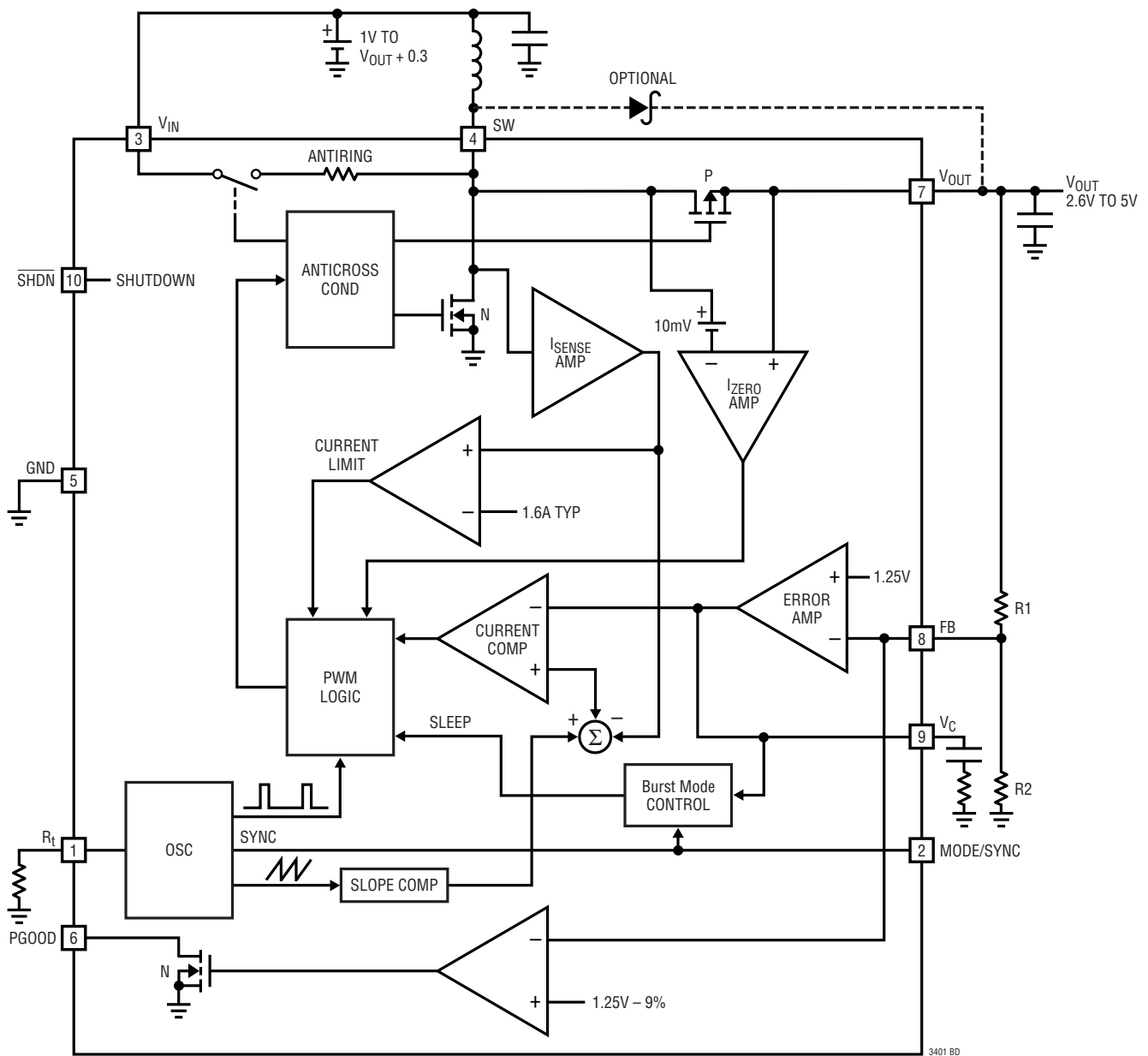
APPLICATIONS INFORMATION

DETAILED DESCRIPTION

The LTC3401 provides high efficiency, low noise power for applications such as portable instrumentation. The current mode architecture with adaptive slope compensation provides ease of loop compensation with excellent transient load response. The low $R_{DS(ON)}$, low gate charge synchronous switches provide the pulse width modulation control at high efficiency.

The Schottky diode across the synchronous PMOS switch is not required, but provides a lower drop during the break-before-make time (typically 20ns) of the NMOS to PMOS transition. The addition of the Schottky diode will improve peak efficiency by typically 1% to 2%. While the IC's quiescent current is a low 38μA, high efficiency is achieved at light loads when Burst Mode operation is entered.

Low Voltage Start-Up

The LTC3401 is designed to start up at input voltages of typically 0.85V. The device can start up under some load, (see graph Start-Up vs Input Voltage). Once the output voltage exceeds a threshold of 2.3V, then the IC powers itself from V_{OUT} instead of V_{IN}. At this point, the internal circuitry has no dependency on the V_{IN} input voltage, eliminating the requirement for a large input capacitor. The input voltage can drop below 0.5V without affecting the operation, but the limiting factor for the application becomes the availability of the power source to supply sufficient energy to the output at the low voltages.

Low Noise Fixed Frequency Operation

Oscillator. The frequency of operation is set through a resistor from the R_t pin to ground where $f = 3 \cdot 10^{10}/R_t$. An internally trimmed timing capacitor resides inside the IC. The oscillator can be synchronized with an external clock inserted on the MODE/SYNC pin. When synchronizing the oscillator, the free running frequency must be set to approximately 30% lower than the desired synchronized frequency. Keeping the sync pulse width below 2μs will ensure that Burst Mode operation is disabled.

Current Sensing. Lossless current sensing converts the peak current signal to a voltage to sum in with the internal slope compensation. This summed signal is compared to the error amplifier output to provide a peak current control command for the PWM. The slope compensation in the IC is adaptive to the input and output voltage. Therefore, the converter provides the proper amount of slope compensation to ensure stability and not an excess causing a loss of phase margin in the converter.

Error Amp. The error amplifier is a transconductance amplifier with $g_m = 0.1$ms. A simple compensation network is placed from the V_C pin to ground.

Current Limit. The current limit amplifier will shut the NMOS switch off once the current exceeds its threshold. The current amplifier delay to output is typically 50ns.

Zero Current Amp. The zero current amplifier monitors the inductor current to the output and shuts off the synchronous rectifier once the current is below 50mA, preventing negative inductor current.

Antiringing Control. The anitringing control will place an impedance across the inductor to damp the ringing on the SW pin during discontinuous mode operation. The LC_{SW} ringing (L = inductor, C_{SW} = capacitance on the switch pin) is low energy, but can cause EMI radiation.

Burst Mode Operation

Burst Mode operation is when the IC delivers energy to the output until it is regulated and then goes into a sleep mode where the outputs are off and the IC is consuming only 38μA. In this mode, the output ripple has a variable frequency component with load current and the steady state ripple will be typically below 3%.

During the period where the device is delivering energy to the output, the peak current will be equal to 1/3 the current limit value and the inductor current will terminate at zero current for each cycle. In this mode the maximum output current is given by:

$$I_{OUT(MAXBURST)} \approx \frac{V_{IN}}{6 \cdot V_{OUT}} \text{ Amps}$$

Burst Mode operation is user controlled by driving the MODE/SYNC pin high to enable and low to disable. It is recommended that Burst Mode operation be entered after the part has started up.

APPLICATIONS INFORMATION

COMPONENT SELECTION

Inductor Selection

The high frequency operation of the LTC3401 allows the use of small surface mount inductors. The minimum inductance value is proportional to the operating frequency and is limited by the following constraints:

$$L > \frac{3}{f}\mu H \text{ and } L > \frac{V_{IN(MIN)} \bullet \left(V_{OUT(MAX)} - V_{IN(MIN)}\right)}{f \bullet Ripple \bullet V_{OUT(MAX)}}H$$

where

f = Operating Frequency (Hz)

Ripple = Allowable Inductor Current Ripple (A)

$V_{IN(MIN)}$ = Minimum Input Voltage (V)

$V_{OUT(MAX)}$ = Maximum Output Voltage (V)

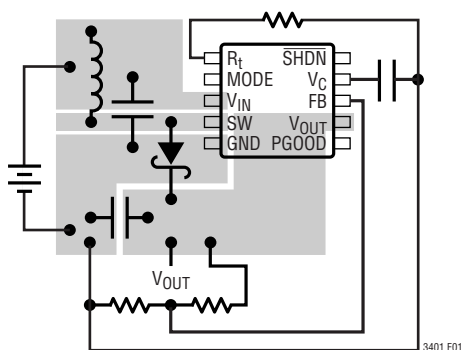The inductor current ripple is typically set to 20% to 40% of the maximum inductor current.

Figure 1. Recommended Component Placement. Traces Carrying High Current Are Direct. Trace Area FB and V_C Pins Are Kept Low. Lead Length to Battery Should be Kept Short

For high efficiency, choose an inductor with a high frequency core material, such as ferrite, to reduce core losses. The inductor should have low ESR (equivalent series resistance) to reduce the I^2R losses and must be able to handle the peak inductor current at full load without saturating. Molded chokes or chip inductors usually do not have enough core to support the peak inductor currents in the 1A to 2A region. To minimize radiated noise, use a toroid, pot core or shielded bobbin inductor. See Table 1 for a list of component suppliers.

Output Capacitor Selection

The output voltage ripple has three components. The bulk value of the capacitor is set to reduce the ripple due to charge into the capacitor each cycle. The max ripple due to charge is given by:

$$VR_{BULK} = \frac{I_P \bullet V_{IN}}{C_{OUT} \bullet V_{OUT} \bullet f}V$$

where

I_P = Peak Inductor Current

The ESR is usually the most dominant factor for ripple in most power converters. The ripple due to capacitor ESR is simply given by:

$$VR_{CESR} = I_P \bullet R_{ESR} V$$

where

R_{ESR} = Capacitor Series Resistance

Low ESR capacitors should be used to minimize output voltage ripple. For surface mount applications, AVX TPS series tantalum capacitors and Sanyo POSCAP or Taiyo-Yuden ceramic capacitors are recommended. For through-hole applications Sanyo OS-CON capacitors offer low ESR in a small package size.

Table 1. Inductor Vendor Information

SUPPLIER	PHONE	FAX	WEBSITE
Coilcraft	(847) 639-6400	(847) 639-1469	www.coilcraft.com
Coiltronics	(516) 241-7876	(516) 241-9339	www.coiltronics.com
Murata	(814) 237-1431 (800) 831-9172	(814) 238-0490	www.murata.com
Sumida	USA: (847) 956-0666 Japan: 81-3-3607-5111	(847) 956-0702 81-3-3607-5144	www.japanlink.com sumida

APPLICATIONS INFORMATION

In some layouts it may be required to place a 1µF low ESR capacitor as close to the V_{OUT} and GND pins as possible.

Input Capacitor Selection

The input filter capacitor reduces peak currents drawn from the input source and reduces input switching noise. Since the IC can operate at voltages below 0.5V once the output is regulated, then demand on the input capacitor is much less and in most applications a 3.3µF is recommended.

Output Diode

The Schottky diode across the synchronous PMOS switch is not required, but provides a lower drop during the break-before-make time (typically 20ns) of the NMOS to PMOS transition. The addition of the Schottky diode will improve peak efficiency (see graph "Efficiency Loss Without Schottky vs Frequency"). Use of a Schottky diode such as a MBR0520L, 1N5817 or equivalent. Since slow recovery times will compromise efficiency, do not use ordinary rectifier diodes.

Operating Frequency Selection

There are several considerations in selecting the operating frequency of the converter. The first is determining the sensitive frequency bands that cannot tolerate any spectral noise. For example, in products incorporating RF communications, the 455kHz IF frequency is sensitive to any noise, therefore switching above 600kHz is desired. Some communications have sensitivity to 1.1MHz. In this case, a 2MHz or 3MHz converter frequency may be employed.

The second consideration is the physical size of the converter. As the operating frequency goes up, the inductor and filter caps go down in value and size. The trade off is in efficiency since the switching losses due to gate charge are going up proportional with frequency. For example in Figure 2, for a 2.4V to 3.3V converter, the efficiency at 100mA is 5% less at 2MHz compared to 300kHz.

Another operating frequency consideration is whether the application can allow "pulse skipping." In this mode, the minimum on time of the converter cannot support the duty cycle, so the converter ripple will go up and there will be a low frequency component of the output ripple. In many applications where physical size is the main criterion then running the converter in this mode is acceptable. In applications where it is preferred not to enter this mode, then the maximum operating frequency is given by:

$$f_{MAX\_NOSKIP} = \frac{V_{OUT} - V_{IN}}{V_{OUT} \bullet t_{ON(MIN)}} \, Hz$$
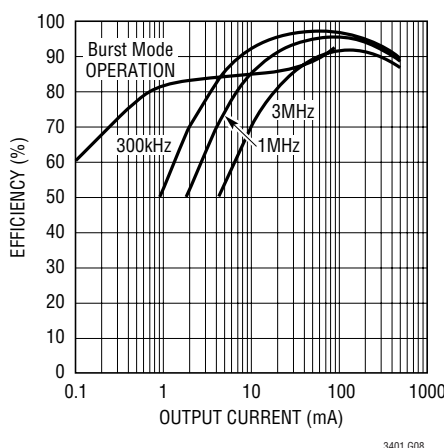
where $t_{ON(MIN)}$ = minimum on time = 120ns

Figure 2. Converter Efficiency 2.4V to 3.3V

APPLICATIONS INFORMATION

Closing the Feedback Loop

The LTC3401 uses current mode control with internal adaptive slope compensation. Current mode control eliminates the 2nd order filter due to the inductor and output capacitor exhibited in voltage mode controllers, and simplifies it to a single-pole filter response. The product of the modulator control to output DC gain plus the error amp open-loop gain equals the DC gain of the system.

$$G_{DC} = G_{CONTROLOUTPUT} \bullet G_{EA}$$

$$G_{CONTROL} = \frac{2 \bullet V_{IN}}{I_{OUT}}, \quad G_{EA} \approx 2000$$

The output filter pole is given by:

$$f_{FILTERPOLE} = \frac{I_{OUT}}{\pi \bullet V_{OUT} \bullet C_{OUT}} Hz$$

where C_{OUT} is the output filter capacitor.

The output filter zero is given by:

$$f_{FILTERZERO} = \frac{1}{2 \bullet \pi \bullet R_{ESR} \bullet C_{OUT}} Hz$$

where R_{ESR} is the capacitor equivalent series resistance.

A troublesome feature of the boost regulator topology is the right half plane zero (RHP) and is given by:

$$f_{RHPZ} = \frac{V_{IN}^2 R_O}{2\pi L V_O^2} Hz$$

At heavy loads this gain increase with phase lag can occur at a relatively low frequency. The loop gain is typically rolled off before the RHP zero frequency.

The typical error amp compensation is shown in Figure 3. The equations for the loop dynamics are as follows:

$$f_{POLE1} \approx \frac{1}{2 \bullet \pi \bullet 20 \bullet 10^6 \bullet C_{C1}} Hz$$

which is extremely close to DC

$$f_{ZERO1} = \frac{1}{2 \bullet \pi \bullet R_Z \bullet C_{C1}} Hz$$

$$f_{POLE2} \approx \frac{1}{2 \bullet \pi \bullet R_Z \bullet C_{C2}} Hz$$
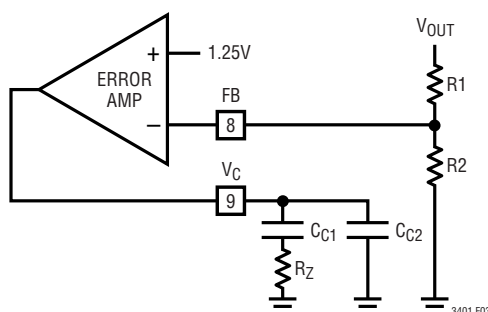
Figure 3

TYPICAL APPLICATIONS

Single Cell to 3V at 50mA, 3MHz Step-Up Converter

C1, C2: AVX TPS SERIES
D1: CENTRAL SEMICONDUCTOR CMDSH2-3
L1: TAIYO YUDEN LB2016

L1 2.2µH
D1

1 CELL
C1 3.3µF

V_{IN}
PGOOD
V_C
R_t

LTC3401

SW
V_{OUT}
FB
$\overline{SHDN}$
MODE/SYNC
GND

V_{OUT} 3V 50mA

R1 870k
C2 4.7µF
R2 620k

C_{C1} 470pF
C_{C2} 20pF
R_C 40k
R_t 10k

3401 TA03a

Efficiency

EFFICIENCY (%) vs OUTPUT CURRENT (mA)

Burst Mode OPERATION

FIXED FREQUENCY

3401 TA03b
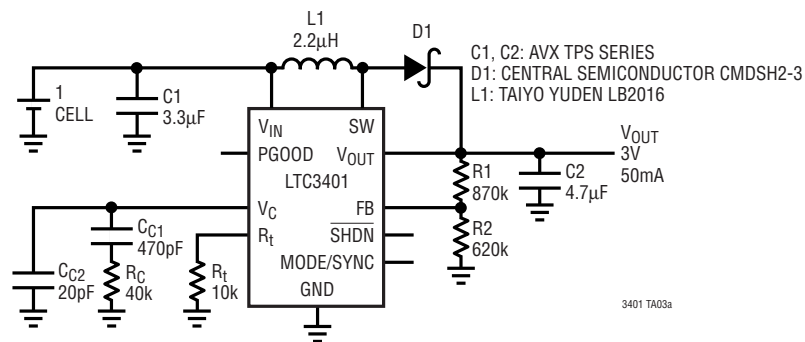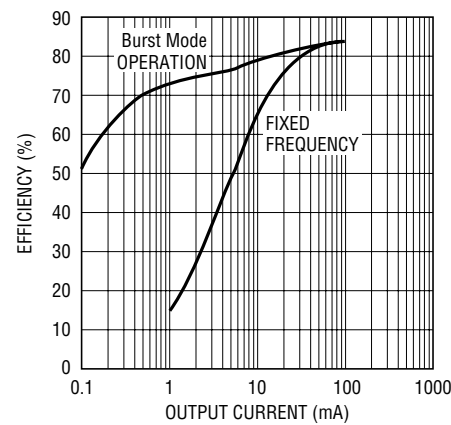
TYPICAL APPLICATIONS

Single Cell to 3V at 100mA, 600kHz Step-Up Converter

C1, C2: AVX TPS SERIES
D1: MOTOROLA MBR0520L
L1: COILCRAFT DO3316P-103

L1 10µH
D1

1 CELL
C1 3.3µF

V_IN   SW
PGOOD   V_OUT
        LTC3401
V_C   FB
R_t   SHDN
        MODE/SYNC
        GND

V_OUT 3V 200mA

R1 870k
C2 22µF
R2 620k

C_C1 3000pF
C_C2 100pF
R_C 40k
R_t 50k

3401 TA04a

Efficiency

EFFICIENCY (%)

Burst Mode OPERATION

1MHz FIXED FREQUENCY

LOAD CURRENT (mA)

3401 TA04b

LTC3401
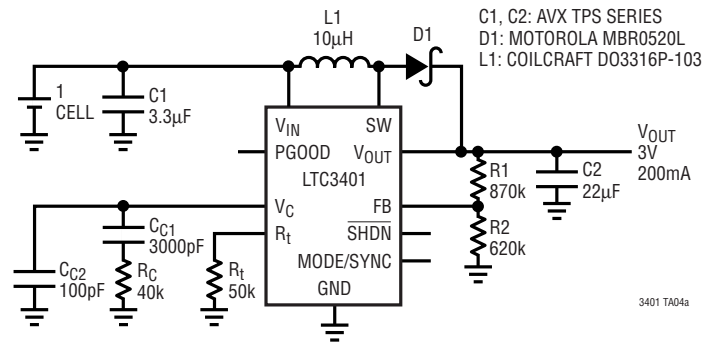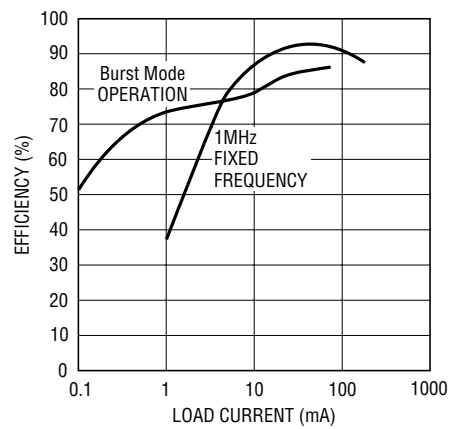
TYPICAL APPLICATIONS

Li-Ion to 5V at 300mA, 1MHz Step-Up Converter

C1, C2: AVX TPS SERIES
D1: MOTOROLA MBR0520L
L1: COILCRAFT DO3316P-103

L1
10µH

D1

2.5V
TO 4.2V

C1
4.7µF

V_{IN} SW

PGOOD V_{OUT}

LTC3401

V_C FB

R_t $\overline{SHDN}$

MODE/SYNC

GND

C_{C1}
630pF

C_{C2}
20pF

R_C
40k

R_t
30k

R1
1.85M

R2
620k

V_{OUT}
5V
300mA

C2
22µF

3401 TA05a

Efficiency

EFFICIENCY (%)

Burst Mode OPERATION

1MHz
FIXED
FREQUENCY

100
90
80
70
60
50
40
30
20
10
0
0.1   1   10   100   1000

LOAD CURRENT (mA)

3401 G10
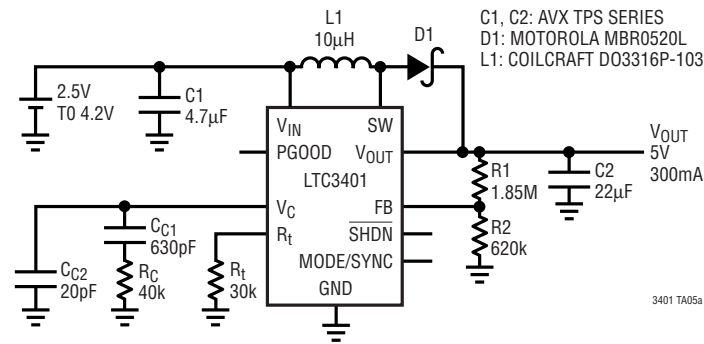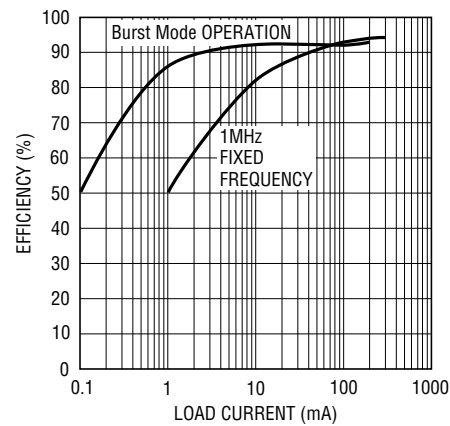
PACKAGE DESCRIPTION
Dimensions in inches (millimeters) unless otherwise noted.

MS10 Package
10-Lead Plastic MSOP
(LTC DWG # 05-08-1661)
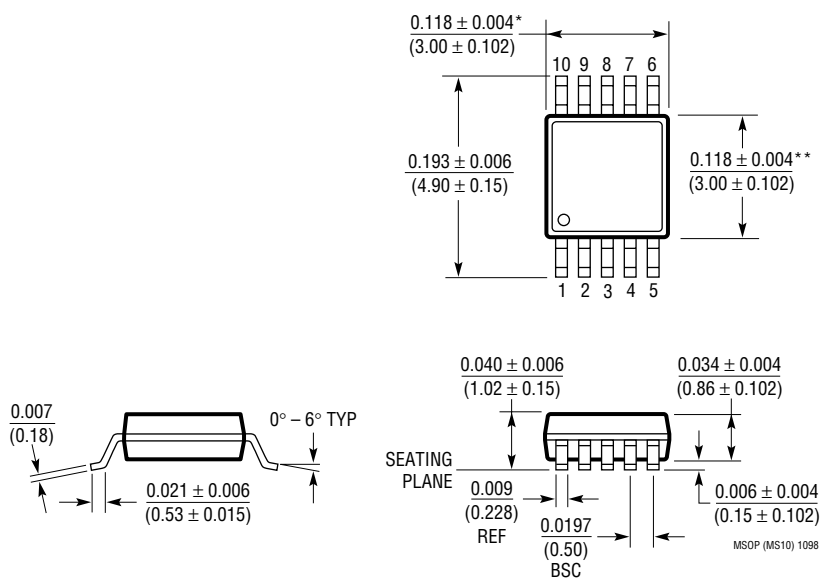
0.118 ± 0.004*
(3.00 ± 0.102)

10 9 8 7 6

0.193 ± 0.006
(4.90 ± 0.15)

0.118 ± 0.004**
(3.00 ± 0.102)

1 2 3 4 5

0.007
(0.18)

0° – 6° TYP

0.021 ± 0.006
(0.53 ± 0.015)

0.040 ± 0.006
(1.02 ± 0.15)

0.034 ± 0.004
(0.86 ± 0.102)

SEATING
PLANE

0.009
(0.228)
REF

0.0197
(0.50)
BSC

0.006 ± 0.004
(0.15 ± 0.102)

MSOP (MS10) 1098

* DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH,
PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

** DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

LTC3401

TYPICAL APPLICATION

Triple Output Converter

C1, C2: AVX TPS SERIES
D1: MOTOROLA MBR0520L
D2 TO D7: ZETEX FMND7000 DUAL DIODE

3401 TA06

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1306	Sync, Fixed Frequency, Step-Up DC/DC Converter	Internal 2A Switches, V_{IN} As Low As 1.8V
LT1308A/LT1308B	High Current, Micropower, Single Cell 600kHz DC/DC Converter	5V at 1A from Single Li-Ion Cell
LT1317/LT1317B	Micropower 600kHz PWM DC/DC Converter	V_{IN} As Low As 1.5V, I_Q = 100µA
LT1610	1.7MHz, Single Cell Micropower DC/DC Converter	3V at 30mA from 1V, 5V at 200mA from 3.3V
LT1613	1.4MHz, Single Cell DC/DC Converter in SOT-23	V_{IN} As Low As 1.1V, 3V at 30mA from Single Cell
LT1615	Micropower Step-Up DC/DC Converter in SOT-23	I_Q = 20µA, 1µA Shutdown Current, V_{IN} As Low As 1V
LT1949	600kHz, 1A Switch PWM DC/DC Converter	1.1A, 0.5Ω/30V Internal Switch, V_{IN} As Low As 1.8V
LT3402	Single Cell, High Current (2A) Micropower, Synchronous 3MHz Step-Up DC/DC Converter	V_{IN} = 0.7V to 5V, Up to 95% Efficiency Synchronizable Oscillator from 100kHz to 3MHz