

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 Ω (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

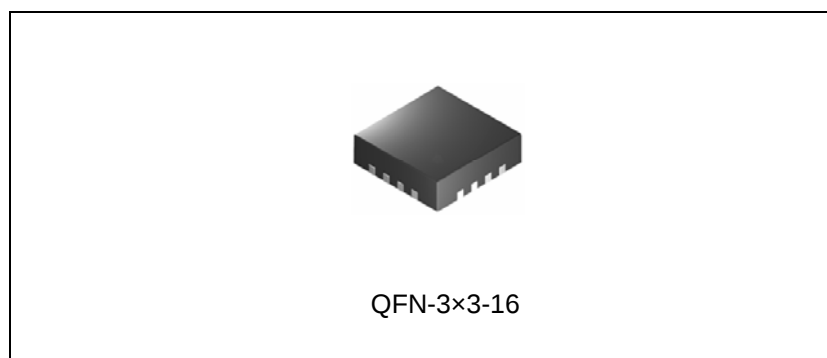


Figure 1. Package Type of AP3433

3A, 2MHz High Performance Synchronous Buck Converter

AP3433

Pin Configuration

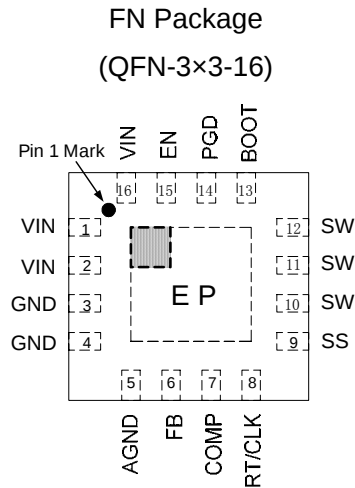


Figure 2. Pin Configuration of AP3433 (Top View)

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

3A, 2MHz High Performance Synchronous Buck Converter

AP3433

Functional Block Diagram

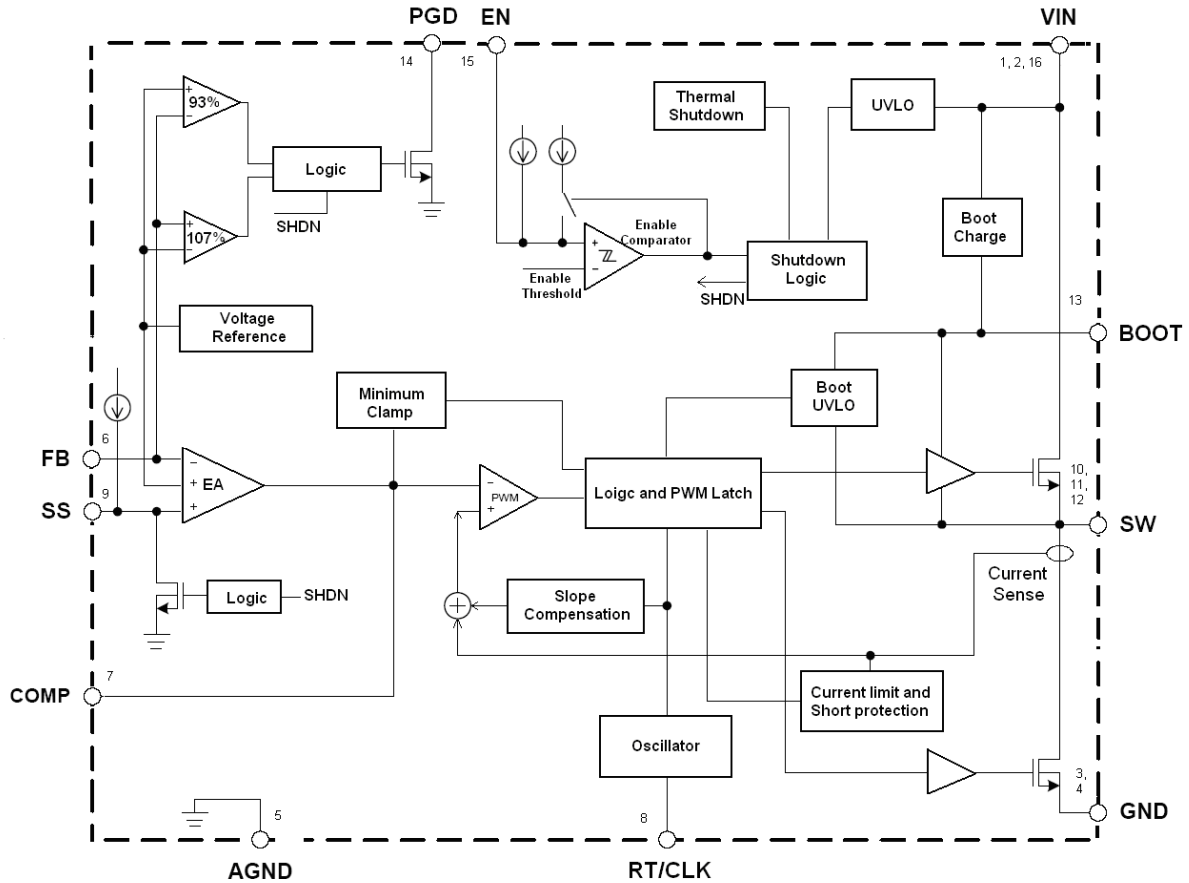


Figure 3. Functional Block Diagram of AP3433

Ordering Information

AP3433	□	□ - □
Circuit Type	□	G1: Green
Package	□	TR: Tape & Reel
FN: QFN-3×3-16		

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)	θ_{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
SUPPLY VOLTAGE (VIN PIN)						
Input Voltage	V _{IN}		2.95		5.5	V
Quiescent Current	I _Q	V _{FB} =0.9V,V _{IN} =5V, T _A =25°C, R _T =400kΩ		360	575	μA
Shutdown Supply Current	I _{SHDN}	V _{EN} =0V,T _A =25°C 2.95V≤V _{IN} ≤5.5V		2	5	μA
ENABLE AND UVLO (EN PIN)						
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
VOLTAGE REFERENCE (FB PIN)						
Voltage Reference	V _{REF}	2.95V≤V _{IN} ≤5.5V	0.802	0.827	0.852	V
MOSFET						
High Side Switch On-resistance	R _{ON_H}	V _{BOOT-SW} =5V		45	81	mΩ
		V _{BOOT-SW} =2.95V		64	110	mΩ
Low Side Switch On-resistance	R _{ON_L}	V _{IN} =5V		42	81	mΩ
		V _{IN} =2.95V		59	110	mΩ
CURRENT LIMIT						
Current Limit Threshold	I _{LIMIT}		4.2	6.6		A
THERMAL SHUTDOWN						
Thermal Shutdown	T _{TSD}			140		°C
Hysteresis				20		°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
TIMING RESISTOR AND EXTERNAL CLOCK (RT/CLK PIN)						
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
BOOT (BOOT PIN)						
BOOT Charge Resistor	R_{BOOT}	$V_{IN}=5V$		16		Ω
BOOT-SW UVLO		$V_{IN}=2.95V$		2.2		V
SOFT START (SS PIN)						
Charge Current	I_{SS}	$V_{SS}=0.4$		2.2		μA
SS to Reference Crossover	V_{SS}	98% Nominal		1.1		V
POWER GOOD (PGD PIN)						
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		

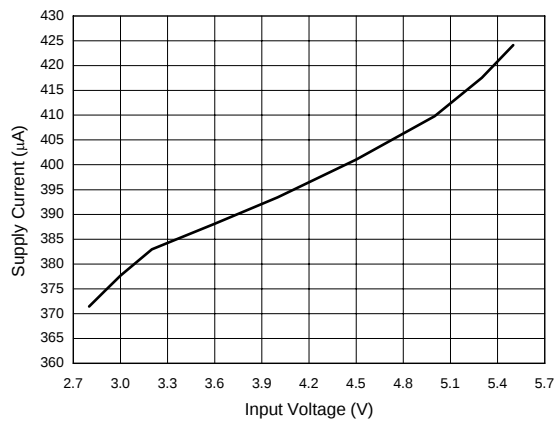
**Typical Performance Characteristics**

Figure 4. Supply Current vs. Input Voltage

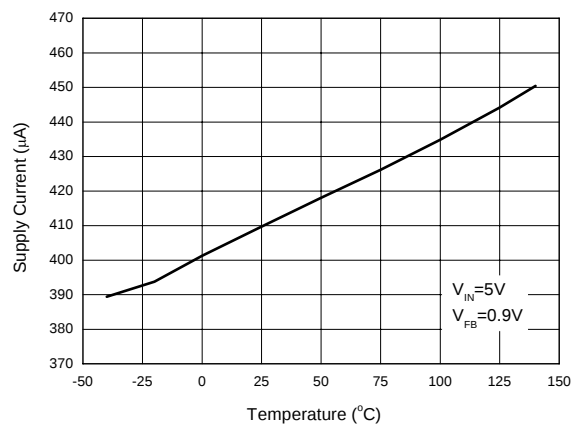


Figure 5. Supply Current vs. Temperature

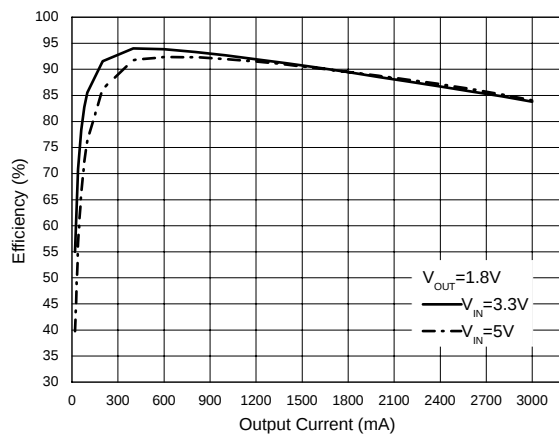


Figure 6. Efficiency vs. Output Current

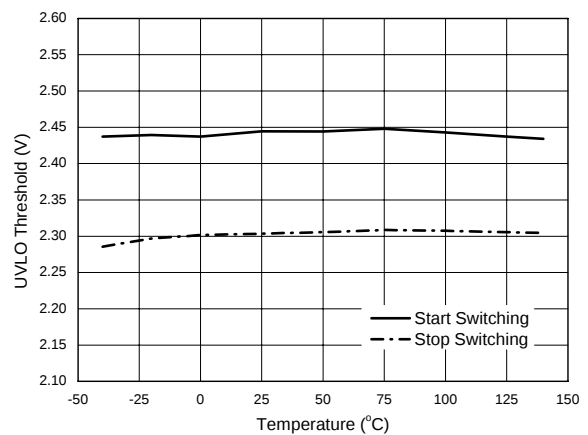


Figure 7. UVLO Threshold vs. Temperature

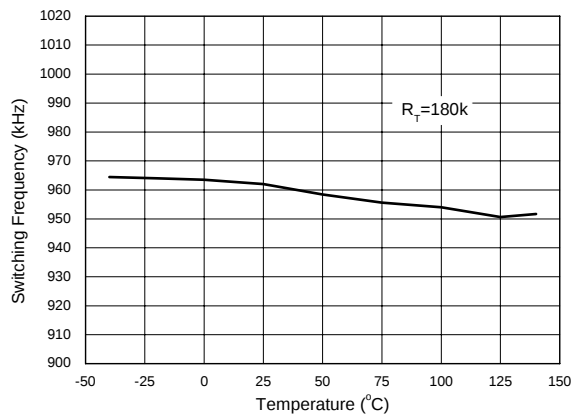
**Typical Performance Characteristics (Continued)**

Figure 8. Switching Frequency vs. Temperature

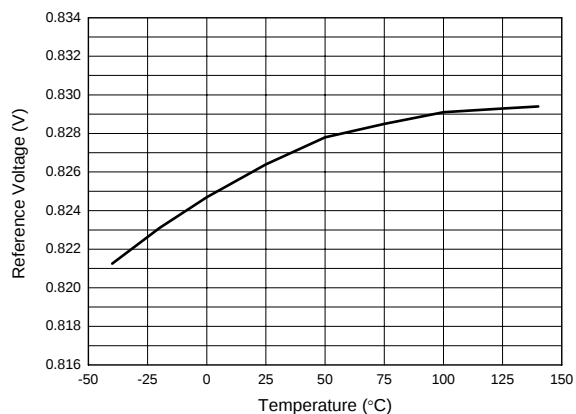
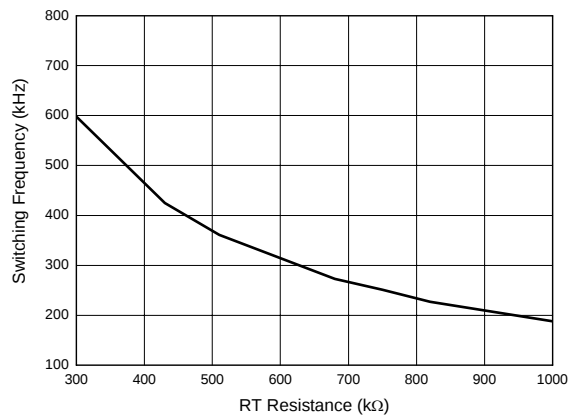
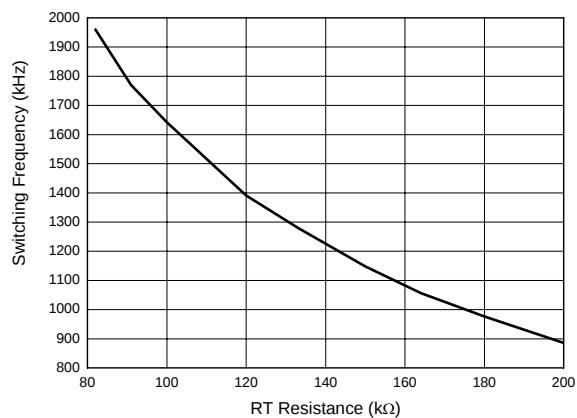


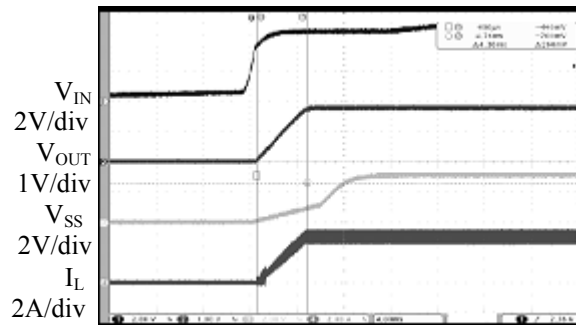
Figure 9. Reference Voltage vs. Temperature

Figure 10. Switching Frequency vs. RT Resistance
Low Frequency RangeFigure 11. Switching Frequency vs. RT Resistance
High Frequency Range

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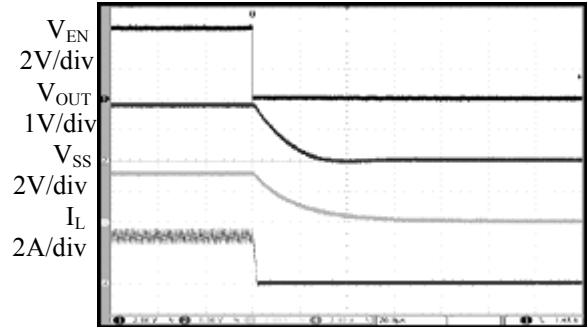
AP3433

Typical Performance Characteristics (Continued)



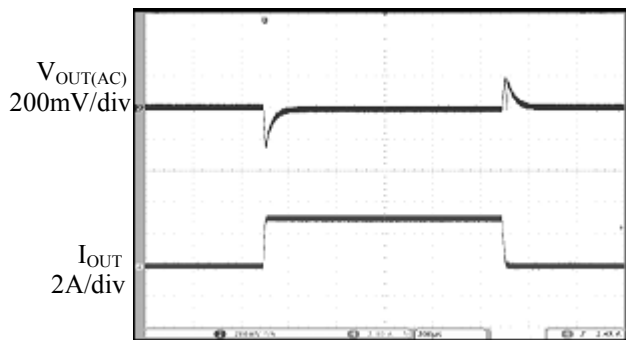
Time 4ms/div

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



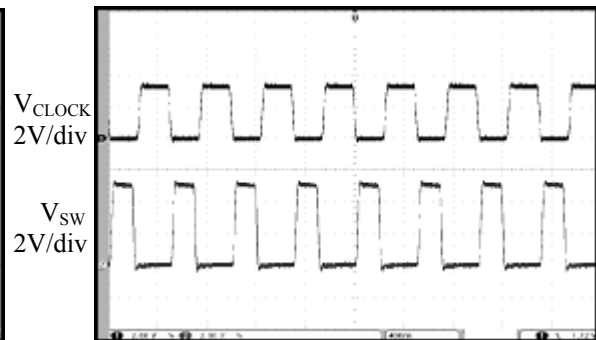
Time 20μs/div

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



Time 200μs/div

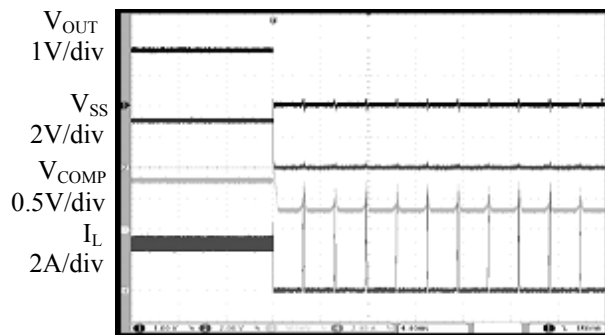
Figure 14. Load Transient Response
($V_{IN}=5V$, $V_{OUT}=1.8V$, $I_{OUT}=0$ to $3A$)



Time 400ns/div

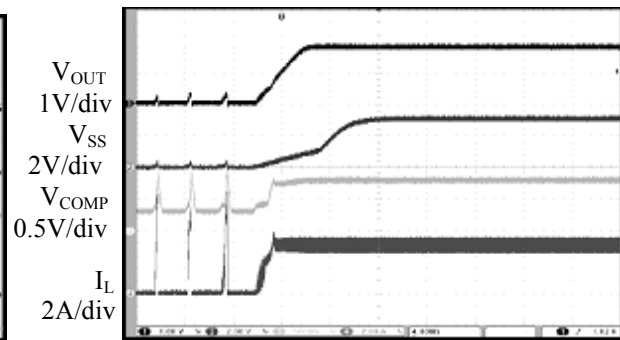
Figure 15. Synchronizing to External Clock
($f_{CLOCK}=2MHz$)

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

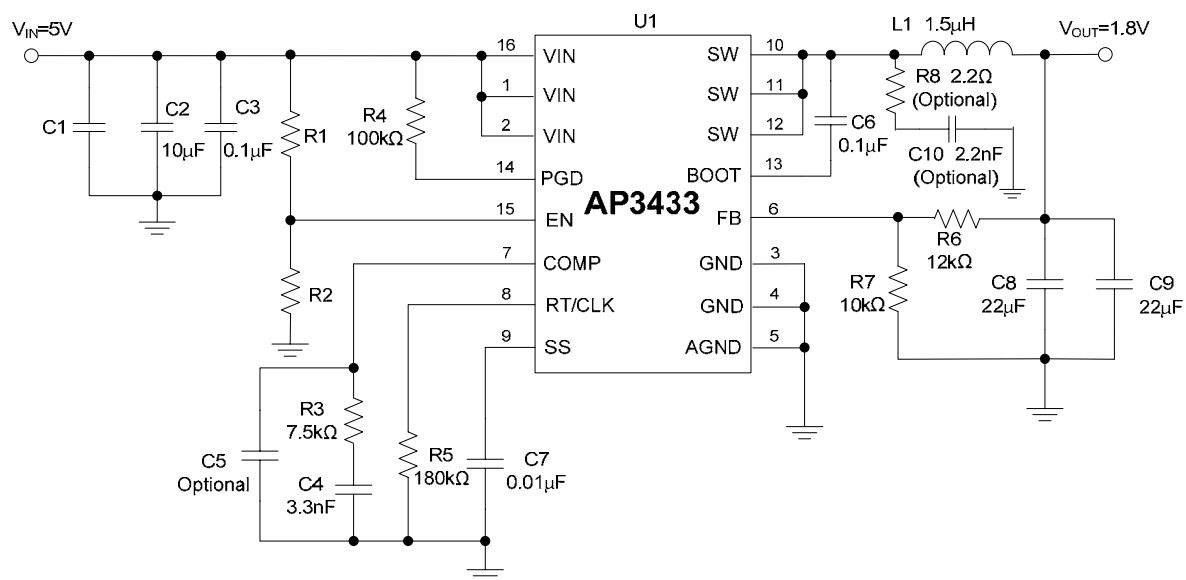
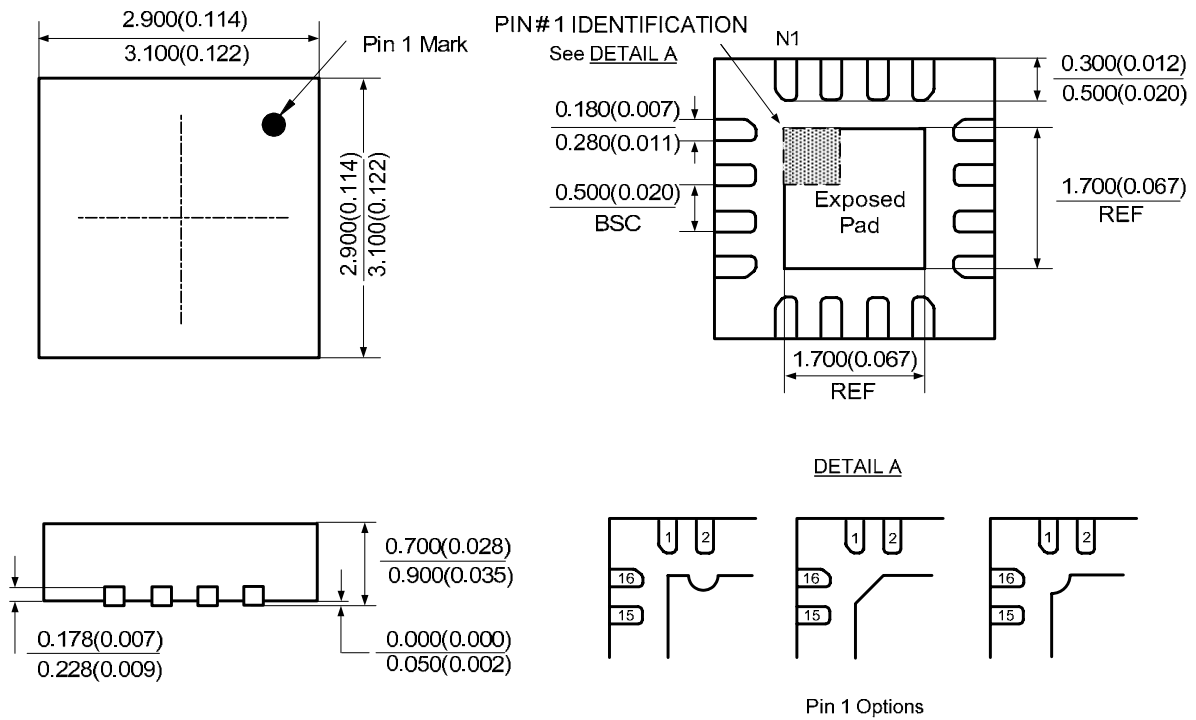


Figure 18. Typical Application of AP3433

3A, 2MHz High Performance Synchronous Buck Converter

AP3433

Mechanical Dimensions

QFN-3×3-16
Unit:mm(inch)




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