■ General Description

The AME5143 switching regulator is current-mode boost converters operating at fixed frequency of 1.4MHz.

The use of MSOP-8/PP package, made possible by the minimal power loss of the internal 1.8A switch, and use of small inductor and capacitors result in the industry's highest power density. The 30V internal switch makes these solutions perfect for boosting to voltages up to 30V.

These parts have a logic-level shutdown pin that can be used to reduce quiescent current and extend battery life. Protection is provided through cycle-by-cycle current limiting and thermal shutdown. Internal compensation simplifies and reduces component count.

■ Features

- 30V DMOS FET Switch
- 1.4MHz Switching Frequency
- Low R_{DSON} DMOS FET
- Switch Current Up to 1.8A (CS Connects to GND)
- Wide Input Voltage Range (2.7V-5.5V)
- Low Shutdown Current (<1µA)
- MSOP-8/PP Package
- Uses Tiny Capacitors and Inductor
- Meet RoHS Standards

■ Applications

- White LED Current Source
- PDA's and Palm-Top Computers
- Digital Cameras
- Portable Phones and Games
- Local Boost Regulator

■ Typical Application

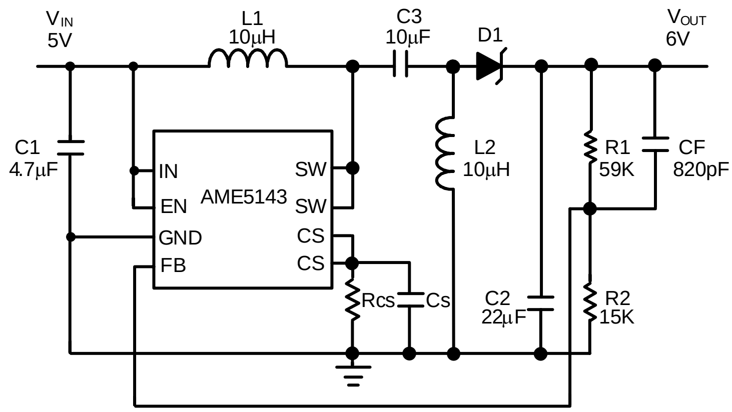


Figure 1. 5V to 6V Boost Converter

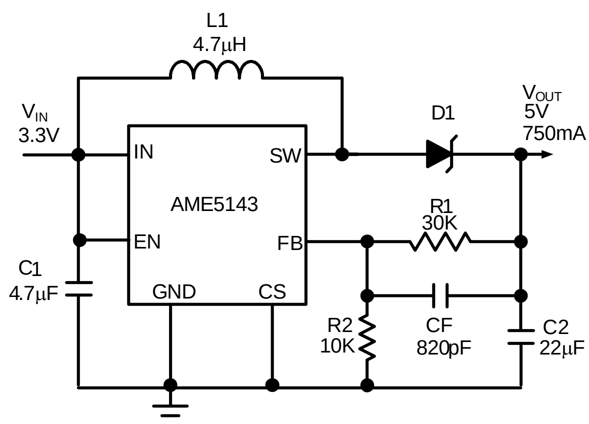


Figure 2. 3.3V to 5V Boost Converter

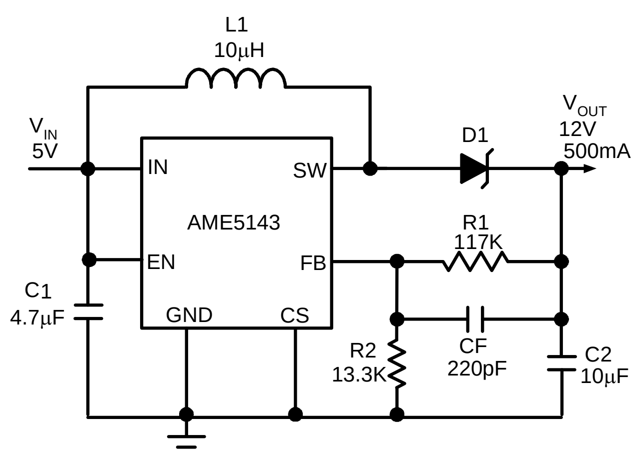


Figure 3. 5V to 12V Boost Converter

■ Function Block Diagram

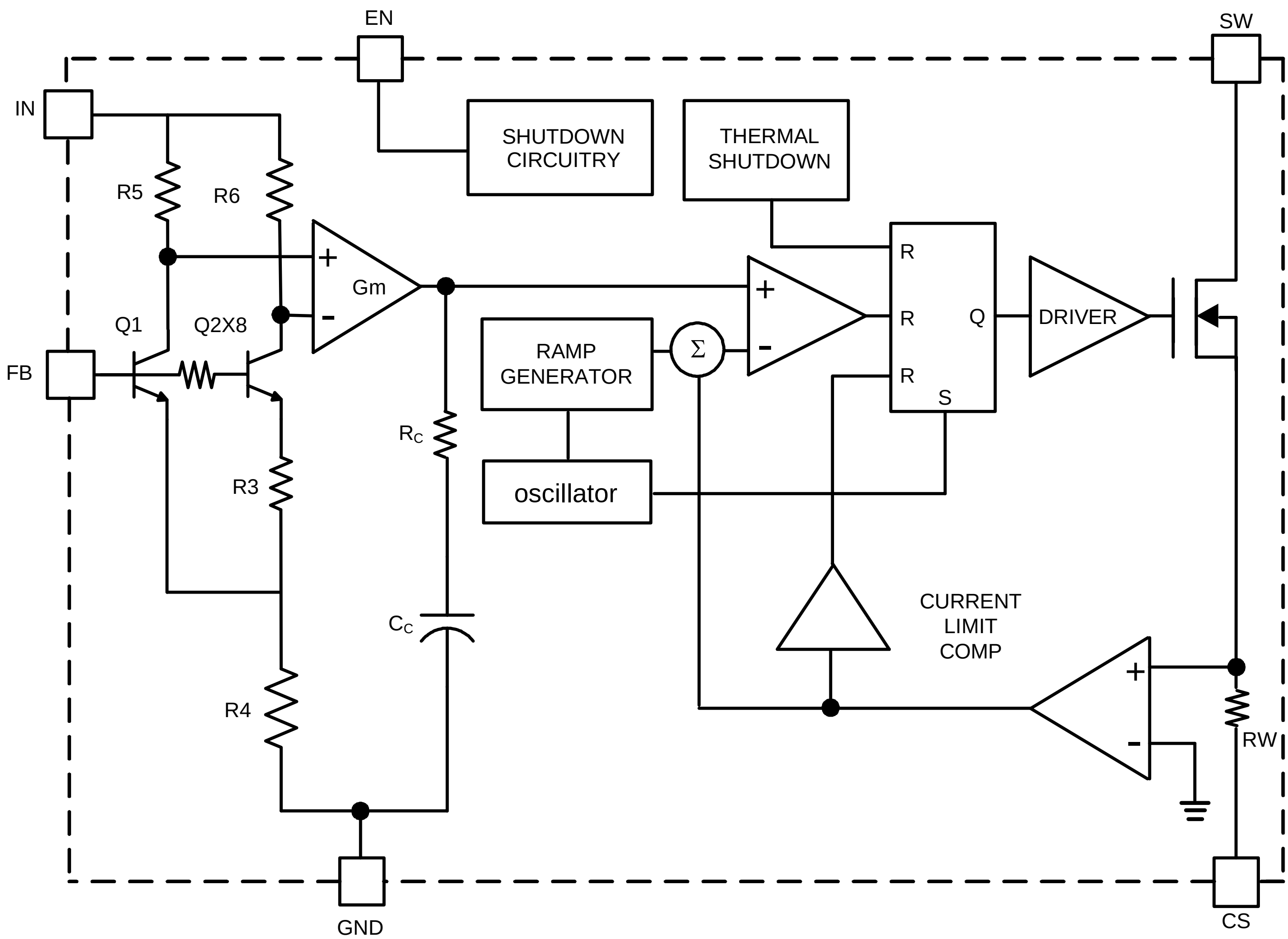
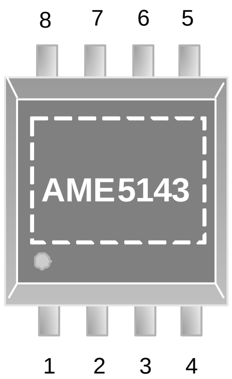


Figure 4. Functional Block Diagram

■ Pin Configuration

MSOP-8/PP
Top View



AME5143AE2Axxx

1. IN
2. EN
3. GND
4. FB
5. SW
6. SW
7. CS
8. CS

Die Attach:
Conductive Epoxy

Note: The rectangular area enclosed by dashed line represents Exposed Pad and is GND.

■ Pin Description

AME5143AE2A MSOP-8/PP

Pin Number	Pin Name	Pin Description
1	IN	Analog and Power input. Input Supply Pin. Place bypass capacitor as close to V_{IN} as possible.
2	EN	Enable, active high. The enable pin is an active high control. Tie this pin above 2V to enable the device. Tie this pin below 0.4V to turn off the device.
3	GND	Ground. Tie directly to ground plane.
4	FB	Output voltage feedback input. Set the output voltage by selecting values for R1 and R2 using: $R1 = R2\left(\frac{V_{out}}{1.23V} - 1\right)$ Connect the ground of the feedback network to a GND plane.
5 , 6	SW	Power Switch input. This is the drain of the internal NMOS power switch. Minimize the metal trace area connected to this pin to minimize EMI.
7 , 8	CS	Current sense pins

■ Ordering Information

AME5143 x x x x xxx x

- x — Pin Configuration
- x — Operating Ambient Temperature Range
- x — Package Type
- x — Number of Pins
- xxx — Output Voltage
- x — Special Feature

Pin Configuration	Operating Ambient Temperature Range	Package Type	Number of Pins	Output Voltage	Special Feature
A (MSOP-8/PP) 1. IN 2. EN 3. GND 4. FB 5. SW 6. SW 7. CS 8. CS	E: -40^{O}C to +85^{O}C	2: MSOP/PP	A: 8	ADJ: Adjustable	Z: Lead free

■ Available Options

Part Number	Marking*	Output Voltage	Package	Operating Ambient Temperature Range
AME5143AE2AADJZ	5143 Ayww	ADJ	MSOP-8/PP	-40^{O}C to +85^{O}C

Note: yww represents the date code and pls refer to Date Code Rule before Package Dimension.
* A line on top of the first letter represents lead free plating such as $\overline{5}$143.
Please consult AME sales office or authorized Rep./Distributor for the availability of package type.

■ Absolute Maximum Ratings

Parameter	Symbol	Maximum	Unit
Input Supply Voltage	V_{IN}	6	V
EN, FB Voltages	V_{EN},V_{FB}	V_{IN}	V
SW Voltage	V_{SW}	30	V
ESD Classification	B*		

Caution: Stress above the listed absolute maximum rating may cause permanent damage to the device.
* HBM B:2000V~3999V

■ Recommended Operating Conditions

Parameter	Symbol	Rating	Unit
Ambient Temperature Range	T_A	-40 to +85	^oC
Junction Temperature Range	T_J	-40 to +125	
Storage Temperature Range	T_{STG}	-65 to +150	

■ Thermal Information

Parameter	Package	Die Attach	Symbol	Maximum	Unit
Thermal Resistance* (Junction to Case)	MSOP-8/PP	Conductive Epoxy	θ_{JC}	9	$^OC/W$
Thermal Resistance (Junction to Ambient)	MSOP-8/PP		θ_{JA}	142	
Internal Power Dissipation	MSOP-8/PP		P_D	900	mW
Solder Iron (10 Sec)**				350	^oC

* Measure θ_{JC} on backside center of molding compund if IC has no tab.
** MIL-STD-202G 210F

■ Electrical Specifications

V_{IN} = 5V, EN = V_{IN}, T_A= 25ºC, I $_L$= 0A, unless otherwise noted.

Parameter	Symbol	Test Condition		Min	Typ	Max	Units
Input Voltage	V_{IN}			2.7		5.5	V
Switch Current Limit	I_{CL}	Rcs = 0			1.8		A
Switch Current Limit Trip Volatge Point	V_{CS}	I_{SW} = 5mA		90	100	110	mV
Switch ON Resistance	R_{DSON}	V_{IN} = 5V	T_A = 25^{O}C		0.4	0.6	Ω
			T_A = -40 to +85^{o}C			0.7	
		V_{IN} = 3.3V	T_A = 25^{O}C		0.5	0.7	
			T_A = -40 to +85^{o}C			0.8	
Feedback Pin Reference Voltage	V_{FB}	V_{IN} = 3V		1.205	1.23	1.255	V
Feedback Pin Bias Current	I_{FB}	V_{FB} = 1.23V			60	500	nA
Quiescent Current	I_Q	FB = 1.15V (Switching)	T_A = 25^{o}C		2		mA
			V_{IN} = 5V T_A = -40 to +85^{o}C			3	
		FB = 1.3V (Not Switching)	T_A = 25^{o}C		400		µA
			V_{IN} = 5V T_A = -40 to +85^{o}C			500	
Shutdown Current		EN = 0V			0.01	1	µA
Undervoltage Lockout	UVP	Rising Edge		2.15	2.35	2.55	V
Over Temperature Protection	OTP	V_{IN}=2.7V to 5.5V			160		^{o}C
OTP Hysteresis Temperature					20		^{o}C
FB Voltage Line Regulation	$\frac{\Delta V_{FB}}{\Delta V_{IN}}$	2.7V <= V_{IN} <= 5.5V			0.02		%V
Switching Frequency	f_{SW}	V_{IN} = 3V, T_A = -40 to +85^{o}C		1	1.4	1.65	MHz
Maximum Duty Cycle	D_{MAX}	V_{IN} = 3V, T_A = -40 to +85^{o}C		86	93		%
Switch Leakage	I_{SW}	EN = 0V			0.1	2	µA
EN Input Threshold (Low) (Shutdown)	EN Threshold	T_A = -40 to +85^{o}C				0.4	V
EN Input Threshold (High) (Enable the device)		T_A = -40 to +85^{o}C		2			

■ Detailed Description

The AME5143 is a switching converter IC that operates at a fixed frequency (1.4MHz) for fast transient response over a wide input voltage range and incorporates pulse-by-pulse current limiting protection. Operation can be best understood by referring to Figure 4. Because this is current mode control, a 40mΩ sense resistor RW in series with the switch FET is used to provide a voltage (which is proportional to the FET current) to both the input of the pulse width modulation (PWM) comparator and the current limit amplifier. We can develop an expression which allows the maximun current limit to be calculated.

$$R_{CS} = V_{CS} / I_{CL} - 40mW$$

At the beginning of each cycle, the S-R latch turns on the FET. As the current through the FET increases, a voltage (proportional to this current) is summed with the ramp coming from the ramp generator and then fed into the input of the PWM comparator. When this voltage exceeds the voltage on the other input (coming from the Gm amplifier), the latch resets and turns the FET off. Since the signal coming from the Gm amplifier is derived from the feedback (which samples the voltage at the output), the action of the PWM comparator constantly sets the correct peak current through the FET to keep the output voltage in regulation.

Q1 and Q2 align with R3 - R6 form a bandgap voltage reference used by the IC to hold the output in regulation. The currents flowing through Q1 and Q2 will be equal, and the feedback loop will adjust the regulated output to maintain this. Because of this, the regulated output is always maintained at a voltage level equal to the voltage at the FB node "multiplied up" by the ratio of the output resistive divider.

The current limit comparator feeds directly into the flip-flop that drives the switch FET. If the FET current reaches the limit threshold, the FET is turned off and the cycle terminated until the next clock pulse. The current limit input terminates the pulse regardless of the status of the output of the PWM comparator.

■ Application Hints

Selecting The External Capacitors

The best capacitors for use with the AME5143 are multilayer Ceramic capacitors. They have the lowest ESR (equivalent series resistance) and highest resonance frequency, which makes them optimum for use with high frequency switching Converters. When selecting a ceramic capacitor, only X5R and X7R dielectric types should be used. Other types such as Z5U and Y5F have such severe loss of capacitance due to effects of temperature variation and applied voltage, they may provide as little as 20% of rated capacitance in many typical applications. Always consult capacitor manufacturer's data curves before selecting a capacitor. High-quality ceramic capacitors can be obtained from Taiyo-Yuden, AVX, and Murata.

Selecting The Output Capacitor

A single ceramic capacitor of value 4.7µF to 10µF will provide sufficient output capacitance for most applications. If larger amounts of capacitance are desired for improved line support and transient response, tantalum capacitors can be used. Aluminum electrolytic with ultra low ESR such as Sanyo Oscon can be used, but are usually prohibitively expensive. Typical AI electrolytic capacitors are not suitable for switching frequencies above 500kHz due to significant ringing and temperature rise due to self-heating from ripple current. An output capacitor with excessive ESR can also reduce phase margin and cause instability. In general, if electrolytic are used, it is recommended that. They be paralleled with ceramic capacitors to reduce ringing, switching losses, and output voltage ripple.

Selecting The Input Capacitor

An input capacitor is required to serve as an energy reservoir for the current which must flow into the coil each time the switch turns ON. This capacitor must have extremely low ESR, so ceramic is the best choice. We recommend a nominal value of 4.7µF, but larger values can be used. Since this capacitor reduces the amount of voltage ripple seen at the input pin, it also reduces the amount of EMI passed back along that line to other circuitry.

■ Application Hints

Feed-Forward Compensation

Although internally compensated, the feed-forward capacitor Cf is required for stability. Adding this capacitor puts a zero in the loop response of the Converter. The recommended frequency for the zero fz should be approximately 6kHz. Cf can be calculated using the formula:

$$Cf = 1 / (2 \times \pi \times R1 \times fz)$$

Selecting Diodes

The external diode used in the typical application should be a Schottky diode. A 30V diode such as the MBR0530 is recommended. The MBR05XX series of diodes are designed to handle a maximum average current of 0.5A. For applications exceeding 0.5A average but less than 1A, a Microsemi UPS5817 can be used.

Thermal Consuderations

At higher duty cycles, the increased ON time of the FET means the maximum output current will be determined by power dissipation within the AME5143 FET switch. The switch power dissipation from ON-state conduction is calculated by:

$$P_{(SW)} = D \times I^2_{IND(AVE)} \times R_{DS}(ON)$$

There will be some switching losses as well, so some derating needs to be applied when calculating IC power dissipation.

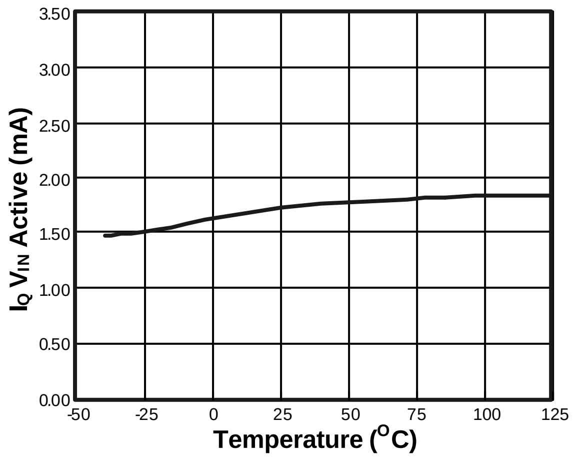
Inductor Suppliers

Recommended suppliers of inductors for this product include, but are not limited to Sumida, Coilcraft, Panasonic, TDK and Murata. When selecting an inductor, make certain that the continuous current rating is high enough to avoid saturation at peak currents. A suitable core type must be used to minimize core (switching) losses, and wire power losses must be considered when selecting the current rating.

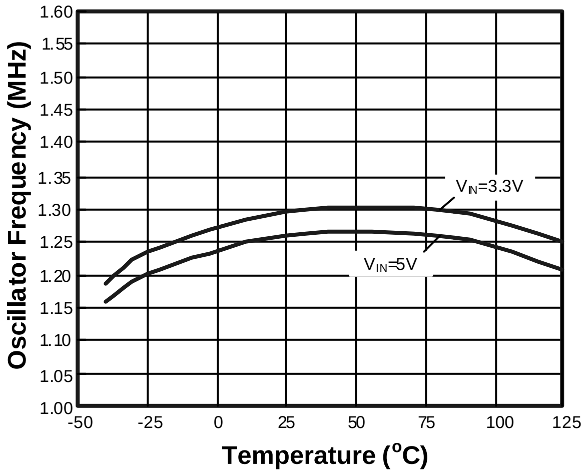
Shutdown Pin Operation

The device is turned off by pulling the shutdown pin low. If this function is not going to be used, the pin should be tied directly to V_{IN}. If the SHDN function will be needed, a pull-up resistor must be used to V_{IN} (approximately 50k-100k recommended). The EN pin must not be left unterminated.

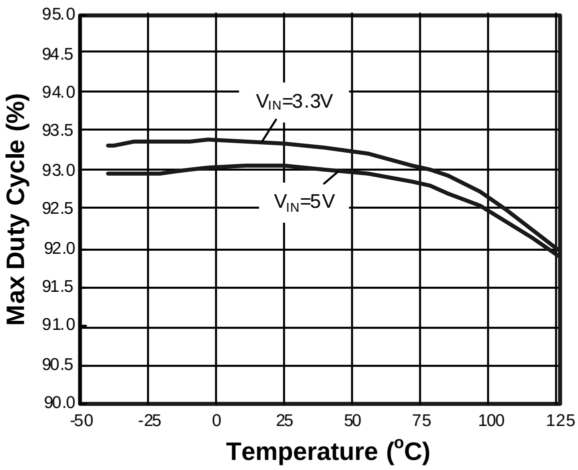
I_Q V_{IN}(Active) vs Temperature



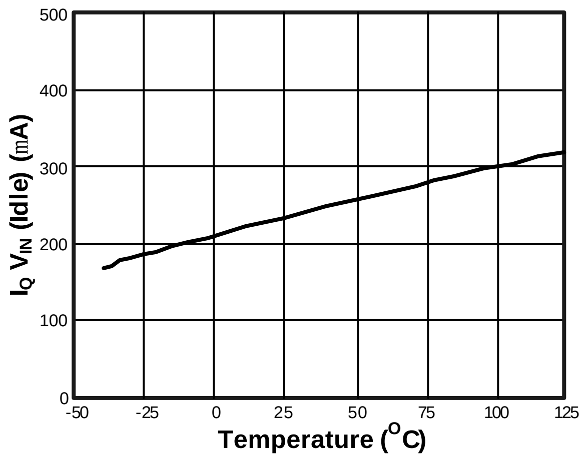
Oscillator Frequency vs Temperature



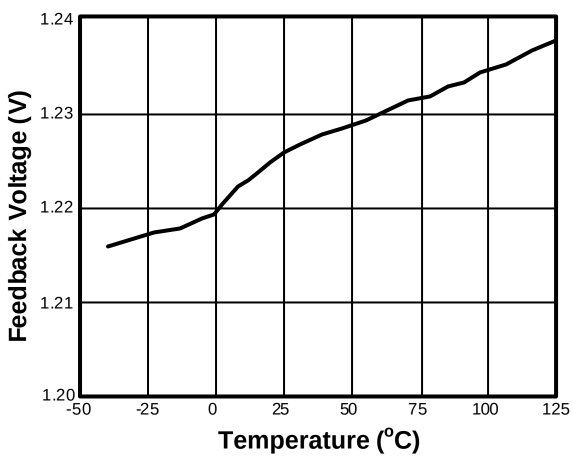
Max. Duty Cycle vs Temperature



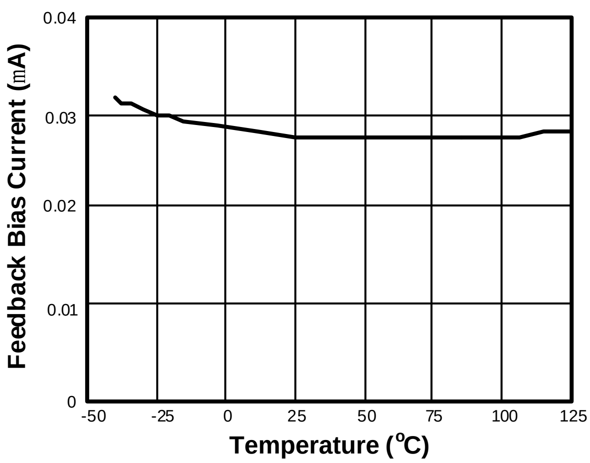
I_Q V_{IN} (Idle) vs Temperature



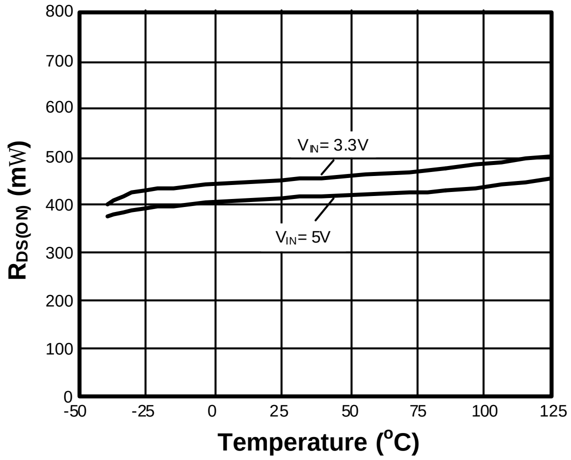
Feedback Voltage vs Temperature



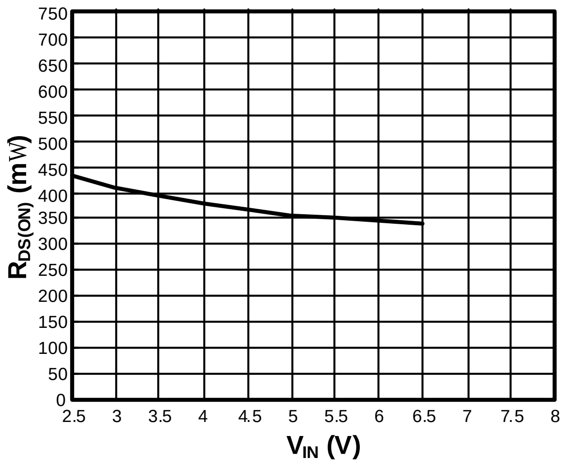
Feedback Bias Current vs Temperature



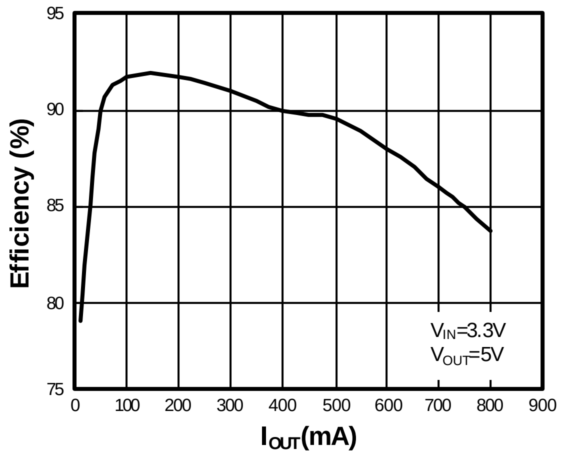
$R_{DS(ON)}$ vs Temperature



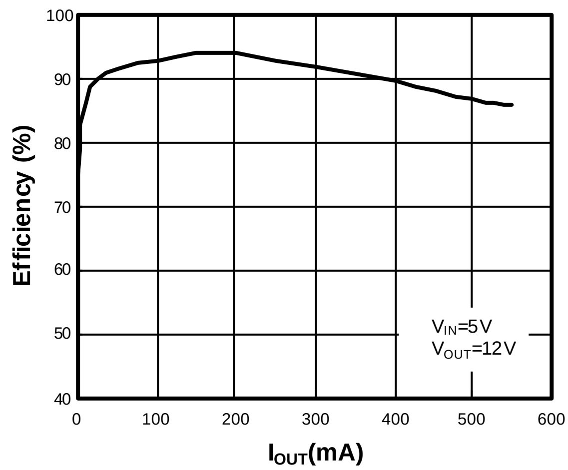
$R_{DS(ON)}$ vs V_{IN}



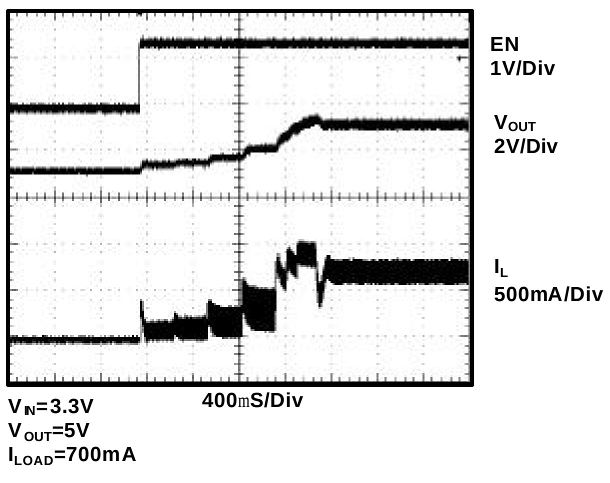
Efficiency vs I_{out}



Efficiency vs I_{out}

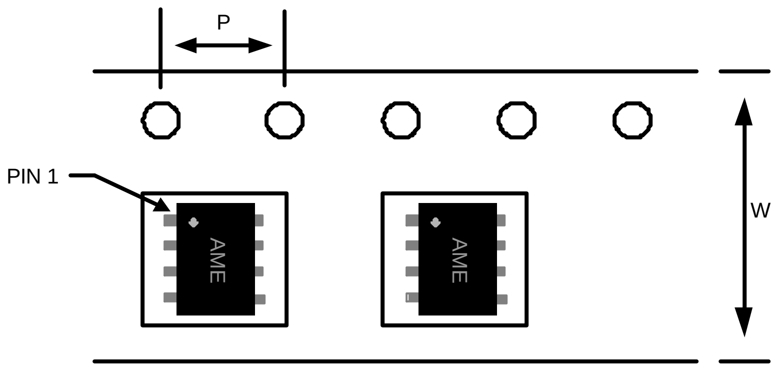


Start Up Waveform



■ Tape and Reel Dimension

MSOP-8/PP

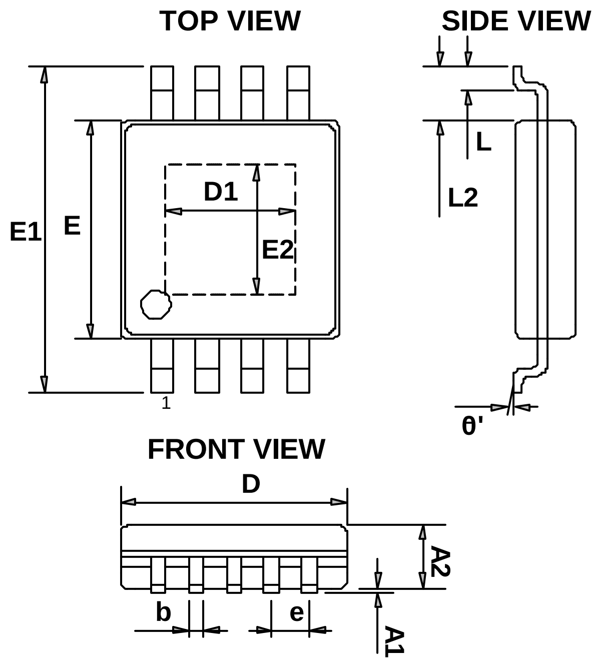


Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
MSOP-8/PP	12.0±0.1 mm	4.0±0.1 mm	4000pcs	330±1 mm

■ Package Dimension

MSOP-8/PP



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A1	0.000	0.150	0.0000	0.0059
A2	0.750	0.950	0.0295	0.0374
b	0.220	0.380	0.0087	0.0150
E	3.000 BSC		0.1181 BSC	
D	3.000 BSC		0.1181 BSC	
e	0.650 BSC		0.0256 BSC	
E1	4.900 BSC		0.1929 BSC	
L	0.400	0.800	0.0157	0.0315
q'	0°	8°	0°	8°
L2	0.950 REF		0.0374 REF	
E2	1.380	1.800	0.0543	0.0709
D1	1.420	1.800	0.0559	0.0709

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