

**2A, 4MHz High Efficiency Synchronous Buck Converter****AP3408**

## General Description

The AP3408 is a current mode, PWM synchronous buck DC/DC converter, capable of driving a 2A load with high efficiency, excellent line and load regulation. It operates in continuous PWM mode.

The AP3408 integrates synchronous P-channel and N-channel power MOSFET switches with low on-resistance. It is ideal for portable applications powered from a single Li-ion battery. 100% duty cycle and low on-resistance P-channel internal power MOSFET can maximize the battery life.

The switching frequency of AP3408 can be programmable from 300kHz to 4MHz, which allows small-sized components, such as capacitors and inductors. A standard series of inductors from several different manufacturers are available. This feature greatly simplifies the design of switch-mode power supplies.

The AP3408 is available in DFN-3×3-10 and PSOP-8 packages.

## Features

- Input Voltage Range: 2.6 to 5.5V
- Adjustable Output from 0.8 to 5V
- 0.8V Reference Voltage with  $\pm 2\%$  Precision
- Output Current: 2A
- High Efficiency up to 95%
- Low  $R_{DS(on)}$  Internal Switches
- Programmable Frequency: 300kHz to 4MHz
- Current Mode Control
- Forced Continuous-mode Operation
- 100% Duty Cycle
- Synchronizable Switching Frequency
- Power Good Output Voltage Monitoring
- Built-in Soft-start
- Built-in Short Circuit Protection
- Built-in Thermal Shutdown Protection
- Built-in Current Limit Function

## Applications

- Portable Media Player
- Digital Still and Video Cameras
- Notebook

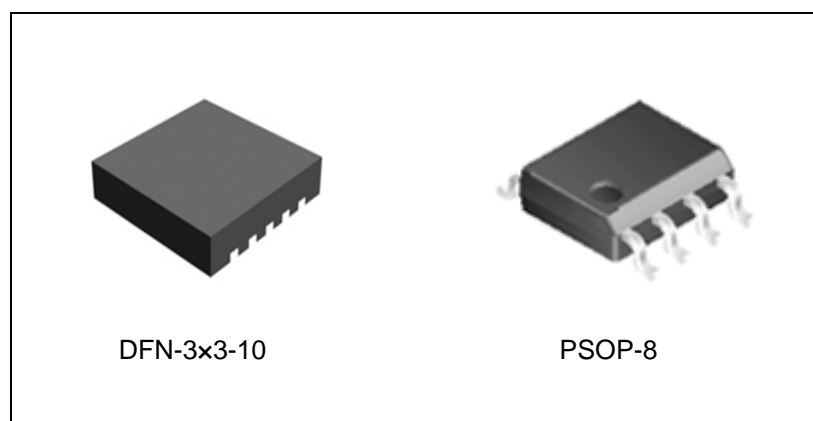


Figure 1. Package Types of AP3408

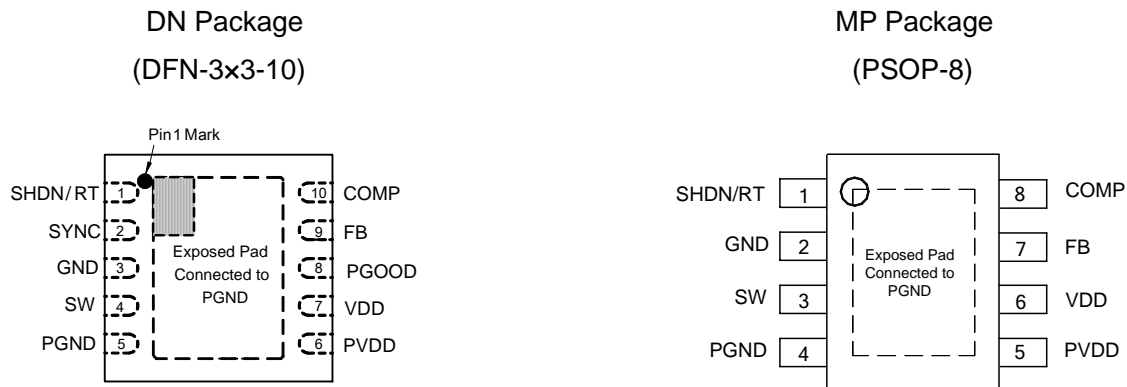
**2A, 4MHz High Efficiency Synchronous Buck Converter**
**AP3408**
**Pin Configuration**


Figure 2. Pin Configuration of AP3408 (Top View)

**Pin Description**

Pin Number		Pin Name	Description
DFN-3x3-10	PSOP-8		
1	1	SHDN/RT	Oscillator resistor input. Connect a resistor to GND from this pin to set the switching frequency. Forcing this pin to $V_{DD}$ to shutdown the device
2		SYNC	External clock synchronization input. The oscillation frequency can be synchronized to an external oscillation applied to this pin. When tied to $V_{DD}$ , the internal oscillator is selected
3	2	GND	Signal ground. All small-signal ground, such as the compensation components and the exposed pad should be connected to this pin, which in turn connects to PGND at one point
4	3	SW	Internal power switch output. Connect this pin with one terminal of the inductor
5	4	PGND	Power ground. Connect this pin as close as possible to CIN and COUT
6	5	PVDD	Power input supply. Decouple this pin to PGND with a capacitor
7	6	VDD	Signal input supply. Decouple this pin to GND with a capacitor. Normally $V_{DD}$ is equal to $V_{PVDD}$
8		PGOOD	Power Good Indicator. Open-drain logic output that is pulled to ground when the output voltage is not within $\pm 12.5\%$ of regulation point
9	7	FB	Feedback voltage. This pin is the inverting input of internal error amplifier. It senses the converter output voltage through an external resistor divider. The internal reference voltage is 0.8V, which determines the output voltage through the resistor divider
10	8	COMP	Compensation input. This pin is the output of internal error amplifier. Connect external compensation elements to this pin to stabilize the control loop

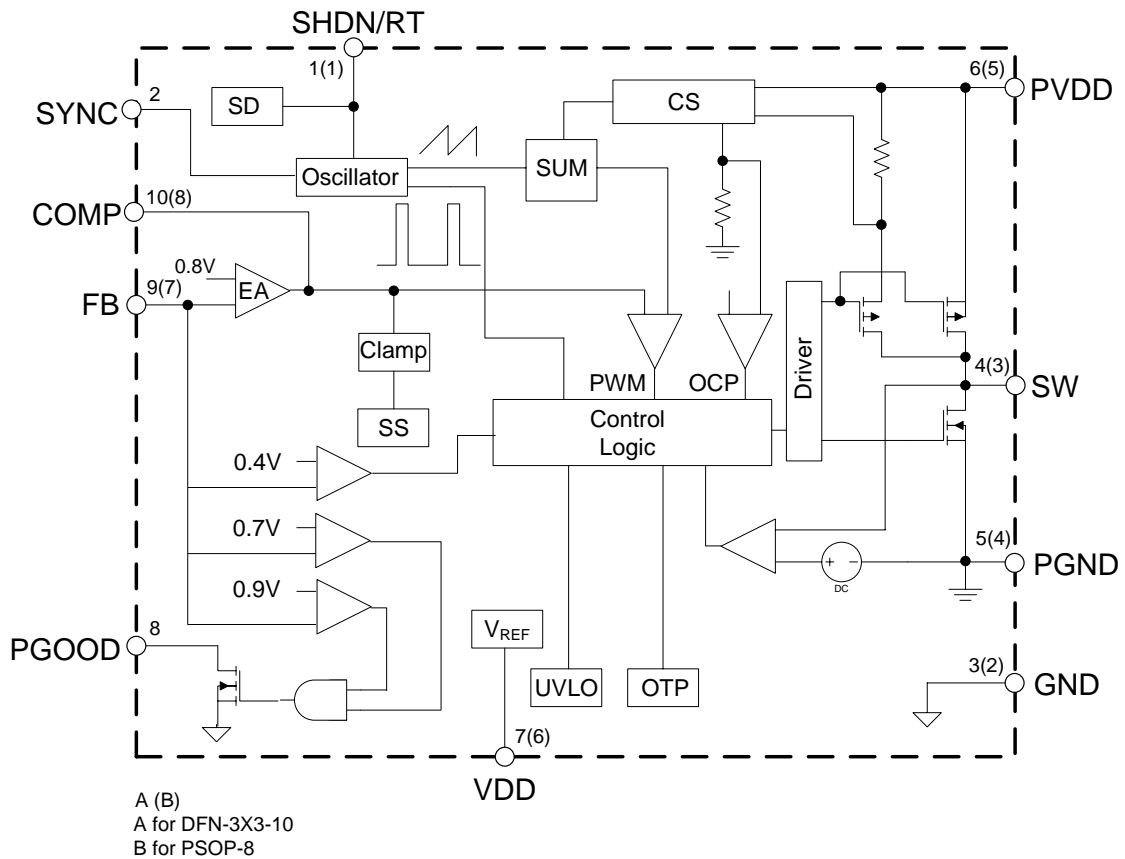
**2A, 4MHz High Efficiency Synchronous Buck Converter**
**AP3408**
**Functional Block Diagram**


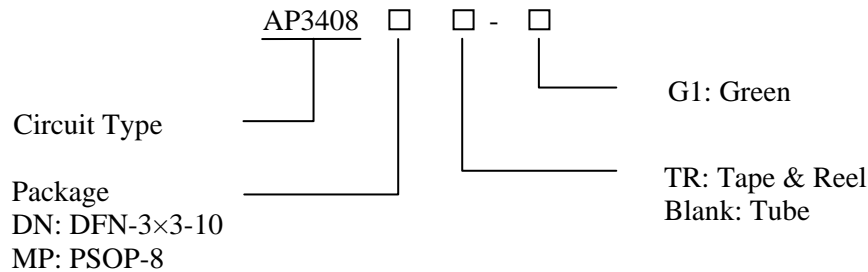
Figure 3. Functional Block Diagram of AP3408



**2A, 4MHz High Efficiency Synchronous Buck Converter**

**AP3408**

**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing Type
		Green	Green	
DFN-3×3-10	-40 to 125°C	AP3408DNTR-G1	BFA	Tape & Reel
PSOP-8		AP3408MP-G1	3408MP-G1	Tube
		AP3408MPTR-G1	3408MP-G1	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

**Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit	
VDD Pin Voltage	$V_{DD}$	-0.3 to 6	V	
PVDD Pin Voltage	$V_{PVDD}$	-0.3 to 6	V	
FB Pin Voltage	$V_{FB}$	-0.3 to 6	V	
COMP Pin Voltage	$V_{COMP}$	-0.3 to 6	V	
SW Pin Voltage	$V_{SW}$	-0.3 to $V_{IN}+0.3$	V	
SHDN/RT Pin Voltage	$V_{SHDN/RT}$	-0.3 to 6	V	
Thermal Resistance	$\theta_{JA}$	DFN-3×3-10	110	°C/W
		PSOP-8	75	
Operating Junction Temperature	$T_J$	150	°C	
Storage Temperature	$T_{STG}$	-65 to 150	°C	
Lead Temperature (Soldering, 10 sec)	$T_{LEAD}$	260	°C	
ESD (Machine Model)		200	V	
ESD (Human Body Model)		2000	V	

Note 1: Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

**2A, 4MHz High Efficiency Synchronous Buck Converter****AP3408****Recommended Operating Conditions**

Parameter	Symbol	Min	Max	Unit
Input Voltage	$V_{IN}$	2.6	5.5	V
Maximum Output Current	$I_{OUT(MAX)}$	2		A
Operating Junction Temperature	$T_J$	-40	125	°C

**Electrical Characteristics**

$V_{IN}=V_{DD}=V_{PVDD}=3.3V$ ,  $T_A=25^\circ C$ , unless otherwise specified.

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT SECTION</b>						
Input Voltage Range	$V_{DD}$		2.6		5.5	V
Supply Current	$I_Q$	$V_{FB}=0.75V$ , No Switching		460		$\mu A$
Shutdown Supply Current	$I_{SHDN}$	Shutdown, $V_{IN}=5.5V$			1	$\mu A$
Under Voltage Threshold Lockout	$V_{UVLO}$	$V_{DD}$ Rising		2.2		V
Under Voltage Hysteresis Lockout	$V_{HUVLO}$			300		mV
<b>FEEDBACK SECTION</b>						
Feedback Voltage	$V_{FB}$		0.784	0.8	0.816	V
FB Pin Bias Current	$I_{FB}$			0.1	0.4	$\mu A$
Current Sense Transresistance	$R_T$			0.2		$\Omega$
Switching Leakage Current		$V_{SHDN/RT}=V_{IN}$ $=5.5V$			1	$\mu A$
Error Gain Amplifier Voltage	$G_V$			800		
Error Amplifier Trans-conductance	$G_S$			800		$\mu A/V$

**2A, 4MHz High Efficiency Synchronous Buck Converter****AP3408****Electrical Characteristics (Continued)** $V_{IN}=V_{DD}=V_{PVDD}=3.3V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified.

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
<b>OSCILLATOR SECTION</b>						
RT Pin Voltage	$V_{RT}$			0.8		V
Switching Frequency	$f_{OSC}$	$R_{OSC}=330k\Omega$	0.8	1	1.2	MHz
		ADJ Frequency	0.3		4	MHz
Maximum Duty Cycle	$D_{MAX}$	$V_{FB}=0.75V$	100			%
<b>POWER SWITCH SECTION</b>						
Switch Current Limit	$I_{LIMIT}$	$V_{FB}=0.75V$	2.2	3.8		A
Internal P-FET On Resistance	$R_{PDSON}$	$I_{SW}=500mA$		0.11	0.16	$\Omega$
Internal N-FET On Resistance	$R_{NDSON}$	$I_{SW}=-500mA$		0.11	0.17	$\Omega$
<b>SHDN/RT SECTION</b>						
Shutdown Threshold				$V_{DD}-0.7$	$V_{DD}-0.4$	V
<b>PGOOD SECTION</b>						
PGOOD Voltage Range				$\pm 12.5$	$\pm 15$	%
PGOOD Pull Down Resistance					120	$\Omega$
<b>TOTAL DEVICE</b>						
Output Current	$I_{OUT}$	$V_{DD}=2.6$ to $5.5V$ $V_{OUT}=2.5V$	2			A
Output Voltage Line Regulation	LNR	$V_{DD}=2.7$ to $5.5V$ $I_{OUT}=100mA$		0.4		%/V
Output Voltage Load Regulation	LOD	$I_{OUT}=0.01$ to $2A$		$\pm 0.2$		%
Soft-start Time	$t_{SS}$	$I_{OUT}=10mA$		1.5		ms
Thermal Shutdown Temperature	$T_{OTSD}$			160		$^{\circ}C$
Thermal Shutdown Temperature Hysteresis	$T_{HYS}$			20		$^{\circ}C$



2A, 4MHz High Efficiency Synchronous Buck Converter

AP3408

Typical Performance Characteristics

$V_{IN}=V_{DD}=V_{PVDD}=3.3V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified.

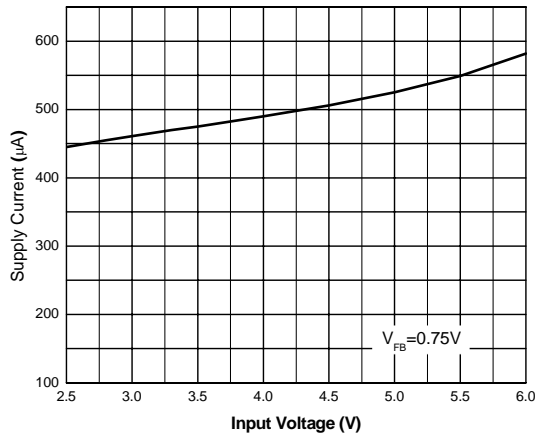


Figure 4. Supply Current vs. Input Voltage

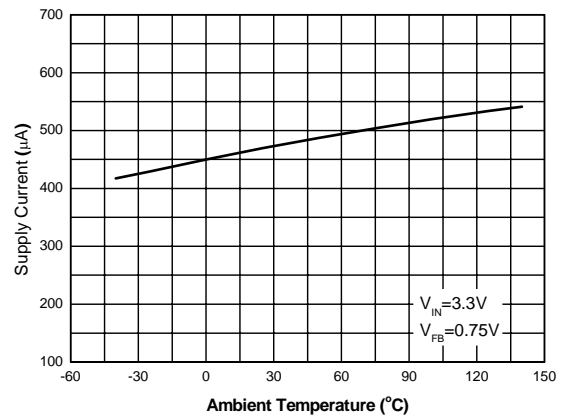


Figure 5. Supply Current vs. Ambient Temperature

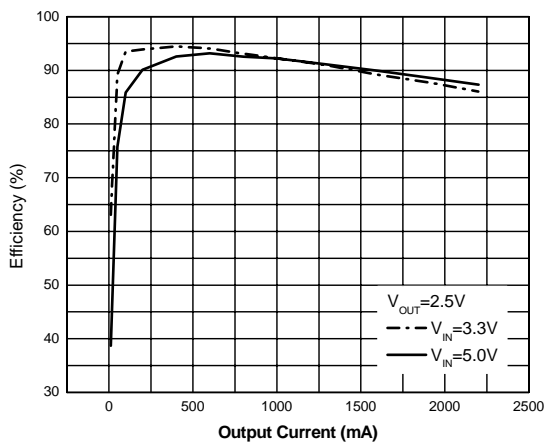


Figure 6. Efficiency vs. Output Current

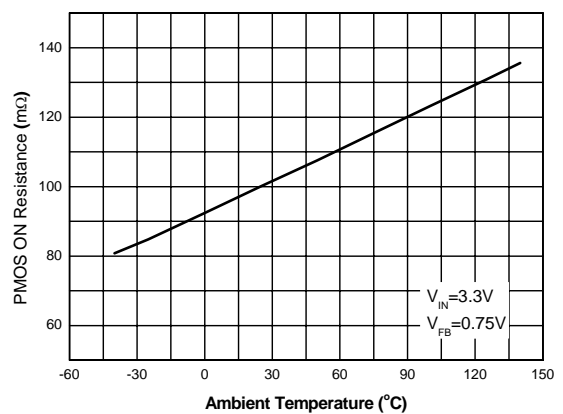


Figure 7. PMOS ON Resistance vs. Ambient Temperature



2A, 4MHz High Efficiency Synchronous Buck Converter

AP3408

Typical Performance Characteristics (Continued)

$V_{IN}=V_{DD}=V_{PVDD}=3.3V$ ,  $T_A=25^\circ C$ , unless otherwise specified.

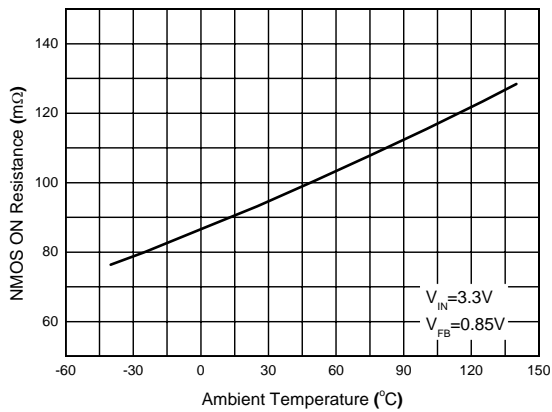


Figure 8. NMOS ON Resistance vs. Ambient Temperature

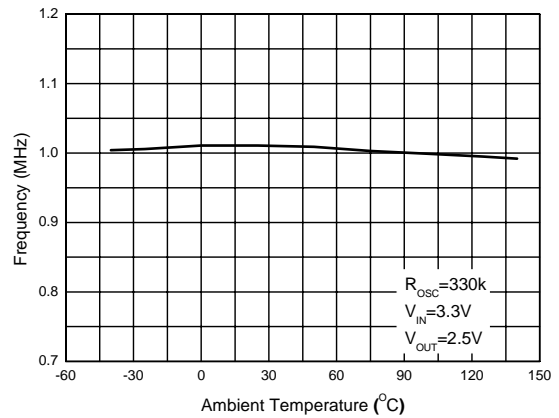


Figure 9. Frequency vs. Ambient Temperature

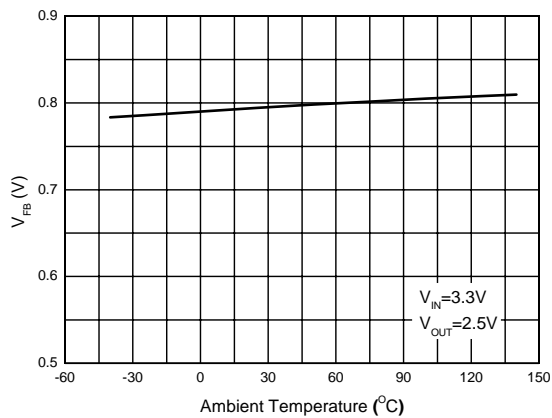


Figure 10.  $V_{FB}$  vs. Ambient Temperature

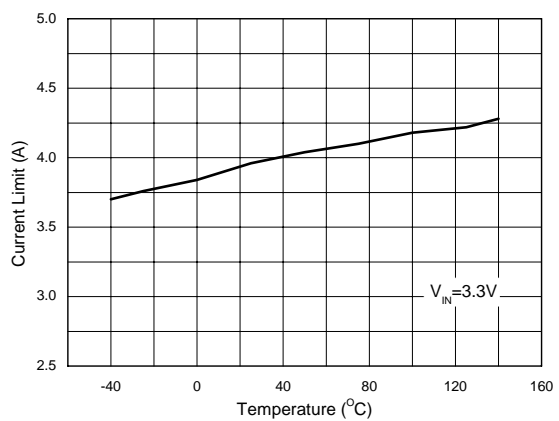


Figure 11. Current Limit vs. Ambient Temperature



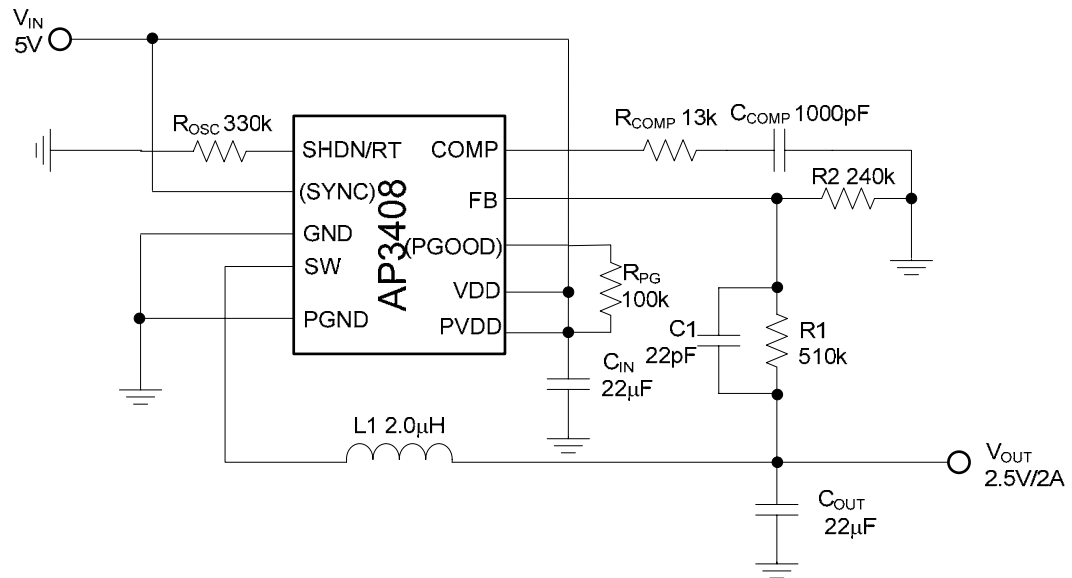
**Typical Application**


Figure 12. Typical Application of AP3408



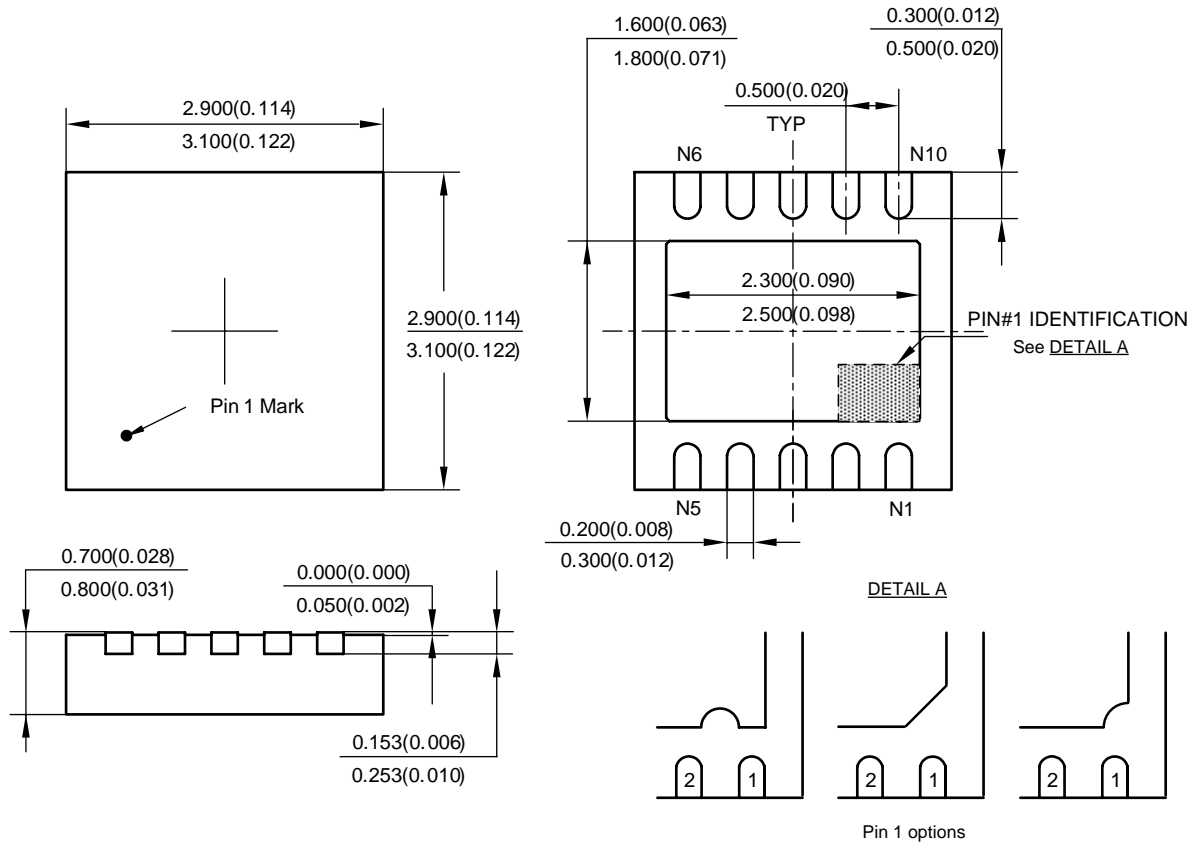
**2A, 4MHz High Efficiency Synchronous Buck Converter**

**AP3408**

**Mechanical Dimensions**

**DFN-3x3-10**

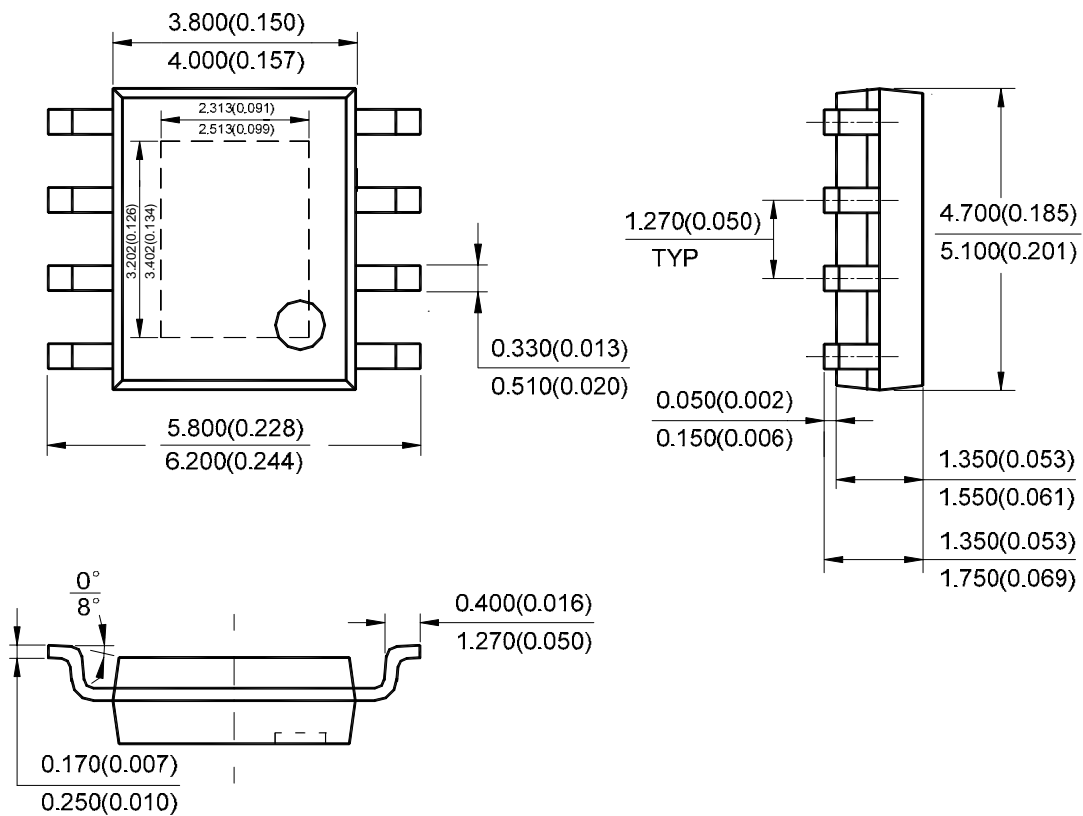
**Unit: mm(inch)**



**Mechanical Dimensions (Continued)**

**PSOP-8**

**Unit: mm(inch)**



Note: Eject hole, oriented hole and mold mark is optional.



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