PWM Control 2A Step-Down Controller

❖ GENERAL DESCRIPTION

AX3164 is a step-down switching PWM controller. These devise 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.

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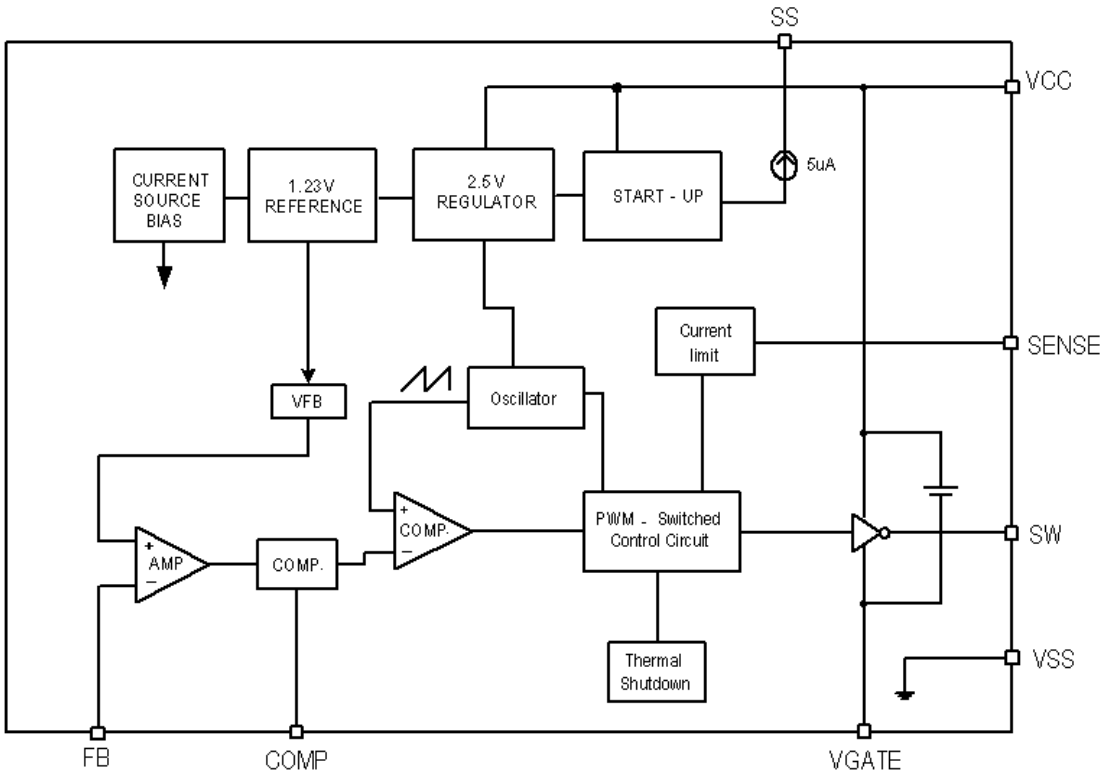
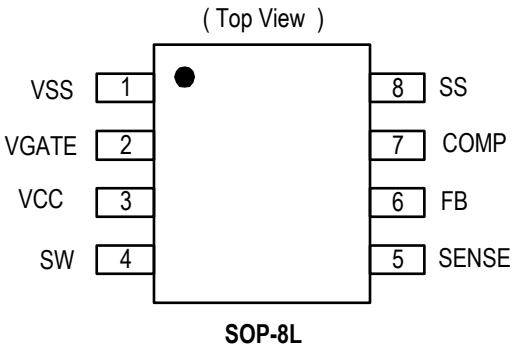
❖ BLOCK DIAGRAM



❖ PIN ASSIGNMENT

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



SOP-8L

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.

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❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX3164 X X Package Type S: SOP-8L Packing Blank : Tube A : Taping	Logo ← AX 3 1 6 4 → Part number Y Y W W 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	Vsense	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	$\Delta V_{OUT}/V_{OUT}$	V_{CC} =10V~58V, I_{OUT}=10mA	-	0.3	0.6	%
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	I_{OUT} = 0.2 to 2A	-	0.3	0.6	%
Current Limit	VCC-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	-	%

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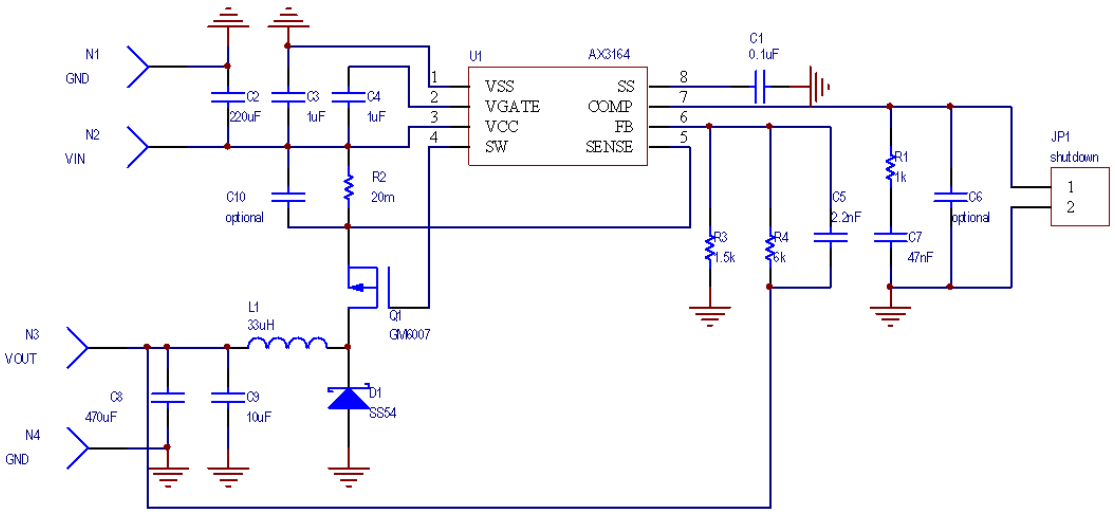
❖ APPLICATION CIRCUIT



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

V_{FB} = 1.0V ; R3 suggest 0.8K ~ 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

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❖ 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:

$$Maximum\,Inductor\,Peak\,Current = \frac{70mV}{Rsense}$$

❖ 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:

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

Table 1 Resistor select for output voltage setting

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

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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, 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 (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 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.

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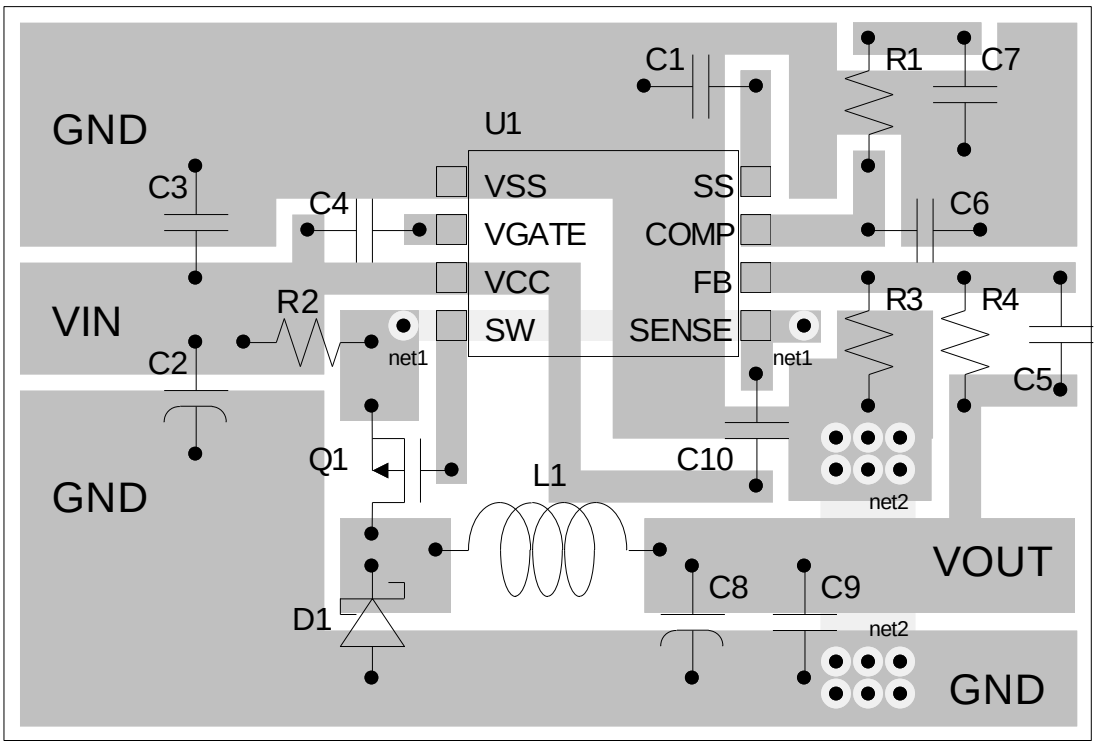
PCB Layout Guide



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 VGAE 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.

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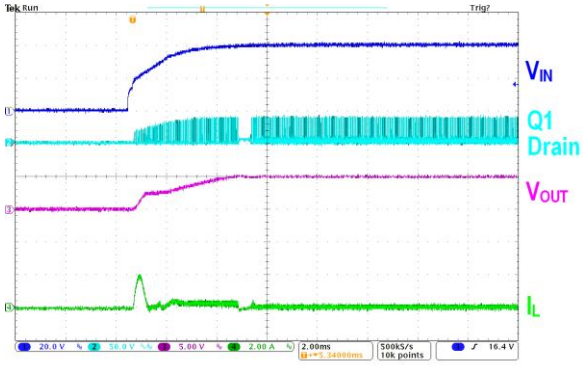
❖ TYPICAL CHARACTERISTICS

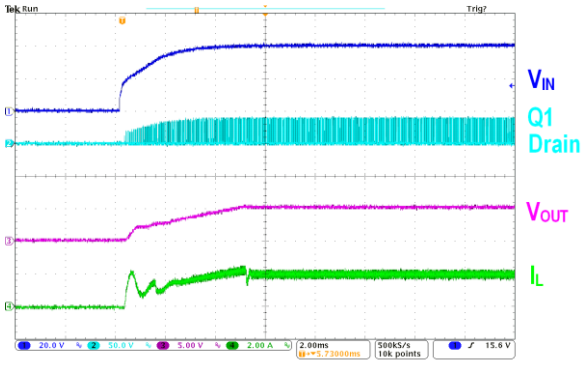
100mA Light Load Power On

$40V_{IN}$ to $5V_{OUT}$



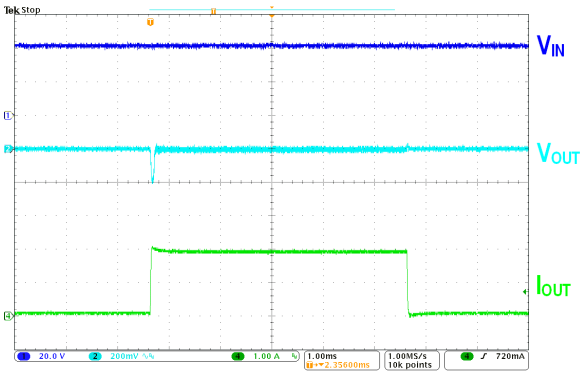
2A Full Load Power On

$40V_{IN}$ to $5V_{OUT}$



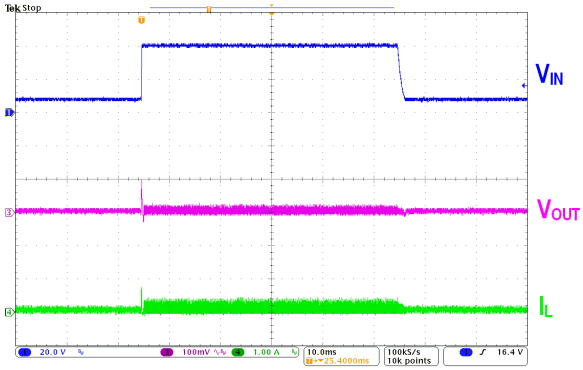
100mA~2A Load Transient Test

$40V_{IN}$ to $5V_{OUT}$



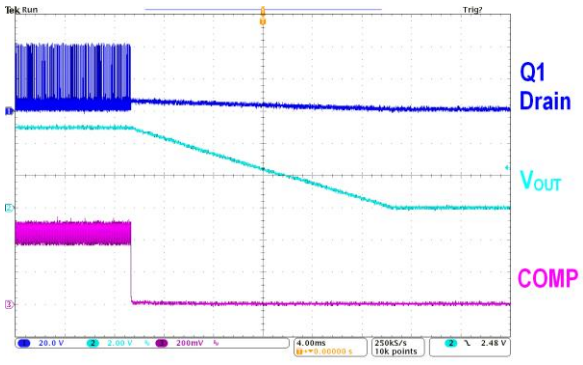
$8V_{IN}$ ~$40V_{IN}$ Line Transient Test

$5V_{OUT}$ 100mA Load



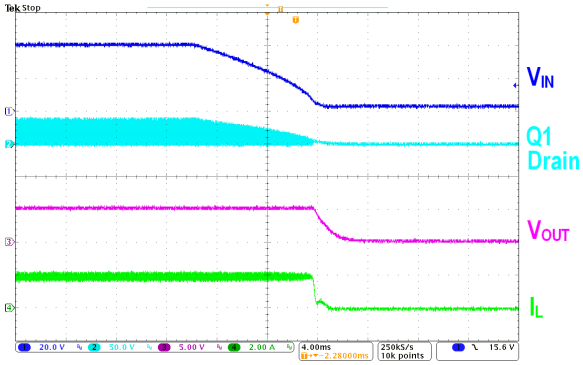
COMP Pull Low to Shutdown Output

$40V_{IN}$ to $5V_{OUT}$, 100mA load



2A Full Load Power Off

$40V_{IN}$ to $5V_{OUT}$



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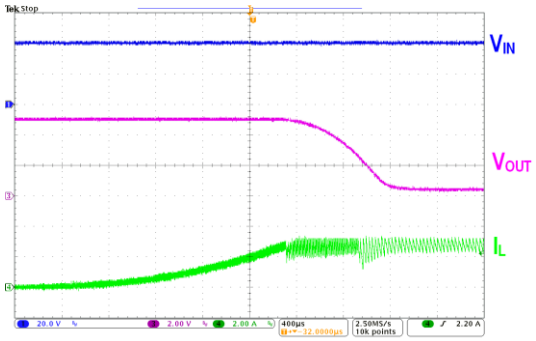
❖ TYPICAL CHARACTERISTICS (CONTINUES)

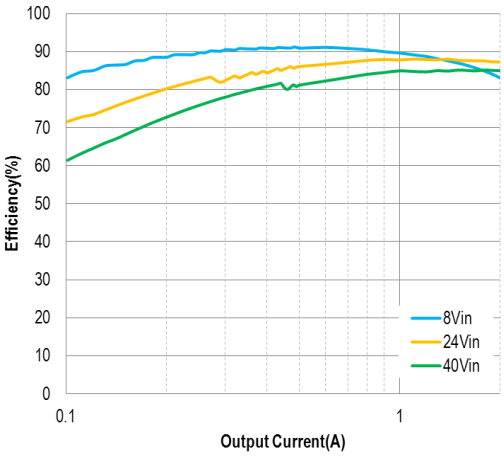
Over Current Protection

$40V_{IN}$ to $5V_{OUT}$



Efficiency vs. Output Current

V_{OUT}=5V, T_A=25°C



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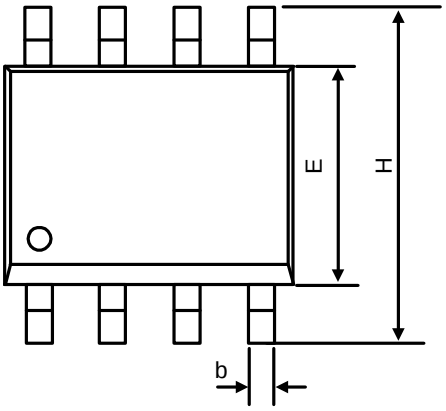
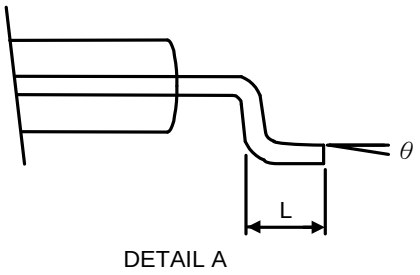
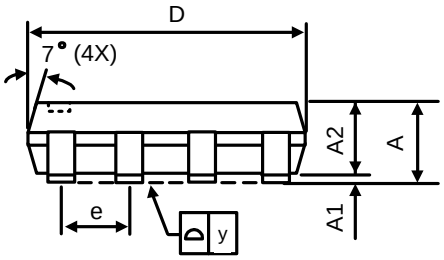
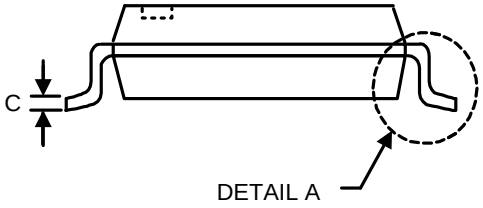
❖ PACKAGE OUTLINES









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

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