élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

EL7512C - Preliminary

High Frequency PWM Step-Up Regulator

Features

- 90% efficiency
- Up to 600mA I_{OUT}
- 5V < V_{OUT} < 18V
- V_{IN} > 2V
- Up to 1.2MHz adjustable frequency
- < 3µA shutdown current
- Adjustable soft-start
- Low battery detection
- Internal thermal protection
- 1.1mm max height 10-pin MSOP package

Applications

- 3V to 5V, 12V, and 18V converters
- 5V to 12V and 16V converters
- TFT-LCD
- DSL
- Portable equipment
- Desktop equipment

Ordering Information

Part No	Package	Tape & Reel	Outline #
EL7512CY	10-Pin MSOP		MDP0043

General Description

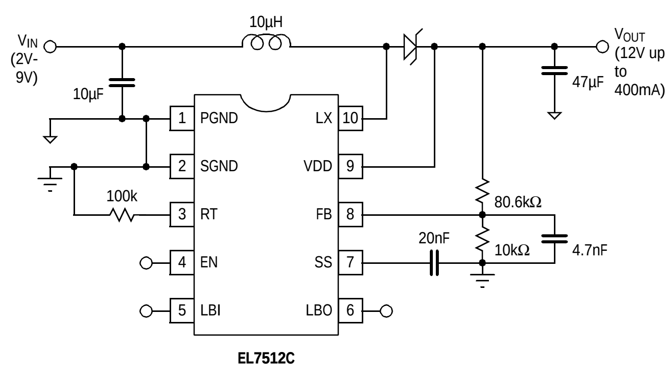
The EL7512C is a high frequency, high efficiency step-up DC:DC regulator operated at fixed frequency PWM mode. With an integrated 1A MOSFET, it can deliver up to 600mA output current at up to 90% efficiency. The adjustable switching frequency is up to 1.2MHz, making it ideal for DSL applications.

When shut down, it draws <3µA of current. This feature, along with the minimum starting voltage of 2V, makes it suitable for portable equipment powered by one lithium ion or 3 to 4 NiMH cells.

The EL7512C is available in a 10-pin MSOP package, with maximum height of 1.1mm. With proper external components, the whole converter takes less than 0.25in^2 PCB space.

This device is specified for operation over the full -40°C to +85°C temperature range.

Typical Application Diagram



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Absolute Maximum Ratings (T_A = 25°C)

Values beyond absolute maximum ratings can cause the device to be prematurely damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied

V_{IN}, LBI, V_{DD}	+18V
LX Voltage	20V
Storage Temperature	-65°C to +150°C
Operating Temperature	-40°C to +85°C
Lead Temperature	300°C

Important Note:

All parameters having Min/Max specifications are guaranteed. Typ values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$

Electrical Characteristics

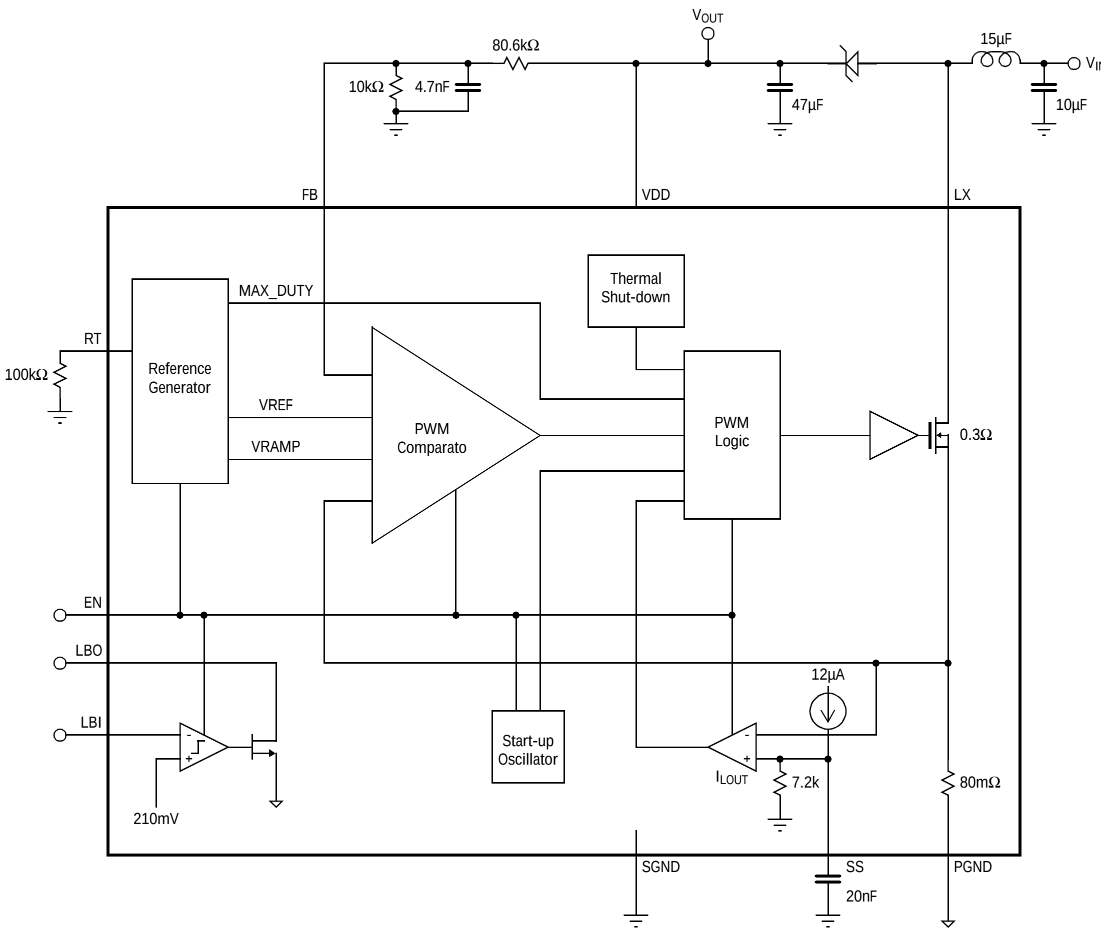
V_{IN} = 5V, V_{OUT} = 12V, I_{OUT} = 0mA, F_{OSC} = 600kHz, T_A = 25°C unless otherwise specified.

Parameter	Description	Condition	Min	Typ	Max	Unit
IQ1	Quiescent Current - Shut-down	$V\overline{SHDN}$ = 0V			3	µA
IQ2	Quiensent Current	$V\overline{SHDN}$ = 2V, Frequency = 600kHz		2.5	4	mA
VFB	Feedback Voltage		1.31	1.35	1.39	V
IB	Feedback Input Bias Current				0.10	µA
V_{IN}	Input Voltage Range		2			V
D_{MAX}	Maximum Duty Cycle		84	90		%
I_{LIM}	Current limit - Max Average Input Current		1000	1250	1500	mA
I_{SHDN}	Shut-down Input Bias Current				1	µA
V_{LBI}	LBI Threshold Voltage		190	220	250	mV
$V_{OL\text{-}LBO}$	LBO Output Low	ILBO = 1mA		0.1	0.2	V
$I_{LEAK\text{-}LBO}$	LBO Output Leakage Current	VLBI = 250mV, VLBO = 5V		0.02	1	µA
$R_{DS\text{-}ON}$	Switch On Resistance	at 12V output		300		mΩ
$I_{LEAK\text{-}SWITCH}$	Switch Leakage Current				1	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	3V < V_{IN} < 6V, V_{OUT} = 12V, no load			0.15	%/V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	I_{OUT} < 250µA		0.5	1	%
$F_{OSC\text{-}RANGE}$	Frequency Range				1200	kHz
F_{OSC1}	Switching Frequency	R_{OSC} = 100kΩ	530	670	800	kHz
VHI-$\overline{SHDN}$	SHDN Input High Threshold		1.6			V
VLO-$\overline{SHDN}$	SHDN Input Low Threshold				0.5	V

Pin Descriptions

Pin Number	Pin Name	Pin Function
1	PGND	Power ground; connected to the source of internal N-channel power MOSFET
2	SGND	Signal ground; ground reference for all the control circuitry; needs to have only a single connection to PGND
3	RT	Timing resister to adjust the oscillation frequency of the converter
4	EN	Chip enable; connects to logic HI (>1.6V) for chip to function
5	LBI	Low battery input; connects to a sensing voltage, or left open if function is not used
6	LBO	Low battery detection output; connected to the open drain of a MOSFET; able to sink 1mA current
7	SS	Soft-start; connects to a capacitor to control the start of the converter
8	FB	Voltage feedback input; needs to connect to resistor divider to decide V_O
9	VDD	Control circuit positive supply
10	LX	Inductor drive pin; connected to the drain of internal N-channel power MOSFET

Block Diagram



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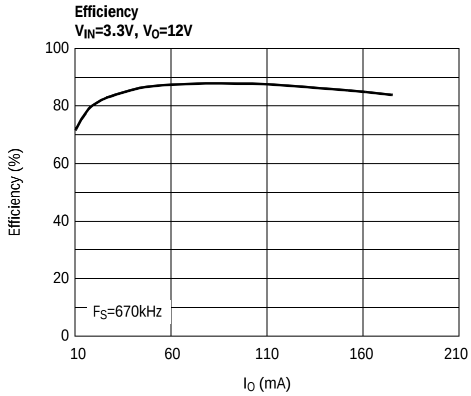
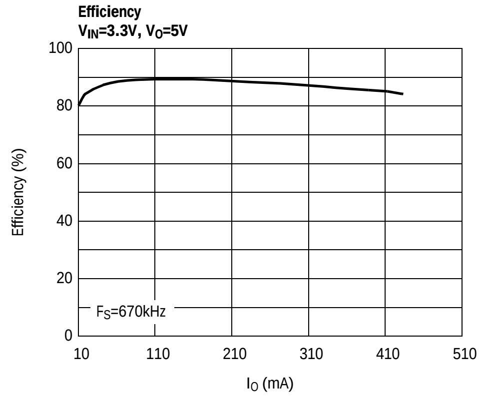
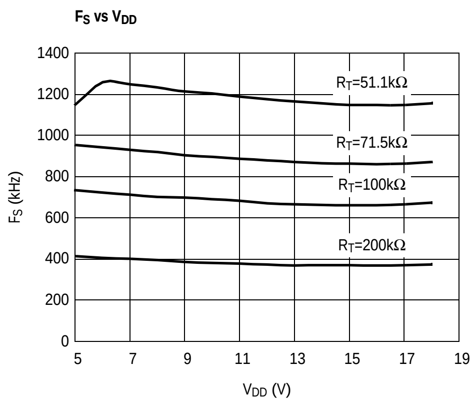
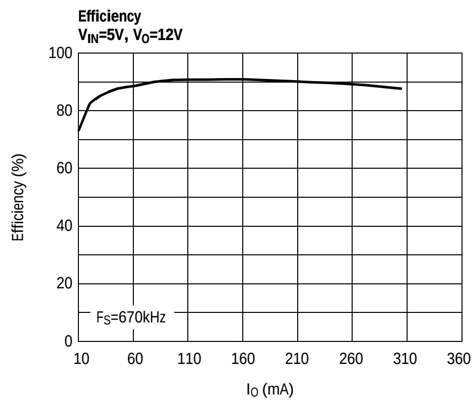
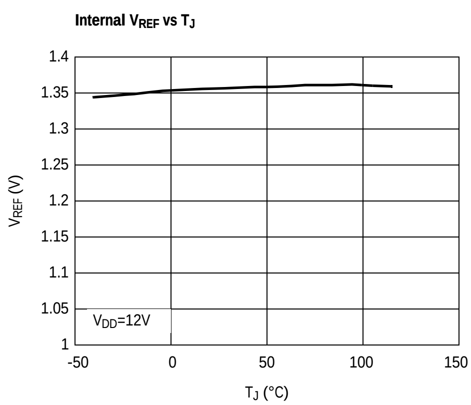
Typical Performance Curves

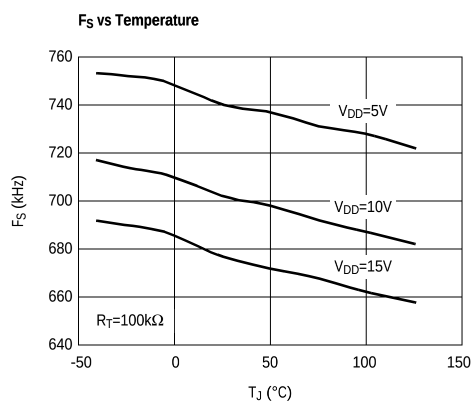












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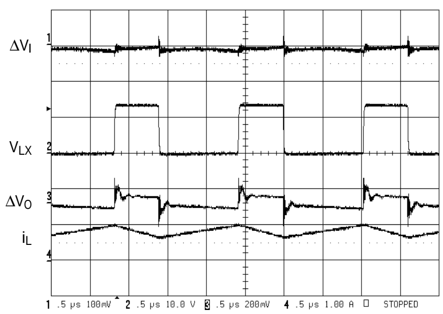
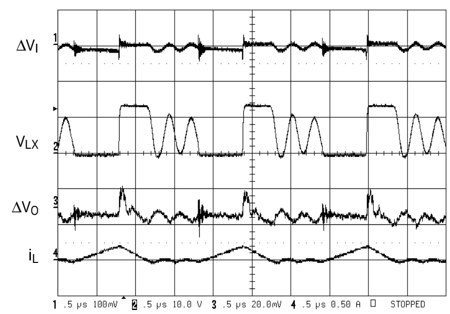
Typical Performance Curves

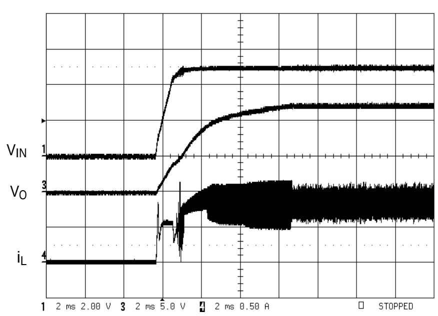
Steady State Operation (inductor continuous conduction)
V_{IN}=5V, V_O=12V, I_O=300mA



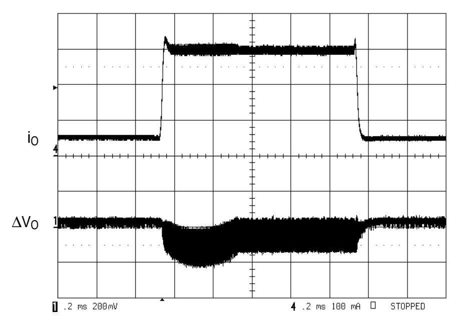
Steady State Operation (inductor discontinuous conduction)
V_{IN}=5V, V_O=12V, I_O=25mA



Power-Up
V_{IN}=5V, V_O=12V, I_O=300mA



Load Transient Response
V_{IN}=5V, V_O=12V, I_O=50mA-300mA



Applications Information

The EL7512C is a step-up regulator, operated at fixed frequency pulse-width-modulation (PWM) control. The input voltage is 2V-12V and output voltage is 5V-16V. The switching frequency (up to 1.2MHz) is decided by the resistor connected to RT pin.

Start-up

After VDD reaches a threshold of about than 2V, the power MOSFET is controlled by the start-up oscillator, which generates fixed duty-ratio of 0.5-0.7 at a frequency of several hundred kilohertz. This will boost the output voltage.

When VDD reaches about 3.7V, the PWM comparator takes over the control. The duty ratio will be decided by the multiple-input direct summing comparator, Max_Duty signal (about 90% duty-ratio), and the Current Limit Comparator, whichever is the smallest.

The soft-start is provided by the current limit comparitor. As the internal 12µA current source changes the external CSS, the peak MOSFET current is limited by the voltage on the capacitor. This in turn controls the rising rate of output voltage.

The regulator goes through the start-up sequence as well after the EN signal is pulled to HI.

Steady-State Operation

When the output reaches the preset voltage, the regulator operates at steady state. Depending on the input/output condition and component, the inductor operates at either continuous-conduction mode or discontinuous-conduction mode.

In the continuous-conduction mode, the inductor current is a triangular waveform and LX voltage a pulse waveform. In the discontinuous-conduction mode, the inductor current is complete dry out before the MOSFET is turned on again. The input voltage source, the inductor, and the MOSFET and output diode parasitic capacitors forms a resonant circuit. Oscillation will occur in this period. This oscillation is normal and will not affect the regulation.

At very low load, the MOSFET will skip pulse sometimes. This is normal.

Current Limit

The MOSFET current limit is nominal 1.2A and guaranteed 1A. This restricts the maximum output current Iomax based on the following formula:

$$I_{OMAX} = 1 - \frac{\Delta I_L}{2} \times \frac{V_{IN}}{V_O}$$

where:

ΔI_L is the inductor peak-to-peak current ripple and is decided by:

$$\Delta I_L = \frac{V_{IN}}{L} \times \frac{D}{F_S}$$

D is the MOSFET turn-on radio and is decided by:

$$D = \frac{V_O - V_{IN}}{V_O}$$

F_S is the switching frequency.

The following table gives typical values:

Maximum Output Current

V_{IN} (V)	V_O (V)	L (µH)	F_S (kHz)	I_{OMAX} (mA)
2	5	10	600	360
2	9	10	600	190
2	12	10	600	140
3	5	10	600	540
3	9	10	600	270
3	12	10	600	200
4.5	9	10	600	400
4.5	12	10	600	280
4.5	15	10	600	220
9	12	10	600	600
9	15	10	600	420

Component Considerations

It is recommended that C_{IN} is larger than 10µF. Theoretically, the input capacitor has ripple current of ΔIL. Due to high-frequency noise in the circuit, the input current ripple may exceed the theoretical value. Larger capacitor will reduce the ripple further.

The inductor has peak and average current decided by:

$$I_{LPK} = I_{LAVG} + \frac{\Delta I_L}{2}$$

$$I_{LAVG} = \frac{I_O}{1 - D}$$

The inductor should be chosen to be able to handle this current. Furthermore, due to the fixed internal compensation, It is recommended that maximum inductance of 10µH and 15µH to be used in the 5V and 12V or higher output voltage, respectively.

The output diode has average current of I_O, and peak current the same as the inductor's peak current. Schottky diode is recommended and it should be able to handle those currents.

Output voltage ripple is the product of peak inductor current times the ESR of output capacitor. Low ESR capacitor is to be used to reduce the output ripple. The minimum out capacitance of 330µF, 47µF, and 33µF is recommended for 5V, 12V, and 16V for 600kHz switching frequency, respectively. For 1MHz switching frequency, 220µF, 33µF, and 22µF capacitor can be used for the output voltages. In addition to the voltage rating, the output capacitor should also be able to handle the rms current is given by:

$$I_{CORMS} = \sqrt{(1 - D) \times \left(D + \frac{\Delta I_L^{\,2}}{I_{LAVG}^{\,2}} \times \frac{1}{12}\right)} \times I_{LAVG}$$

Layout Considerations

The layout is very important for the converter to function properly. Power Ground (⏚) and Signal Ground (⏚) should be separated to ensure that the high pulse current in the Power Ground never interferes with the sensitive signals connected to Signal Ground. They should only be connected at one point.

The trace connected to pin 8 (FB) is the most sensitive trace. It needs to be as short as possible and in a “quiet” place, preferably between PGND or SGND traces.

In addition, the bypass capacitor connected to the VDD pin needs to be as close to the pin as possible.

The heat of the chip is mainly dissipated through the PGND pins. Maximizing the copper area around these pins is preferable. In addition, a solid ground plane is always helpful for the EMI performance.

The demo board is a good example of layout based on these principles. Please refer to the EL7512C Application Brief for the layout.

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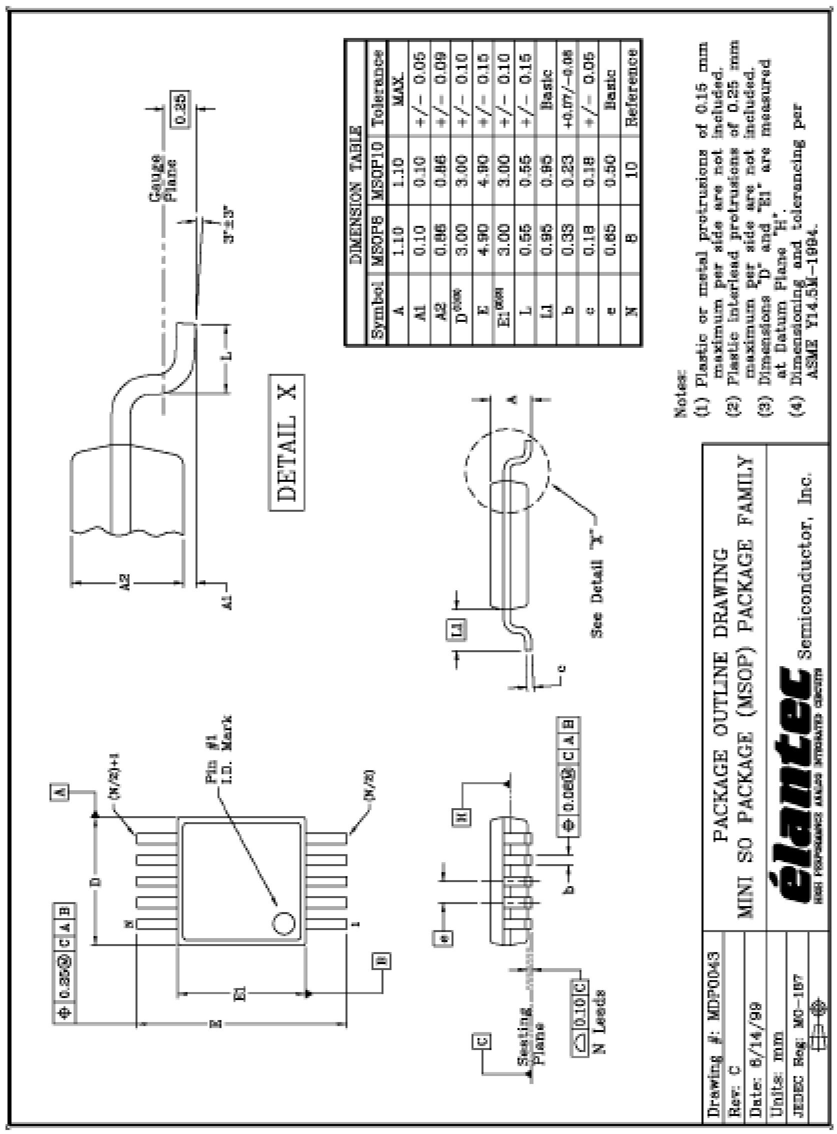
Package Outline Drawing



NOTE: The package drawing shown here may not be the most recent revision. To verify the latest version, please refer to the Elantec website at: http://www.elantec.com/pages/package_outline.html

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General Disclaimer

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