PWM Control 3A Step-Down Converter

❖ GENERAL DESCRIPTION

AX3140/A consists of step-down switching regulator with PWM control. These devise include a reference voltage source, oscillation circuit, error amplifier, internal PMOS and etc.

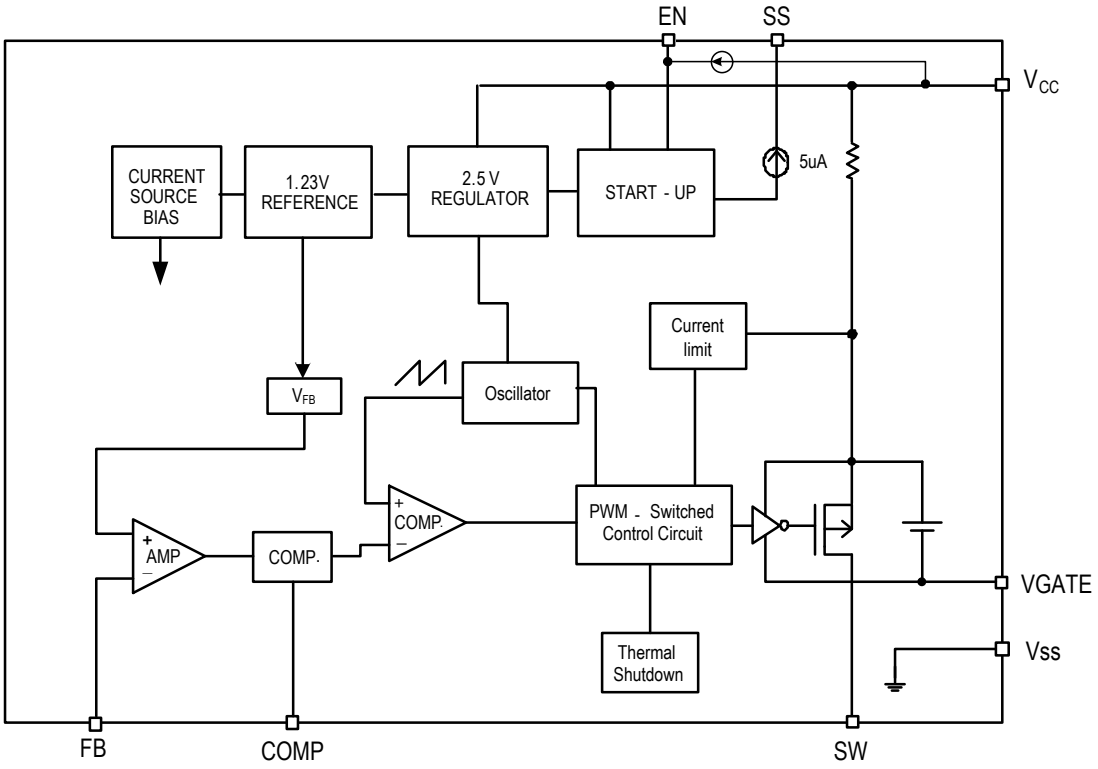
AX3140/A provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit is able to the duty ratio linearly form 0 up to 100%. This converter is build out soft start function that prevents overshoot and inrush current at startup. An over current protect function and short circuit protect function are built inside, and when OCP or SCP happens, the operation frequency will be reduced. An external compensation is easily to system stable; the low ESR output capacitor can be used.

With the addition of an internal P-channel Power MOS, a coil, capacitors, and a diode connected externally, these ICs can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP-8L with exposed pad package, providing such outstanding features as low current consumption. Since this converter can accommodate an input voltage up to 40V, it is also suitable for the operation via an AC adapter.

❖ FEATURES

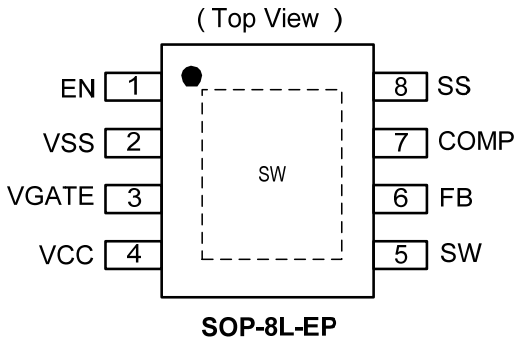
- Input voltage：8V to 40V
- Output voltage：3.3V to 38V
- Duty ratio：0% to 100% PWM control
- Soft-Start function
- Current Limit, Short Circuit Protect (SCP) and Thermal Shutdown protection
- Built-in internal SW P-channel MOS.
- SOP-8L-EP Pb-Free package.

❖ BLOCK DIAGRAM



❖ PIN ASSIGNMENT

The package of AX3140/A is SOP-8L-EP; the pin assignment is given by:



SOP-8L-EP

Name	Description
EN	ON/OFF Shutdown pin
VSS	GND pin
VGATE	Driver GATE clamping pin. The pin must connect a 1uF capacitor to VCC
VCC	IC power supply pin
SW	Switch pin. Connect external inductor and diode here.
FB	Feedback pin
COMP	Compensation pin
SS	Soft-start pin

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX3140 X XX X Frequency: Blank: 100KHz, A: 350KHz Package Type: ES: SOP-8L-EP Packing: Blank : Tube, A : Taping	Logo ← AX 3 1 4 0 → Part number A Y Y WW X → ID code:internal WW: 01~52 Year: 10=2010, 11=2011 Blank: AX3140 A: AX3140A

❖ ABSOLUTE MAXIMUM RATINGS (at T_A=25°C)

Characteristics	Symbol	Rating	Unit
V_{CC} Pin Voltage	V_{CC}	V_{SS} - 0.3 to V_{SS} + 45	V
Feedback Pin Voltage	V_{FB}	V_{SS} - 0.3 to 6	V
EN Pin Voltage	$V_{EN/SS}$	V_{SS} - 0.3 to 6	V
SS Pin Voltage	V_{OSC}	V_{SS} - 0.3 to 6	V
COMP Pin Voltage	V_{COMP}	V_{SS} - 0.3 to 6	V
VGATE Pin Voltage	V_{GATE}	V_{SS} - 0.3 to V_{CC}	V
Switch Pin Voltage	V_{SW}	V_{SS} - 0.3 to V_{CC} + 0.3	V
Power Dissipation	PD	Internally limited	mW
Storage Temperature Range	T_{ST}	-65 to +150	°C
Operating Junction Temperature Range	T_{OJP}	-40 to +125	°C
Operating Supply Voltage	V_{OP}	8 to 40	V
Thermal Resistance from Junction to case	θ_{JC}	15	°C/W
Thermal Resistance from Junction to ambient	θ_{JA}	40	°C/W

Note: θ_{JA} is measured with the PCB copper area (need connect to Exposed Pad) of approximately 1.5 in^2 (Multi-layer).

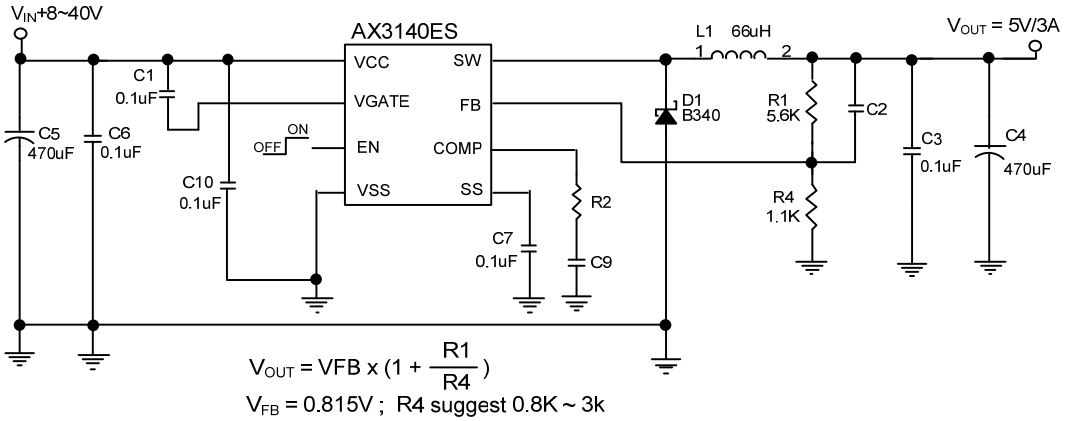
❖ ELECTRICAL CHARACTERISTICS

(V_{CC} = 12V, T_A=25°C, unless otherwise specified)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Feedback Voltage	V_{FB}	I_{OUT}=200mA	0.800	0.815	0.830	V
Quiescent Current	I_{CCQ}	V_{FB}=1.2V force driver off	-	3	6	mA
Feedback Bias Current	I_{FB}	I_{OUT}=0.1A	-	0.1	0.5	uA
Shutdown Supply Current	I_{SD}	$V_{EN/SS}$ =0V	-	200	400	uA
Line Regulation	$\Delta V_{OUT}/V_{OUT}$	V_{CC} =8V~40V, I_{OUT}=10mA	-	0.5	1	%
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	I_{OUT} = 0.2 to 3A	-	0.3	0.6	%
Current Limit	I_{CL}		3.5	-	-	A
Oscillator frequency	F_{OSC}	AX3140	75	100	125	KHz
		AX3140A	280	350	420	
Short frequency	F_{OSC1}	V_{OUT}=0V	-	50	-	KHz
EN Pin Logic input threshold voltage	V_{IH}	High (regulator ON)	2.0	-	-	V
	V_{IL}	Low (regulator OFF)	-	-	0.8	V
EN Pull Low current	I_{EN}	EN=GND	-	10	20	uA
Soft-Start	I_{ss}	V_{EN}=2V, SS=GND Charge Current	-	5	-	uA
Internal MOSFET R_{DSON}	R_{DSON}	V_{CC}=12V, 1A,V_{FB}=0V	-	120	180	mΩ
Efficiency	EFFI	V_{CC} = 12V, V_{OUT} = 5V, I_{OUT} = 2A	-	91	-	%
		V_{CC} = 32V, V_{OUT} = 5V, I_{OUT} = 2A		87		

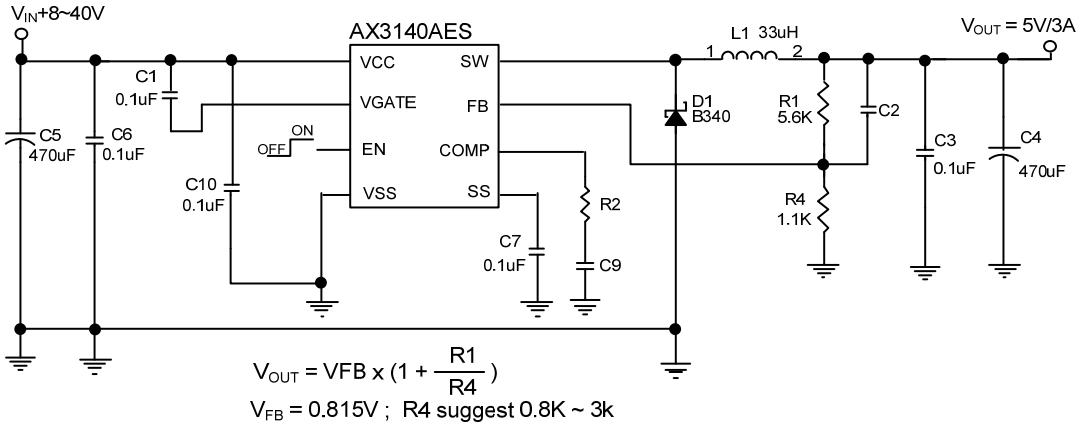
❖ APPLICATION CIRCUIT

(1) AX3140



EL Capacitor Compensation Table				
COUT ESR Range	V_{OUT}	R2	C9	C2
30m~80mΩ	5.0V	470R	10N	1800P
	3.3V	2KR	4N7	1200P
80m~300mΩ	5.0V	470R	10N	3300P
	3.3V	2KR	4N7	1000P

(2) AX3140A



EL Capacitor Compensation Table				
COUT ESR Range	V_{OUT}	R2	C9	C2
30m~80mΩ	5.0V	470R	4N7	1200P
	3.3V	470R	10N	1000P
80m~300mΩ	5.0V	470R	4N7	470P
	3.3V	470R	10N	180P

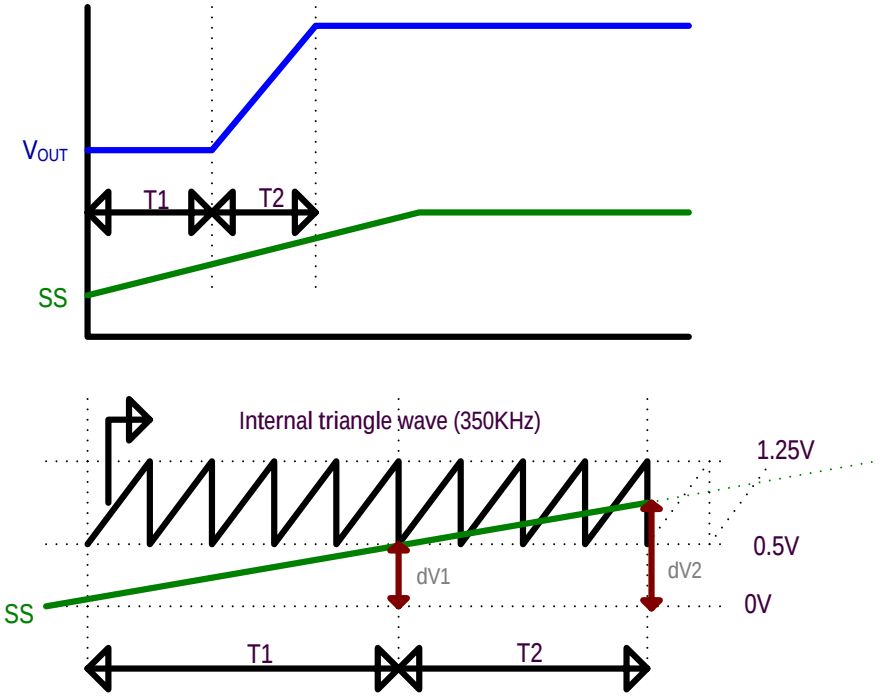
❖ FUNCTION DESCRIPTIONS

EN

This pin can be supplied shutdown function. It is inside pull high function. Allow the switching regulator circuit to be shutdown pulling this pin below a 0.8V threshold voltage.

SS

This pin can be supplied soft start function. The pin must be connected a capacitor to ground. There is a 5uA current to charge this capacitor, vary the different capacitor value to control soft start time.



Start-up Delay Time: $T1 = C_{SS} \times dV1/I_{SS}$
Soft Start Time: $T2 = C_{SS} \times dV2/I_{SS}$

Where:

dV1 = 0.5V

dV2 = (1.25-0.5) × Duty

$I_{SS} \fallingdotseq 6.8\mu$

$$Duty \fallingdotseq \frac{V_{OUT}}{V_{IN}}$$

Example: C6=0.1μ, V_{IN}=10V, V_O=5V

T1 = 0.1μ × 0.5V/6.8μ = 7.35mS

T2 = 0.1μ × (1.25-0.5) × 50%/6.8μ = 5.51mS

COMP

Compensation pin. For EL output capacitor application, the COMP pin connects R2 and C9 to ground for all condition; please refer the compensation table.

❖ APPLICATION INFORMATION

Setting the Output Voltage

Application circuit item shows the basic application circuit with adjustable output version. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.815V \times \left(1 + \frac{R1}{R4}\right)$$

Table 1 Resistor select for output voltage setting

V_{OUT}	R4	R1
5.0V	1.1K	5.6K
3.3V	2.7K	8.2K

Inductor Selection

For most designs, the different frequency can be reducing the inductor value; The AX3140/A suggest to 33μH. Where is inductor Ripple Current. Large value inductors lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately 15% of the maximum load current 3A, ΔI_L=0.4A. The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation (3A+0.2A).

Input Capacitor Selection

This capacitor should be located close to the IC using short leads and the voltage rating should be approximately 1.5 times the maximum input voltage. The RMS current rating requirement for the input capacitor of a buck regulator is approximately 1⁄2 the DC load current. A low ESR input capacitor sized for maximum RMS current must be used. A 470µF low ESR capacitor for most applications is sufficient.

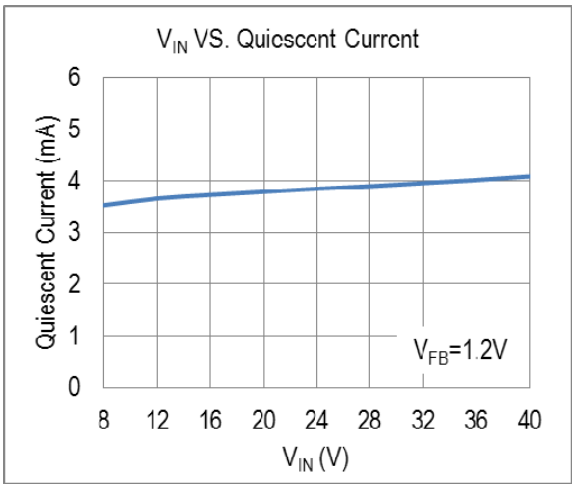
Output Capacitor Selection

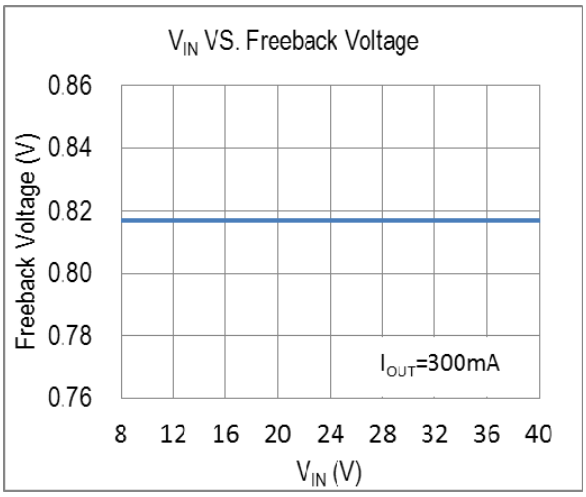
The output capacitor is required to filter the output and provide regulator loop stability. The important capacitor parameters are; the 100 KHz Equivalent Series Resistance (ESR), the RMS ripples current rating, voltage rating, and capacitance value. For the output capacitor, the ESR value is the most important parameter. The ESR can be calculated from the following formula.

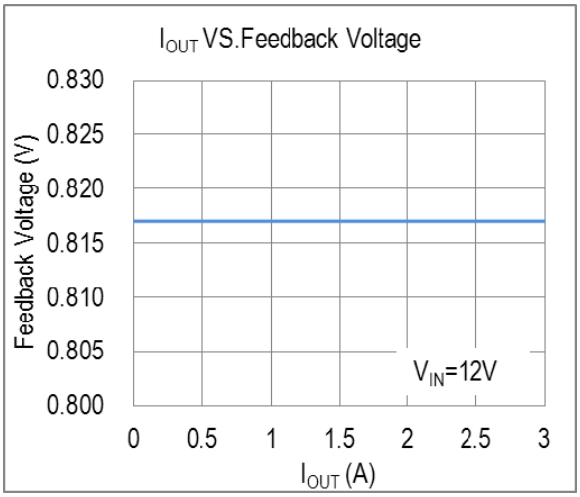
$$V_{RIPPLE} = \Delta I_L \times ESR$$ = 0.4A x 80mΩ= 32mV

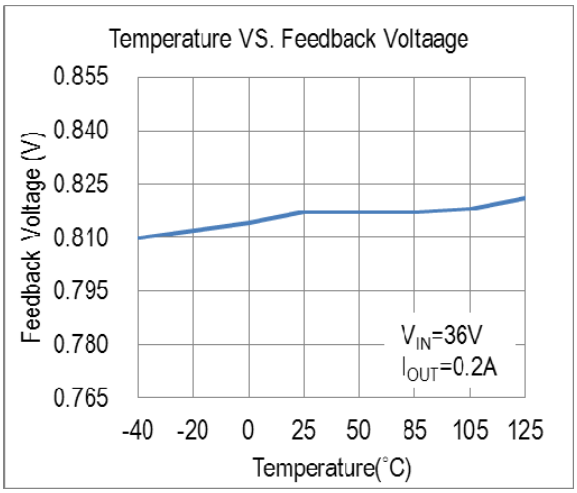
An aluminum electrolytic capacitor's ESR value is related to the capacitance and its voltage rating. In most case, higher voltage electrolytic capacitors have lower ESR values. Most of the time, capacitors with much higher voltage ratings may be needed to provide the low ESR values required for low output ripple voltage. It is recommended to replace this low ESR capacitor by using a 470µF low ESR values < 80mΩ.

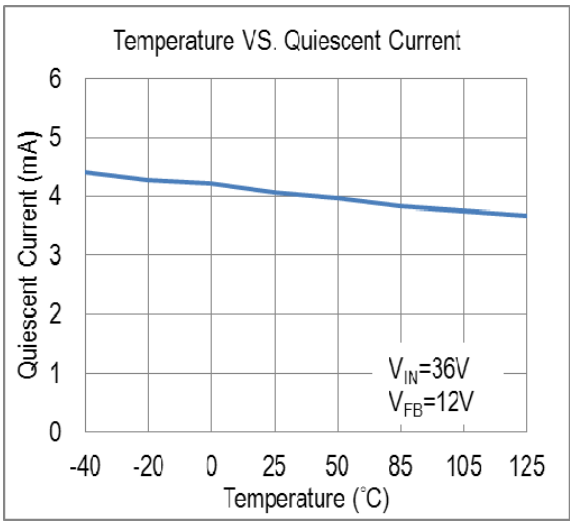
❖ TYPICAL CHARACTERISTICS

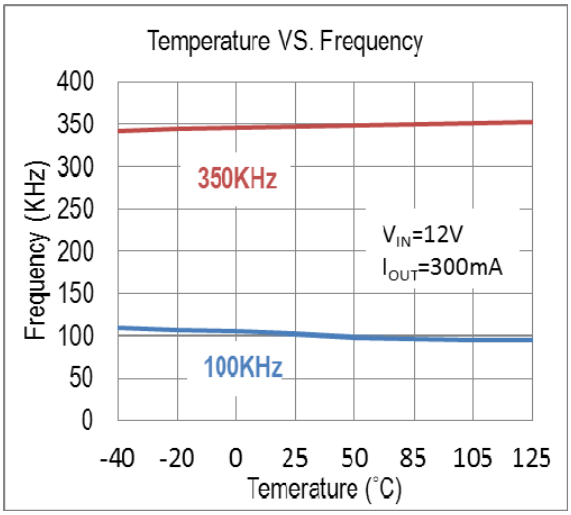




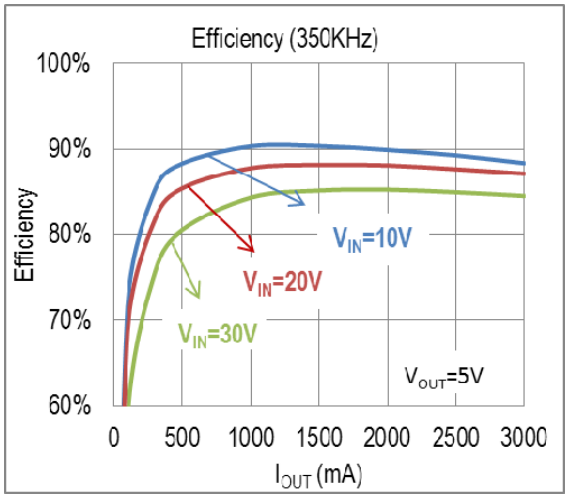


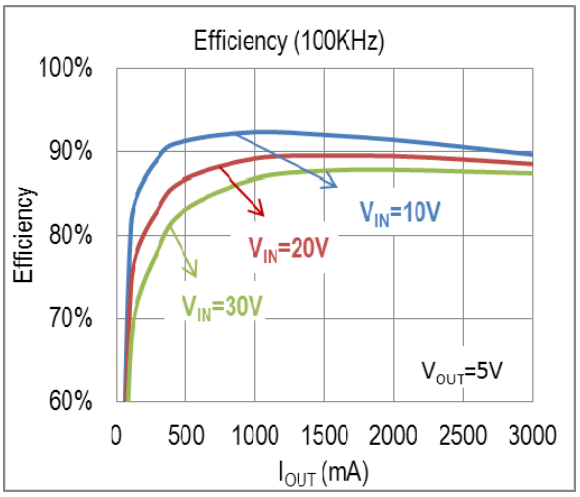






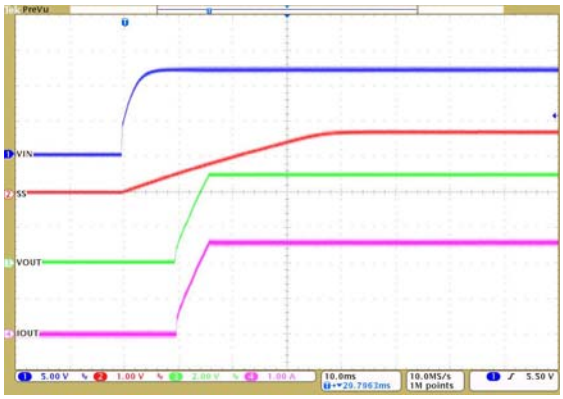
❖ TYPICAL CHARACTERISTICS (CONTINUOUS)



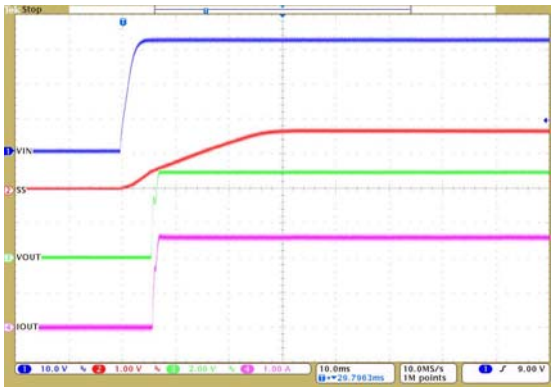


❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

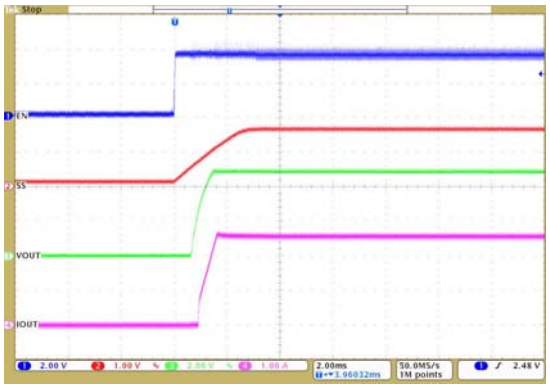
V_{IN}=12V, V_{OUT}=5V, I_{OUT}=2.7A, C_{SS}=100n



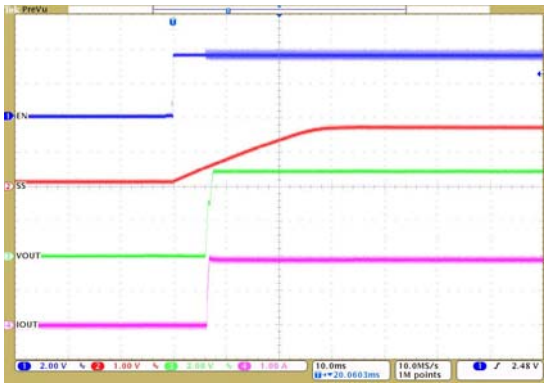
V_{IN}=32V, V_{OUT}=5V, I_{OUT}=2.7A, C_{SS}=100n



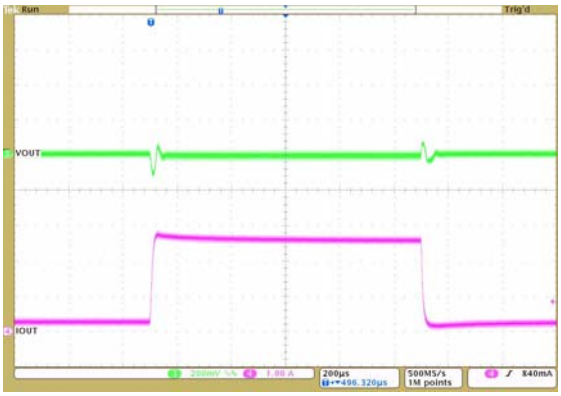
V_{IN}=32V, V_{OUT}=5V, I_{OUT}=2.7A, C_{SS}=10n



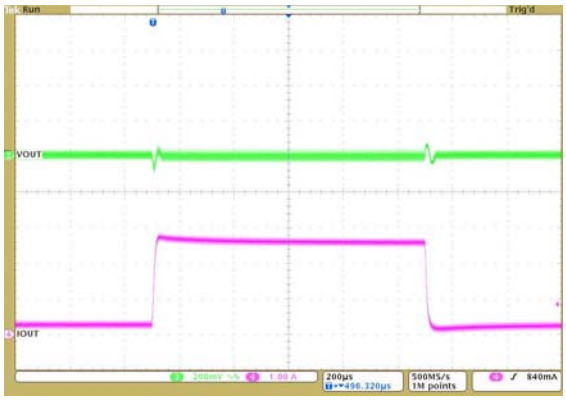
V_{IN}=32V, V_{OUT}=5V, I_{OUT}=2.7A, C_{SS}=100n



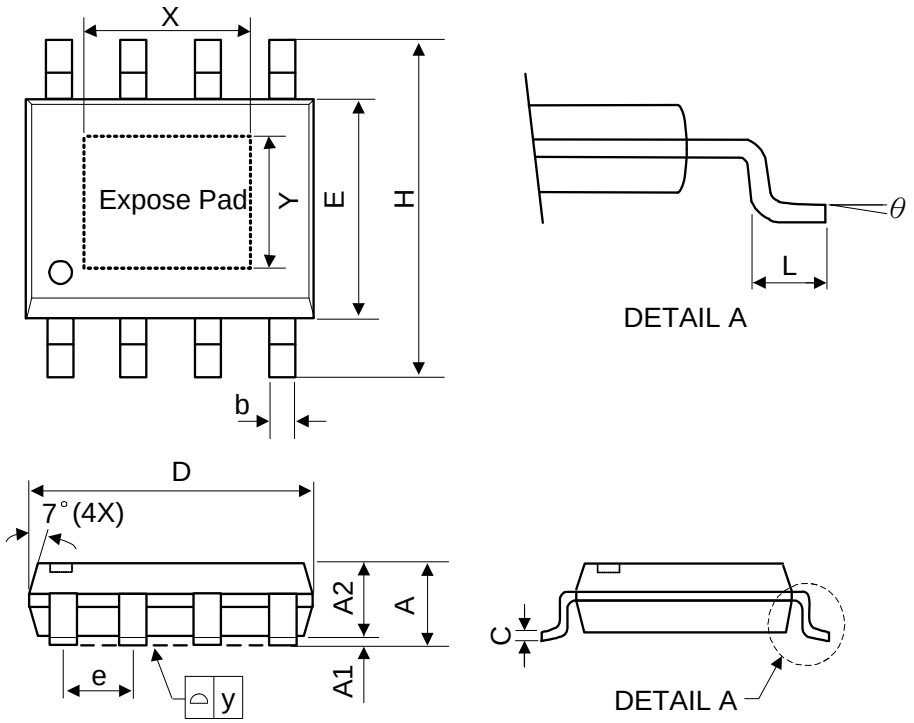
V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.3~2.7A



V_{IN}=32V, V_{OUT}=5V, I_{OUT}=0.3~2.7A



❖ PACKAGE OUTLINES



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0	-	0.15	0	-	0.06
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	0.05
b	0.31	0.41	0.51	0.012	0.016	0.02
e	1.27 BSC			0.050 BSC		
y	-	-	0.1	-	-	0.004
X	-	2.34	-	-	0.092	-
Y	-	2.34	-	-	0.092	-
θ	0°	-	8°	0°	-	8°

Mold flash shall not exceed 0.25mm per side
JEDEC outline: MS-012 BA