High Efficiency 1.2MHz 2A Step Up Converter

FEATURES

- Integrated 80mΩ Power MOSFET
- 2V to 24V Input Voltage
- 1.2MHz Fixed Switching Frequency
- Internal 4A Switch Current Limit
- Adjustable Output Voltage
- Internal Compensation
- Up to 28V Output Voltage
- Automatic Pulse Frequency Modulation Mode at Light Loads
- up to 97% Efficiency
- Available in a 6-Pin SOT23-6 Package

APPLICATIONS

- Battery-Powered Equipment
- Set-Top Boxed
- LCD Bais Supply
- DSL and Cable Modems and Routers
- Networking cards powered from PCI or PCI express slots

GENERAL DESCRIPTION

The MT3608 is a constant frequency, 6-pin SOT23 current mode step-up converter intended for small, low power applications. The MT3608 switches at 1.2MHz and allows the use of tiny, low cost capacitors and inductors 2mm or less in height. Internal soft-start results in small inrush current and extends battery life.

The MT3608 features automatic shifting to pulse frequency modulation mode at light loads. The MT3608 includes under-voltage lockout, current limiting, and thermal overload protection to prevent damage in the event of an output overload. The MT3608 is available in a small 6-pin SOT-23 package.

TYPICAL APPLICATION

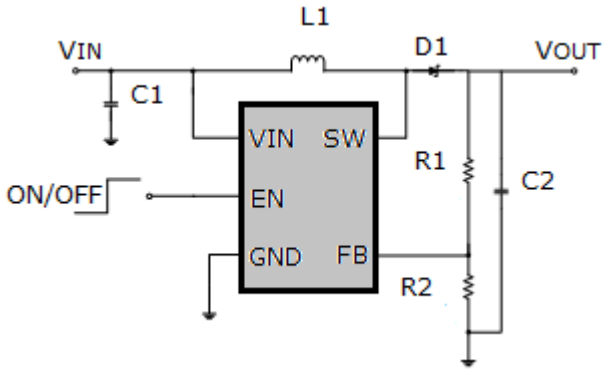


Figure 1. Basic Application Circuit

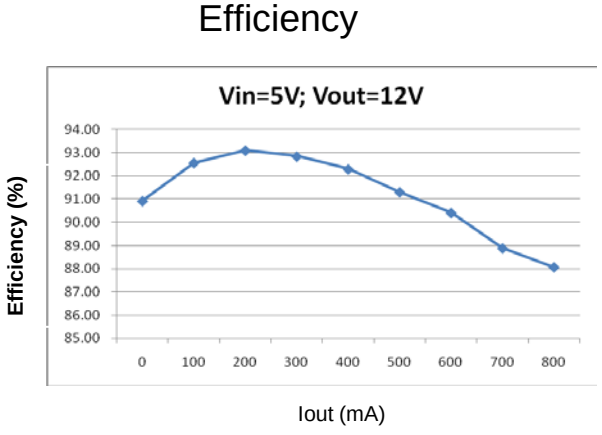
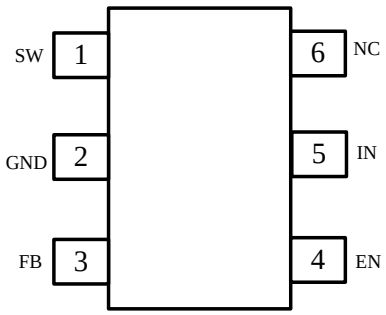


Figure 2. Efficiency Curve

ABSOLUTE MAXIMUM RATINGS

IN, EN voltages …… -0.3V to 26V
Operating Temperature…... -40°C to +85°C
FB Voltages .....-0.3V to 6V
Junction Temperature ……...160°C
SW Voltage ……..-0.3V to 30V
Storage Temperature Range -65°C to 150°C
Peak SW Sink and Source Current ……4A
Lead Temperature (Soldering, 10s) ...+300°C

PACKAGE/ORDER INFORMATION



SOT23-6
(MT3608)

PIN DESCRIPTION

PIN	NAME	FUNCTION
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 28V.
2	GND	Ground Pin
3	FB	Feedback Input. The FB voltage is 0.6V. Connect a resistor divider to FB.
4	EN	Regulator On/Off Control Input. A high input at EN turns on the converter, and a low input turns it off. When not used, connect EN to the input supply for automatic startup.
5	IN	Input Supply Pin. Must be locally bypassed.
6	NC	NC

ELECTRICAL CHARACTERISTICS

(V_{IN}=V_{EN}=5V, T_A = 25°C, unless otherwise noted.)

Parameter	Conditions	MIN	TYP	MAX	unit
Operating Input Voltage		2		24	V
Under Voltage Lockout				1.98	V
Under Voltage Lockout Hysteresis			100		mV
Current (Shutdown)	V_{EN}= 0V		0.1	1	μA
Quiescent Current (PFM)	V_{FB}=0.7V， No switch		100	200	μA
Quiescent Current (PWM)	V_{FB}=0.5V， switch		1.6	2.2	mA
Switching Frequency			1.2		MHz
Maximum Duty Cycle	V_{FB} = 0V	90			%
EN Input High Voltage		1.5			V
EN Input Low Voltage				0.4	V
FB Voltage		0.588	0.6	0.612	V
FB Input Bias Current	V_{FB} = 0.6V	-50	-10		nA
SW On Resistance (1)			80	150	mΩ
SW Current Limit (1)	V_{IN}= 5V, Duty cycle=50%		4		A
SW Leakage	V_{SW} = 20V			1	μA
Thermal Shutdown			155		℃

Note:

1) Guaranteed by design, not tested.

OPERATION

The MT3608 uses a fixed frequency, peak current mode boost regulator architecture to regulate voltage at the feedback pin. The operation of the MT3608 can be understood by referring to the block diagram of Figure 3. At the start of each oscillator cycle the MOSFET is turned on through the control circuitry. To prevent sub-harmonic oscillations at duty cycles greater than 50 percent, a stabilizing ramp is added to the output of the current sense amplifier and the result is fed into the negative input of the PWM comparator. When this voltage equals

The output voltage of the error amplifier the power MOSFET is turned off. The voltage at the output of the error amplifier is an amplified version of the difference between the 0.6V bandgap reference voltage and the feedback voltage. In this way the peak current level keeps the output in regulation. If the feedback voltage starts to drop, the output of the error amplifier increases. These results in more current to flow through the power MOSFET, thus increasing the power delivered to the output. The MT3608 has internal soft start to limit the amount of input current at startup and to also limit the amount of overshoot on the output.

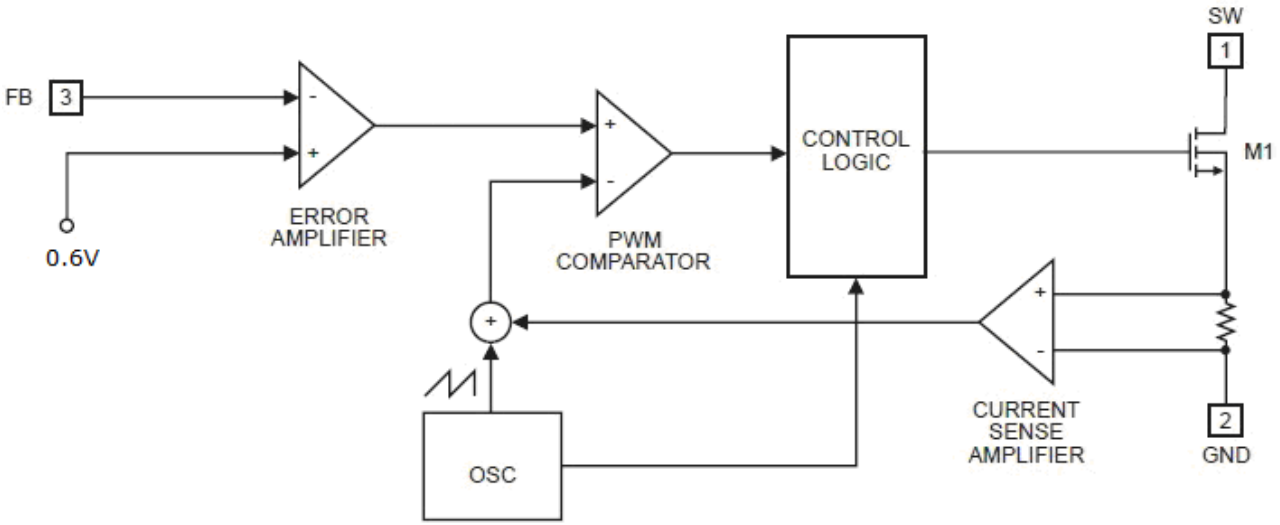
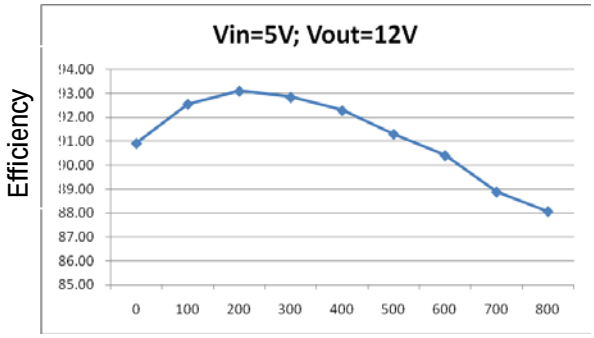


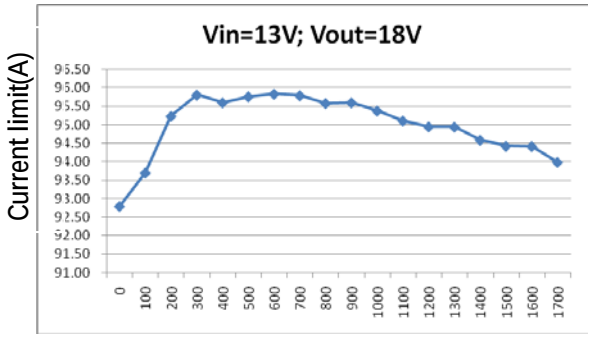
Figure 3. Functional Block Diagram

TYPICAL OPERATING CHARACTERISTICS

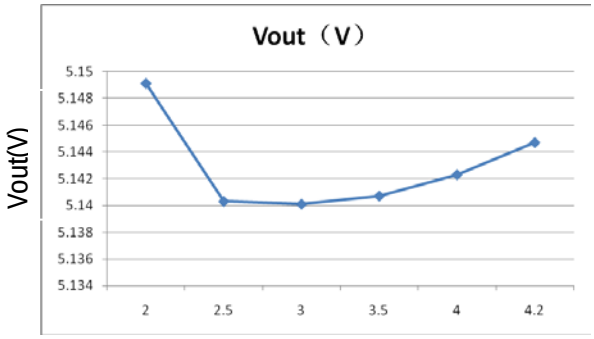
Efficiency Curve



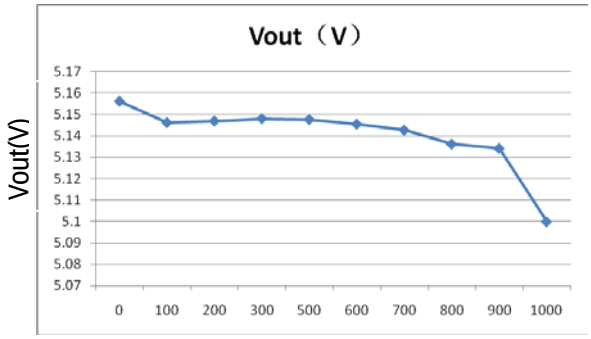
Efficiency Curve



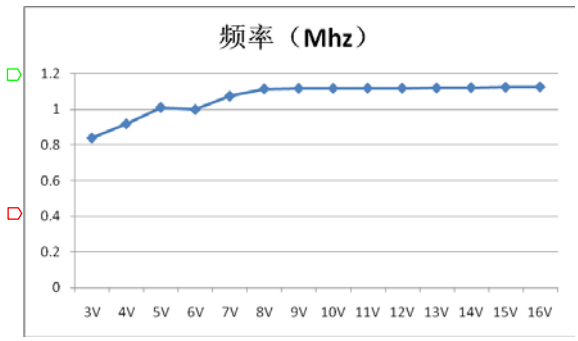
line Regulation



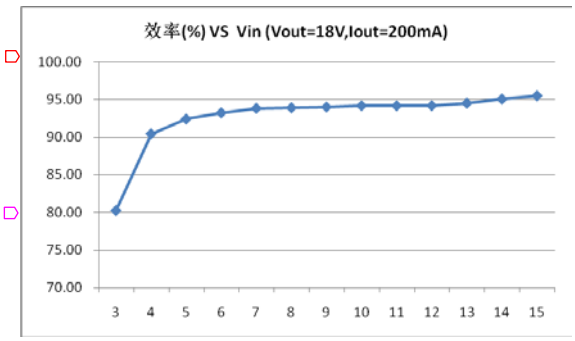
Load regualation



Freq VS Vin



Efficiency VS Vin



APPLICATION INFORMATION

Setting the Output Voltage

The internal reference VREF is 0.6V (Typical).The output voltage is divided by a resistor divider,R1 and R2 to the FB pin. The output voltage is given by

$$V_{OUT} = V_{REF} \times (1 + \frac{R_1}{R_2})$$

Inductor Selection

The recommended values of inductor are 4.7 to 22μH. Small size and better efficiency are the major concerns for portable device, such as MT3608 used for mobile phone. The inductor should have low core loss at 1.2MHz and low DCR for better efficiency. To avoid inductor saturation current rating should be considered.

Capacitor Selection

Input and output ceramic capacitors of 22μF are recommended for MT3608 applications. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

Diode Selection

Schottky diode is a good choice for MT3608 because of its low forward voltage drop and fast reverses recovery. Using Schottky diode can get better efficiency. The high speed rectification is also a good characteristic of Schottky diode for high switching frequency. Current rating of the diode must meet the root mean square of the peak current and output average current multiplication as following :

$$I_D(RMS) \approx \sqrt{I_{OUT} \times I_{PEAK}}$$

The diode' s reverse breakdown voltage should be larger than the output voltage.

Layout Consideration

For best performance of the MT3608, the following guidelines must be strictly followed.

- Input and Output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
- The GND should be connected to a strong ground plane for heat sinking and noise protection.
- Keep the main current traces as possible as short and wide.
- SW node of DC-DC converter is with high frequency voltage swing. It should be kept at a small area.
- Place the feedback components as close as possible to the IC and keep away from the noisy devices.

PACKAGE DESCRIPTION

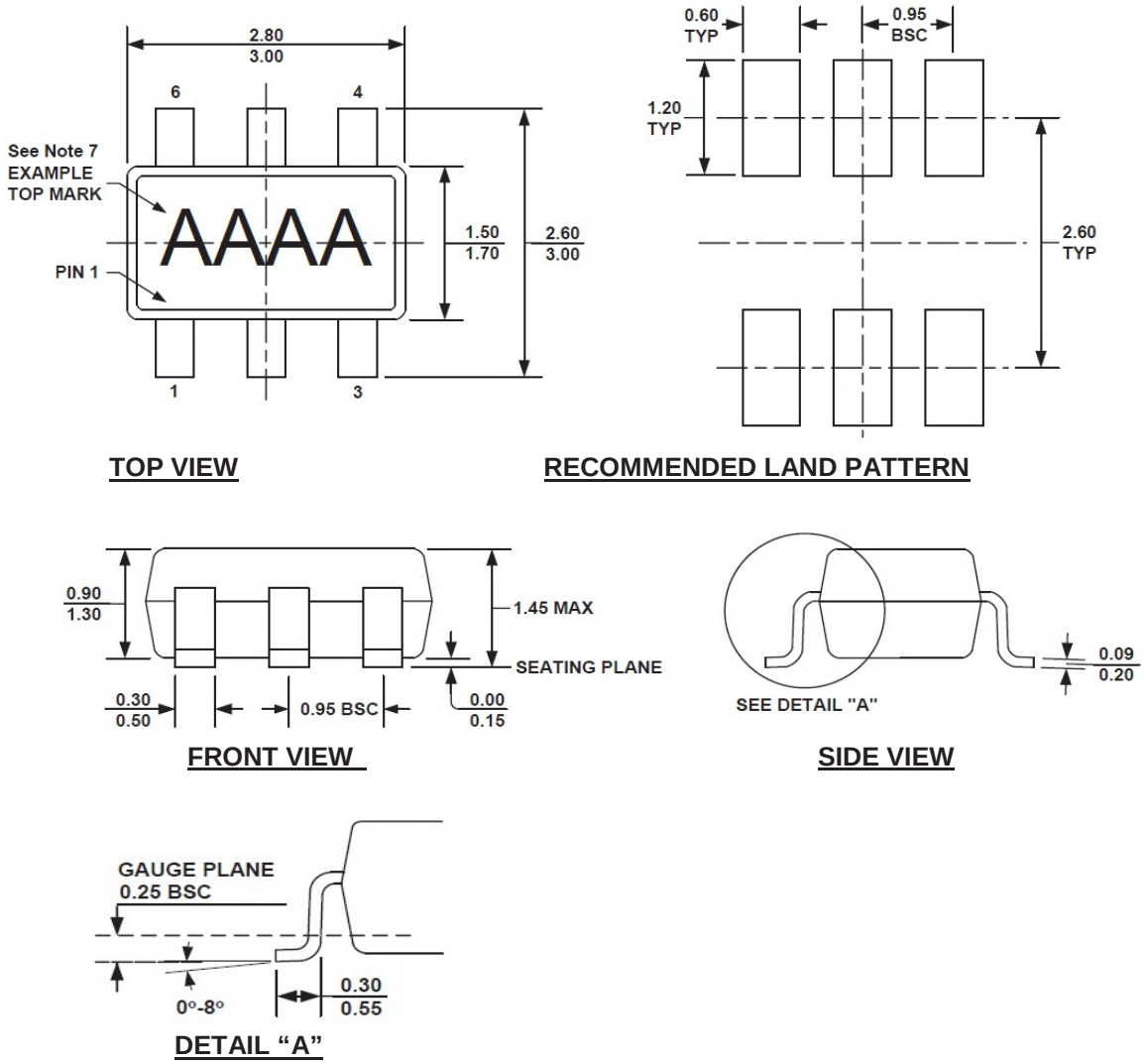


Figure 4. TSOT23-6/SOT23-6 Physical Dimensions

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-193, VARIATION AB.

6) DRAWING IS NOT TO SCALE.

7) PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT, (SEE EXAMPLE TOP MARK)

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1.5MHz, 2A Synchronous Step-Down Converter

FEATURES

- High Efficiency: Up to 96%
- 1.5MHz Constant Frequency Operation
- 2A Output Current
- No Schottky Diode Required
- 2.3V to 6V Input Voltage Range
- Output Voltage as Low as 0.6V
- PFM Mode for High Efficiency in Light Load
- 100% Duty Cycle in Dropout Operation
- Low Quiescent Current: 40μA
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- <1μA Shutdown Current
- SOT23-6 package

APPLICATIONS

- Cellular and Smart Phones
- Wireless and DSL Modems
- PDAs
- Portable Instruments
- Digital Still and Video Cameras
- PC Cards

GENERAL DESCRIPTION

The MT3420B is a 1.5MHz constant frequency, current mode step-down converter. It is ideal for portable equipment requiring very high current up to 2A from single-cell Lithium-ion batteries while still achieving over 90% efficiency during peak load conditions. The MT3420B also can run at 100% duty cycle for low dropout operation, extending battery life in portable systems while light load operation provides very low output ripple for noise sensitive applications. The MT3420B can supply up to 2A output load current from a 2.3V to 6V input voltage and the output voltage can be regulated as low as 0.6V. The high switching frequency minimizes the size of external components while keeping switching losses low. The internal slope compensation setting allows the device to operate with smaller inductor values to optimize size and provide efficient operation. The M3420B is offered in a low profile (1mm) 6-pin, thin SOT package, and is available in an adjustable version.

This device offers two operation modes, PWM control and PFM Mode switching control, which allows a high efficiency over the wider range of the load.

TYPICAL APPLICATION

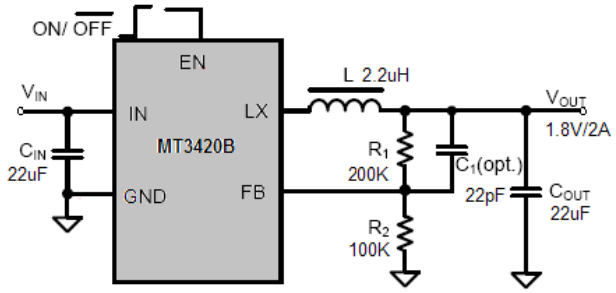
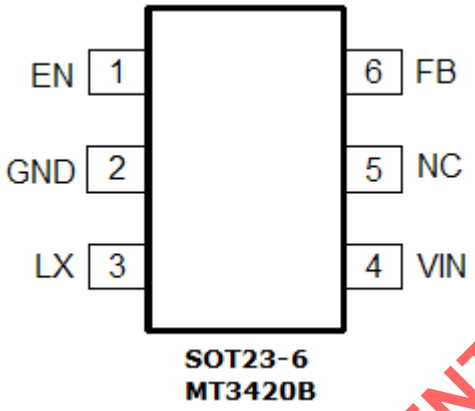


Figure 1. Basic Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage …… -0.3V to 6.5V
EN,FB Voltages…….-0.3 to (Vin+0.3V)
LX Voltage ……-0.3V to (Vin+0.3V)
Operating Temperature Range ... -40°C to +85°C
Lead Temperature(Soldering,10s) ……..+300°C
Storage Temperature Range ……-65°C to 150°C

PIN CONFIGURATION



SOT23-6
MT3420B

PIN DESCRIPTION

NAME	PIN	FUNCTION
EN	1	Chip Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.3V to turn it off. Do not leave EN floating.
GND	2	Analog ground pin.
LX	3	Power Switch Output. It is the switch node connection to Inductor. This pin connects to the drains of the internal P-ch and N-ch MOSFET switches.
VIN	4	Analog supply input pin.
NC	5	No Connect.
FB	6	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

ELECTRICAL CHARACTERISTICS (Note 3)

2

(V_{IN}=V_{EN}=3.6V, V_{OUT}=1.8V, T_A = 25°C, unless otherwise noted.)

Parameter	Conditions	MIN	TYP	MAX	unit
Input Voltage Range		2.3		6	V
UVLO Threshold		1.7	1.9	2.1	V
Input DC Supply Current	(Note 4)				μA
PWM Mode	Vout = 90%, Iload=0mA		150	300	μA
PFM Mode	Vout = 105%, Iload=0mA		40	75	μA
Shutdown Mode	V_{EN} = 0V, V_{IN}=4.2V		0.1	1.0	μA
Regulated Feedback Voltage VFB	T_A = 25°C	0.588	0.600	0.612	V
	T_A = 0°C ≤ T_A ≤ 85°C	0.586	0.600	0.613	V
	T_A = -40°C ≤ T_A ≤ 85°C	0.585	0.600	0.615	V
Reference Voltage Line Regulation	Vin=2.5V to 5.5V		0.1		%/V
Output Voltage Accuracy	V_{IN} = 2.5V to 5.5V, Iout=10mA to 2000mA	-3		+3	%Vout
Output Voltage Load Regulation	Iout=10mA to 2000mA		0.2		%/A
Oscillation Frequency	Vout=100%		1.5		MHz
	Vout=0V		300		kHz
On Resistance of PMOS	I_{LX}=100mA		100	150	mΩ
On Resistance of NMOS	I_{LX}=-100mA		90	150	mΩ
Peak Current Limit	V_{IN}= 3V, Vout=90%		4		A
EN Threshold		0.30	1.0	1.50	V
EN Leakage Current			±0.01	±1.0	μA
LX Leakage Current	V_{EN}=0V,V_{IN}=V_{LX}=5V		±0.01	±1.0	μA

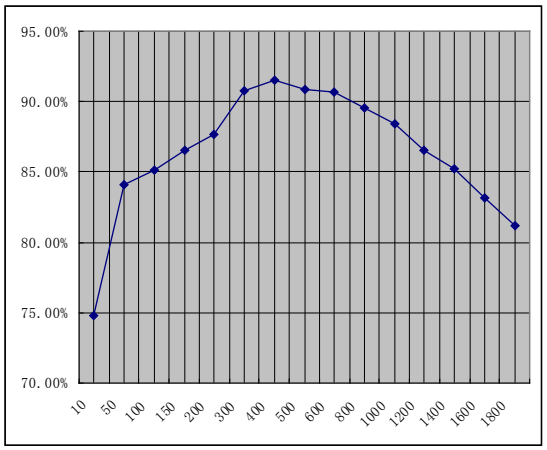
Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: T_J = TA + (PD) x (250°C/W).

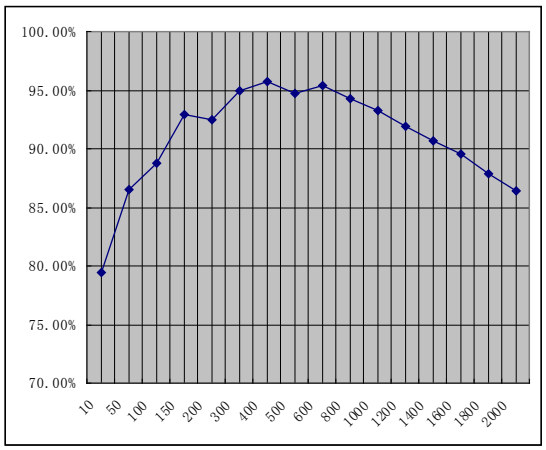
Note3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

Note 4: Dynamic supply current is higher due to the gate charge being delivered at the switching frequency.

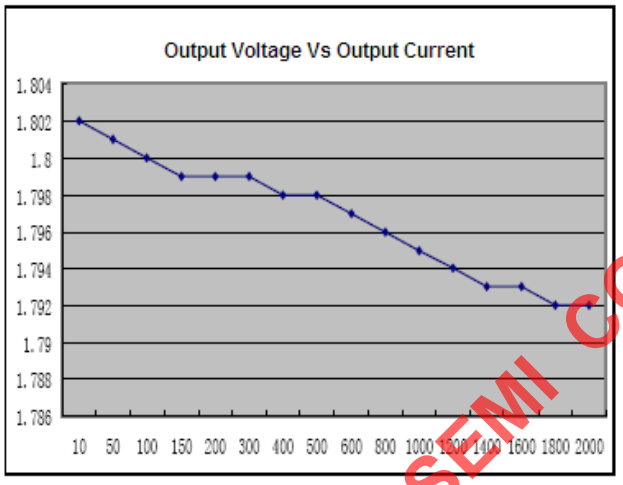
TYPICAL PERFORMANCE CHARACTERISTICS



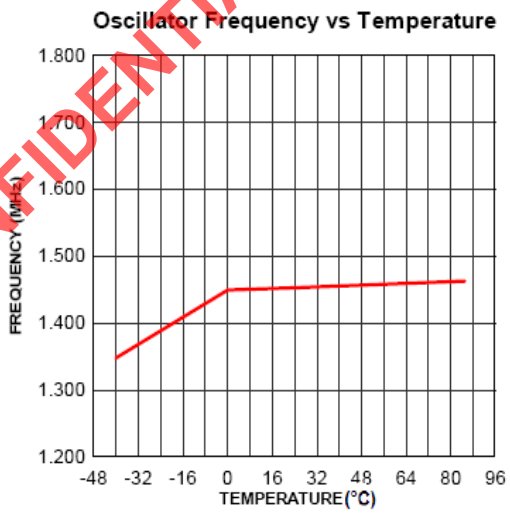
Vin=5V, Vout=1.8V

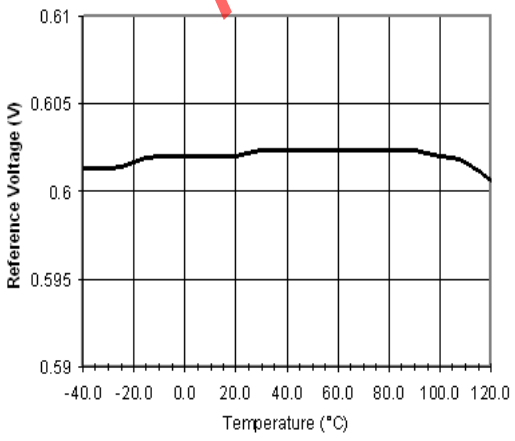


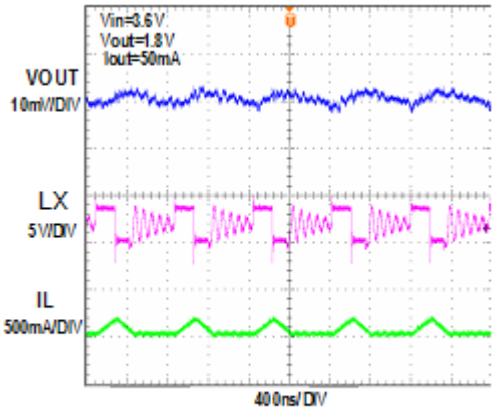
Vin=5V, Vout=3.3V



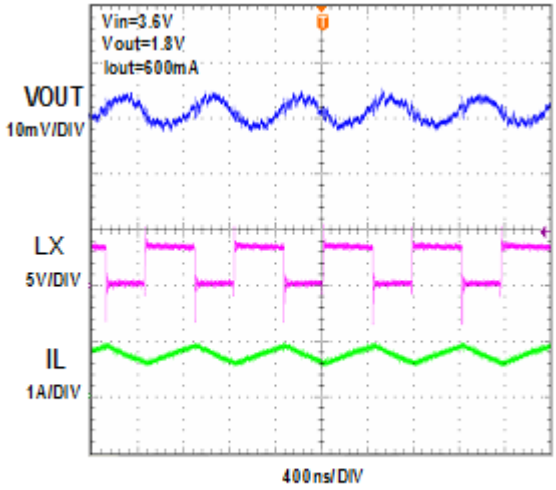
Vin=3.6V,Vout=1.8V



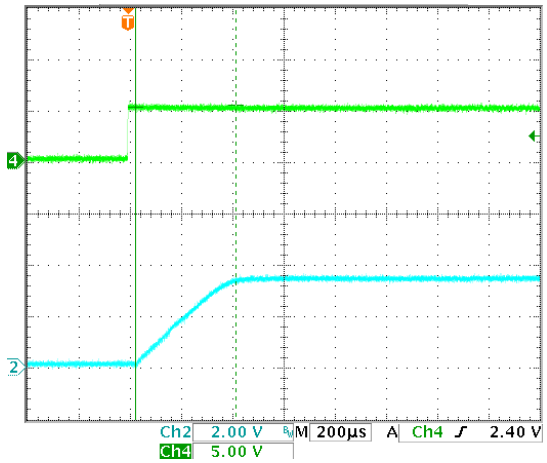




PFM MODE



PWM MODE



Start-Up

FUNCTIONAL BLOCK DIAGRAM

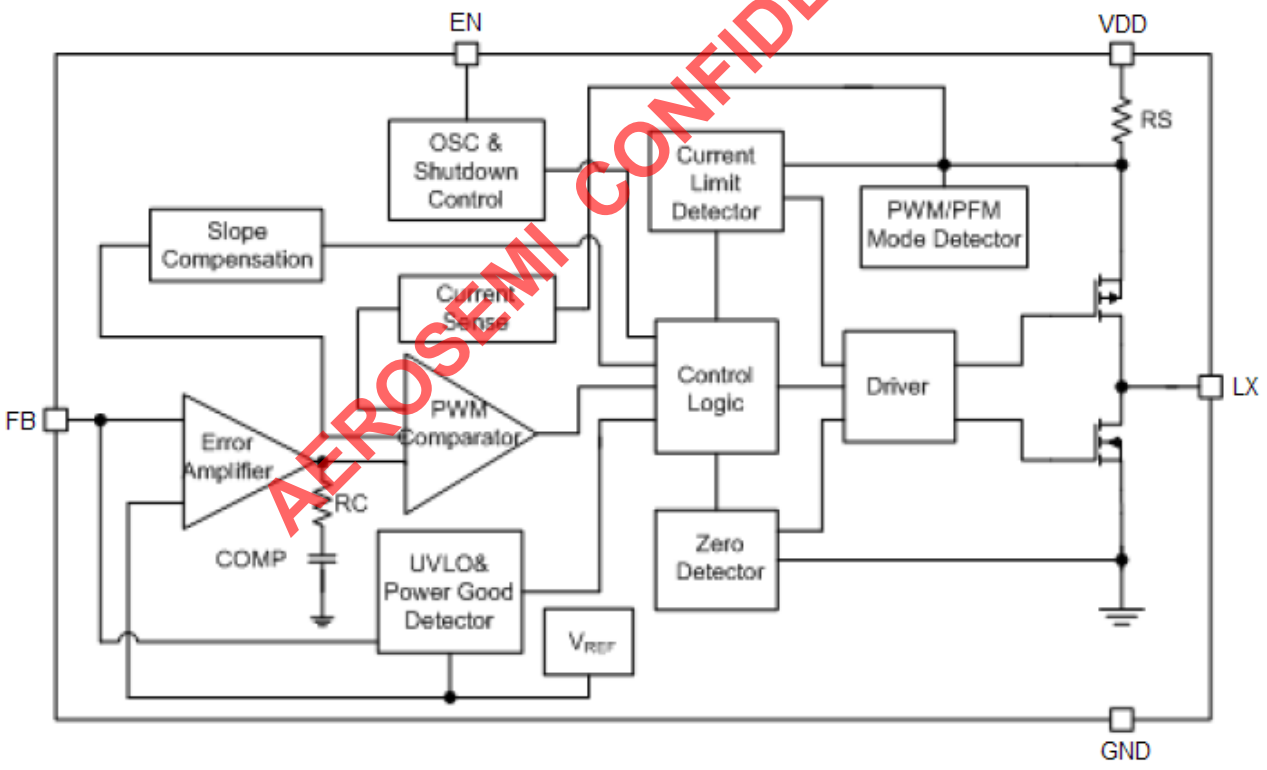


Figure2. MT3420B Block Diagram

FUNCTIONAL DESCRIPTION

The MT3420B is a high output current monolithic switch mode step-down DC-DC converter. The device operates at a fixed 1.5MHz switching frequency, and uses a slope compensated current mode architecture. This step-down DC-DC converter can supply up to 2A output current at VIN = 3.6V and has an input voltage range from 2.3V to 6V. It minimizes external component size and optimizes efficiency at the heavy load range. The slope compensation allows the device to remain stable over a wider range of inductor values so that smaller values (1μH to 4.7μH) with lower DCR can be used to achieve higher efficiency. Only a small bypass input capacitor is required at the output. The adjustable output voltage can be programmed with external feedback to any voltage, ranging from 0.6V to near the input voltage. It uses internal MOSFETs to achieve high efficiency and can generate very low output voltages by using an internal reference of 0.6V. At dropout operation, the converter duty cycle increases to100% and the output voltage tracks the input voltage minus the low RDS(ON) drop of the P-channel high-side MOSFET and the inductor DCR. The internal error amplifier and compensation provides excellent transient response, load and line regulation. Internal soft start eliminates any output voltage overshoot when the enable or the input voltage is applied.

Setting the Output Voltage

Figure 1 shows the basic application circuit for the MT3420B. The MT3420B can be externally programmed. Resistors R1 and R2 in Figure 1 program the output to regulate at a voltage higher than 0.6V. To limit the bias current required for the external feedback resistor string while maintaining good noise immunity, the minimum suggested value for R2 is 59kΩ. Although a larger value will further reduce quiescent current, it will also increase the impedance of the feedback node, making it more sensitive to external noise and interference. Table 1 summarizes the resistor values for various output voltages with R2 set to either 59kΩ for good noise immunity or 316kΩ for reduced no load input current. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.6 \times (1 + \frac{R_1}{R_2})$$

$$R_1 = (V_{OUT} / 0.6 - 1) \times R_2$$

Table 1 shows the resistor selection for different output voltage settings.

V_{OUT} (V)	R2 = 59kΩ R1 (kΩ)	R2 = 316kΩ R1 (kΩ)
0.8	19.6	105
0.9	29.4	158
1.0	39.2	210
1.1	49.9	261
1.2	59.0	316
1.3	68.1	365
1.4	78.7	422
1.5	88.7	475
1.8	118	634
1.85	124	655
2.0	137	732
2.5	187	1000
3.3	267	1430

Table 1: Resistor selections for different output voltage settings (standard 1% resistors substituted for calculated values).

APPLICATIONS INFORMATION

Inductor Selection

For most designs, the MT3420B operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

Manufacturer	*Part Number*	*Ind (uH)*	*DCR (Ohm)*	*Max DC Current(A)*	*Size L*W*H(mm3)*
Sumida	CDRH5D16	2.2	28.7	3	5.8x5.8x1.8
		3.3	35.6	2.6	
		4.7	19	3.4	8.3x8.3x3.0
Sumida	CDRH5D16	2.2	23	3.3	5.2x5.2x3.0
		3.3	29	2.6	
		4.7	39	2.1	

Table2.Recommend Surface Mount Inductors

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 22μF ceramic capacitor for most applications is sufficient. A large value may be used for improved input voltage filtering.

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings. The output ripple ΔV_{OUT} is determined by:

$$\Delta V_{OUT} \le \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(ESR + \frac{1}{8 \times f_{osc} \times C3} \right)$$

A 22μF ceramic can satisfy most applications.

PCB Layout Recommendations

When laying out the printed circuit board, the following checking should be used to ensure proper operation of the MT3420B. Check the following in your layout:

1. The power traces, consisting of the GND trace, the LX trace and the VIN trace should be kept short, direct and wide.
2. Does the (+) plates of Cin connect to Vin as closely as possible. This capacitor provides the AC current to the internal power MOSFETs.
3. Keep the switching node, LX, away from the sensitive VOUT node.
4. Keep the (-) plates of Cin and Cout as close as possible

PACKAGE DESCRIPTION

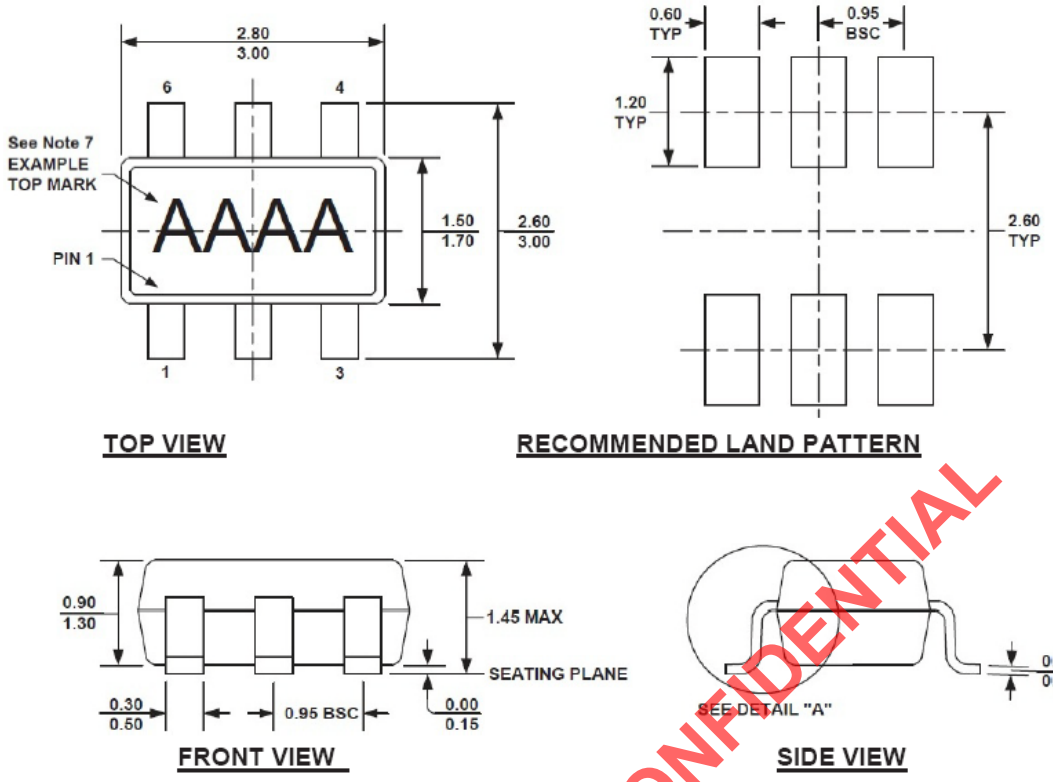


Figure 9. TSOT23-6/SOT23-6 Physical Dimensions

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-193, VARIATION AB.
6) DRAWING IS NOT TO SCALE.
7) PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT, (SEE EXAMPLE TOP MARK)

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