AT7109

Dual 1.5MHz, 800mA Synchronous Step-Down Converter

Immense Advance Tech.

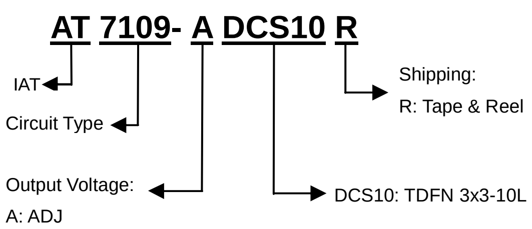
FEATURES

- High Efficiency: Up to 93%
- 800mA Output Current
- 2.5V to 5.5V Input Voltage Range
- 1.5MHz Constant Frequency Operation
- No Schottky Diode Required
- Low Dropout Operation: 100% Duty Cycle
- 0.6V Reference Allows Low Output Voltages
- Shutdown Mode Draws ≤ 1uA Supply Current
- Current Mode Operation for Excellent Line and Load Transient Response
- Thermal Fault Protection
- Short Circuit Protection

APPLICATION

- Cellular Telephones
- Wireless and DSL Modems
- Digital Still Cameras
- Mp3 Players
- Portable Instruments
- Microprocessors and DSP Core Supplies

ORDER INFORMATION



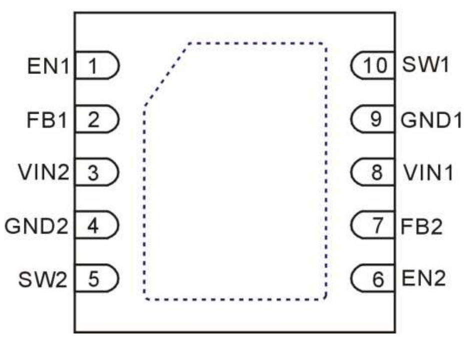
DESCRIPTION

The AT7109 is a dual channel, constant frequency, synchronous step-down DC/DC converter. Intended for low power applications, it operates from 2.5V to 5.0V input voltage range and has a constant 1.5MHz switching frequency, enabling the use of tiny, low cost capacitors and inductors 1mm or less in height. Each output voltage is adjustable from 0.6V to 4.2V. Internal synchronous 0.35Ω, 1A power switches provide high efficiency without the need for external Schottky diodes.

The current mode operation achieves fast line and load transient response. To maximize battery life, the p-channel MOSFETs are turned on continuously in dropout (100% duty cycle), and both channels draw a total quiescent current of only 250μA for each output. In shutdown, the device draws <1μA.

PIN CONFIGURATIONS (TOP VIEW)

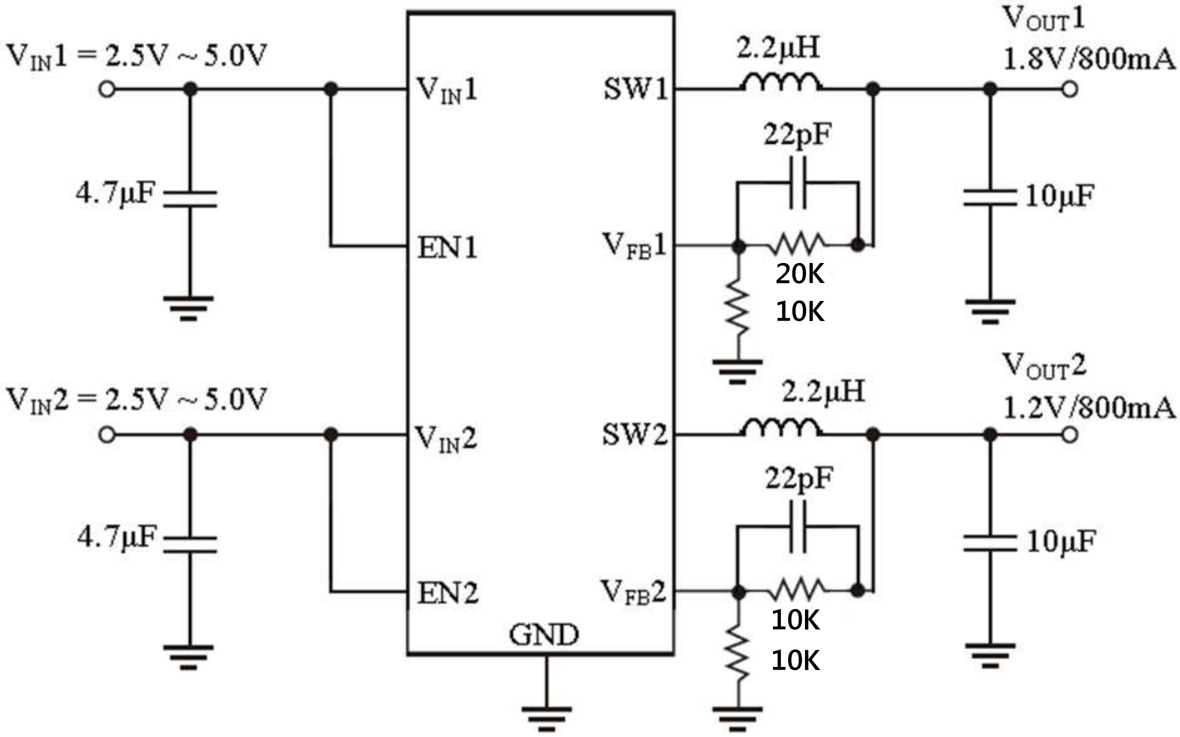
TDFN 3x3-10L



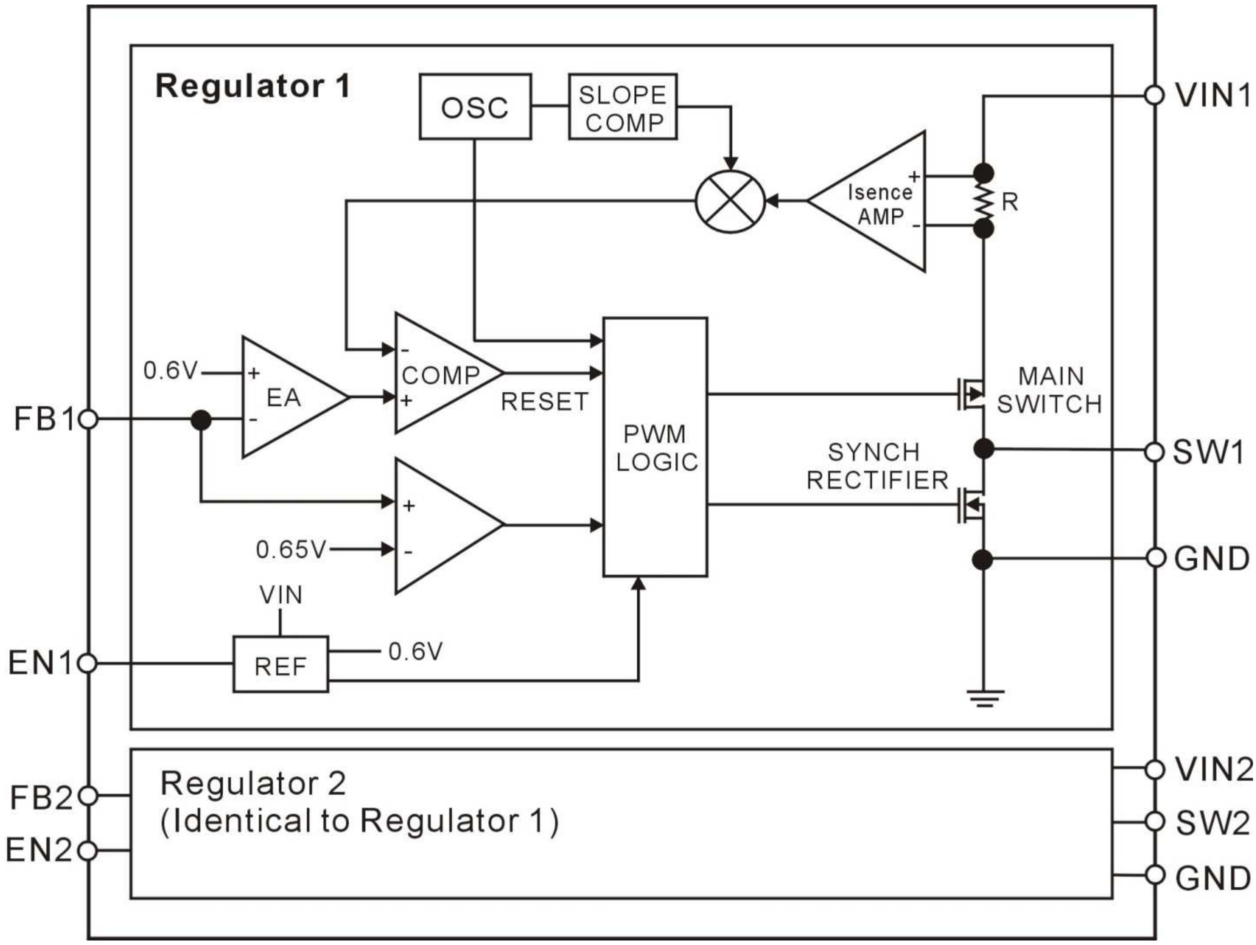
PIN DESCRIPTIONS

Pin Name	Pin Description
EN1/ EN2	Regulator Enable Control Input. Drive EN above 1.5V to turn on the part. Drive EN below 0.3V to turn it off. In shutdown, all functions are disabled and supply current < 1μA. Do not leave EN floating.
GND	Ground.
SW1/ SW2	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.
$V_{IN}1$/ $V_{IN}2$	Supply Input Pin. Must be closely decoupled to GND.
$V_{FB}1$/ $V_{FB}2$	Feedback Input Pin. Connect V_{FB} to the center point of the external resistive divider.

TYPICAL APPLICATION CIRCUIS



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Note 1)

Parameter	Range	Unit
$V_{IN}1$, $V_{IN}2$	-0.3 to 6.0	V
EN1, SW1, $V_{FB}1$	-0.3 to $V_{IN}1$+0.3	V
EN2, SW2, $V_{FB}2$	-0.3 to $V_{IN}2$+0.3	V
Peak SW Current	1.3	A
Operating Temperature Range	-40 to 85	℃
Storage Temperature Range	-65 to 150	℃
Lead Temperature (Soldering, 5 sec)	260	℃
Thermal Resistance TDFN 3x3-10L(Note 2)	43	℃/ W

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

Note 2: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

ELECTRICAL CHARACTERISTICS

Specifications with standard type face are for T_A= 25℃, and those with **boldface type** apply over **Full Operating Temperature Range**.

V_{IN}=3.6V, L=2.2μH, C_{OUT}=10μF unless otherwise specified.

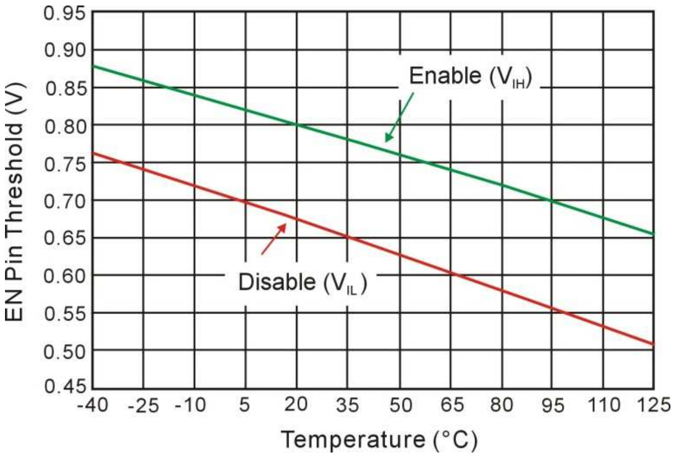
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		5.5	V
Quiescent Current	I_Q	I_{OUT}= 0mA, V_{FB}= V_{REF} + 5% (Note3)		250		μA
Shutdown Current	I_{SHDN}	EN= GND		0.1	1	μA
Regulated Feedback Voltage	V_{FB}	T_A= +25℃	0.5880	0.6000	0.6120	V
V_{FB} Input Bias Current	I_{FB}	V_{FB} =0.65V			±30	nA
Reference Voltage Line Regulation(Adj)	REG_{LINE}	V_{IN}=2.5V to 5.5V, V_{OUT}= V_{FB}		0.11	0.4	%/V
Reference Voltage Load Regulation(Adj)	REG_{LOAD}	Iout=10mA to 800mA		0.5		%
Peak Inductor Current	I_{PK}	V_{IN}=3V, V_{FB}=0.5V or V_{OUT}=90% Duty cycle<35%		1.3		A
Oscillator Frequency	F_{OSC}	V_{FB}=0.6V or V_{OUT}=100%	1.2	1.5	1.8	MHz
$R_{DS(ON)}$ of P-CH MOSFET	R_{PFET}	I_{SW}=300mA		0.4	0.5	Ω
$R_{DS(ON)}$ of N-CH MOSFET	R_{NFET}	I_{SW}=-300mA		0.35	0.45	Ω
SW Leakage	I_{LSW}	V_{EN}=0V, V_{SW}=0V or 5V, V_{IN}=5V		±0.01	±1	μA
EN Threshold	V_{EN}	-40℃ ≤T_A≤85℃	0.3	1.0	1.5	V
EN Leakage Current	I_{EN}			±0.01	±1	μA

Note 3: SW pin open, supply current is measured without switching loss.

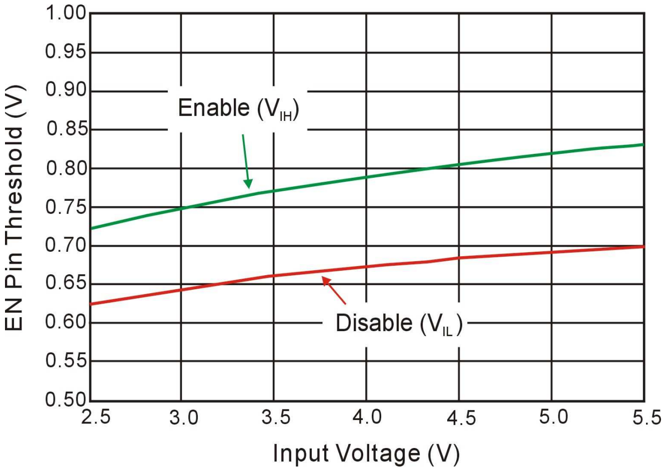
TYPICAL OPERATING CHARACTERISTICS

(1) EN Pin Threshold vs. Temperature

V_{IN}= 3.6V, V_{OUT}= 1.2V

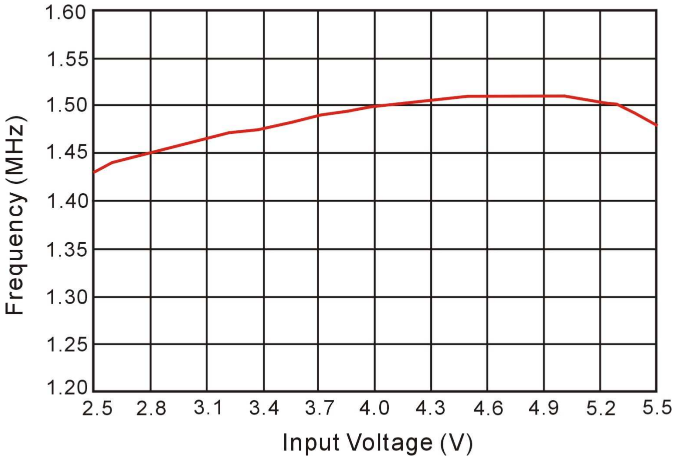


(2) EN Pin Threshold vs. Input Voltage



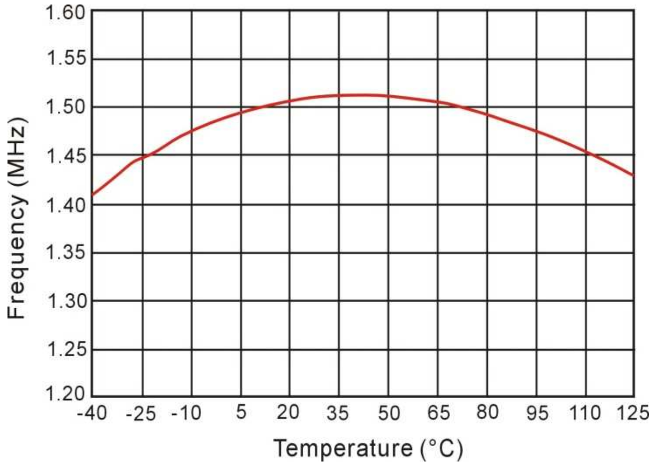
(3) Switching Frequency vs. Input Voltage

V_{OUT}= 1.2V, I_{OUT}= 300mA

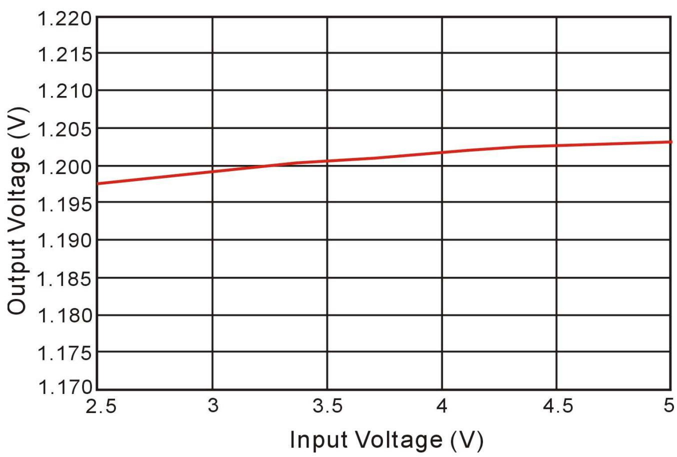


(4) Switching Frequency vs. Temperature

V_{OUT}= 1.2V, I_{OUT}= 300mA

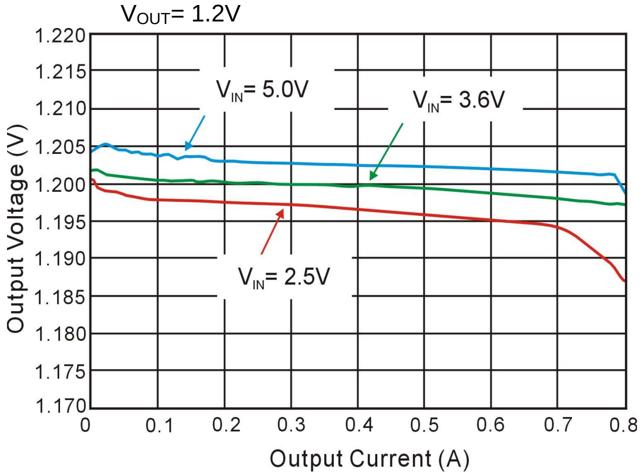


(5) Output Voltage vs. Input Voltage



(6) Output Voltage vs. Output Current

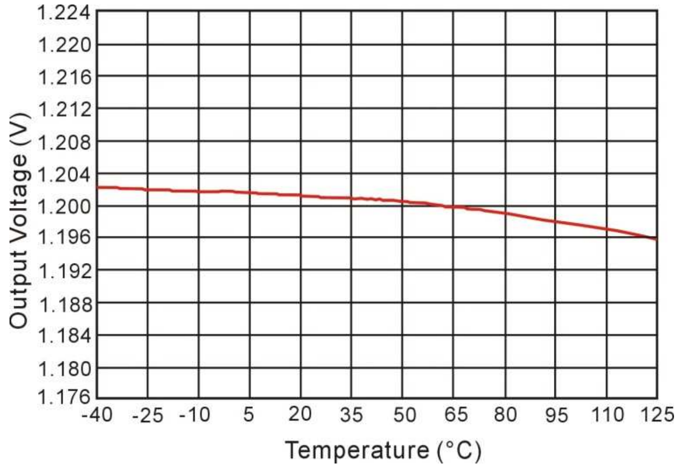
V_{OUT}= 1.2V



TYPICAL OPERATING CHARACTERISTICS (CONTINUED)

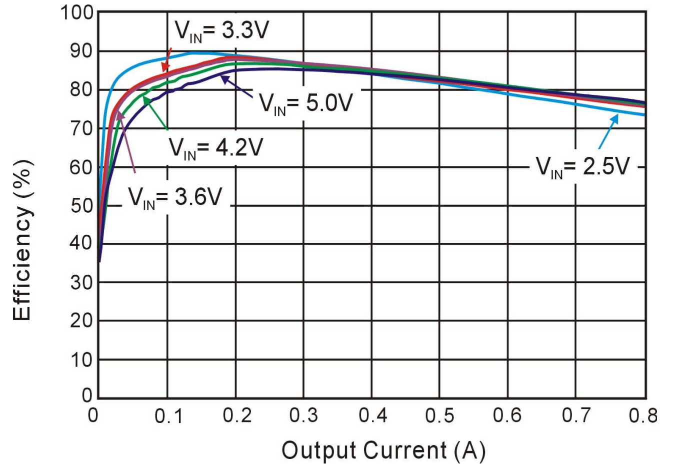
(7) Output Voltage vs. Temperature

V_{IN}= 3.6V, V_{OUT}= 1.2V



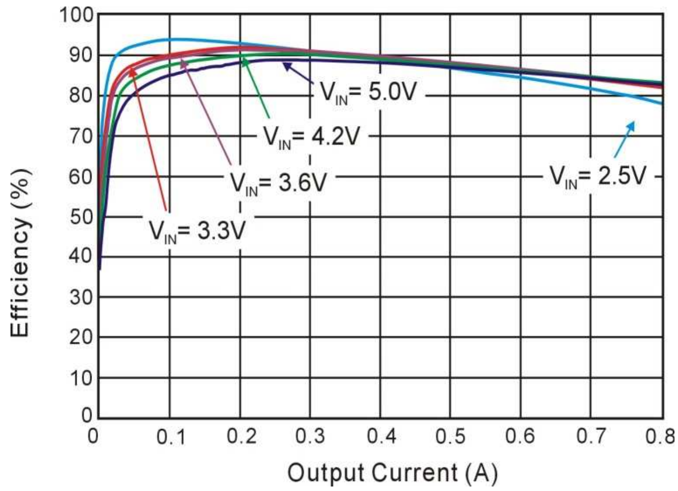
(8) Efficiency vs. Output Current

V_{OUT}= 1.2V, C_{IN}= 10μF, C_{OUT}= 10μF, L= 2.2μH



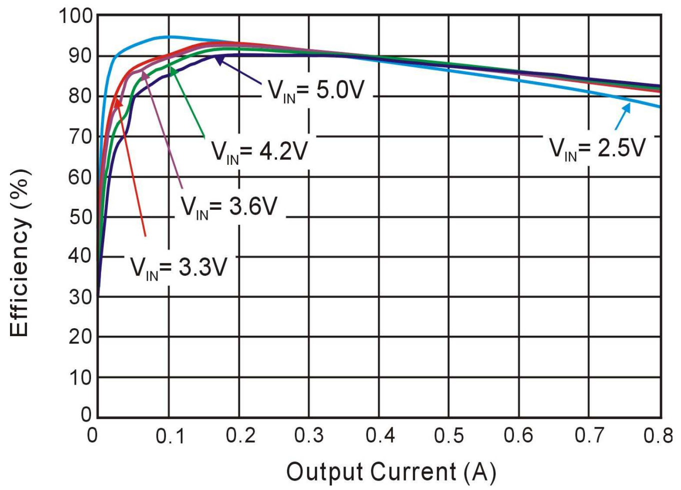
(9) Efficiency vs. Output Current

V_{OUT}= 1.8V, C_{IN}= 10μF, C_{OUT}= 10μF, L= 2.2μH



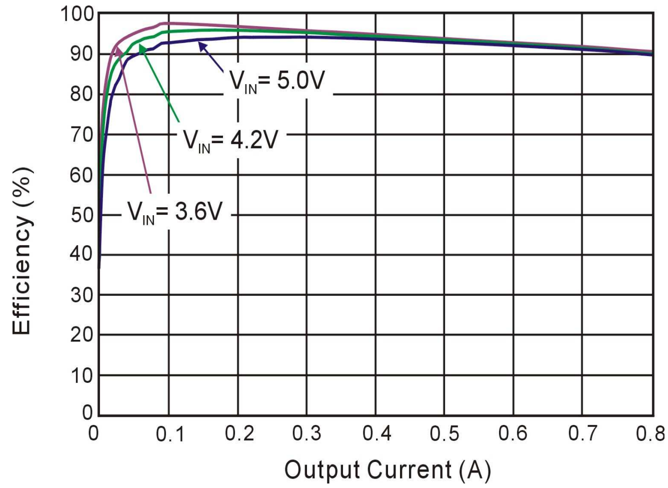
(10) Efficiency vs. Output Current

V_{OUT}= 1.8V, C_{IN}= 10μF, C_{OUT}= 10μF, L= 4.7μH



(11) Efficiency vs. Output Current

V_{OUT}= 3.3V, C_{IN}= 10μF, C_{OUT}= 10μF, L= 2.2μH



APPLICATION INFORMATION

Operation

The AT7109 is a dual channel switching mode Step-Down DC-DC converter. It utilizes internal MOSFETs to achieve high efficiency and can generate very low output voltage by using internal reference at 0.6V. It operates at a fixed switching frequency, and uses the slope compensated current mode architecture.

Current Mode PWM Control

Slope compensated current mode PWM control provides stable switching and cycle-by-cycle current limit for excellent load and line responses and protection of the internal main switch (P-Ch MOSFET) and synchronous rectifier (N-Ch MOSFET). During normal operation, the internal P-Ch MOSFET is turned on for a certain time to ramp the inductor current at each rising edge of the internal oscillator, and switched off when the peak inductor current is above the error voltage. The current comparator, I_{COMP}, limits the peak inductor current. When the main switch is off, the synchronous rectifier will be turned on immediately and stay on until either the inductor current starts to reverse. The OVDET comparator controls output transient overshoots by turning the main switch off and keeping it off until the fault is no longer present.

Dropout Operation

When the input voltage decreases toward the value of the output voltage, the AT7109 allows the main switch to remain on for more than one switching cycle and increases the duty cycle until it reaches 100%. The output voltage then is the input voltage minus the voltage drop across the main switch and the inductor.

At low input supply voltage, the $R_{DS(ON)}$ of the P-Ch MOSFET increases, and the efficiency of the converter decreases. Caution must be exercised to ensure the heat dissipated not to exceed the maximum junction temperature of the IC.

Note 3. The duty cycle D of a step-down converter is defined as:

$$D = T_{ON} \times f_{OSC} \times 100\% \approx \frac{V_{OUT}}{V_{IN}} \times 100\%$$

Where T_{ON} is the main switch on time, and f_{OSC} is the oscillator frequency (1.5Mhz).

Maximum Load Current

The AT7109 will operate with input supply voltage as low as 2.5V, however, the maximum load current decreases at lower input due to large IR drop on the main switch and synchronous rectifier. The slope compensation signal reduces the peak inductor current as a function of the duty cycle to prevent sub-harmonic oscillations at duty cycles greater than 50%. Conversely the current limit increases as the duty cycle decreases.

Short-Circuit Protection

A current limit (1.3A) circuit is equipped in the AT7109, to protect the AT7109 when the output pin is shorted to GND pin. This current limit will suppress the output current so that the inductor current has enough time to decay.

Setting the Output Voltage

Figure 2 above shows the basic application circuit with AT7109 adjustable output version. R2 should be smaller than 100kΩ for reasons of stability. The external resistor sets the output voltage according to the following equation:

APPLICATION INFORMATION (CONTINUED)

$$V_{OUT} = 0.6V(1+\frac{R1}{R2})$$

R2=10kΩ for all outputs

R1=10kΩ for V_{OUT}=1.2V

R1=15kΩ for V_{OUT}=1.5V

R1=20kΩ for V_{OUT}=1.8V

R1=31.6kΩ for V_{OUT}=2.5V

R1=45kΩ for V_{OUT}=3.3V

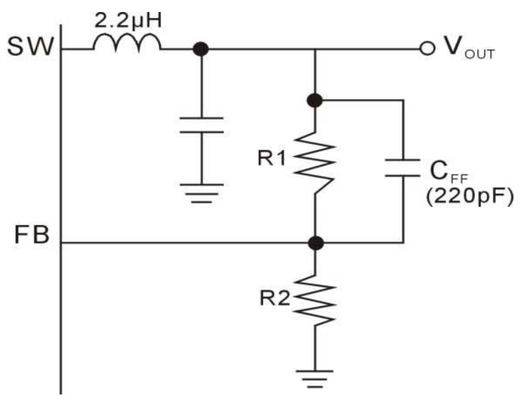


Figure 2.

To add a feed-forward capacitor (C_{FF}) between V_{OUT} and V_{FB} is recommended. The C_{FF} can advantage transient response and stability.

Input Capacitor Selection

A current limit (1.3A) circuit is equipped in the 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 shall 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 4.7μF ceramic capacitor for most applications is sufficient.

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. The output ripple $\triangle V_{OUT}$ is determined by :

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

Inductor Selection

For most designs, the AT7109 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:

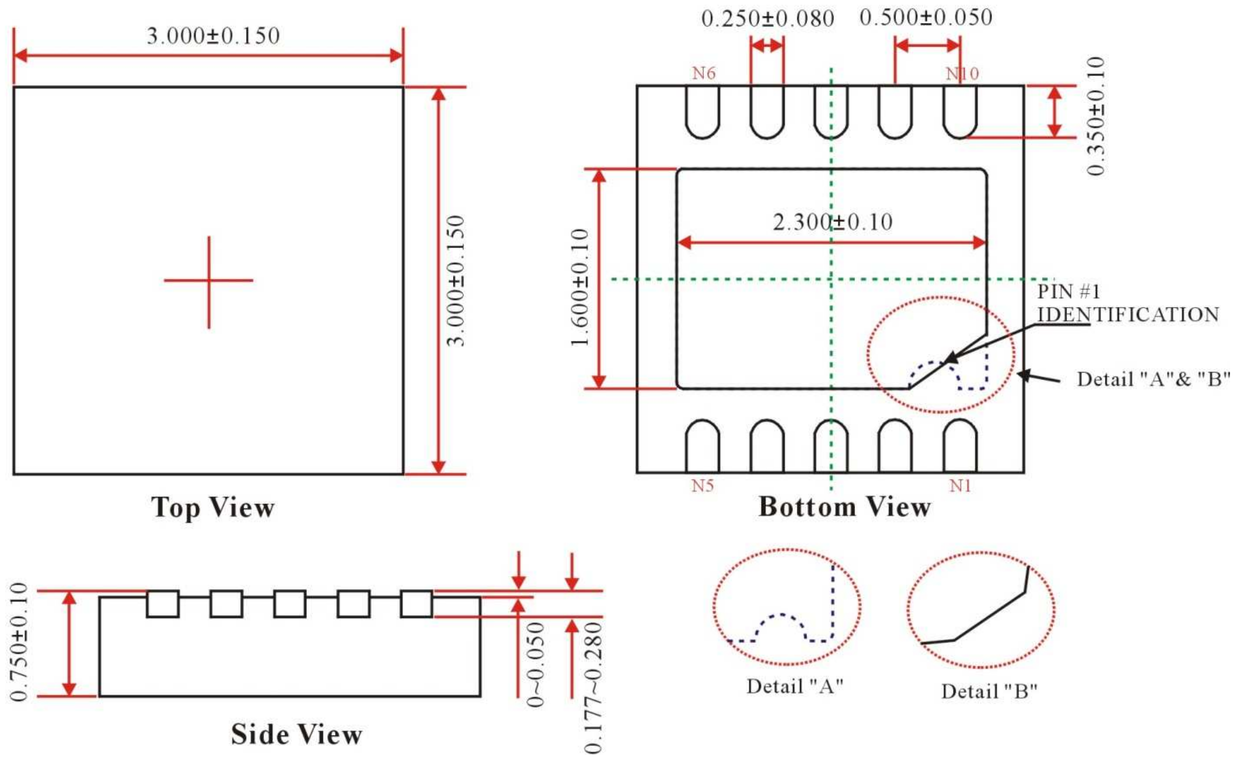
$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where $\triangle I_L$ is inductor Ripple Current. Large value inductors lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately 35% of the maximum load current 800mA.

For output voltages above 2.0V, the minimum recommended inductor is 2.2μH. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range. For higher efficiency at heavy loads (above 200mA), or minimal load regulation (but some transient overshoot), the resistance should be kept below 100mΩ. The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation.

PACKAGE OUTLINE DIMENSIONS

TDFN 3x3-10L PACKAGE OUTLINE DIMENSIONS



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