

**3A, 2MHz High Performance Synchronous Buck Converter**
**AP3433**

## General Description

The AP3433 is a current mode, PWM synchronous buck (step-down) DC-DC converter, capable of driving a 3A load with high efficiency, excellent line and load regulation.

The device integrates two N-channel power MOSFETs with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

The switching frequency of AP3433 can be programmable from 300kHz to 2MHz, 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.

Under voltage lockout is internally set at 2.6V, but can be increased by programming the threshold with a resistor network on the enable pin. The output voltage startup ramp is controlled by the soft-start pin. An open drain power good signal indicates the output is within 93% to 107% of its nominal voltage.

The AP3433 is available in QFN-3×3-16 package.

## Features

- Input Voltage Range: 2.95V to 5.5V
- 0.827V Reference Voltage with  $\pm 3\%$  Precision
- Two 45m $\Omega$ (typical) MOSFETs for High Efficiency at 3A Load
- High Efficiency: up to 94%
- Output Current: 3A
- Programmable Frequency: 300kHz to 2MHz
- Current Mode Control
- Synchronizes to External Clock
- Adjustable Soft-start
- Soft Start-up into Pre-biased Output
- UV and OV Power Good Output
- Built-in Over Current Protection
- Built-in Thermal Shutdown Function
- Programmable UVLO Function
- Built-in Over Voltage Protection
- Thermally Enhanced 3mm×3mm 16-pin QFN

## Applications

- Low-voltage, High-density Power Systems
- Point of Load Regulation for Consumer Applications such as Set Top Boxes, LCD Displays, CPE Equipment

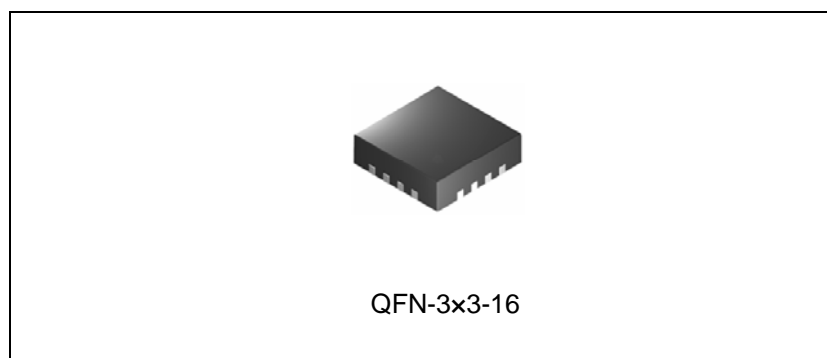


Figure 1. Package Type of AP3433

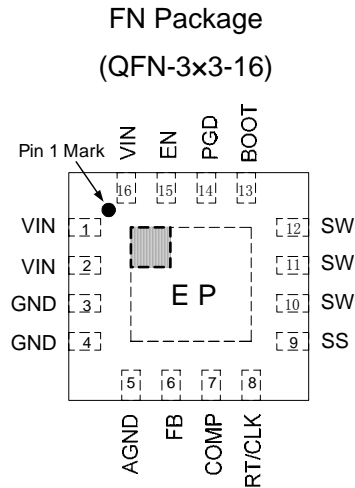
**3A, 2MHz High Performance Synchronous Buck Converter**
**AP3433**
**Pin Configuration**


Figure 2. Pin Configuration of AP3433 (Top View)

**Pin Description**

Pin Number	Pin Name	Function
1,2,16	VIN	Supply input pin. A capacitor should be connected between the VIN and GND pin to keep the DC input voltage constant
3,4	GND	Power ground. This pin should be electrically connected to the power pad under the IC
5	AGND	Analog ground. This pin should be electrically connected to GND close to the device
6	FB	Feedback pin. Inverting node of the transconductance error amplifier
7	COMP	Compensation pin. This pin is the output of the transconductance error amplifier and the input to the current comparator. Connect external compensation elements to this pin to stabilize the control loop
8	RT/CLK	Resistor timing or external clock input pin
9	SS	Soft-start pin. An external capacitor connected to this pin sets the output voltage rise time. This pin can also be used for tracking
10,11,12	SW	Internal power switch output pin. This pin is connected to the inductor and bootstrap capacitor
13	BOOT	Bootstrap pin. A bootstrap capacitor is connected between the BOOT pin and SW pin. The voltage across the bootstrap capacitor drives the internal high-side power MOSFET
14	PGD	Power good indicator output. Asserts low if output voltage is low due to thermal shutdown, over-current, over/under-voltage or EN shut down
15	EN	Enable pin, internal pull-up current source. Pull below 1.2V to disable. Float to enable. Can be used to set the on/off threshold (adjust UVLO) with two additional resistors

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**AP3433**

**Functional Block Diagram**

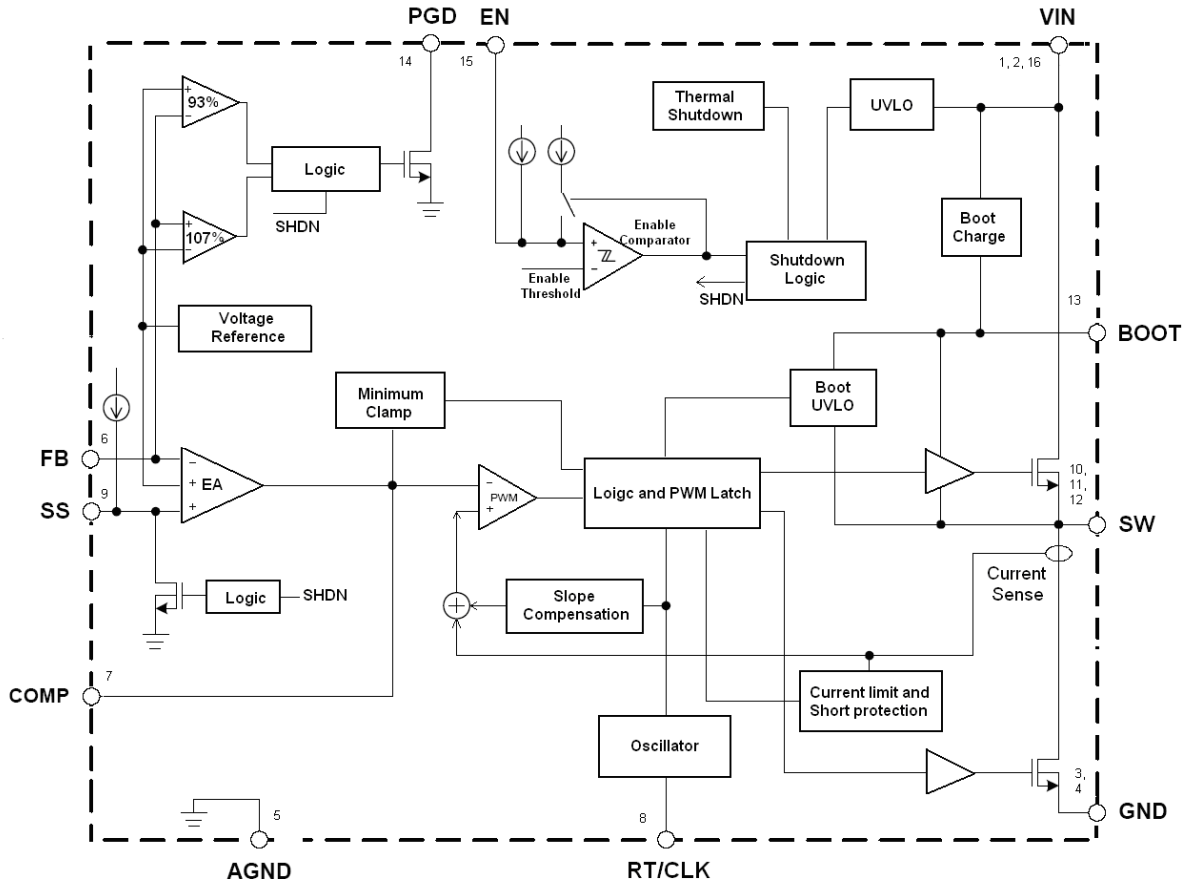
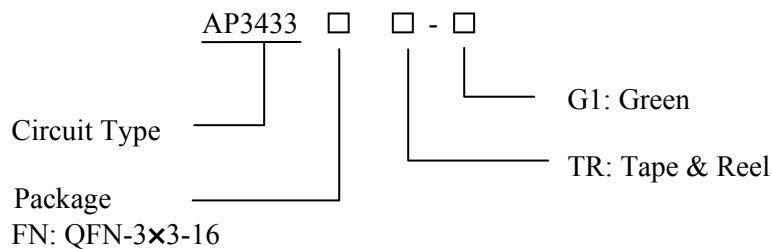


Figure 3. Functional Block Diagram of AP3433

**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing Type
QFN-3×3-16	-40 to 85°C	AP3433FNTR-G1	B1D	Tape & Reel

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

**3A, 2MHz High Performance Synchronous Buck Converter****AP3433****Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit
VIN Pin Voltage	$V_{IN}$	-0.3 to 6.5	V
EN Pin Voltage	$V_{EN}$	-0.3 to 6.5	V
SW Pin Voltage	$V_{SW}$	-0.3 to $V_{IN}+0.3$	V
FB Pin Voltage	$V_{FB}$	-0.3 to 6.5	V
COMP Pin Voltage	$V_{COMP}$	-0.3 to 6.5	V
PGD Pin Voltage	$V_{PGD}$	-0.3 to 6.5	V
RT/CLK Pin Voltage	$V_{RT/CLK}$	-0.3 to 6.5	V
SS Pin Voltage	$V_{SS}$	-0.3 to 6.5	V
Thermal Resistance (Junction to Ambient)	$\theta_{JA}$	70	°C/W
Thermal Resistance (Junction to Case)	$\theta_{JC (BOTTOM)}$	5	°C/W
Operating Junction Temperature	$T_J$	-40 to 125	°C
Storage Temperature	$T_{STG}$	-65 to 150	°C
Lead Temperature (Soldering, 10sec)	$T_{LEAD}$	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.

**Recommended Operating Conditions**

Parameter	Symbol	Min	Max	Unit
Input Voltage	$V_{IN}$	2.95	5.5	V
Maximum Output Current	$I_{OUT(MAX)}$	3		A
Operating Ambient Temperature	$T_A$	-40	85	°C



**3A, 2MHz High Performance Synchronous Buck Converter AP3433**

**Electrical Characteristics**

$V_{IN}=2.95$  to  $5.5V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified. Specifications with **boldface type** apply over full operating temperature range from  $-40$  to  $85^{\circ}C$ .

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
<b>SUPPLY VOLTAGE (VIN PIN)</b>						
Input Voltage	$V_{IN}$		2.95		5.5	V
Quiescent Current	$I_Q$	$V_{FB}=0.9V, V_{IN}=5V,$ $T_A=25^{\circ}C, R_T=400k\Omega$		360	575	$\mu A$
Shutdown Supply Current	$I_{SHDN}$	$V_{EN}=0V, T_A=25^{\circ}C$ $2.95V \leq V_{IN} \leq 5.5V$		2	5	$\mu A$
<b>ENABLE AND UVLO (EN PIN)</b>						
Enable Threshold	$V_{EN\_H}$	Rising	1.16	1.25	1.37	V
	$V_{EN\_L}$	Falling		1.18		V
Internal Under Voltage Lockout Threshold	$V_{UVLO}$			2.6	2.8	V
Internal Under Voltage Hysteresis	$V_{HYS}$			150		mV
<b>VOLTAGE REFERENCE (FB PIN)</b>						
Voltage Reference	$V_{REF}$	$2.95V \leq V_{IN} \leq 5.5V$	<b>0.802</b>	<b>0.827</b>	<b>0.852</b>	V
<b>MOSFET</b>						
High Side Switch On-resistance	$R_{ON\_H}$	$V_{BOOT-SW}=5V$		45	81	m $\Omega$
		$V_{BOOT-SW}=2.95V$		64	110	m $\Omega$
Low Side Switch On-resistance	$R_{ON\_L}$	$V_{IN}=5V$		42	81	m $\Omega$
		$V_{IN}=2.95V$		59	110	m $\Omega$
<b>CURRENT LIMIT</b>						
Current Limit Threshold	$I_{LIMIT}$		4.2	6.6		A
<b>THERMAL SHUTDOWN</b>						
Thermal Shutdown	$T_{TSD}$			140		$^{\circ}C$
Hysteresis				20		$^{\circ}C$



**3A, 2MHz High Performance Synchronous Buck Converter AP3433**

**Electrical Characteristics (Continued)**

$V_{IN}=2.95$  to  $5.5V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified. Specifications with **boldface type** apply over full operating temperature range from  $-40$  to  $85^{\circ}C$ .

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
<b>TIMING RESISTOR AND EXTERNAL CLOCK (RT/CLK PIN)</b>						
Switching Frequency Range (RT Mode)			300		2000	kHz
Switching Frequency Range (CLK Mode)			300		2000	kHz
Switching Frequency	$f_s$	$R_T=400k\Omega$	400	500	600	kHz
Minimum CLK Pulse Width			75			ns
RT/CLK Voltage		$R_T=400k\Omega$		0.5		V
RT/CLK High Threshold				1.6	2.2	V
RT/CLK Low Threshold			0.4	0.6		V
<b>BOOT (BOOT PIN)</b>						
BOOT Charge Resistor	$R_{BOOT}$	$V_{IN}=5V$		16		$\Omega$
BOOT-SW UVLO		$V_{IN}=2.95V$		2.2		V
<b>SOFT START (SS PIN)</b>						
Charge Current	$I_{SS}$	$V_{SS}=0.4$		2.2		$\mu A$
SS to Reference Crossover	$V_{SS}$	98% Nominal		1.1		V
<b>POWER GOOD (PGD PIN)</b>						
Feedback Threshold	$V_{FB\_TH}$	$V_{FB}$ Falling (Fault)		91		% $V_{REF}$
		$V_{FB}$ Rising (Good)		93		
		$V_{FB}$ Rising (Fault)		107		
		$V_{FB}$ Falling (Good)		105		



### Typical Performance Characteristics

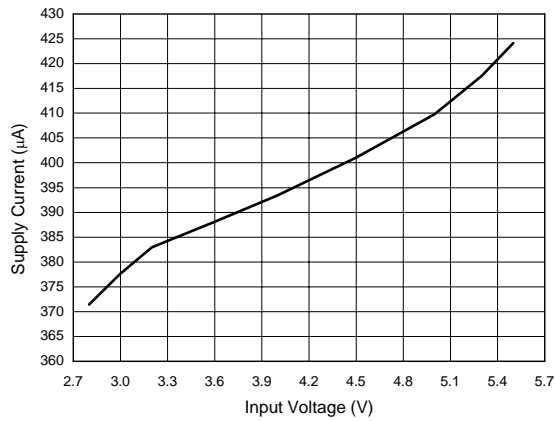


Figure 4. Supply Current vs. Input Voltage

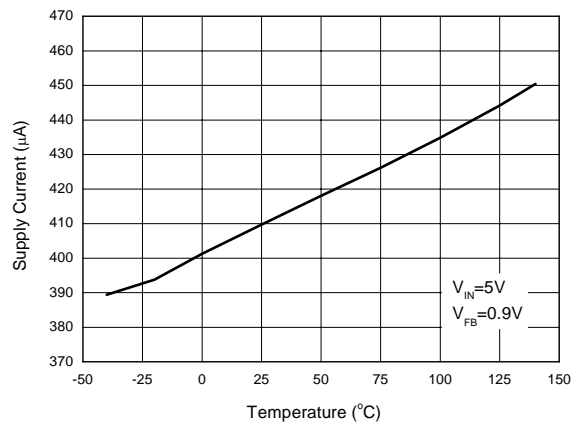


Figure 5. Supply Current vs. Temperature

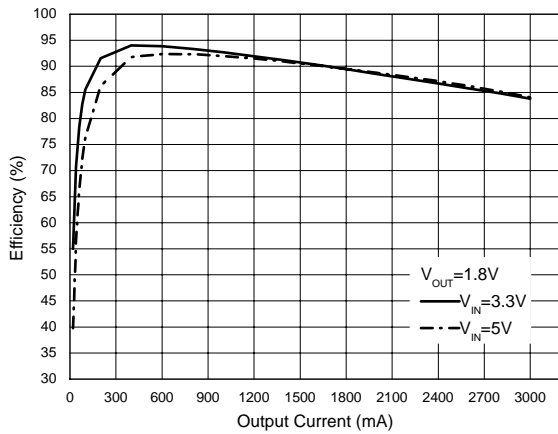


Figure 6. Efficiency vs. Output Current

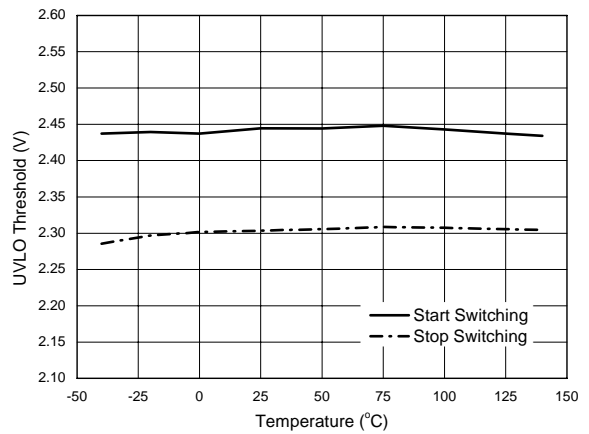


Figure 7. UVLO Threshold vs. Temperature



Typical Performance Characteristics (Continued)

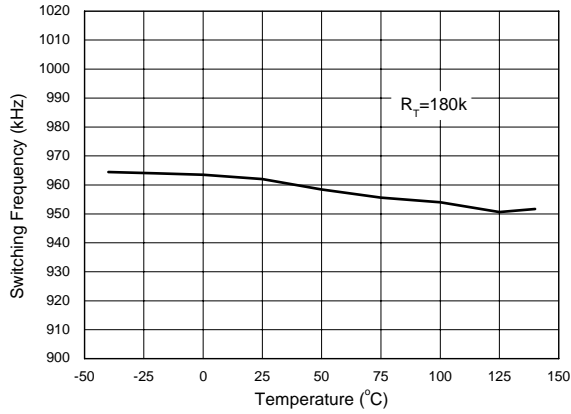


Figure 8. Switching Frequency vs. Temperature

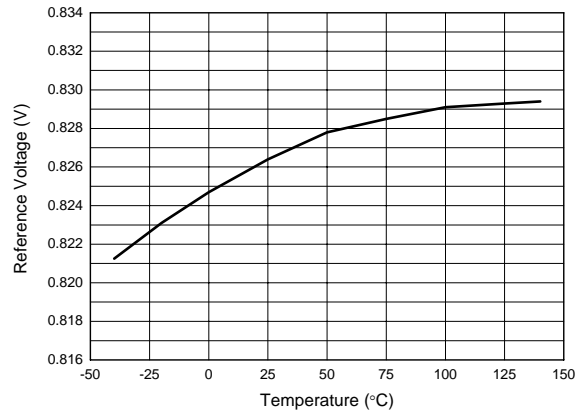


Figure 9. Reference Voltage vs. Temperature

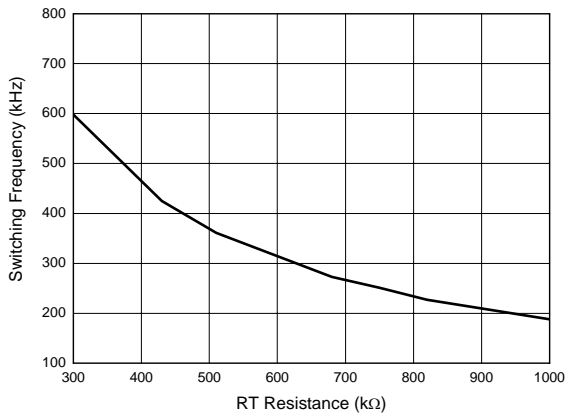


Figure 10. Switching Frequency vs. RT Resistance Low Frequency Range

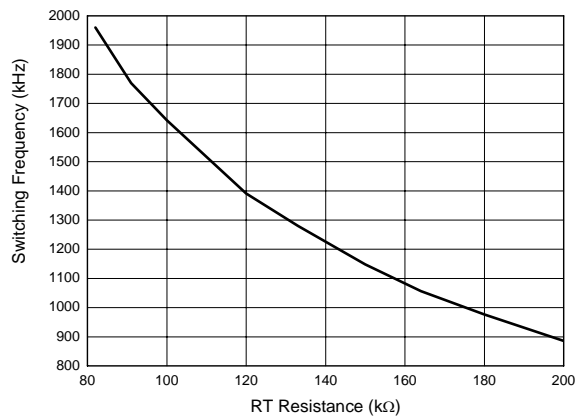
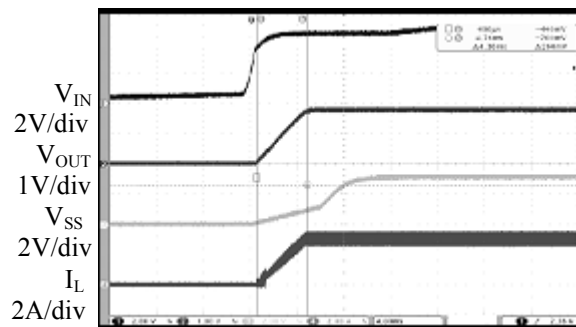
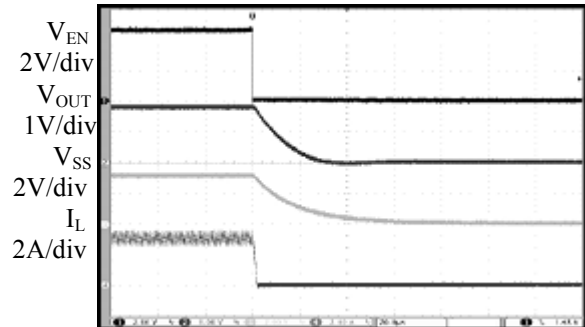


Figure 11. Switching Frequency vs. RT Resistance High Frequency Range

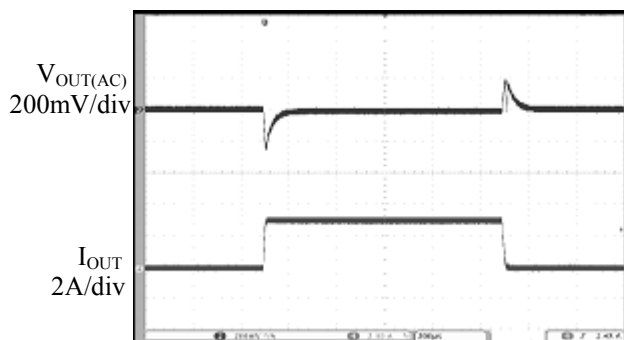


**Typical Performance Characteristics (Continued)**


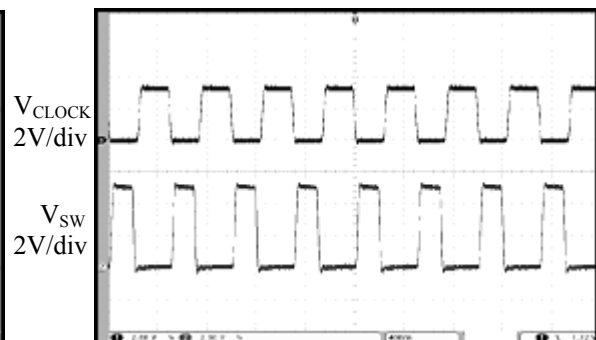
Time 4ms/div

 Figure 12. Start up from  $V_{IN}$  ( $V_{IN}=5V$ ,  $V_{OUT}=1.8V$ ,  $I_{OUT}=3A$ )


Time 20µs/div

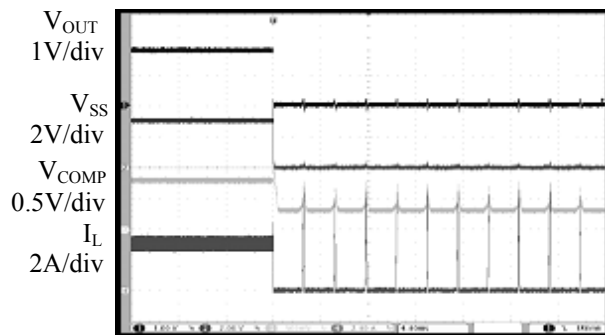
 Figure 13. Disable IC ( $V_{IN}=5V$ ,  $V_{OUT}=1.8V$ ,  $I_{OUT}=3A$ )


Time 200µs/div

 Figure 14. Load Transient Response  
 ( $V_{IN}=5V$ ,  $V_{OUT}=1.8V$ ,  $I_{OUT}=0$  to  $3A$ )


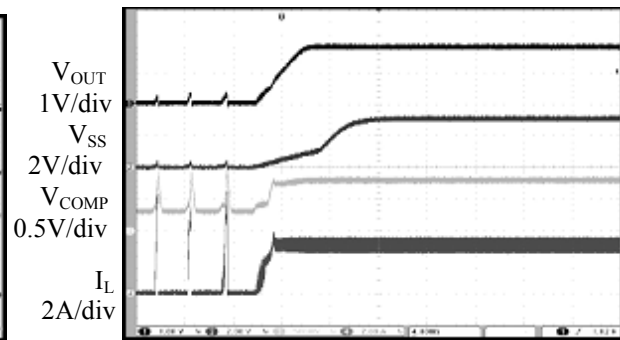
Time 400ns/div

 Figure 15. Synchronizing to External Clock  
 ( $f_{CLOCK}=2MHz$ )

**Typical Performance Characteristics (Continued)**


Time 4ms/div

Figure 16. Short Circuit Protection  
 ( $V_{IN}=5V$ ,  $V_{OUT}=1.8V$ ,  $I_{OUT}=3A$ )



Time 4ms/div

Figure 17. Short Circuit Recovery  
 ( $V_{IN}=5V$ ,  $V_{OUT}=1.8V$ ,  $I_{OUT}=3A$ )

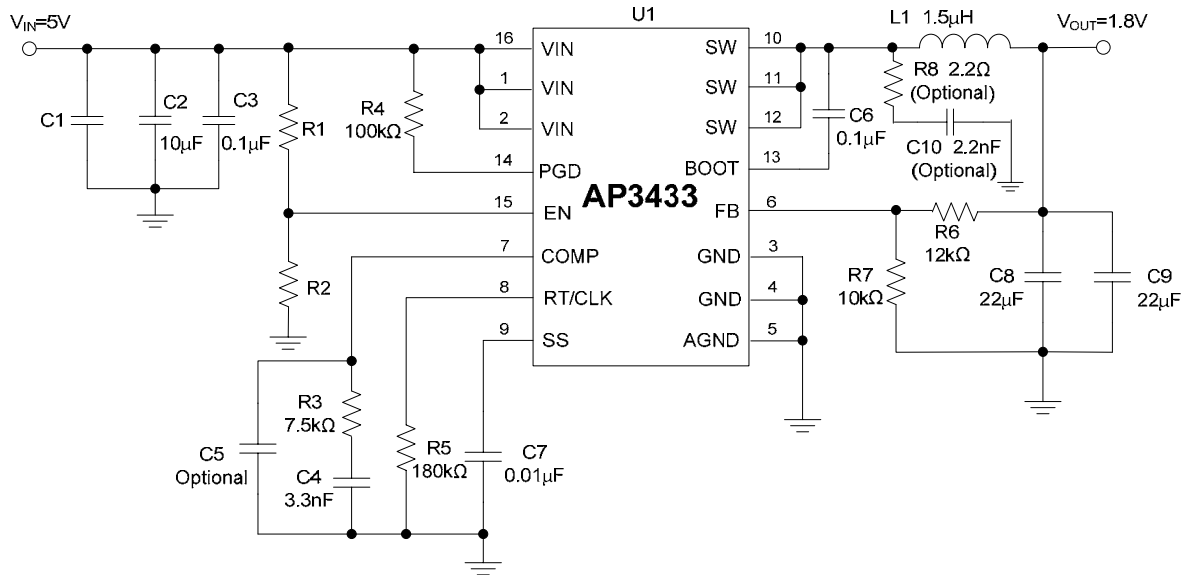
**3A, 2MHz High Performance Synchronous Buck Converter**
**AP3433**
**Typical Application**


Figure 18. Typical Application of AP3433

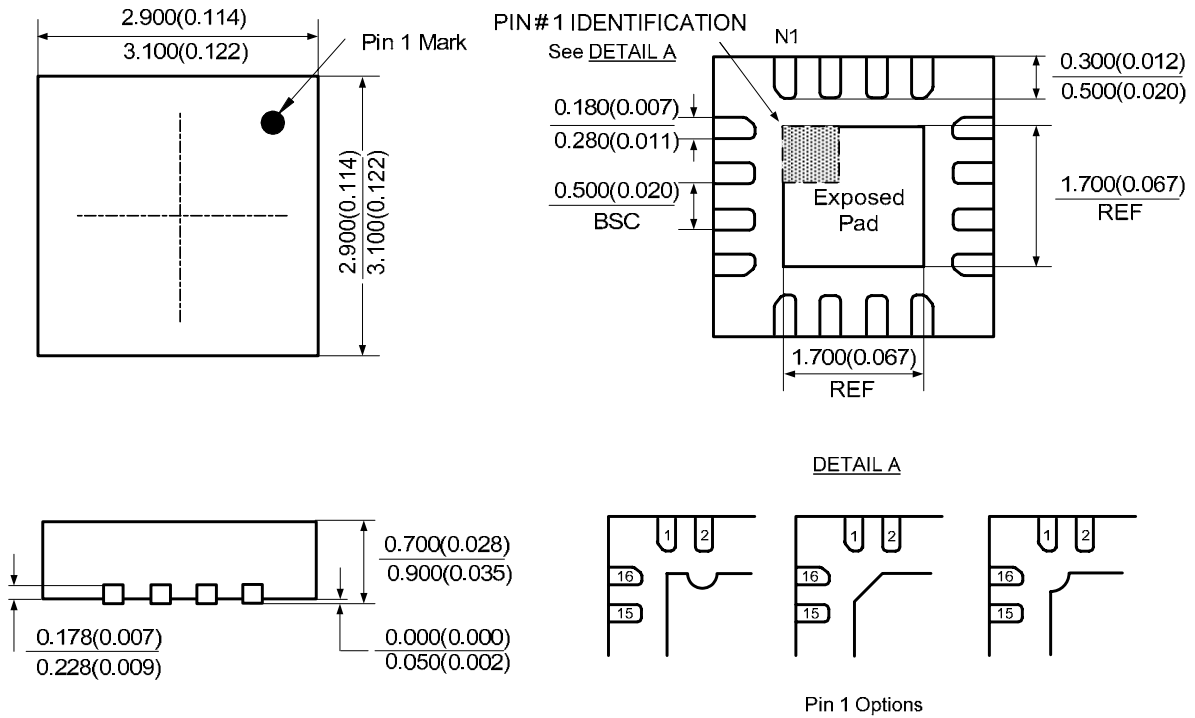
**3A, 2MHz High Performance Synchronous Buck Converter**

**AP3433**

**Mechanical Dimensions**

**QFN-3x3-16**

**Unit:mm(inch)**





## **BCD Semiconductor Manufacturing Limited**

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