

PWM Control 3A Step-Down Converter

❖ **GENERAL DESCRIPTION**

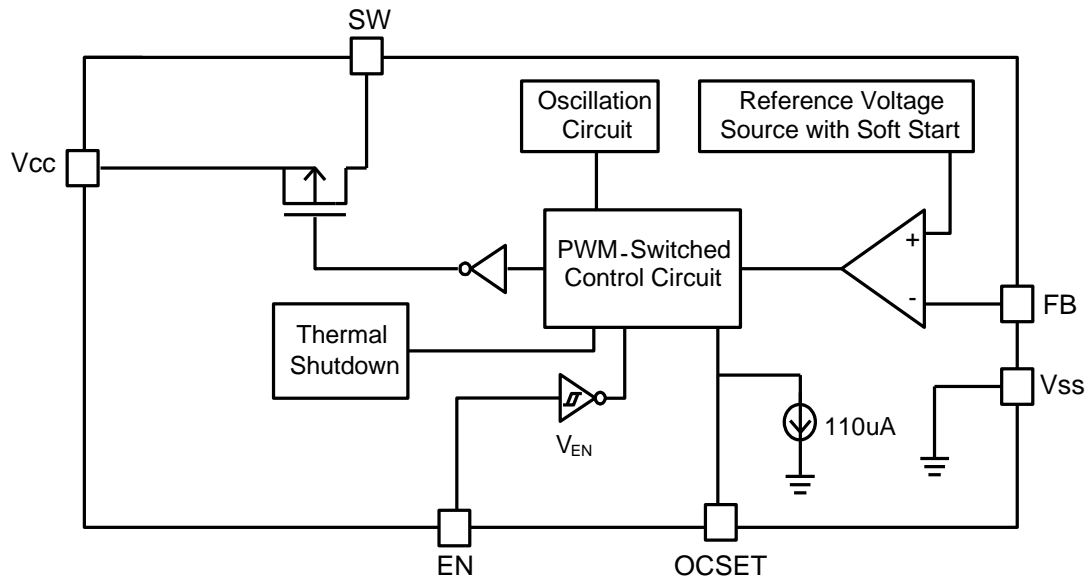
AX3102A consists of step-down switching regulator with PWM control. These device include a reference voltage source, oscillation circuit, error amplifier, internal PMOS and etc. AX3102A provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit is able to the duty ratio linearly form 0 up to 100%. This converter also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup. An enable function, 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. Also, an internal compensation block is built in to minimum external component count.

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 package, providing such outstanding features as low current consumption. Since this converter can accommodate an input voltage up to 23V, it is also suitable for the operation via an AC adapter.

❖ **FEATURES**

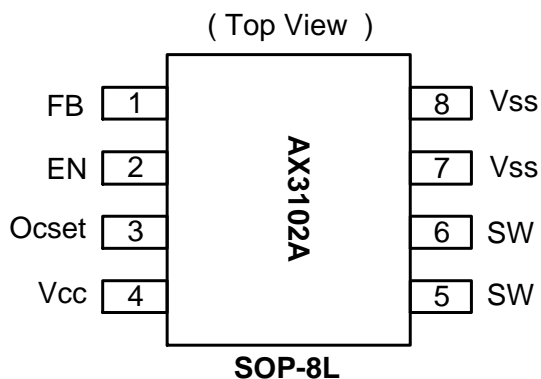
- Input voltage : 4V to 23V
- Output voltage : 0.8V to V_{CC}
- Duty ratio : 0% to 100% PWM control
- Oscillation frequency : 330KHz typ.
- Soft-Start (SS), Current Limit (CL), Enable function.
- Thermal Shutdown function.
- Short Circuit Protect (SCP).
- Built-in internal SW P-channel MOS.
- SOP-8L Pb-Free package.

❖ BLOCK DIAGRAM



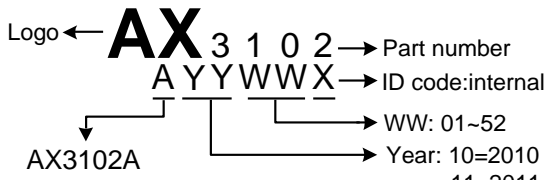
❖ PIN ASSIGNMENT

The package of AX3102A is SOP-8L; the pin assignment is given by:



Name	Description
FB	Feedback pin
EN	Power-off pin H : normal operation(Step-down) L : Step-down operation stopped (All circuits deactivated)
OCSET	Add an external resistor to set max switch output current.
Vcc	IC power supply pin
SW	Switch pin. Connect external inductor and diode here.
Vss	GND pin

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX3102A X X <div style="display: flex; justify-content: space-around;"> <div> Package Type S: SOP-8L </div> <div> Packing Blank : Tube A : Taping </div> </div>	<div style="text-align: center;">  </div> <div style="display: flex; justify-content: space-between;"> <div> Logo ← AX AX3102A </div> <div> 3 1 0 2 → Part number A Y Y W W X → ID code:internal WW: 01~52 Year: 10=2010 11=2011 </div> </div>

❖ **ABSOLUTE MAXIMUM RATINGS** (at $T_A=25^{\circ}\text{C}$)

Characteristics	Symbol	Rating	Unit
VCC Pin Voltage	V_{CC}	$V_{SS} - 0.3$ to $V_{SS} + 23$	V
Feedback Pin Voltage	V_{FB}	$V_{SS} - 0.3$ to V_{CC}	V
ON/OFF Pin Voltage	V_{EN}	$V_{SS} - 0.3$ to $V_{CC} + 0.3$	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}	-40 to +150	$^{\circ}\text{C}$
Operating Junction Temperature Range	T_J	-20 to +125	$^{\circ}\text{C}$
Operating Supply Voltage	V_{OP}	4 to 23	V
Thermal Resistance from Junction to case	θ_{JC}	25	$^{\circ}\text{C/W}$
Thermal Resistance from Junction to ambient	θ_{JA}	70	$^{\circ}\text{C/W}$

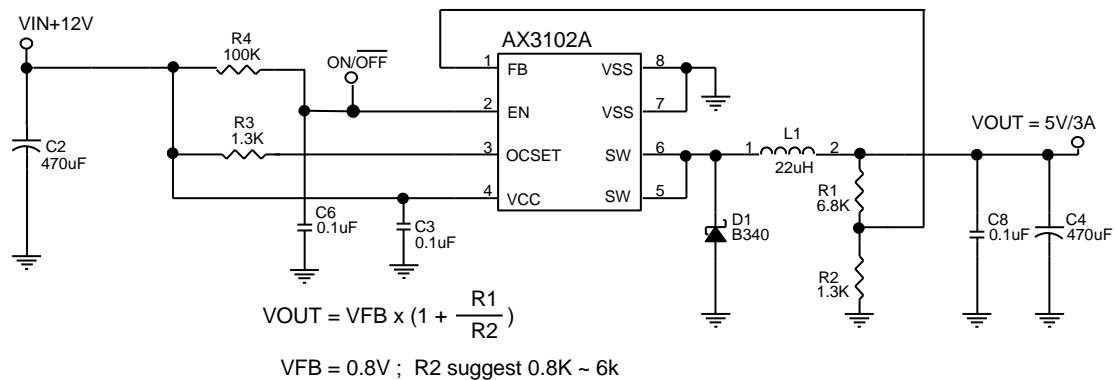
Note : θ_{JA} is measured with the PCB copper area(need connect to SW pins) of approximately 1 in²(Multi-layer).

❖ **ELECTRICAL CHARACTERISTICS**

($V_{IN} = 12\text{V}$, $V_{OUT}=3.3\text{V}$, $T_A=25^{\circ}\text{C}$, unless otherwise specified)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Feedback Voltage	V_{FB}	$I_{OUT}=0.1\text{A}$	0.784	0.8	0.816	V
Quiescent Current	I_{CCQ}	$V_{FB}=1.2\text{V}$ force driver off	-	3	5	mA
Feedback Bias Current	I_{FB}	$I_{OUT}=0.1\text{A}$	-	0.1	0.5	μA
Shutdown Supply Current	I_{SD}	$V_{EN}=0\text{V}$	-	2	10	μA
OCSET pin bias current	I_{OCSET}		95	110	135	μA
Switch Current	I_{SW}		4.0	-	-	A
Line Regulation	$\Delta V_{OUT}/V_{OUT}$	$V_{CC}=8\text{V}\sim 23\text{V}$, $I_{OUT}=0.2\text{A}$	-	1	2	%
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	$I_{OUT} = 0.1$ to 3A	-	0.2	0.5	%
Oscillation Frequency	F_{OSC}	SW pin	260	330	400	KHz
EN Pin Logic input threshold voltage	V_{SH}	High (regulator ON)	2.0	-	-	V
	V_{SL}	Low (regulator OFF)	-	-	0.8	
EN Pin Input Current	I_{SH}	$V_{EN}=2.5\text{V}$ (ON)	-	20	-	μA
	I_{SL}	$V_{EN}=0.3\text{V}$ (OFF)	-	-10	-	μA
Soft-Start Time	T_{SS}		2	5	10	ms
Internal MOSFET $R_{DS(on)}$	$R_{DS(on)}$	$V_{CC}=5\text{V}$, $V_{FB}=0\text{V}$	-	90	140	m Ω
		$V_{CC}=12\text{V}$, $V_{FB}=0\text{V}$	-	55	90	
Efficiency	EFFI	$V_{CC} = 12\text{V}$, $V_{OUT} = 5\text{V}$	-	92	-	%
		$I_{OUT}=2\text{A}$ $I_{OUT}=3\text{A}$		91	-	

❖ APPLICATION CIRCUIT



L1 recommend value ($V_{IN}=12V$)				
V_{OUT}	1.8 V	2.5V	3.3V	5V
$I_{OUT}=3A$	12uH	15uH	18uH	22uH

❖ FUNCTION DESCRIPTIONS

PWM Control

The AX3102A consists of DC/DC converters that employ a pulse-width modulation (PWM) system. In converters of the AX3102A, the pulse width varies in a range from 0 to 100%, according to the load current. The ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant. Therefore, these converters provide a low-ripple power over broad ranges of input voltage and load current.

RDS (ON) Current Limiting

The current limit threshold is setting by the external resistor (R3) connecting from V_{CC} supply to OCSET pin. The internal 110uA sink current crossing the resistor sets the voltage at pin of OCSET. When the PWM voltage is less than the voltage at OCSET, an over-current condition is triggered. Please refer to the formula for setting the current limit value:

$$I_{SW(MAX)} = \frac{I_{OCSET} \times R3 + 0.095}{R_{DS(ON)}}$$

(Normally, The $I_{SW(MAX)}$ setting more than I_{OUT} 1.0A).

Example:

$$I_{SW} = (110uA \times 1.3k + 0.095) / 55m\Omega = 4.3A$$

$$I_{SW} = (0.11 \times 1.3 + 0.095) / 0.055 = 4.3A$$

Setting the Output Voltage

Application circuit item shows the basic application circuit with AX3102A adjustable output version. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.8V \times (1 + \frac{R1}{R2})$$

Table 1 Resistor select for output voltage setting

V _{OUT}	R2	R1
5V	1.3K	6.8K
	5.6K	30K
3.3V	1.5K	4.7K
	5.6K	18K
2.5V	2.2K	4.7K
1.8V	2K	2.5K
1.5V	2.2K	2.0K
1.2V	3K	1.5K
1.0	3K	0.75K

The R2 setting 5.6k that No load current can be reduce to under 4mA for EL CAP.

Inductor Selection

For most designs, the operates with inductors of 12μH to 22μH. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

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=0.45A. 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+0.23A).

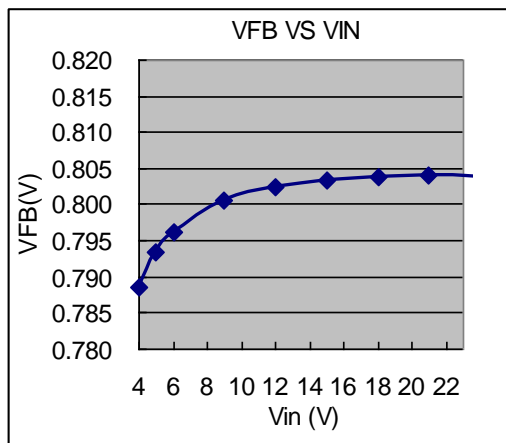
PCB Layout Guide

If you need low Tc and Tj or large PD (Power Dissipation), the dual SW pins (5 and 6) on the SOP-8L package are internally connected to die pad, The PCB layout should allow for maximum possible copper area at the SW pins.

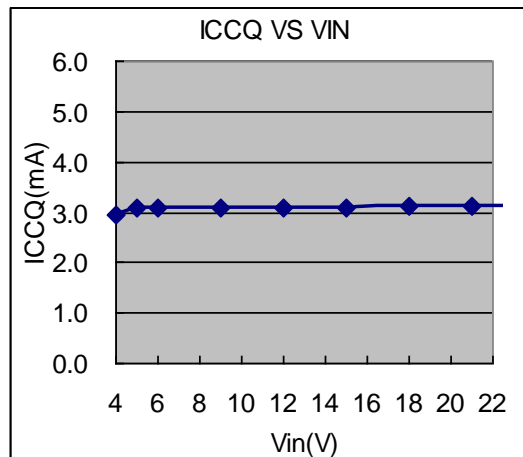
- 1. Connect C3 to V_{CC} pin as closely as possible to get good power filter effect.
- 2. Connect R3 to V_{CC} pin as closely as possible.
- 3. Connect power ground side of the C2 and D1 as closely as possible.

❖ TYPICAL CHARACTERISTICS

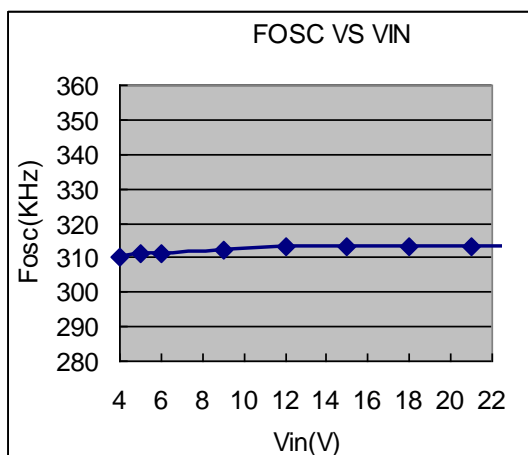
VFB VS VIN



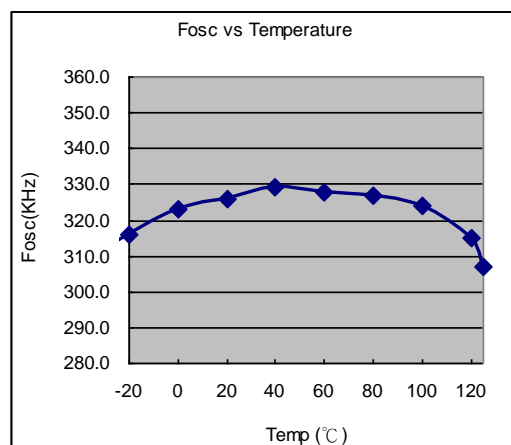
ICCQ VS VIN



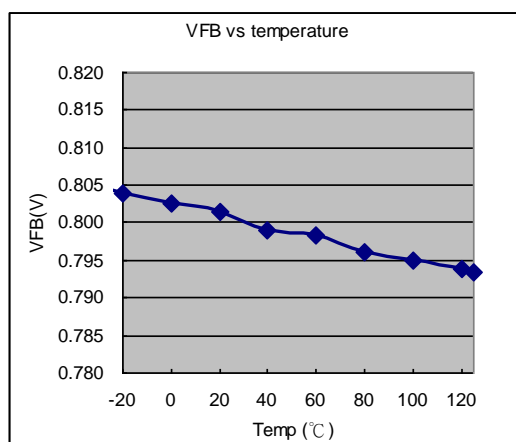
FOSC VS VIN



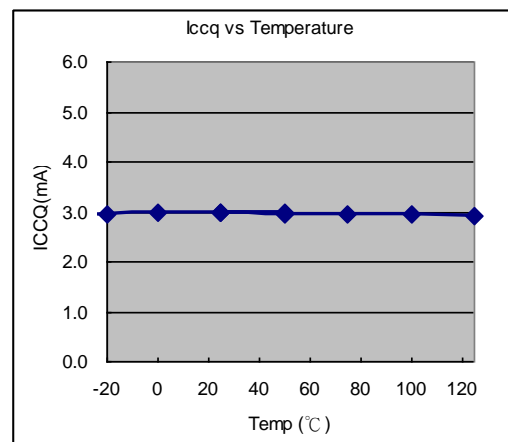
FOSC VS TEMPERATURE



VFB VS TEMPERATURE

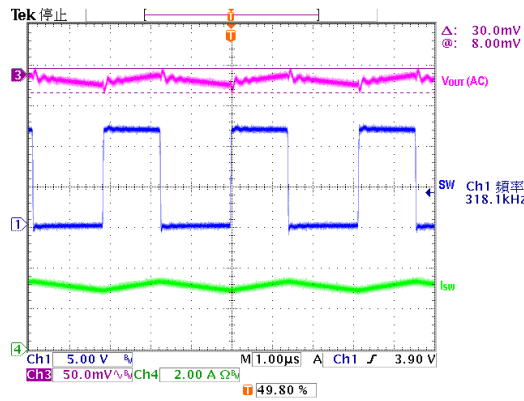


ICCQ VS TEMPERATURE

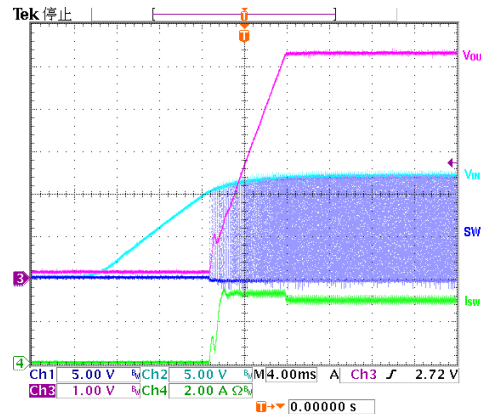


❖ TYPICAL CHARACTERISTICS (CONTINUES)

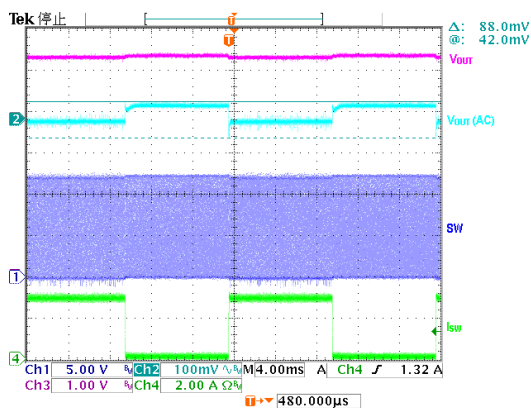
Output Ripple
($V_{IN}=12V$, $V_{OUT}=5V$, $I_{OUT}=3A$)



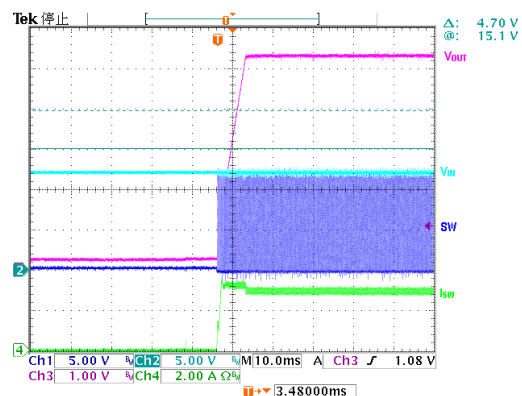
Power on test wave
($V_{IN}=12V$, $V_{OUT}=5V$, $I_{OUT}=3A$)



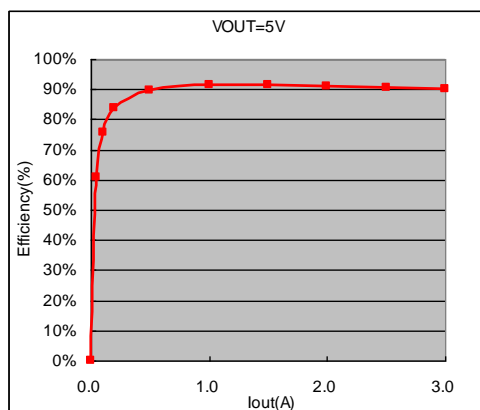
Load Transient Response
($V_{IN}=12V$, $V_{OUT}=5V$, $I_{OUT}=0.1\sim 3A$)



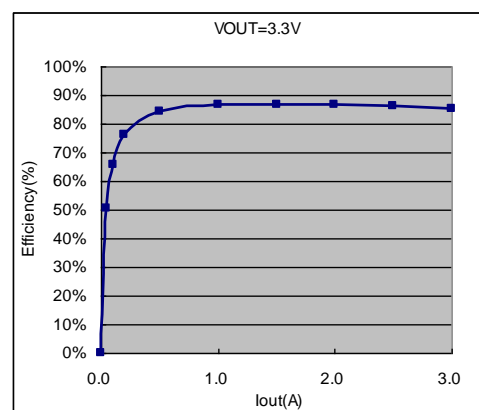
EN PIN on test wave
($V_{IN}=12V$, $V_{OUT}=5V$, $I_{OUT}=3A$)



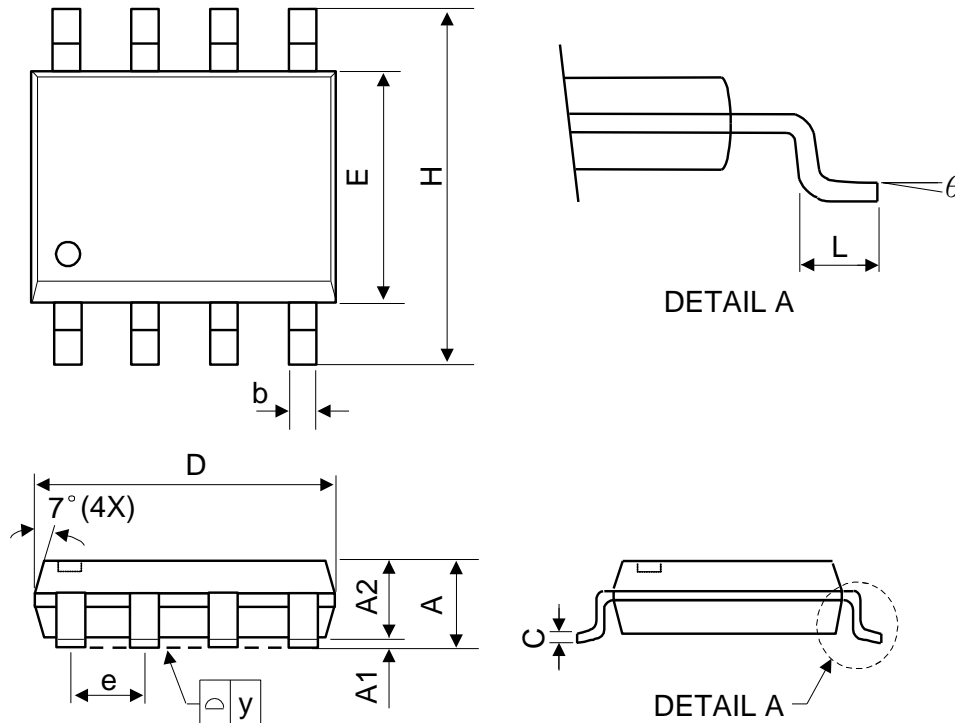
Efficiency
($V_{IN}=12V$, $V_{OUT}=5V$)



Efficiency
($V_{IN}=12V$, $V_{OUT}=3.3V$)



❖ PACKAGE OUTLINES



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0.1	-	0.25	0.04	-	0.1
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
θ	0°	-	8°	0°	-	8°

Mold flash shall not exceed 0.25mm per side

JEDEC outline: MS-012 AA