

PWM Control 2A Step-Down Controller

❖ GENERAL DESCRIPTION

AX3164 is a step-down switching PWM controller. These device include a reference voltage source, oscillation circuit, error amplifier. External P-channel MOSFET is need in application circuit for switching driver.

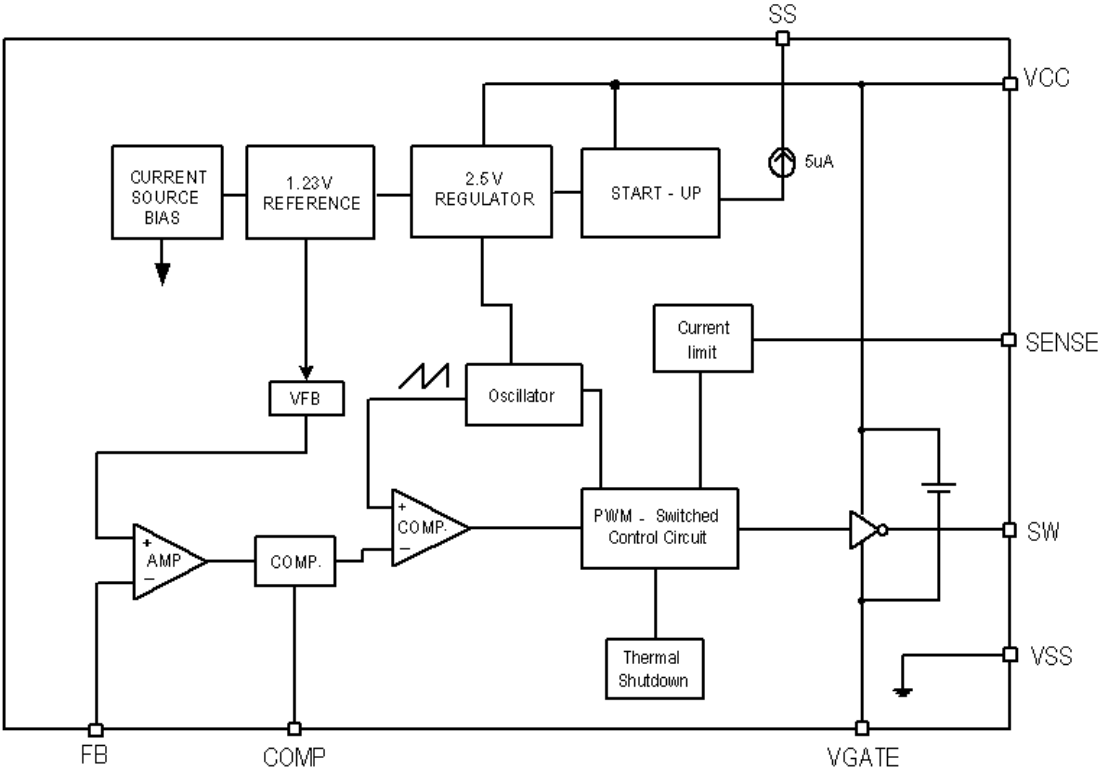
AX3164 controller provides low-ripple power, high efficiency, and excellent transient characteristics control. The AX3164 PWM control circuit is able to the duty ratio linearly form 0 up to 100%. This controller is build out soft start function that prevents overshoot and inrush current at startup. An over current protect function and short circuit protect function are determined external VCC-SENSE resistor, 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 a P-channel Power MOSFET, 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 controller can accommodate an input voltage up to 58V, it is also suitable for the operation via an AC adapter.

❖ FEATURES

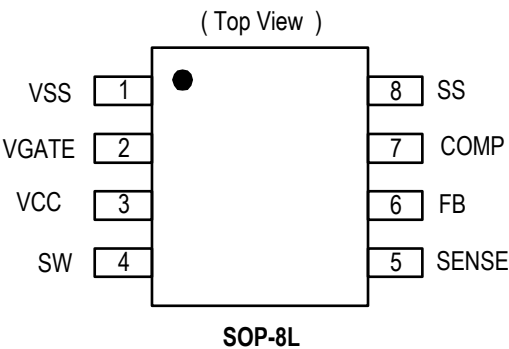
- Input voltage : 10V to 58V
- Output voltage : 3.3V to 56V
- Duty ratio : 0% to 100% PWM control
- Soft-Start function
- Current limit, Short Circuit Protect (SCP) protection and thermal Shutdown protection
- External SW P-channel MOSFET.
- SOP-8L Pb-Free package.

❖ BLOCK DIAGRAM



❖ PIN ASSIGNMENT

The package of AX3164 is SOP-8L; the pin assignment is given by:



Name	Description
VSS	GND pin
VGATE	Driver GATE clamping pin. The pin must connect a 1uF capacitor to VCC
VCC	IC power supply pin
SW	Switch control pin. Connect to external P-channel MOSFET gate.
FB	Feedback pin
COMP	Compensation pin
SS	Soft-start pin
SENSE	Current sense for current-limit.

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX3164 X X Package Type Packing S: SOP-8L Blank : Tube A : Taping	Logo ← AX 3 1 6 4 → Part number YY WW X → ID code:internal → WW: 01~52 → Year: 10=2010 11=2011 ⋮ 19=2019

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

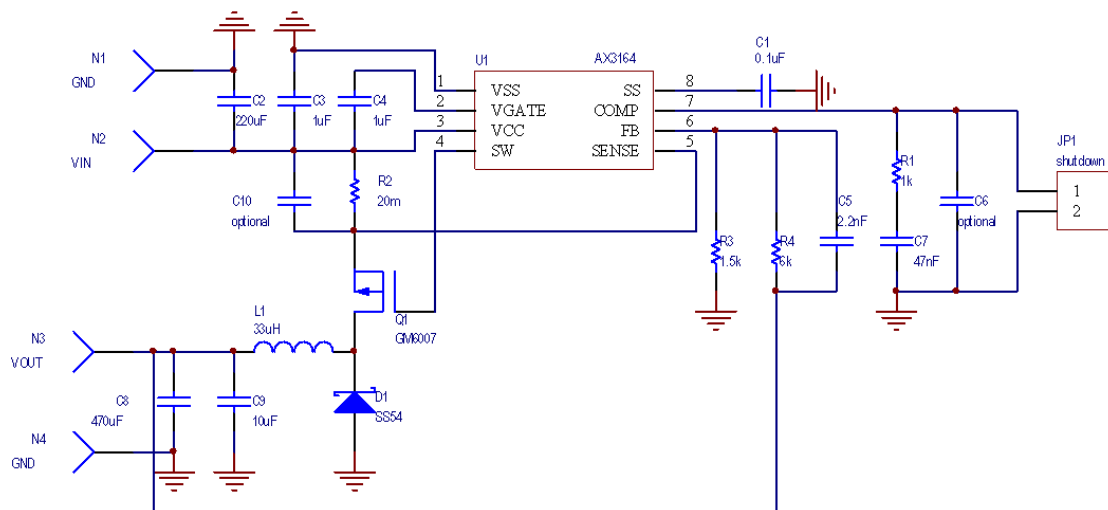
Characteristics	Symbol	Rating	Unit
VCC Pin Voltage	V _{CC}	V _{SS} - 0.3 to V _{SS} + 63	V
Feedback Pin Voltage	V _{FB}	V _{SS} - 0.3 to 6	V
SS Pin Voltage	SS	V _{SS} - 0.3 to 6	V
COMP Pin Voltage	V _{COMP}	V _{SS} - 0.3 to 6	V
VGATE Pin Voltage	V _{GATE}	V _{SS} - 0.3 to V _{CC}	V
SENSE Pin Voltage	V _{sense}	V _{SS} - 0.3 to V _{CC} + 0.3	V
SW Pin Voltage	V _{SW}	V _{SS} - 0.3 to V _{CC} + 0.3	V
Power Dissipation	P _D	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}	10 to 58	V
Thermal Resistance from Junction to case	θ _{JC}	15	°C/W
Thermal Resistance from Junction to ambient	θ _{JA}	40	°C/W

❖ ELECTRICAL CHARACTERISTICS

(V_{CC} = 24V, T_A=25°C, unless otherwise specified)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Feedback Voltage	V _{FB}	I _{OUT} =10mA	0.98	1.00	1.02	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 _{COMP} =0V	-	0.5	1	mA
Line Regulation	ΔV _{OUT} /V _{OUT}	V _{CC} =10V~58V, I _{OUT} =10mA	-	0.3	0.6	%
Load Regulation	ΔV _{OUT} /V _{OUT}	I _{OUT} = 0.2 to 2A	-	0.3	0.6	%
Current Limit	V _{CC} -SENSE		-	70	-	mV
Oscillator frequency	F _{OSC}		200	250	300	KHz
Short frequency	F _{OSC1}	I _{CL}	-	110	-	KHz
	F _{OSC2}	V _{FB} < 0.3	-	30	-	KHz
Efficiency	EFFI	V _{CC} = 24V, V _{OUT} = 5V, I _{OUT} = 2A	-	90	-	%

❖ APPLICATION CIRCUIT



$$V_{OUT} = V_{FB} \times \left(1 + \frac{R4}{R3}\right)$$

$V_{FB} = 1.0V$; $R3$ suggest $0.8K \sim 3K$

EL Capacitor Compensation Table						
COUT ESR Range	FREQ	V _{OUT}	R1	C7	C5	L1
30m~80mΩ	250KHz	5V	2.2K	47nF	560pF	33uH
80m~300mΩ	250KHz		2.2K	47nF	470pF	33uH

❖ FUNCTION DESCRIPTIONS

SS

This pin can be supplied soft start function. The pin must be connected a capacitor to ground. There is a 10uA current to charge this capacitor, vary the different capacitor value to control soft start time.

COMP

Compensation pin. For EL output capacitor application, the COMP pin connects R1 and C7 to ground for all condition; please refer the compensation table.

SENSE

The current limit is set by outside resistance (R_{SENSE}), When the VCC-SENSE voltage larger than 100mV, the current limit is happened that driver can be turned off. The current limit set according to the following equation:

$$\text{MaximumInductorPeakCurrent} = \frac{70\text{mV}}{R_{\text{sense}}}$$

❖ 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:

$$V_{\text{OUT}} = 1.0\text{V} \times \left(1 + \frac{R4}{R3}\right)$$

Table 1 Resistor select for output voltage setting

V_{OUT}	R3	R4
5V	1.5K	6K
3.3V	1.3K	3K

Inductor Selection

For most designs, the different frequency can be reducing the inductor value; The AX3164 controller is suggested 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 20% of the maximum load current 2A, $\Delta I_L=0.4A$. 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 (2A+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.

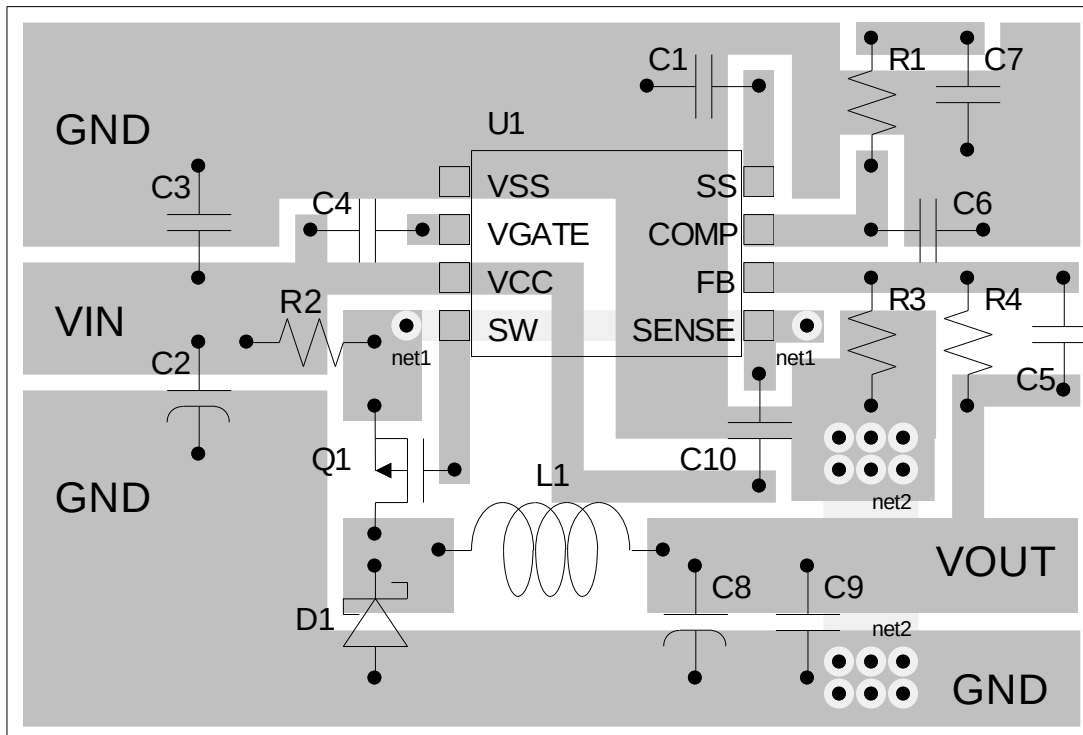
Output Capacitor Selection

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.

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

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.

PCB Layout Guide

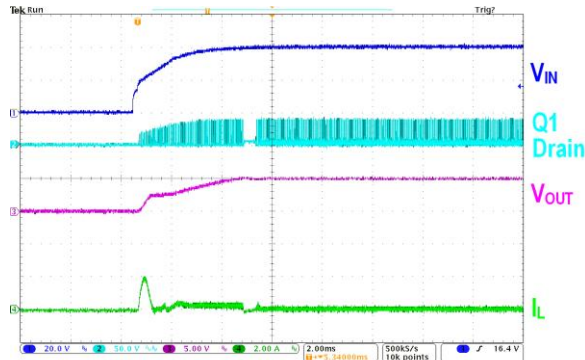


Recommended layout guidelines are as follows:

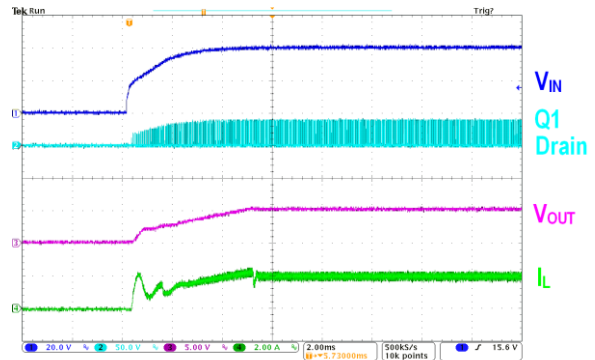
1. Connect the C3 VIN bypass capacitor next to the VCC pin with a short return to the VSS pin.
2. Keep the VGATE to VCC bypass capacitor C4 near both pins as it provides the internal P-ch MOSFET gate driver.
3. Keep the Q1-Drain switch node as short as is practically possible as these carry high peak currents to decrease the EMI issue.
4. Carefully connect the noise sensitive signals such as FB, COMP, SENSE as close to the IC as practically possible.
5. VCC-SENSE should be connected to R2 resistor directly to provide accurate current sensing.

❖ TYPICAL CHARACTERISTICS

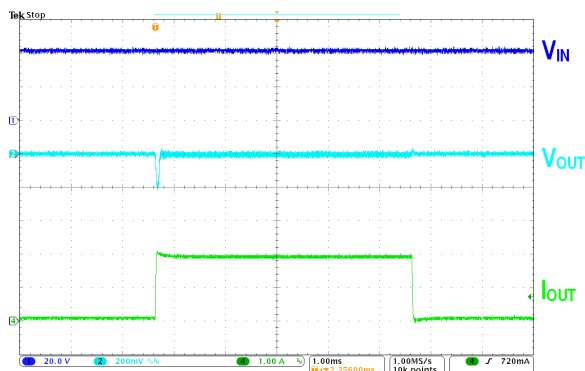
100mA Light Load Power On
40V_{IN} to 5V_{OUT}



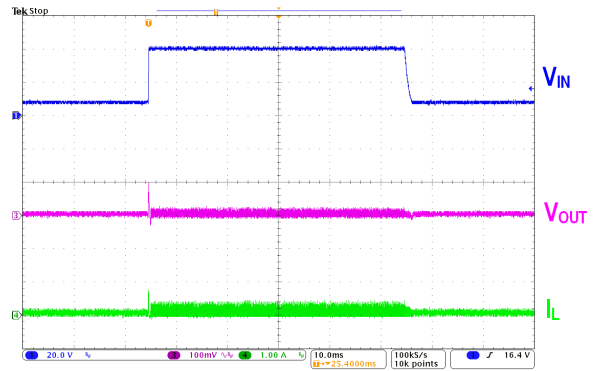
2A Full Load Power On
40V_{IN} to 5V_{OUT}



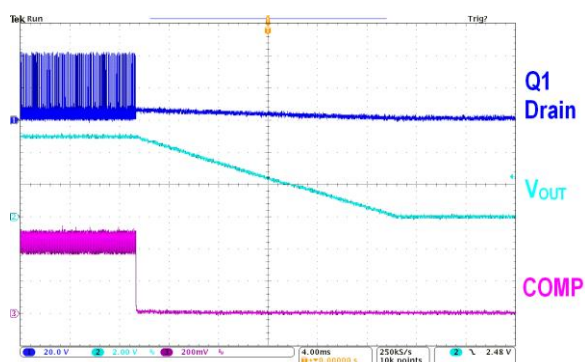
100mA~2A Load Transient Test
40V_{IN} to 5V_{OUT}



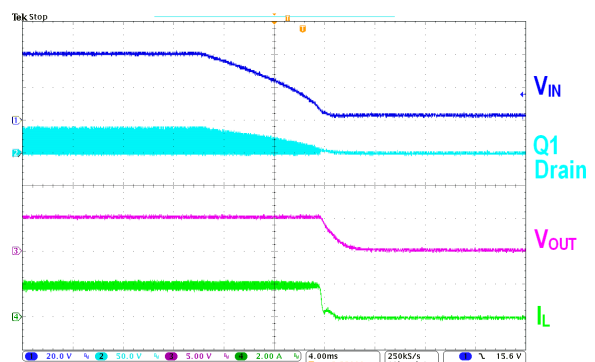
8V_{IN} ~40V_{IN} Line Transient Test
5V_{OUT} 100mA Load



COMP Pull Low to Shutdown Output
40V_{IN} to 5V_{OUT}, 100mA load

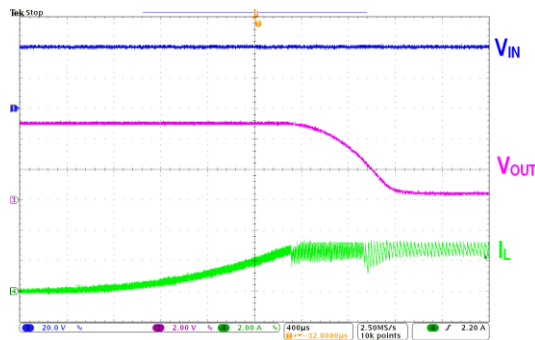


2A Full Load Power Off
40V_{IN} to 5V_{OUT}

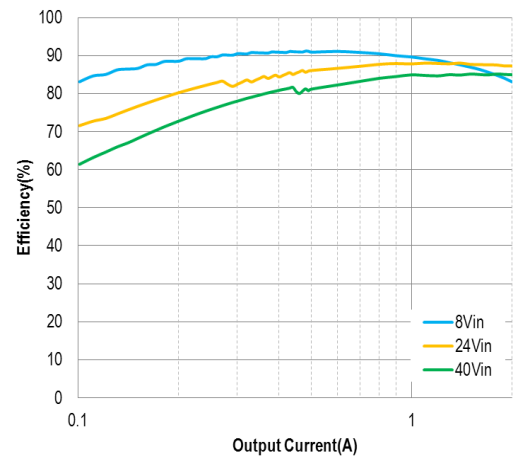


❖ TYPICAL CHARACTERISTICS (CONTINUES)

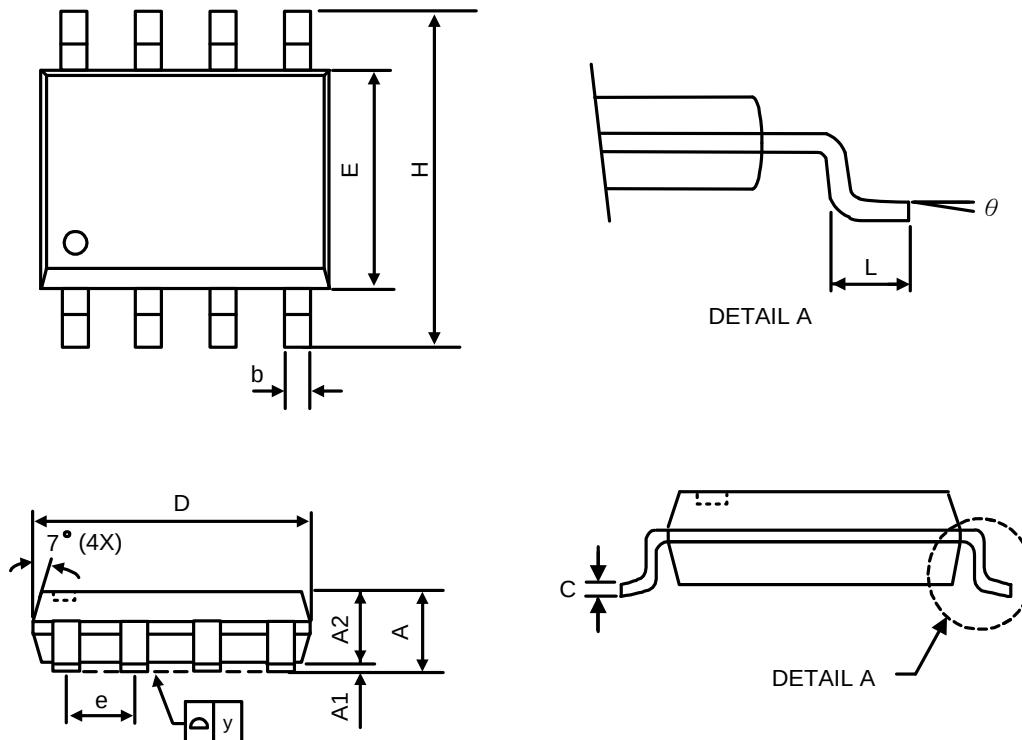
Over Current Protection
40V_{IN} to 5V_{OUT}



Efficiency vs. Output Current
V_{OUT}=5V, T_A=25°C



❖ 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