Figure 1. Physical Photos of AT3408

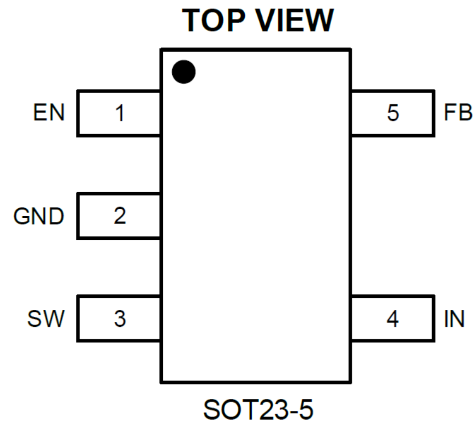


Figure 2. Pin Configuration

ORDERING GUIDE

Online Stores		Commission Fee	Unit Price (June 2024)	Buy Now
AS	shop.analogtechnologies **Our own online store**	Zero sale commission	$0.30/PCs (≥100PCs)	*
SZ	SMTZone **Our own online store**	Zero sale commission	$0.30/PCs (≥100PCs)	*
K	Digikey	≈40% sale commission	$0.42/PCs (≥100PCs)	*
a	Amazon	≈57% sale commission	$0.47/PCs (≥100PCs)	*

FEATURES

- High Efficiency: Up to 96%
- 2.5V to 5.5V Input Voltage Range
- 1.5MHz Constant Frequency Operation
- No Schottky Diode Required
- Low Dropout Operation: 100% Duty Cycle
- PFM Mode for High Efficiency in Light Load
- Over Temperature Protected
- Low Quiescent Current: 40μA
- Short Circuit Protection
- Inrush Current Limit and Soft Start
- 1A Continuous Output Current
- SOT23-5 Package

APPLICATIONS

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

DESCRIPTION

The AT3408 is a high-efficiency monolithic synchronous buck regulator using a constant frequency, current mode architecture. The device is available in an adjustable version. Supply current with no load is 40uA and drops to <1uA in shutdown. The 2.5V to 5.5V input voltage range makes the AT3408 ideally suited for single Li-Ion battery powered applications. 100% duty cycle provides low dropout operation, extending battery life in portable systems. PWM/PFM mode operation provides very low output ripple voltage for noise sensitive applications.

Switching frequency is internally set at 1.5MHz, allowing the use of small surface mount inductors and capacitors. Low output voltages are easily supported with the 0.6V feedback reference voltage.

The AT3408 is offered in a low profile (1mm) 5-pin, thin SOT package, and is available in an adjustable version.

TYPICAL APPLICATION

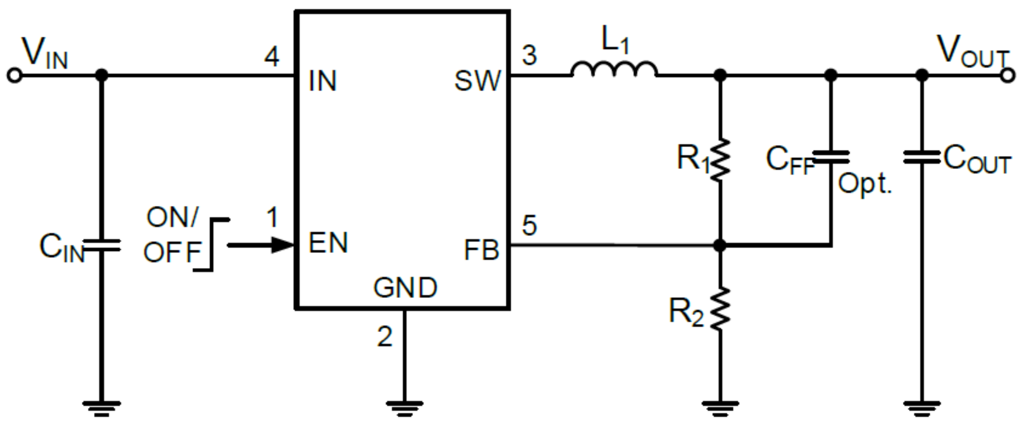


Figure 3. Typical Application Circuit

ABSOLUTE MAXIMUM RATING

Table 1.

Parameter	Value
Input Supply Voltage	−0.3V to 6V
EN, FB Voltage	−0.3V to 6V
SW Voltage	−0.3V to (V_{IN}+0.3V)
Peak SW Sink and Source Current	3A
Thermal Resistance (θJA)	170°C/W
ESD (HBM)	>2000V
Operating Ambient Temperature(T_A)	−40°C to +85°C
Junction Temperature(Note2)	125°C
Storage Temperature(T_S)	−65°C to +150°C
Lead Temperature & Time	300°C, 10s
Thermal Resistance(θJC)	130°C/W
ESD (MM)	200V

Note (1): Exceeding these ratings may damage the device.

Note (2): The device is not guaranteed to function outside of its operating conditions.

PIN DESCRIPTION

Table 2.

NO.	NAME	DESCRIPTION
1	EN	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.
2	GND	Ground Pin
3	SW	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.
4	IN	Power Supply Input. Must be closely decoupled to GND with a 10μF or greater ceramic capacitor.
5	FB	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

ELECTRICAL CHARACTERISTICS

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

Table 3.

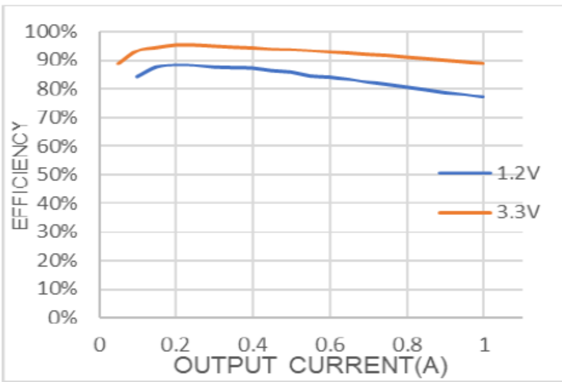
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}		2.5		5.5	V
UVLO Threshold	V_{UVLO}			2.4		V
Input DC Supply Current	I_{IN}	FB = 90%, I_{LOAD} = 0mA		150	300	μA
		FB = 105%, I_{LOAD} = 0mA		40	70	
		V_{EN} = 0V, V_{IN} = 4.2V		0.1	1.0	
Regulated Feedback Voltage	V_{FB}		0.588	0.600	0.612	V
Reference Voltage Line Regulation		V_{IN} = 2.5V to 5.5V		0.04	0.40	%/V
Output Voltage Line Regulation	LNR	V_{IN} = 2.5V to 5.5V		0.04	0.40	%
Output Voltage Load Regulation	LDR			0.5		%
Oscillation Frequency	F_{SOC}			1.5		MHz
PMOS Rdson	R_{DSON_P}	I_{SW} = 100mA		0.3		Ω
NMOS Rdson	R_{DSON_N}	I_{SW} = 100mA		0.2		Ω
Peak Current Limit	I_{LIMIT}	V_{IN} = 3.6V, FB = 90%	1.5			A
EN up Threshold			1.05	1.15	1.25	V
EN Threshold Hysteresis				140		mV
EN Leakage Current	I_{ENLK}			±0.01	±1.0	μA
SW Leakage Current	I_{SWLK}	V_{EN} = 6V, V_{IN} = V_{SW} = 5V		±0.01	±1.0	μA
Soft Start					1.2	Ms
Thermal Shutdown Temperature	T_{SD}			160		°C
Thermal Shutdown Hysteresis	T_{SH}			20		°C

TYPICAL CHARACTERISTICS

(At T_A = +25°C, V_{IN} =5V, V_{OUT} =3.3V, unless otherwise noted.)

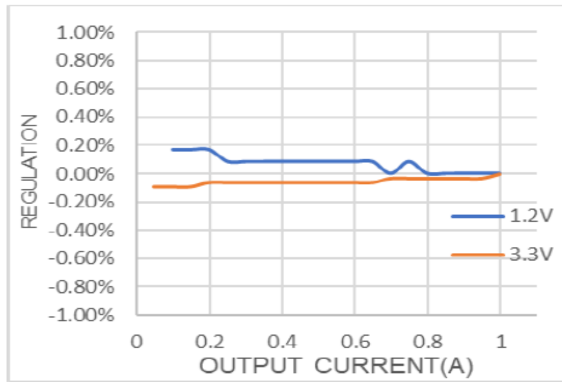
Efficiency vs Load Current

V_{OUT} = 3.3V , 1.2V



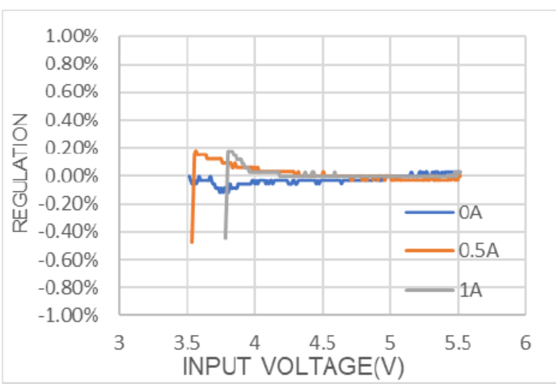
Load Regulation

V_{OUT} = 3.3V, 1.2V



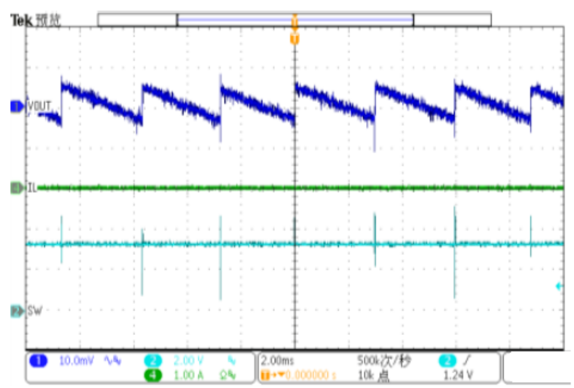
Line Regulation

V_{OUT} = 3.3V



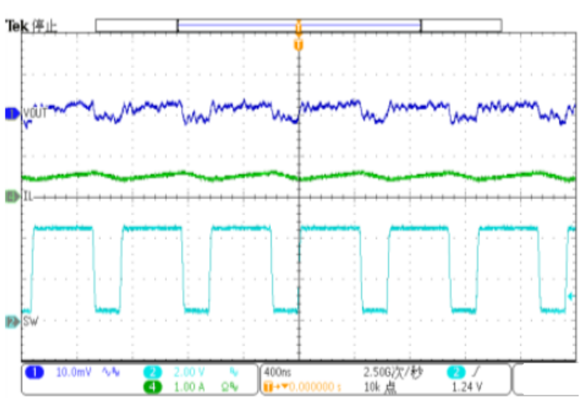
Output Ripple Voltage

V_{IN}=5V, V_{OUT}=3.3V, I_{OUT}=0A



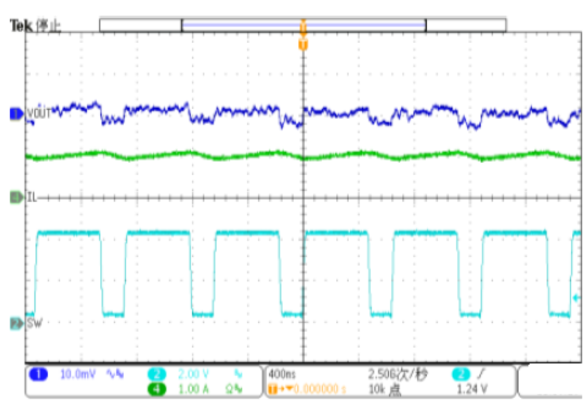
Output Ripple Voltage

V_{IN}=5V, V_{OUT}=3.3V, I_{OUT}=0.5A



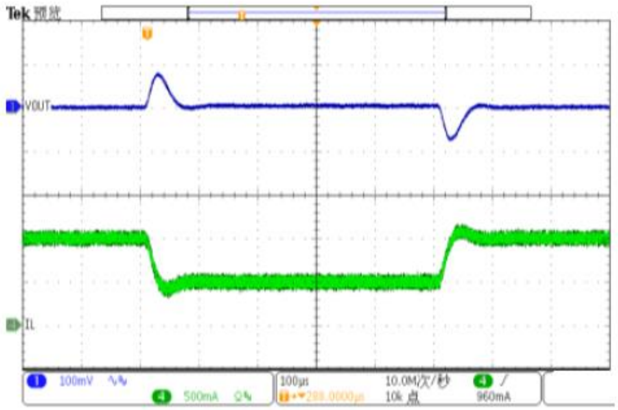
Output Ripple Voltage

V_{IN}=5V, V_{OUT}=3.3V, I_{OUT}=1A



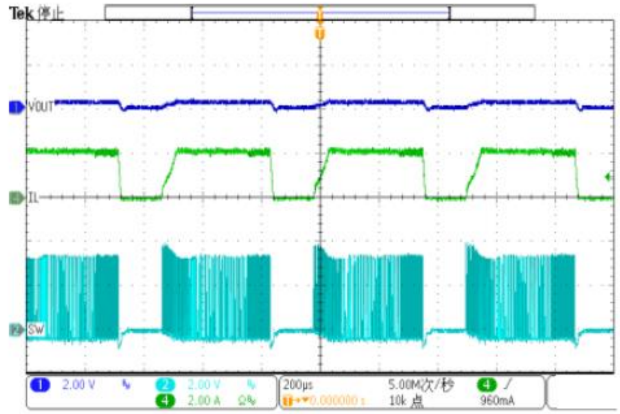
Loop Response

VIN = 5V, VOUT = 3.3V, IINDUCTOR =0.5A-1A



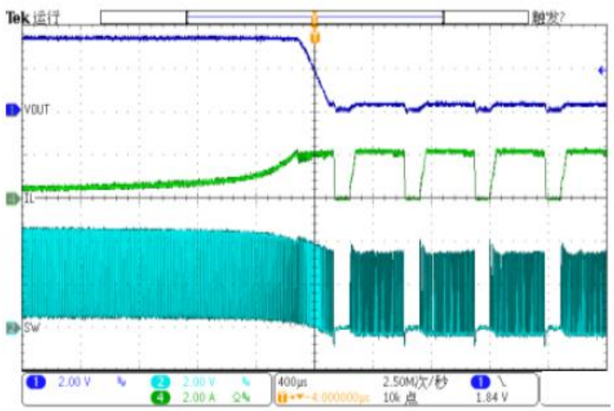
Hiccup with Output Short

VIN = 5V, VOUT = 3.3V



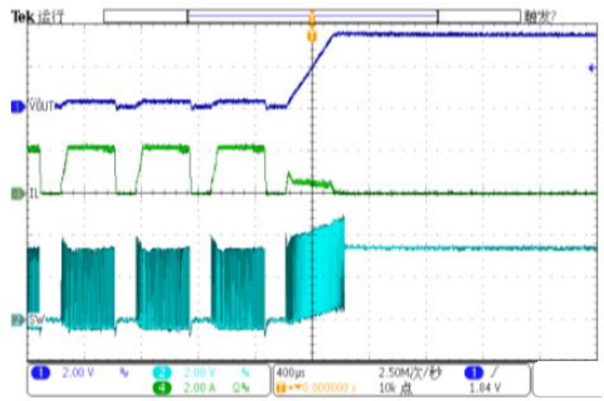
Short Circuit Entry

VIN = 5V, VOUT = 3.3V



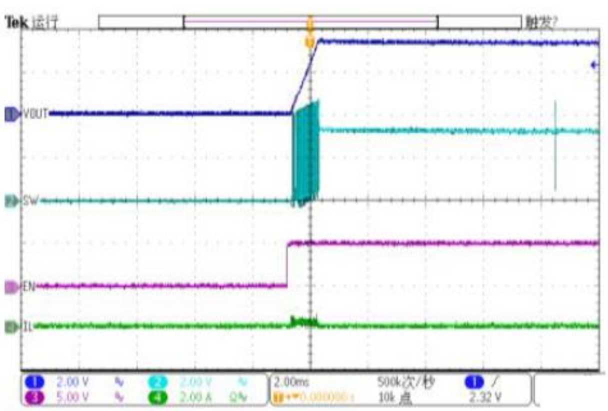
Short Circuit Recovery

VIN = 5V, VOUT = 3.3V



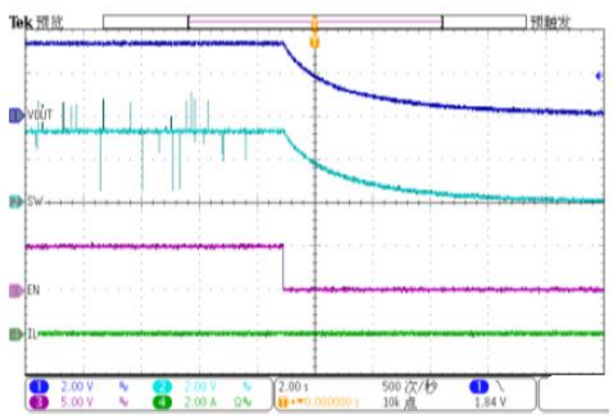
Enable Startup at No Load

VIN = 5V, VOUT = 3.3V



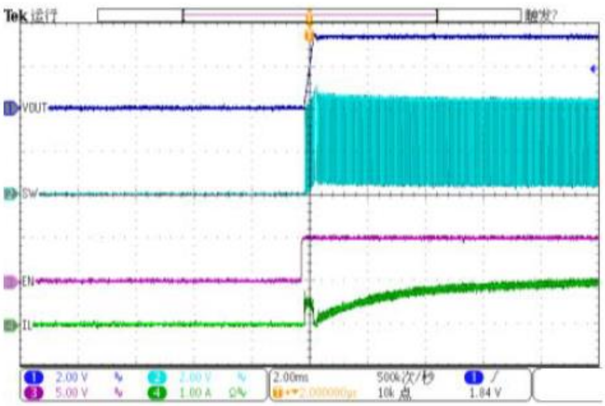
Enable Shutdown at No Load

VIN = 5V, VOUT = 3.3V



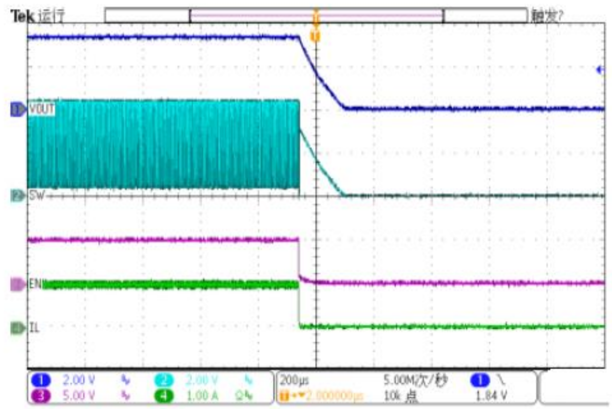
Enable Startup at Full Load

V_{IN} = 5V, V_{OUT} = 3.3V, $I_{INDUCTOR}$ =1A



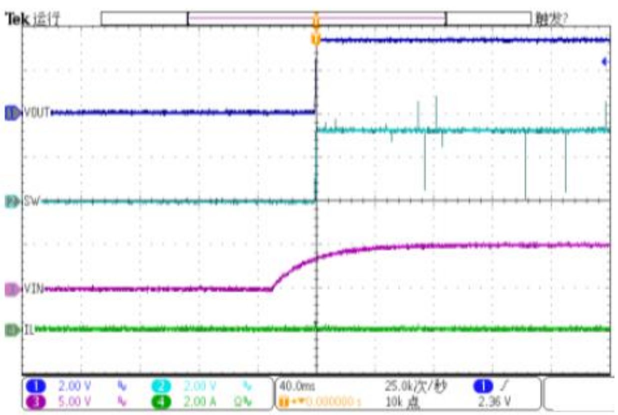
Enable Shutdown at Full Load

V_{IN} = 5V, V_{OUT} = 3.3V, $I_{INDUCTOR}$ =1A



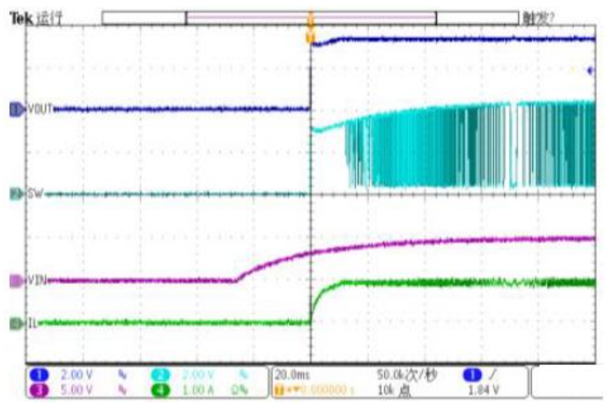
Power Up at No Load

V_{IN} = 5V, V_{OUT} = 3.3V, $I_{INDUCTOR}$ =0A



Power Up at Full Load

V_{IN} = 5V, V_{OUT} = 3.3V, $I_{INDUCTOR}$ =1A



BLOCK DIAGRAM

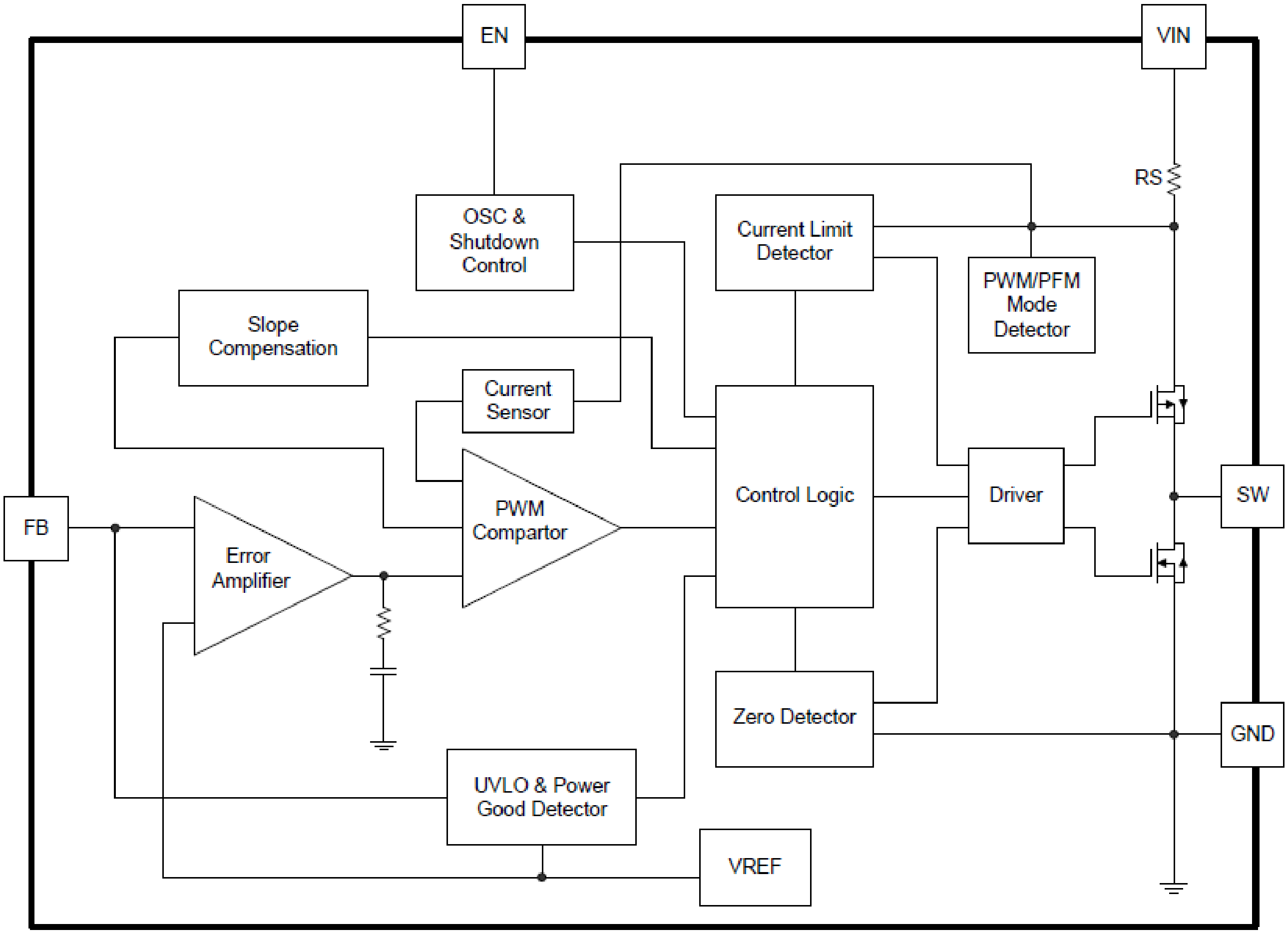


Figure 4. Block Diagram

FUNCTIONS DESCRIPTION

Internal Regulator

The AT3408 is a current mode step down DC/DC converter that provides excellent transient response with no extra external compensation components. This device contains an internal, low resistance, high voltage power MOSFET, and operates at a high 1.5MHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (V_{FB}) and outputs a current proportional to the difference between the two. This output current is then used to charge or discharge the internal compensation network, which is used to control the power MOSFET current. The optimized internal compensation network minimizes the external component counts and simplifies the control loop design.

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.6V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than REF, REF regains control. The SS time is internally max to 1.2ms.

Over Current Protection & Hiccup

The AT3408 has cycle-by-cycle over current limit when the inductor current peak value exceeds the set current limit threshold. Meanwhile, output voltage starts to drop until FB is below the Under-Voltage(UV) threshold, typically 25% below the reference. Once a UV is triggered, the AT3408 enters hiccup mode to periodically restart the part. This protection mode is especially useful when the output is dead-short to ground. The average short circuit current is greatly reduced to alleviate the thermal issue and to protect the regulator. The AT3408 exits the hiccup mode once the over current condition is removed.

Startup and Shutdown

If both V_{IN} and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first, generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator provides stable supply for the remaining circuitries. Three events can shut down the chip: EN low, V_{IN} low and thermal shutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering. The comp voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdown command.

APPLICATIONS INFORMATION

Setting the Output Voltage

AT3408 require an input capacitor, an output capacitor and an inductor. These components are critical to the performance of the device. AT3408 are internally compensated and do not require external components to achieve stable operation. The output voltage can be programmed by resistor divider.

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

VOUT	R1	R2	L1MIN	L1TYP	L1MAX	CIN	COUT	CFF Opt.
1.05V	7.5kΩ	10kΩ	1.0μH	2.2μH	4.7μH	20-47μF	20-68μF	20-1000pF
1.2V	10kΩ	10kΩ	1.0μH	2.2μH	4.7μH	20-47μF	20-68μF	20-1000pF
1.5V	15kΩ	10kΩ	1.0μH	2.2μH	4.7μH	20-47μF	20-68μF	20-1000pF
3.3V	45kΩ	10kΩ	1.0μH	4.7μH	6.8μH	20-47μF	20-68μF	20-1000pF

Setting the Output Voltage

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductor core does not saturate during any foreseeable operational situation. The inductor should be rated to handle the peak load current plus the ripple current: Care should be taken when reviewing the different saturation current ratings that are specified by different manufacturers. Saturation current ratings are typically specified at 25°C, so ratings at maximum ambient temperature of the application should be requested from the manufacturer.

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

Where ΔI_L is the inductor ripple current. Choose inductor ripple current to be approximately 30% if the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Selecting the Output Capacitor

Special attention should be paid when selecting these components. The DC bias of these capacitors can result in a capacitance value that falls below the minimum value given in the recommended capacitor specifications table.

The ceramic capacitor's actual capacitance can vary with temperature. The capacitor type X7R, which operates over a temperature range of −55°C to +125°C, will only vary the capacitance to within ±15%. The capacitor type X5R has a similar tolerance over a reduced temperature range of −55°C to +85°C. Many large value ceramic capacitors, larger than 1uF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance can drop by more than 50% as the temperature varies from 25°C to 85°C. Therefore X5R or X7R is recommended over Z5U and Y5V in applications where the ambient temperature will change significantly above or below 25°C.

Tantalum capacitors are less desirable than ceramic for use as output capacitors because they are more expensive when comparing equivalent capacitance and voltage ratings in the 0.47μF to 44μF range. Another important consideration is that tantalum capacitors have higher ESR values than equivalent size ceramics. This means that while it may be possible to find a tantalum capacitor with an ESR value within the stable range, it would have to be larger in capacitance (which means bigger and more costly) than a ceramic capacitor with the same ESR value. It should also be noted that the ESR of a typical tantalum will increase about 2:1 as the temperature goes from 25°C down to −40°C, so some guard band must be allowed.

PCB Layout Consideration

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance. If change is necessary, please follow these guidelines for reference.

1. Keep the path of switching current short and minimize the loop area formed by Input capacitor, high-side MOSFET and low-side MOSFET.

2. Bypass ceramic capacitors are suggested to be put close to the Vin Pin.

3. Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.

4. VOUT, SW away from sensitive analog areas such as FB.

Connect IN, SW, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.

OUTLINE DIMENSIONS

SOT23-5

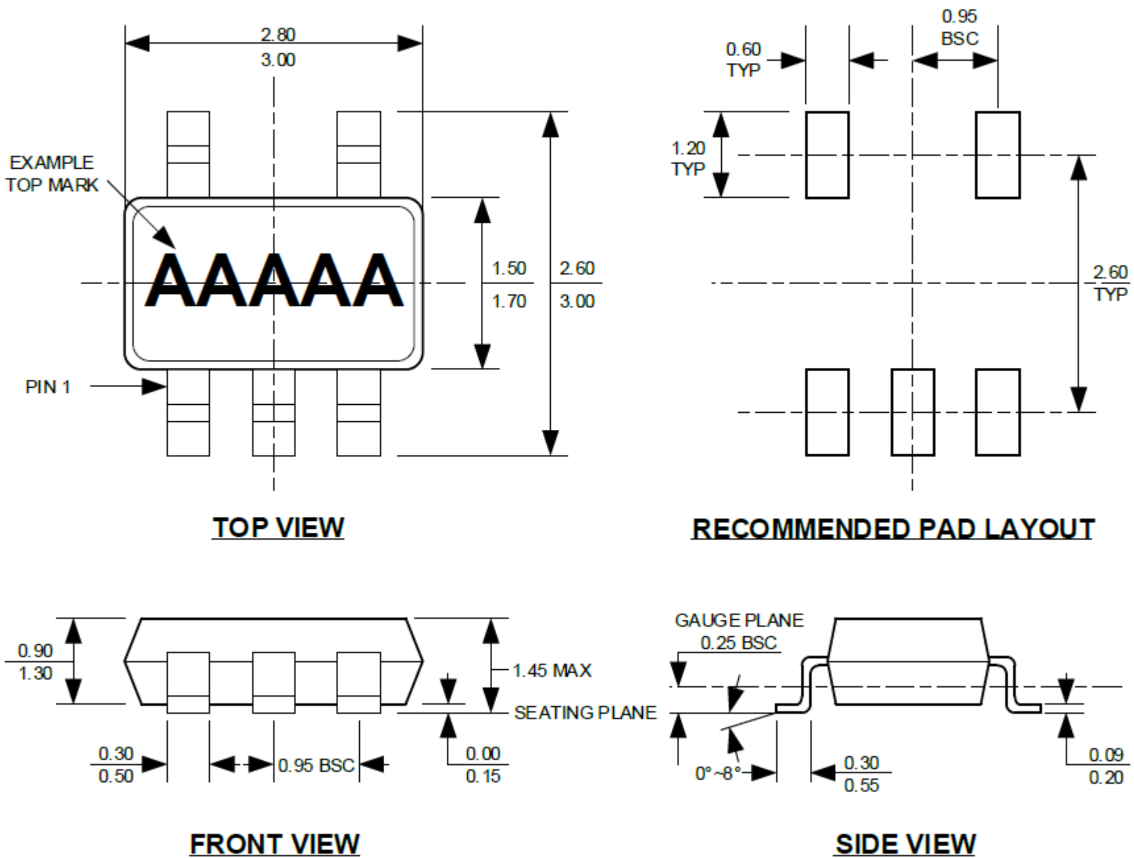


Figure 5. Outline Dimensions

NOTE:
1. CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2. PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3. PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5. DRAWING CONFORMS TO JEDEC MS-012, VARIATION BA.
6. DRAWING IS NOT TO SCALE.

ORDERING INFORMATION

Table 4. Ordering Information

Part Number	Buy Now
AT3408	* *

*: both and are our online store icons. Our products can be ordered from either one of them with the same pricing and delivery time.

NOTICE

1. It is important to carefully read and follow the warnings, cautions, and product-specific notes provided with electronic components. These instructions are designed to ensure the safe and proper use of the component and to prevent damage to the component or surrounding equipment. Failure to follow these instructions could result in malfunction or failure of the component, damage to surrounding equipment, or even injury or harm to individuals. Always take the necessary precautions and seek professional assistance if unsure about proper use or handling of electronic components.
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8. ATI's publication of information regarding third-party products or services does not constitute approval, warranty, or endorsement.
9. ATI retains ownership of all rights for special technologies, techniques, and designs for its products and projects, as well as any modifications, improvements, and inventions made by ATI.
10. Despite operating the electronic modules as specified, malfunctions or failures may occur before the end of their usual service life due to the current state of technology. Therefore, it is crucial for customer applications that require a high level of operational safety, especially in accident prevention or life-saving systems where the malfunction or failure of electronic modules could pose a risk to human life or health, to ensure that suitable measures are taken. The customer should design their application or implement protective circuitry or redundancy to prevent injury or damage to third parties in the event of an electronic module malfunction or failure.