LTC1871-7

High Input Voltage, Current Mode Boost, Flyback and SEPIC Controller

July 2002

FEATURES

- **Optimized for High Input Voltage Applications**
- **Wide Chip Supply Voltage Range: 6V to 36V**
- **Internal 7V Low Dropout Voltage Regulator Optimized for 6V-Rated MOSFETs**
- **Current Mode Control Provides Excellent Transient Response**
- **High Maximum Duty Cycle (92% Typ)**
- **±2% RUN Pin Threshold with 100mV Hysteresis**
- **±1% Internal Voltage Reference**
- Micropower Shutdown: I_Q = 10µA
- Programmable Operating Frequency (50kHz to 1MHz) with One External Resistor
- Synchronizable to an External Clock Up to 1.3 × f_{OSC}
- User-Controlled Pulse Skip or Burst Mode® Operation
- Output Overvoltage Protection
- Can be Used in a No R_{SENSE}™ Mode for V_{DS} < 36V
- Small 10-Lead MSOP Package

APPLICATIONS

- Telecom Power Supplies
- 42V Automotive Systems
- 24V Industrial Controls
- IP Phone Power Supplies

DESCRIPTION

The LTC®1871-7 is a current mode, boost, flyback and SEPIC controller optimized for driving 6V-rated MOSFETs in high voltage applications. The LTC1871-7 works equally well in low or high power applications and requires few components to provide a complete power supply solution. The switching frequency can be set with an external resistor over a 50kHz to 1MHz range, and can be synchronized to an external clock using the MODE/SYNC pin. Burst Mode operation at light loads, a low minimum operating supply voltage of 6V and a low shutdown quiescent current of 10µA make the LTC1871-7 well suited for battery-operated systems. For applications requiring constant frequency operation, Burst Mode operation can be defeated using the MODE/SYNC pin. The LTC1871-7 is available in the 10-lead MSOP package.

PARAMETER	LTC1871-7	LTC1871
$INTV_{CC}$	7.0V	5.2V
$INTV_{CC}$ UV^+	5.6V	2.1V
$INTV_{CC}$ UV^-	4.6V	1.9V

TYPICAL APPLICATION

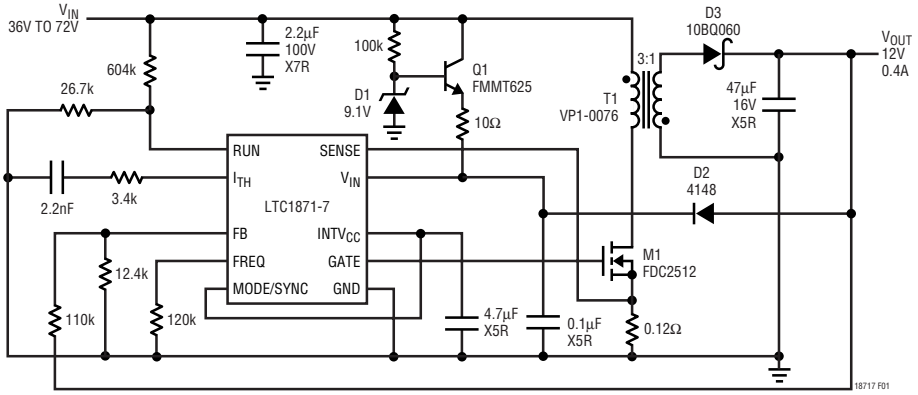


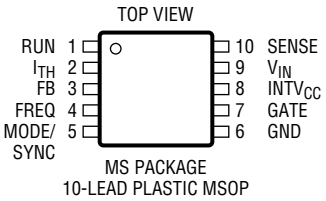
Figure 1. Small, Nonisolated 12V Flyback Telecom Housekeeping Supply

ABSOLUTE MAXIMUM RATINGS

(Note 1)

V_{IN} Voltage ..... –0.3V to 36V
$INTV_{CC}$ Voltage ..... –0.3V to 9V
$INTV_{CC}$ Output Current 50mA
GATE Voltage ..... –0.3V to V_{INTVCC} + 0.3V
I_{TH}, FB Voltages ..... –0.3V to 2.7V
RUN Voltage ..... –0.3V to 7V
MODE/SYNC Voltage .....–0.3V to 9V
FREQ Voltage .....–0.3V to 1.5V
SENSE Pin Voltage ..... –0.3V to 36V
Operating Temperature Range (Note 2) .. –40°C to 85°C
Junction Temperature (Note 3)..... 125°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec).....300°C

PACKAGE/ORDER INFORMATION



MS PACKAGE
10-LEAD PLASTIC MSOP

T_{JMAX} = 125°C, θ_{JA} = 120°C/ W

ORDER PART NUMBER
LTC1871EMS-7
MS PART MARKING
LTG4

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

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{IN} = 8V, V_{RUN} = 1.5V, R_{FREQ} = 80k, $V_{MODE/SYNC}$ = 0V, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Main Control Loop							
$V_{IN(MIN)}$	Minimum Input Voltage			6			V
I_Q	Input Voltage Supply Current Continuous Mode Burst Mode Operation, No Load Shutdown Mode	(Note 4) $V_{MODE/SYNC}$ = 5V, V_{FB} = 1.4V, V_{ITH} = 0.75V $V_{MODE/SYNC}$ = 0V, V_{ITH} = 0.2V (Note 5) V_{RUN} = 0V			 600 280 12	 1000 500 25	 µA µA µA
V_{RUN}^+	Rising RUN Input Threshold Voltage				1.348		V
V_{RUN}^-	Falling RUN Input Threshold Voltage		 ●	1.223 1.198	1.248	1.273 1.298	V V
$V_{RUN(HYST)}$	RUN Pin Input Threshold Hysteresis			50	100	150	mV
I_{RUN}	RUN Input Current				5	60	nA
V_{FB}	Feedback Voltage	V_{ITH} = 0.2V (Note 5)	 ●	1.218 1.212	1.230	1.242 1.248	V V
I_{FB}	FB Pin Input Current	V_{ITH} = 0.2V (Note 5)			18	60	nA
$\frac{\Delta V_{FB}}{\Delta V_{IN}}$	Line Regulation	6V ≤ V_{IN} ≤ 30V			0.002	0.02	%/V
$\frac{\Delta V_{FB}}{\Delta V_{ITH}}$	Load Regulation	$V_{MODE/SYNC}$ = 0V, V_{TH} = 0.5V to 0.90V (Note 5)	●	–1	–0.1		%
$\Delta V_{FB(OV)}$	ΔFB Pin, Overvoltage Lockout	$V_{FB(OV)} – V_{FB(NOM)}$ in Percent		2.5	6	10	%
g_m	Error Amplifier Transconductance	I_{TH} Pin Load = ±5µA (Note 5)			600		µmho
$V_{ITH(BURST)}$	Burst Mode Operation I_{TH} Pin Voltage	Falling I_{TH} Voltage (Note 5)			0.3		V
$V_{SENSE(MAX)}$	Maximum Current Sense Input Threshold	Duty Cycle < 20%		120	150	180	mV
$I_{SENSE(ON)}$	SENSE Pin Current (GATE High)	V_{SENSE} = 0V			35	70	µA
$I_{SENSE(OFF)}$	SENSE Pin Current (GATE Low)	V_{SENSE} = 30V (No R_{SENSE} Mode)			0.1	5	µA

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{IN} = 8V, V_{RUN} = 1.5V, R_{FREQ} = 80k, $V_{MODE/SYNC}$ = 0V, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Oscillator							
f_{OSC}	Oscillator Frequency	R_{FREQ} = 80k		250	300	350	kHz
	Oscillator Frequency Range			50		1000	kHz
D_{MAX}	Maximum Duty Cycle			87	92	97	%
f_{SYNC}/f_{OSC}	Recommended Maximum Synchronized Frequency Ratio	f_{OSC} = 300kHz (Note 6)			1.25	1.30	
$t_{SYNC(MIN)}$	MODE/SYNC Minimum Input Pulse Width	V_{SYNC} = 0V to 5V			25		ns
$t_{SYNC(MAX)}$	MODE/SYNC Maximum Input Pulse Width	V_{SYNC} = 0V to 5V			$0.8/f_{OSC}$		ns
$V_{IL(MODE)}$	Low Level MODE/SYNC Input Voltage					0.3	V
$V_{IH(MODE)}$	High Level MODE/SYNC Input Voltage			1.2			V
$R_{MODE/SYNC}$	MODE/SYNC Input Pull-Down Resistance				50		kΩ
V_{FREQ}	Nominal FREQ Pin Voltage				0.62		V
Low Dropout Regulator							
V_{INTVCC}	$INTV_{CC}$ Regulator Output Voltage	V_{IN} = 8V		6.5	7	7.5	V
UVLO	$INTV_{CC}$ Undervoltage Lockout Thresholds	Rising $INTV_{CC}$ Falling $INTV_{CC}$ UVLO Hysteresis			5.6 4.6 1.0		V V V
$\frac{\Delta V_{INTVCC}}{\Delta V_{IN1}}$	$INTV_{CC}$ Regulator Line Regulation	8V ≤ V_{IN} ≤ 15V			8	25	mV
$\frac{\Delta V_{INTVCC}}{\Delta V_{IN2}}$	$INTV_{CC}$ Regulator Line Regulation	15V ≤ V_{IN} ≤ 30V			70	200	mV
$V_{LDO(LOAD)}$	$INTV_{CC}$ Load Regulation	0 ≤ I_{INTVCC} ≤ 20mA, V_{IN} = 8V		–2	–0.2		%
$V_{DROPOUT}$	$INTV_{CC}$ Regulator Dropout Voltage	V_{IN} = 6V, $INTV_{CC}$ Load = 20mA			280		mV
GATE Driver							
t_r	GATE Driver Output Rise Time	C_L = 3300pF (Note 7)			17	100	ns
t_f	GATE Driver Output Fall Time	C_L = 3300pF (Note 7)			8	100	ns

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

Note 2: The LTC1871-7E 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: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula:

$T_J = T_A + (P_D \bullet 120°C/W)$

Note 4: The dynamic input supply current is higher due to power MOSFET gate charging ($Q_G \bullet f_{OSC}$). See Applications Information.

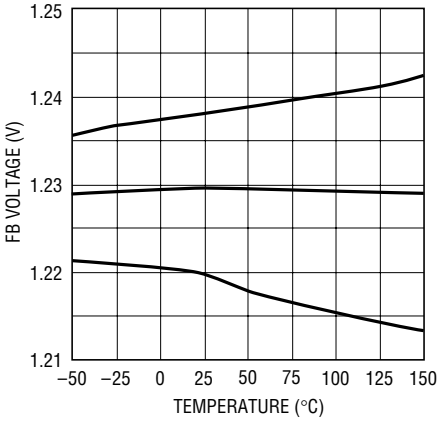
Note 5: The LTC1871-7 is tested in a feedback loop that servos V_{FB} to the reference voltage with the I_{TH} pin forced to a voltage between 0V and 1.4V (the no load to full load operating voltage range for the I_{TH} pin is 0.3V to 1.23V).

Note 6: In a synchronized application, the internal slope compensation gain is increased by 25%. Synchronizing to a significantly higher ratio will reduce the effective amount of slope compensation, which could result in subharmonic oscillation for duty cycles greater than 50%.

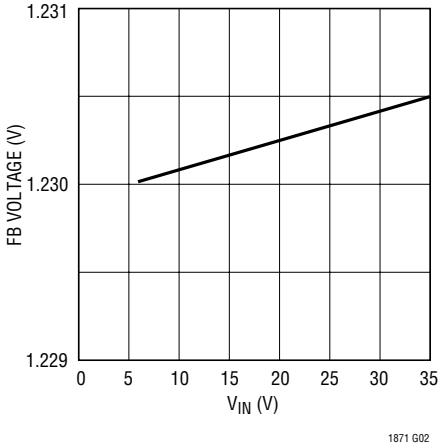
Note 7: Rise and fall times are measured at 10% and 90% levels.

TYPICAL PERFORMANCE CHARACTERISTICS

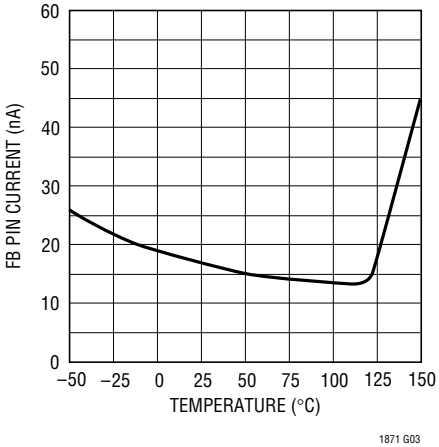
FB Voltage vs Temp



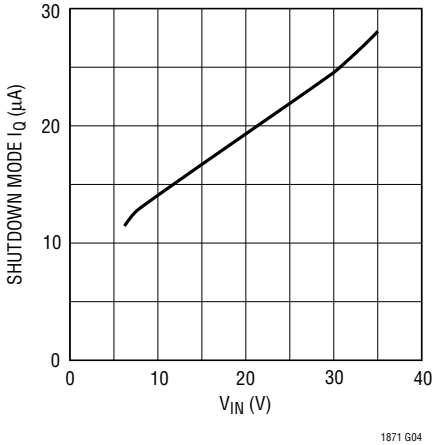
FB Voltage Line Regulation



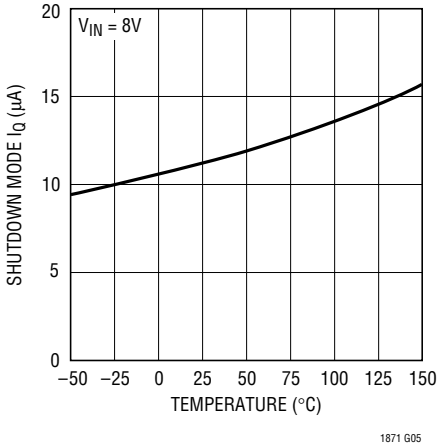
FB Pin Current vs Temperature



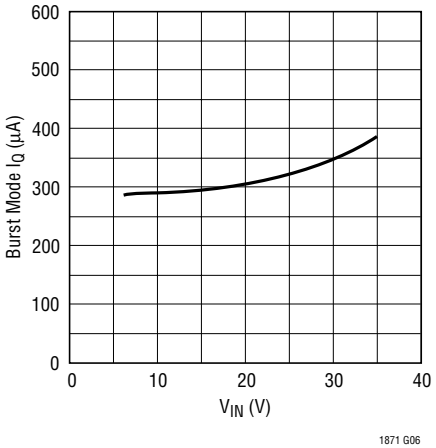
Shutdown Mode I_Q vs V_{IN}



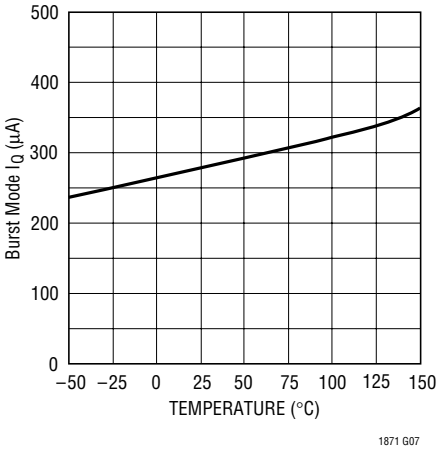
Shutdown Mode I_Q vs Temperature



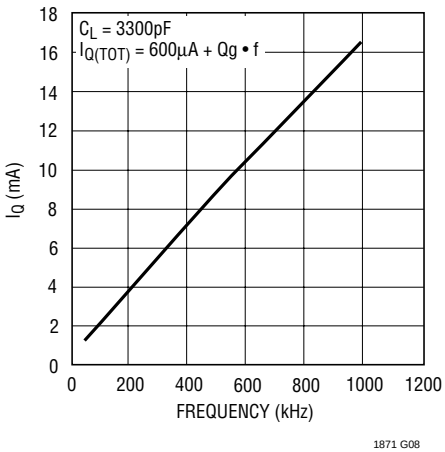
Burst Mode I_Q vs V_{IN}



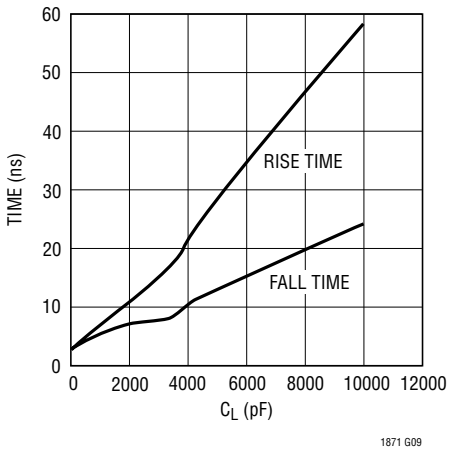
Burst Mode I_Q vs Temperature



Dynamic I_Q vs Frequency

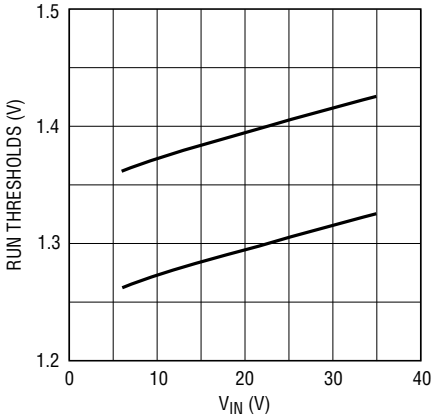


Gate Drive Rise and Fall Time vs C_L



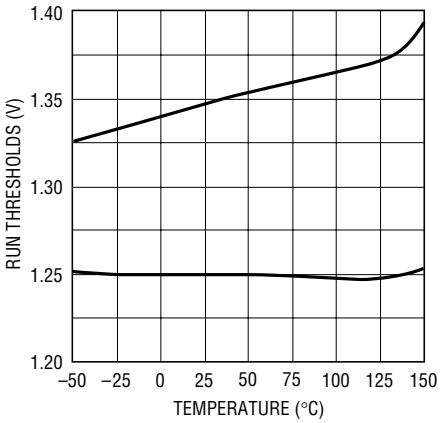
TYPICAL PERFORMANCE CHARACTERISTICS

RUN Thresholds vs V_{IN}



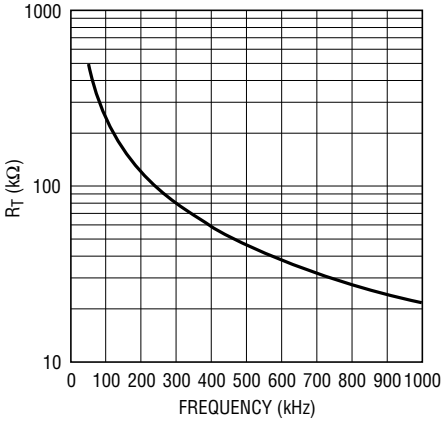
1871 G10

RUN Thresholds vs Temperature



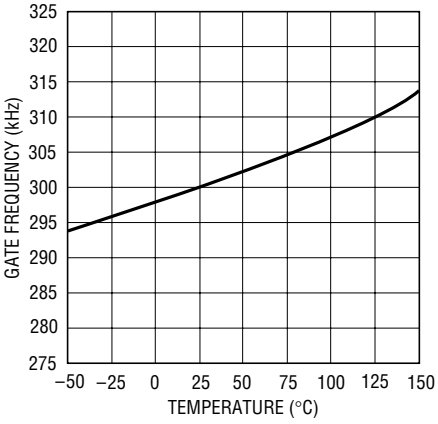
1871 G11

R_T vs Frequency



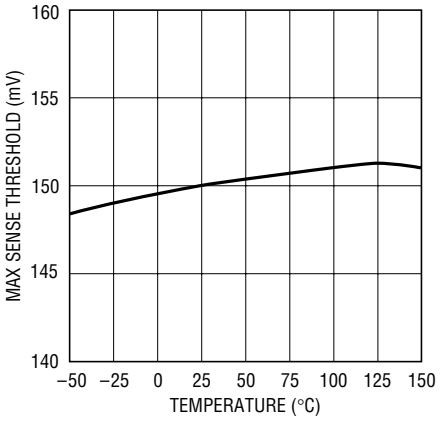
1871 G12

Frequency vs Temperature



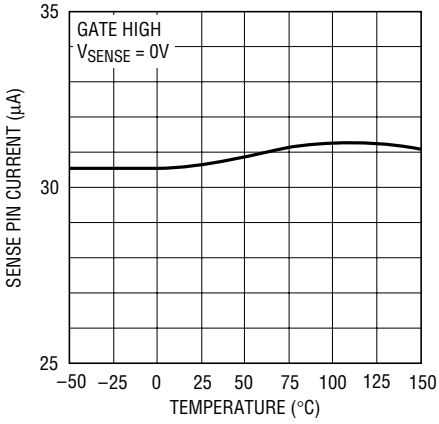
1871 G13

Maximum Sense Threshold vs Temperature



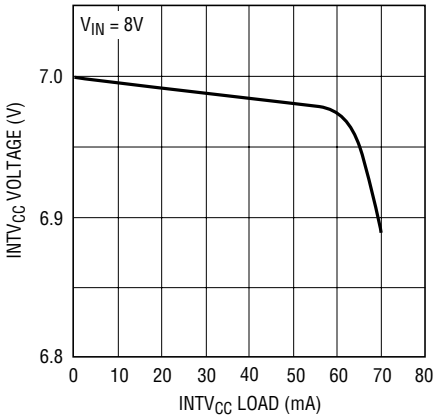
1871 G14

SENSE Pin Current vs Temperature



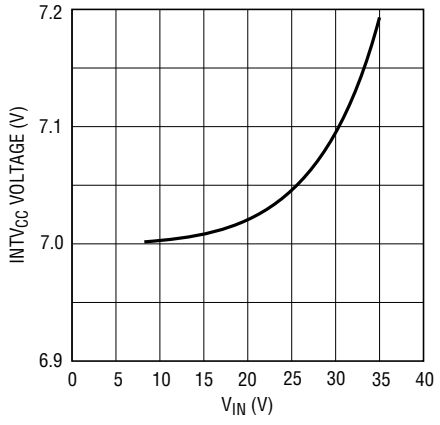
1871 G15

$INTV_{CC}$ Load Regulation



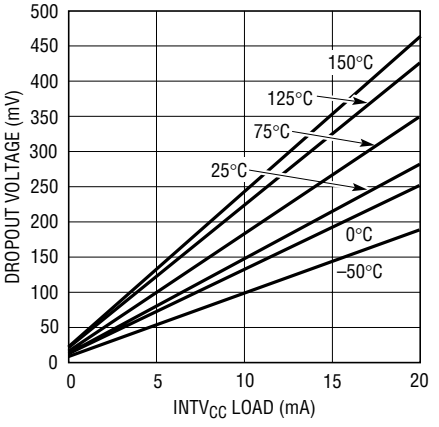
1871 G16

$INTV_{CC}$ Line Regulation



1871 G17

$INTV_{CC}$ Dropout Voltage vs Current, Temperature



1871 G18

PIN FUNCTIONS

RUN (Pin 1): The RUN pin provides the user with an accurate means for sensing the input voltage and programming the start-up threshold for the converter. The falling RUN pin threshold is nominally 1.248V and the comparator has 100mV of hysteresis for noise immunity. When the RUN pin is below this input threshold, the IC is shut down and the V_{IN} supply current is kept to a low value (typ 10μA). The Absolute Maximum Rating for the voltage on this pin is 7V.

I_{TH} (Pin 2): Error Amplifier Compensation Pin. The current comparator input threshold increases with this control voltage. Nominal voltage range for this pin is 0V to 1.40V.

FB (Pin 3): Receives the feedback voltage from the external resistor divider across the output. Nominal voltage for this pin in regulaton is 1.230V.

FREQ (Pin 4): A resistor from the FREQ pin to ground programs the operating frequency of the chip. The nominal voltage at the FREQ pin is 0.6V.

MODE/SYNC (Pin 5): This input controls the operating mode of the converter and allows for synchronizing the operating frequency to an external clock. If the MODE/SYNC pin is connected to ground, Burst Mode operation is enabled. If the MODE/SYNC pin is connected to $INTV_{CC}$, or if an external logic-level synchronization signal is applied to this input, Burst Mode operation is disabled and the IC operates in a continuous mode.

GND (Pin 6): Ground Pin.

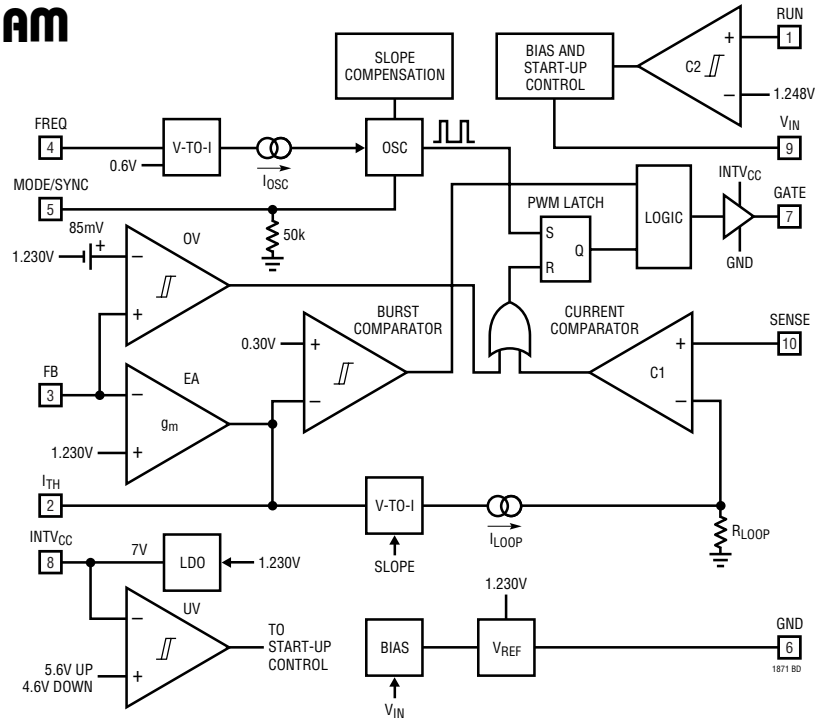
GATE (Pin 7): Gate Driver Output.

$INTV_{CC}$ (Pin 8): The Internal 7V Regulator Output. The gate driver and control circuits are powered from this voltage. Decouple this pin locally to the IC ground with a minimum of 4.7μF low ESR tantalum or ceramic capacitor. This 7V regulator has an undervoltage lockout circuit with 5.6V and 4.6V rising and falling thresholds, respectively.

V_{IN} (Pin 9): Main Supply Pin. Must be closely decoupled to ground.

SENSE (Pin 10): The Current Sense Input for the Control Loop. Connect this pin to a resistor in the source of the power MOSFET. Alternatively, the SENSE pin may be connected to the drain of the power MOSFET, in applications where the maximum V_{DS} is less than 36V. Internal leading edge blanking is provided for both sensing methods.

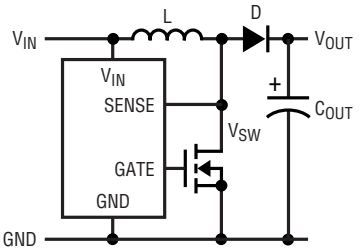
BLOCK DIAGRAM



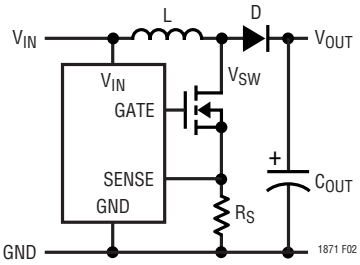
OPERATION

Main Control Loop

The LTC1871-7 is a constant frequency, current mode controller for DC/DC boost, SEPIC and flyback converter applications. With the LTC1871-7 the current control loop can be closed by sensing the voltage drop either across the power MOSFET switch or across a discrete sense resistor, as shown in Figure 2.



2a. SENSE Pin Connection for Maximum Efficiency (V_{SW} < 36V)



2b. SENSE Pin Connection for Precise Control of Peak Current or for V_{SW} > 36V

Figure 2. Using the SENSE Pin On the LTC1871-7

For circuit operation, please refer to the Block Diagram of the IC and Figure 1. In normal operation, the power MOSFET is turned on when the oscillator sets the PWM latch and is turned off when the current comparator C1 resets the latch. The divided-down output voltage is compared to an internal 1.230V reference by the error amplifier EA, which outputs an error signal at the I_{TH} pin. The voltage on the I_{TH} pin sets the current comparator C1 input threshold. When the load current increases, a fall in the FB voltage relative to the reference voltage causes the I_{TH} pin to rise, which causes the current comparator C1 to trip at a higher peak inductor current value. The average inductor current will therefore rise until it equals the load current, thereby maintaining output regulation.

The nominal operating frequency of the LTC1871-7 is programmed using a resistor from the FREQ pin to ground and can be controlled over a 50kHz to 1000kHz range. In addition, the internal oscillator can be synchronized to an external clock applied to the MODE/SYNC pin and can be locked to a frequency between 100% and 130% of its nominal value. When the MODE/SYNC pin is left open, it is pulled low by an internal 50k resistor and Burst Mode operation is enabled. If this pin is taken above 2V or an external clock is applied, Burst Mode operation is disabled and the IC operates in continuous mode. With no load (or an extremely light load), the controller will skip pulses in order to maintain regulation and prevent excessive output ripple.

The RUN pin controls whether the IC is enabled or is in a low current shutdown state. A micropower 1.248V reference and comparator C2 allow the user to program the supply voltage at which the IC turns on and off (comparator C2 has 100mV of hysteresis for noise immunity). With the RUN pin below 1.248V, the chip is off and the input supply current is typically only 10μA.

An overvoltage comparator OV senses when the FB pin exceeds the reference voltage by 6.5% and provides a reset pulse to the main RS latch. Because this RS latch is reset-dominant, the power MOSFET is actively held off for the duration of an output overvoltage condition.

The LTC1871-7 can be used either by sensing the voltage drop across the power MOSFET or by connecting the SENSE pin to a conventional shunt resistor in the source of the power MOSFET, as shown in Figure 2. Sensing the voltage across the power MOSFET maximizes converter efficiency and minimizes the component count, but limits the output voltage to the maximum rating for this pin (36V). By connecting the SENSE pin to a resistor in the source of the power MOSFET, the user is able to program output voltages significantly greater than 36V.

OPERATION

Programming the Operating Mode

For applications where maximizing the efficiency at very light loads (e.g., <100µA) is a high priority, the current in the output divider could be decreased to a few microamps and Burst Mode operation should be applied (i.e., the MODE/SYNC pin should be connected to ground). In applications where fixed frequency operation is more critical than low current efficiency, or where the lowest output ripple is desired, pulse-skip mode operation should be used and the MODE/SYNC pin should be connected to the $INTV_{CC}$ pin. This allows discontinuous conduction mode (DCM) operation down to near the limit defined by the chip's minimum on-time (about 175ns). Below this output current level, the converter will begin to skip cycles in order to maintain output regulation. Figures 3 and 4 show the light load switching waveforms for Burst Mode and pulse-skip mode operation for the converter in Figure 1.

Burst Mode Operation

Burst Mode operation is selected by leaving the MODE/SYNC pin unconnected or by connecting it to ground. In normal operation, the range on the I_{TH} pin corresponding to no load to full load is 0.30V to 1.2V. In Burst Mode operation, if the error amplifier EA drives the I_{TH} voltage below 0.525V, the buffered I_{TH} input to the current comparator C1 will be clamped at 0.525V (which corresponds to 25% of maximum load current). The inductor current peak is then held at approximately 30mV divided by the power MOSFET $R_{DS(ON)}$. If the I_{TH} pin drops below 0.30V, the Burst Mode comparator B1 will turn off the power MOSFET and scale back the quiescent current of the IC to 250µA (sleep mode). In this condition, the load current will be supplied by the output capacitor until the I_{TH} voltage rises above the 50mV hysteresis of the burst comparator. At light loads, short bursts of switching (where the average inductor current is 20% of its maximum value) followed by long periods of sleep will be observed, thereby greatly improving converter efficiency. Oscilloscope waveforms illustrating Burst Mode operation are shown in Figure 3.

Pulse-Skip Mode Operation

With the MODE/SYNC pin tied to a DC voltage above 2V, Burst Mode operation is disabled. The internal, 0.525V buffered I_{TH} burst clamp is removed, allowing the I_{TH} pin to directly control the current comparator from no load to full load. With no load, the I_{TH} pin is driven below 0.30V, the power MOSFET is turned off and sleep mode is invoked. Oscilloscope waveforms illustrating this mode of operation are shown in Figure 4.

When an external clock signal drives the MODE/SYNC pin at a rate faster than the chip's internal oscillator, the oscillator will synchronize to it. In this synchronized mode, Burst Mode operation is disabled. The constant frequency associated with synchronized operation provides a more controlled noise spectrum from the converter, at the expense of overall system efficiency of light loads.

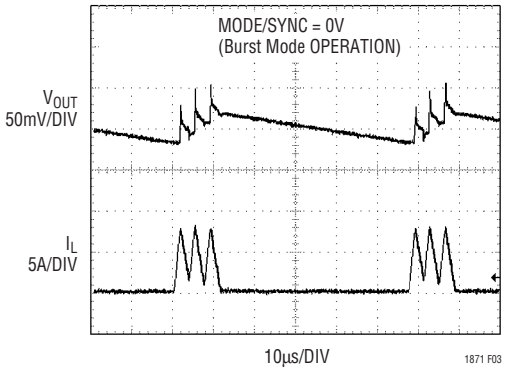


Figure 3. LTC1871-7 Burst Mode Operation (MODE/SYNC = 0V) at Low Output Current

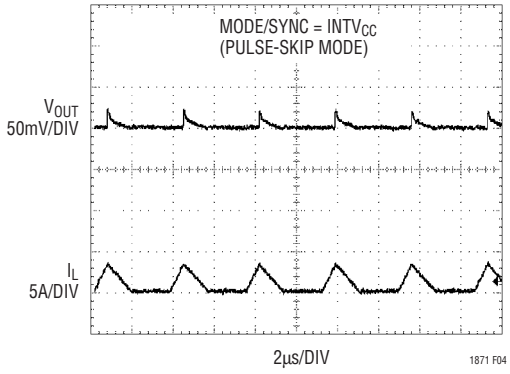


Figure 4. LTC1871-7 Low Output Current Operation with Burst Mode Operation Disabled (MODE/SYNC = $INTV_{CC}$)

APPLICATIONS INFORMATION

When the oscillator's internal logic circuitry detects a synchronizing signal on the MODE/SYNC pin, the internal oscillator ramp is terminated early and the slope compensation is increased by approximately 30%. As a result, in applications requiring synchronization, it is recommended that the nominal operating frequency of the IC be programmed to be about 75% of the external clock frequency. Attempting to synchronize to too high an external frequency (above $1.3f_O$) can result in inadequate slope compensation and possible subharmonic oscillation (or jitter).

The external clock signal must exceed 2V for at least 25ns, and should have a maximum duty cycle of 80%, as shown in Figure 5. The MOSFET turn on will synchronize to the rising edge of the external clock signal.

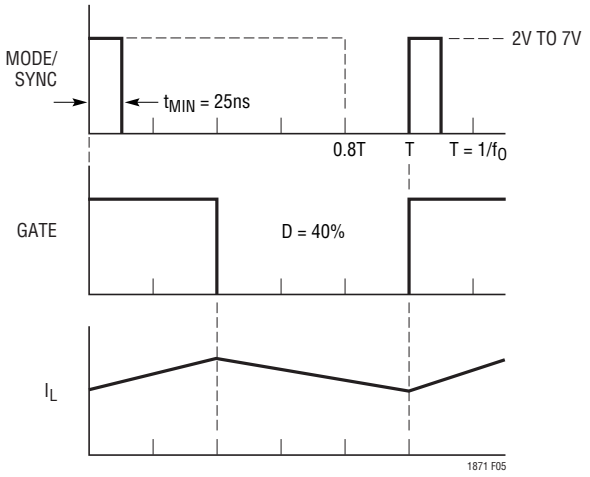


Figure 5. MODE/SYNC Clock Input and Switching Waveforms for Synchronized Operation

Programming the Operating Frequency

The choice of operating frequency and inductor value is a tradeoff between efficiency and component size. Low frequency operation improves efficiency by reducing MOSFET and diode switching losses. However, lower frequency operation requires more inductance for a given amount of load current.

The LTC1871-7 uses a constant frequency architecture that can be programmed over a 50kHz to 1000kHz range with a single external resistor from the FREQ pin to ground, as shown in Figure 1. The nominal voltage on the FREQ pin is 0.6V, and the current that flows into the FREQ pin is used to charge and discharge an internal oscillator capacitor. A graph for selecting the value of R_T for a given operating frequency is shown in Figure 6.

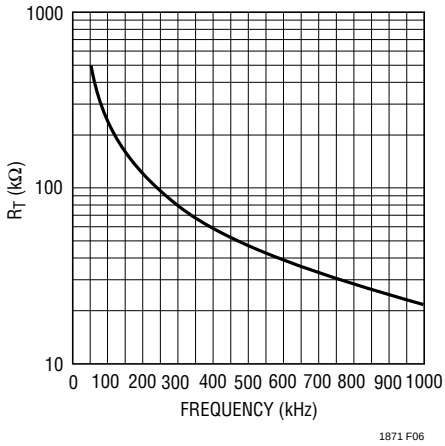


Figure 6. Timing Resistor (R_T) Value

$INTV_{CC}$ Regulator Bypassing and Operation

An internal, P-channel low dropout voltage regulator produces the 7V supply which powers the gate driver and logic circuitry within the LTC1871-7, as shown in Figure 7. The $INTV_{CC}$ regulator can supply up to 50mA and must be bypassed to ground immediately adjacent to the IC pins with a minimum of 4.7µF tantalum or ceramic capacitor. Good bypassing is necessary to supply the high transient currents required by the MOSFET gate driver.

The LTC1871-7 contains an undervoltage lockout circuit which protects the external MOSFET from switching at low gate-to-source voltages. This undervoltage circuit senses the $INTV_{CC}$ voltage and has a 5.6V rising threshold and a 4.6V falling threshold.

For input voltages that don't exceed 8V (the absolute maximum rating for $INTV_{CC}$ is 9V), the internal low dropout regulator in the LTC1871-7 is redundant and the $INTV_{CC}$ pin can be shorted directly to the V_{IN} pin. With the $INTV_{CC}$ pin shorted to V_{IN}, however, the divider that programs the regulated $INTV_{CC}$ voltage will draw 14µA of current from the input supply, even in shutdown mode. For applications that require the lowest shutdown mode input supply current, do not connect the $INTV_{CC}$ pin to V_{IN}. Regardless of whether the $INTV_{CC}$ pin is shorted to V_{IN} or not, **it is always necessary to have the driver circuitry bypassed with a 4.7µF ceramic capacitor to ground immediately adjacent to the $INTV_{CC}$ and GND pins.**

APPLICATIONS INFORMATION

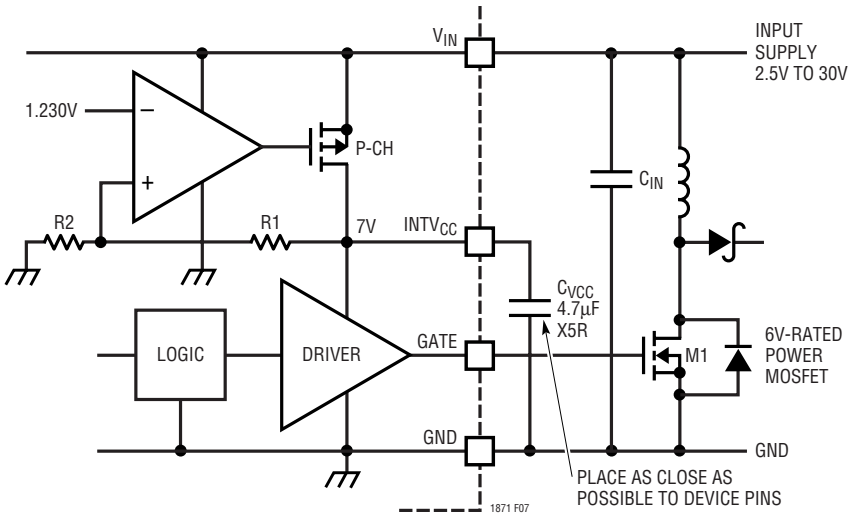


Figure 7. Bypassing the LDO Regulator and Gate Driver Supply

In an actual application, most of the IC supply current is used to drive the gate capacitance of the power MOSFET. As a result, high input voltage applications in which a large power MOSFET is being driven at high frequencies can cause the LTC1871-7 to exceed its maximum junction temperature rating. The junction temperature can be estimated using the following equations:

$I_{Q(TOT)} \approx I_Q + f \bullet Q_G$

$P_{IC} = V_{IN} \bullet (I_Q + f \bullet Q_G)$

$T_J = T_A + P_{IC} \bullet R_{TH(JA)}$

The total quiescent current $I_{Q(TOT)}$ consists of the static supply current (I_Q) and the current required to charge and discharge the gate of the power MOSFET. The 10-pin MSOP package has a thermal resistance of $R_{TH(JA)}$ = 120°C/W.

As an example, consider a power supply with V_{IN} =10V. The switching frequency is 200kHz, and the maximum ambient temperature is 70°C. The power MOSFET chosen is the FDS3670(Fairchild), which has a maximum $R_{DS(ON)}$ of 35mΩ (at room temperature) and a maximum total gate charge of 80nC (the temperature coefficient of the gate charge is low).

$I_{Q(TOT)}$ = 600µA + 80nC • 200kHz = 16.6mA

P_{IC} = 10V • 16.6mA = 166mW

T_J = 70°C + 120°C/W • 166mW = 89.9°C

T_{JRISE} = 19.9°C

This demonstrates how significant the gate charge current can be when compared to the static quiescent current in the IC.

To prevent the maximum junction temperature from being exceeded, the input supply current must be checked when operating in a continuous mode at high V_{IN}. A tradeoff between the operating frequency and the size of the power MOSFET may need to be made in order to maintain a reliable IC junction temperature. Prior to lowering the operating frequency, however, be sure to check with power MOSFET manufacturers for their latest-and-greatest low Q_G, low $R_{DS(ON)}$ devices. Power MOSFET manufacturing technologies are continually improving, with newer and better performance devices being introduced almost yearly.

Output Voltage Programming

The output voltage is set by a resistor divider according to the following formula:

$$V_O = 1.230V \bullet \left(1 + \frac{R2}{R1}\right)$$

APPLICATIONS INFORMATION

The external resistor divider is connected to the output as shown in Figure 1, allowing remote voltage sensing. The resistors R1 and R2 are typically chosen so that the error caused by the current flowing into the FB pin during normal operation is less than 1% (this translates to a maximum value of R1 of about 250k).

Programming Turn-On and Turn-Off Thresholds with the RUN Pin

The LTC1871-7 contains an independent, micropower voltage reference and comparator detection circuit that remains active even when the device is shut down, as shown in Figure 8. This allows users to accurately program an input voltage at which the converter will turn on and off. The falling threshold voltage on the RUN pin is equal to the internal reference voltage of 1.248V. The comparator has 100mV of hysteresis to increase noise immunity.

The turn-on and turn-off input voltage thresholds are programmed using a resistor divider according to the following formulas:

$$V_{IN(OFF)} = 1.248V \bullet \left(1 + \frac{R2}{R1}\right)$$

$$V_{IN(ON)} = 1.348V \bullet \left(1 + \frac{R2}{R1}\right)$$

The resistor R1 is typically chosen to be less than 1M.

For applications where the RUN pin is only to be used as a logic input, the user should be aware of the 7V Absolute Maximum Rating for this pin! The RUN pin can be connected to the input voltage through an external 1M resistor, as shown in Figure 8c, for "always on" operation.

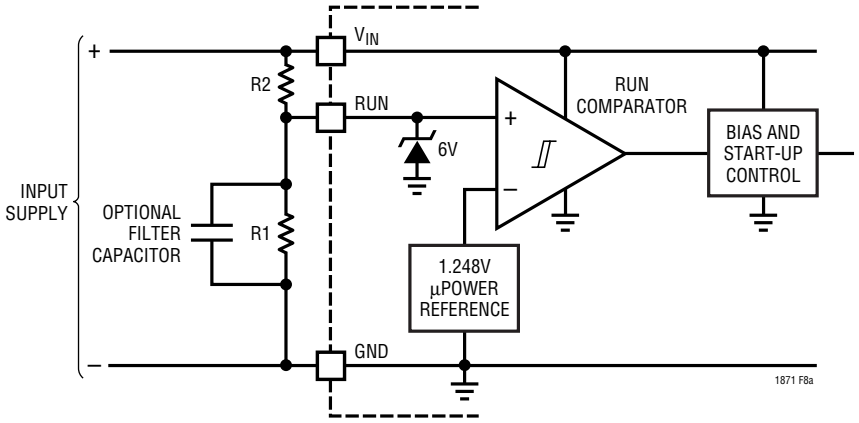


Figure 8a. Programming the Turn-On and Turn-Off Thresholds Using the RUN Pin

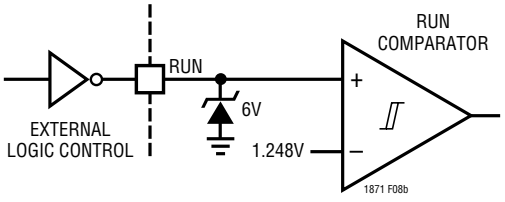


Figure 8b. On/Off Control Using External Logic

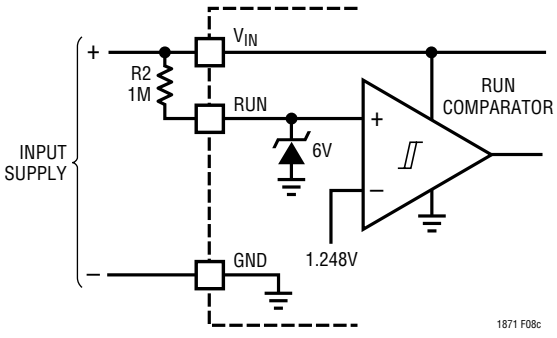
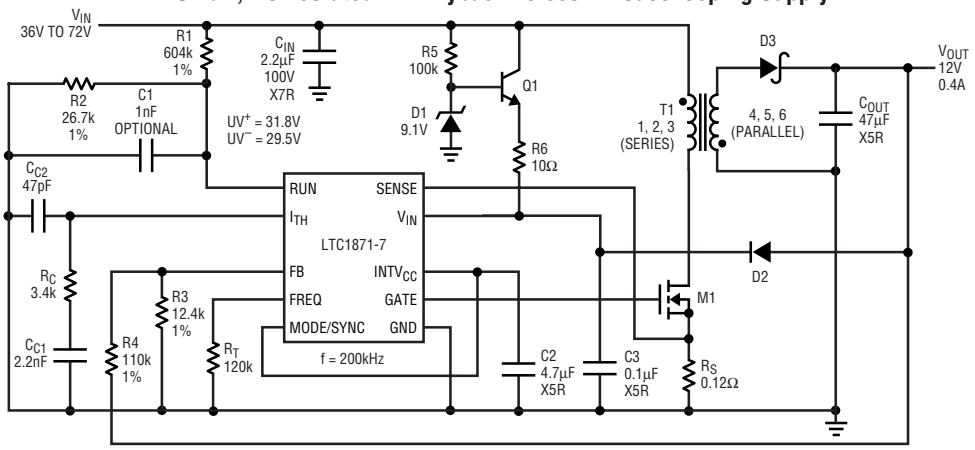


Figure 8c. External Pull-Up Resistor On RUN Pin for "Always On" Operation

TYPICAL APPLICATIONS

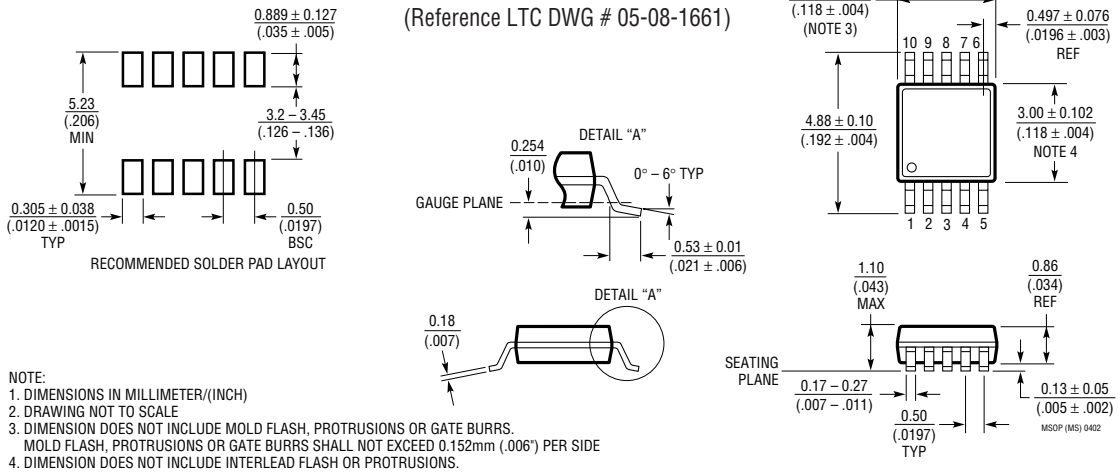
A Small, Nonisolated 12V Flyback Telecom Housekeeping Supply



T1: COILTRONICS VP1-0076
M1: FAIRCHILD FDC2512 (150V, 0.5Ω)
Q1: ZETEX FMMT625 (120V)
D1: ON SEMICONDUCTOR MMBZ5239BLT1 (9.1V)
D2: ON SEMICONDUCTOR MMSD4148T11
D3: INTERNATIONAL RECTIFIER 10BQ060

PACKAGE DESCRIPTION

MS Package
10-Lead Plastic MSOP
(Reference LTC DWG # 05-08-1661)



NOTE:
1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
   MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
   INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT®1619	Current Mode PWM Controller	300kHz Fixed Frequency, Boost, SEPIC, Flyback Topology
LTC1624	Current Mode DC/DC Controller	SO-8; 300kHz Operating Frequency; Buck, Boost, SEPIC Design; V_{IN} Up to 36V
LTC1700	No R_{SENSE} Synchronous Step-Up Controller	Up to 95% Efficiency, Operation as Low as 0.9V Input
LTC1871	Wide Input Range, No R_{SENSE} Controller	Operation as Low as 2.5V Input, Boost Flyback,SEPIC
LTC1872	SOT-23 Boost Controller	Delivers Up to 5A, 550kHz Fixed Frequency, Current Mode
LT1930	1.2MHz, SOT-23 Boost Converter	Up to 34V Output, $2.6V \le V_{IN} \le 16V$, Miniature Design
LT1931	Inverting 1.2MHz, SOT-23 Converter	Positive-to-Negative DC/DC Conversion, Miniature Design
LTC3401/LTC3402	1A/2A 3MHz Synchronous Boost Converters	Up to 97% Efficiency, Very Small Solution, $0.5V \le V_{IN} \le 5V$

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