MP1522

25V Step-Up Converter in a SOT23-5 Package

The Future of Analog IC Technology

DESCRIPTION

The MP1522 is a step up converter that generates up to a 25V output voltage from a 2.7V to 25V input. It uses a current limited Variable Frequency control algorithm to optimize efficiency and minimize external component size and cost. The internal 0.5Ω N-Channel MOSFET switch can withstand up to 28V allowing the MP1522 to produce high output voltage with high efficiency.

The MP1522 includes input under voltage and over temperature protection. The MP1522 is available in tiny 5-pin SOT23 packages.

EVALUATION BOARD REFERENCE

Board Number	Dimensions
EV0022	2.2”X x 1.5”Y x 0.5”Z

FEATURES

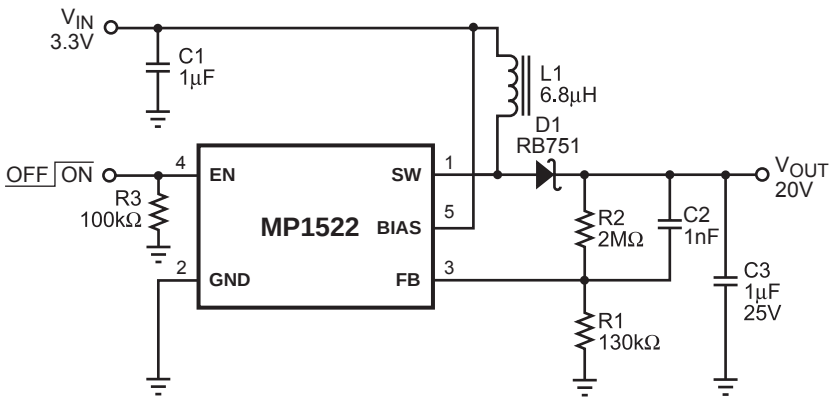
- Internal 0.5Ω Power Switch
- Output Voltage up to 25V
- Up to 90% Efficiency
- Low 1μA Shutdown Current
- Input Under Voltage Protection
- Thermal Shutdown
- Internal Current Limit
- Available in Tiny 5-Pin SOT23 Packages

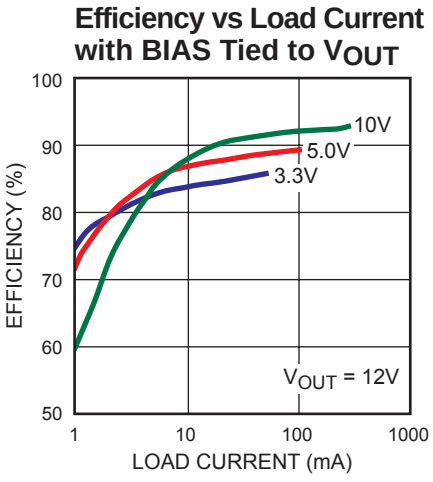
APPLICATIONS

- Handheld Computers, PDAs
- Cell Phones
- Digital Still and Video Cameras
- Small LCD Displays

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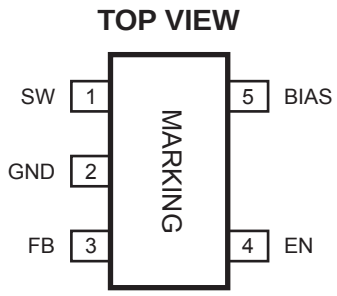
TYPICAL APPLICATION





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PACKAGE REFERENCE



Part Number*	Package	Temperature
MP1522ET	SOT23-5	–20°C to +85°C

* For Tape & Reel, add suffix –Z (eg. MP1522ET–Z)
For RoHS Compliant Packaging, add suffix –LF
(eg. MP1522ET–LF–Z)

ABSOLUTE MAXIMUM RATINGS (1)

BIAS ..... –0.3V to 28V
SW ..... –0.5V to 28V
All Other Pins ..... –0.3V to 6V
Junction Temperature ..... 150°C
Solder Temperature ..... 260°C
Storage Temperature ..... –65°C to 150°C

Recommended Operating Conditions (2)

BIAS Supply Voltage ..... 2.7V to 25V
Output Voltage ..... V_{IN} to 25V
Operating Temperature ..... –20°C to +85°C

Thermal Resistance (3)

	θ_{JA}	θ_{JC}	
SOT23-5	220	110	°C/W

Notes:
1) Exceeding these ratings may damage the device.
2) The device is not guaranteed to function outside of its operating conditions.
3) Measured on approximately 1" square of 1 oz copper.

ELECTRICAL CHARACTERISTICS

V_{BIAS} = V_{EN} = 5.0V, T_A = +25°C, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Supply Current (Shutdown)	$I_{BIAS\ (OFF)}$	V_{EN} = 0V		1	3	µA
Supply Current (Quiescent)	$I_{BIAS(ON)}$	V_{FB} = 1.3V		650	750	µA
Min Off Time, Normal Operation	T_{OFF}	V_{FB} = 1.23V	300	550	700	ns
Min Off Time, Start-Up (4)	T_{OFF}	V_{FB} = 0V		1.6		µs
Undervoltage Lockout						
BIAS Under Voltage Lockout	UVLO	V_{BIAS} Rising, 100mV Hysteresis (Typical)	2.1	2.3	2.65	V
Enable						
EN Threshold		V_{EN} Rising	0.8	1.1	2.0	V
EN Hysteresis				60		mV
EN Input Bias Current		V_{EN} = 0V, 5V			1	µA
Feedback Comparator						
FB Regulation Threshold		V_{FB} Falling	1.19	1.23	1.27	V
FB Hysteresis (5)				10		mV
FB Input Bias Current		V_{FB} = 1.23V	–150	–80		nA
Output Switch						
SW On-Resistance (5)	R_{ON}	V_{BIAS} = 5.0V		0.5	0.6	Ω
SW Current Limit			300	450		mA
SW Leakage Current		V_{SW}=25V			10	µA
Thermal Shutdown (5)				160		°C

Notes:
4) First 64 pulses after EN switches High
5) Guaranteed by design.

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PIN FUNCTIONS

Pin #	Name	Description
1	SW	Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 25V.
2	GND	Ground.
3	FB	Feedback Input. Connect a resistive voltage divider from the output voltage to FB to set the output voltage. The feedback regulation threshold is 1.23V.
4	EN	Regulator On/Off Control Input. A high voltage at EN turns on the converter, and a low voltage turns it off. When not used, connect EN to the input source for automatic startup. If EN is driven over 6V, place a 100kΩ resistor in series with EN.
5	BIAS	Internal Power Input. BIAS powers the internal circuitry. Connect BIAS to the output for enhancement on the internal MOSFET gate at low V_{IN}. If the input source remains above 3.0V, BIAS can be connected to the input source to reduce power consumption.

OPERATION

The MP1522 is a step-up converter that operates from an input voltage as low as 2.7V and generates an output voltage up to 25V. The 0.5Ω internal N-Channel MOSFET power switch is driven with a variable frequency, constant-peak-current architecture for improved regulation and low operating current. The 550ns minimum off-time is extended to 1.6μs during start-up to yield a smooth glitch free turn-on. Start-up mode is activated at initial power-up or when exiting the 1μA shutdown state. The MP1522 features an internal regulator allowing it to be powered from the output for improved low-input voltage operation, or powered from the input source for reduced power consumption due to quiescent current.

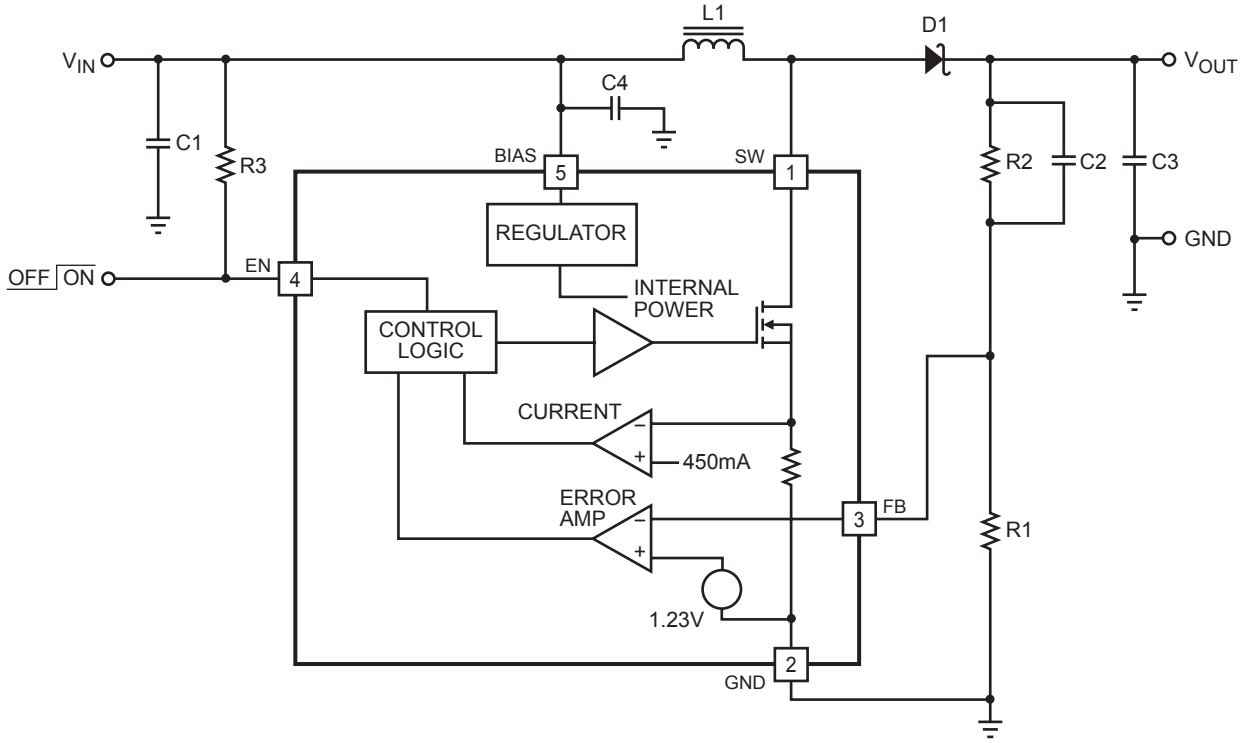


Figure 1—Functional Block Diagram

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Variable Frequency Constant-Peak-Current Operation

When the power MOSFET is turned on the inductor current increases until the 0.45A current limit is reached. The Power MOSFET is then turned off for a minimum of 550ns. At the end of this 550ns transition if the feedback pin is still lower than the 1.23V internal reference the power MOSFET will again be turned on, otherwise the MP1522 waits until the voltage drops below the threshold before turning on the MOSFET again. This process allows for optimal use of the inductor, while minimizing the output ripple and size of the output capacitor and maintaining low operating current.

Setting the Output Voltage

The output voltage is set by a resistive voltage divider connecting the output voltage to FB. The voltage divider reduces the output voltage down by the ratio:

$$\frac{V_{OUT}}{V_{FB}} = \frac{R1+R2}{R1}$$

Solving for V_{OUT}

$$V_{OUT} = V_{FB}\left(\frac{R1+R2}{R1}\right)$$

Where V_{OUT} is the output voltage, and V_{FB} is the 1.23V feedback threshold. Substituting the feedback threshold voltage:

$$V_{OUT} = 1.23V\left(\frac{R1+R2}{R1}\right)$$

R1 can range from 10kΩ to 200kΩ. R2 is determined the equation:

$$R2 = R1\left[\left(\frac{V_{OUT}}{V_{FB}}\right)-1\right]$$

For example for an output voltage of 20V and R1 = 130kΩ the formula yields:

$$R2 = 130k\Omega\left[\left(\frac{20}{1.23V}\right)-1\right]$$

R2 = 2MΩ the closest standard 1% resistor value.

The feedback divider requires a feed-forward capacitor connected in parallel with R2. This capacitor is typically in the range of 1nF-10nF.

On/Off Control

The EN input is used to turn the converter on and off. A high input at EN turns the converter on and a low level turns the converter off. When EN is not being used, connect to the input source for automatic startup. For inputs greater than 6V, pull EN to V_{IN} through a 100kΩ resistor.

Input Capacitor

To reduce noise, use a low ESR/ESL type input capacitor. A 1µF surface mount ceramic capacitor close to the input supply side of the inductor minimizes EMI and ripple current at the input source. See the section on printed circuit board layout for reducing noise and emissions. A bypass capacitor is typically required to prevent noise at the MP1522. This capacitor should also be a low ESR/ESL type capacitor. Place a 0.1µF surface mount ceramic capacitor between BIAS and GND as close to the MP1522 as possible.

Output Capacitor

To minimize output voltage ripple and noise use a low ESR/ESL type output capacitor. Typically a 1µF surface mount ceramic capacitor is sufficient. When using aluminum electrolytics, tantalum or aluminum polymer capacitors the ESR/ESL dominate the output ripple. See the section on printed circuit board layout.

Inductor

The inductor stores energy during the power MOSFET switch on-time. This energy is transferred to the output during the switch off-time. Select an inductor whose peak-current rating is greater than the 450mA peak current limit of the MP1522. Lower value inductors yield higher switching frequencies and thus lower output ripple voltage. However, using too low a value inductor will cause an increase in peak current limit due to the delay of the current-limit comparator. Choose an inductor such that the peak current limit is reached in 550ns or longer.

The minimum value inductor for this criterion is:

$$L \geq 1.31\times10^{-6}\times V_{IN}(\mu H)$$

For maximum V_{IN} = 3.3V, use an inductor value greater than 4.7µH, and for maximum V_{IN} = 5V use an inductor value greater than 6.8µH.

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Diode

The high switching frequencies of the MP1522 require the use of fast recovery or Schottky barrier diodes. In low voltage applications Schottky barrier diodes are recommended for maximum efficiency. The reverse breakdown voltage should be approximately 1.5X the output voltage.

Printed Circuit Board Layout

The printed circuit board layout is important in order to minimize noise and prevent erratic operation. Keep the ground leads short and robust with minimum lead lengths between the input and output capacitors and ground. Place the feedback resistive voltage divider as close to FB as possible to prevent switching noise injection into FB. The use of surface mount capacitors with their low ESL is required to minimize noise at the MP1522. Use separate power and quiet ground planes connected together at a single point whenever possible to minimize ground bounce.

Table 1—Output Current vs. Input Voltage

V_{IN} (V)	V_{OUT} (V)	I_{OUT} (mA)
3.3	5	67
3.3	12	28
3.3	18	15
3.3	25	10
5	12	44
5	18	32
5	25	19
10	12	122
10	18	75
10	25	51

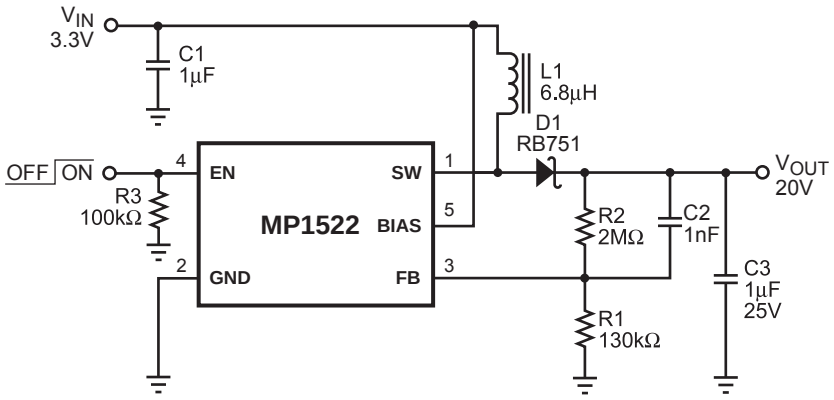
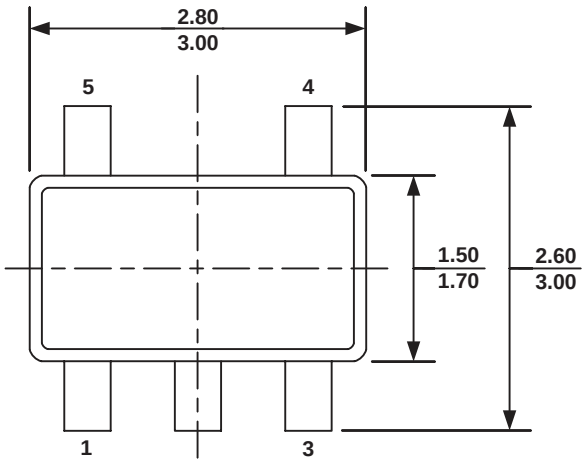


Figure 2—Typical Boost Application

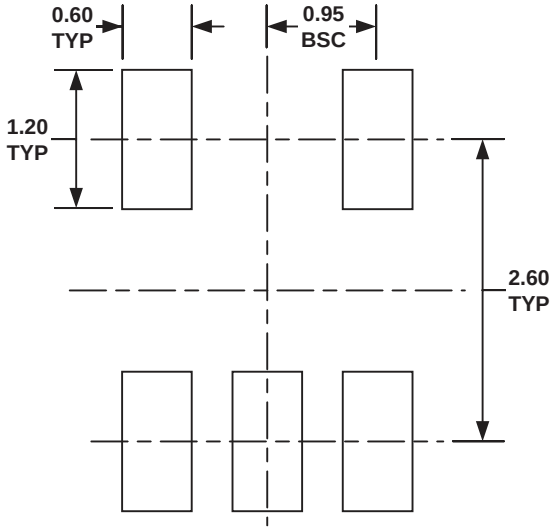
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PACKAGE INFORMATION

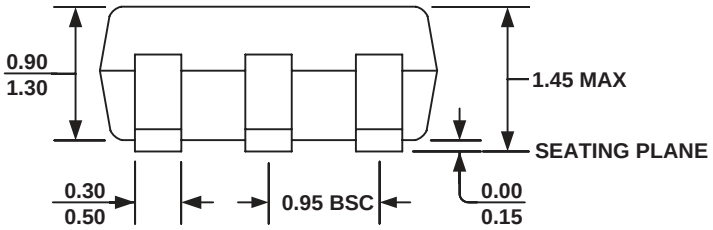
SOT23-5



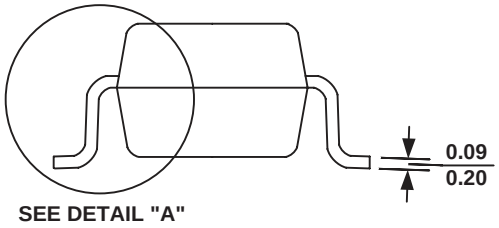
TOP VIEW



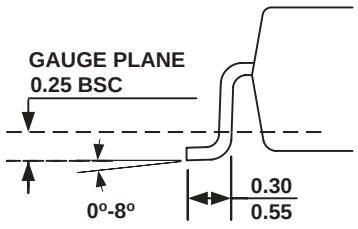
RECOMMENDED LAND PATTERN



FRONT VIEW



SIDE VIEW



DETAIL A

NOTE:

1) ALL DIMENSIONS ARE IN MILLIMETERS.
2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURR.
3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION.
4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.10 MILLIMETERS MAX.
5) DRAWING CONFORMS TO JEDEC MO-178, VARIATION AA.
6) DRAWING IS NOT TO SCALE.

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