PWM Step-Down Controller

❖ GENERAL DESCRIPTION

The AX2201 integrates Pulse-Width-Modulation (PWM) control circuit into a single chip. These devise include a reference voltage source, oscillation circuit, error amplifier and etc.

AX2201 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%. 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.

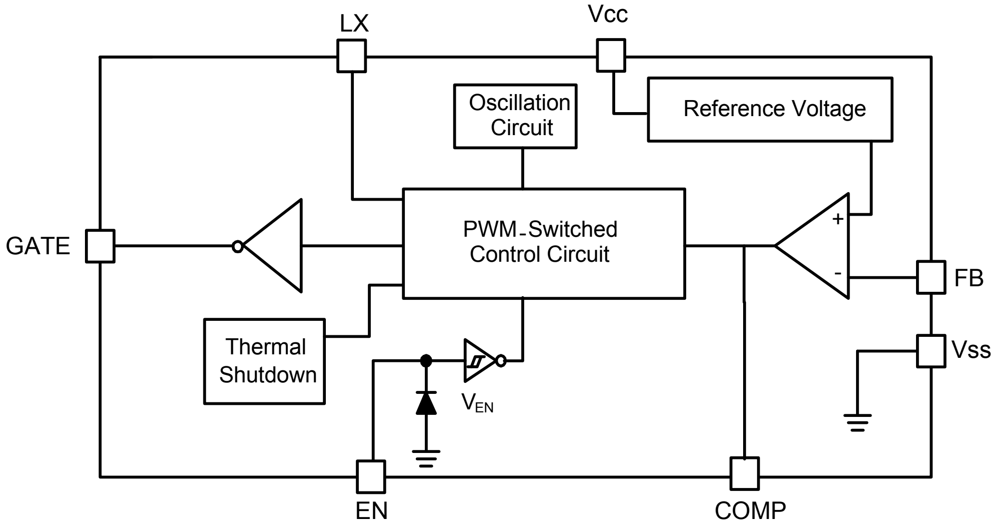
With the addition of an external P-channel Power MOS, a coil, capacitors, and a diode connected externally, these components can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP-8L and MSOP-8L mini-package, providing such outstanding features as low current consumption. Since this converter can accommodate an input voltage up to 24V, it is also suitable for the operation via an AC adapter.

❖ FEATURES

- Input voltage：3.6V to 23V
- Output voltage：0.25V to V_{CC}
- LED backlight and high Power LED application
- Duty ratio：0% to 100% PWM control
- Oscillation frequency：330KHz.
- Current Limit (CL), Enable function.
- Thermal Shutdown function.
- Short Circuit Protect (SCP).
- External SW P-channel MOS.
- Low ESR output capacitor (Multi-layer chip capacitor (MLCC)) application.
- MSOP-8L and SOP-8L Pb-Free packages.

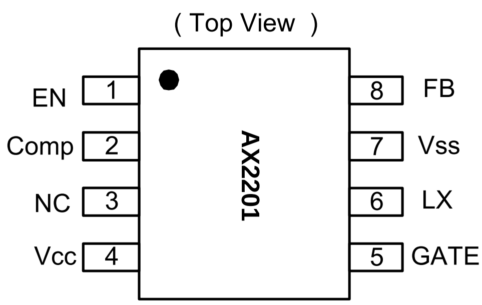
Axelite Confidential Materials, do not copy or distribute without written consent.

❖ BLOCK DIAGRAM



❖ PIN ASSIGNMET

These packages of AX2201 are MSOP-8L and SOP-8L; the pin assignment is given by:



MSOP - 8L and SOP - 8L

Name	Description
FB	Feedback pin
EN	Shutdown Control Input. H : normal operation(Step-down) L : Shutdown mode
Comp	Compensation pin
NC	No connecting Pin
V_{CC}	IC power supply pin
GATE	Gate drive for external P-channel MOSFET.
LX	LX is the current sense input.
V_{SS}	GND pin

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX2201 XX X Package Type S: SOP-8L U8:MSOP-8L Packing Blank : Tube A : Taping	Logo ← AX 2 2 0 1 → Part number YYWWX → ID code:internal WW:01~52 Year: 10=2010 11=2011

Axelite Confidential Materials, do not copy or distribute without written consent.

❖ 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} + 25	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	°C
Operating Temperature Range		T_{OP}	-20 to +125	°C
Operating Supply Voltage		V_{OP}	+3.6 to +23	V
Thermal Resistance from Junction to case	SOP-8L	θ_{JC}	35	°C/W
	MSOP-8L		45	
Thermal Resistance from Junction to ambient	SOP-8L	θ_{JA}	120	°C/W
	MSOP-8L		200	

Note : θ_{JA} is measured with the PCB copper area of approximately 1 in^2(Multi-layer).

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

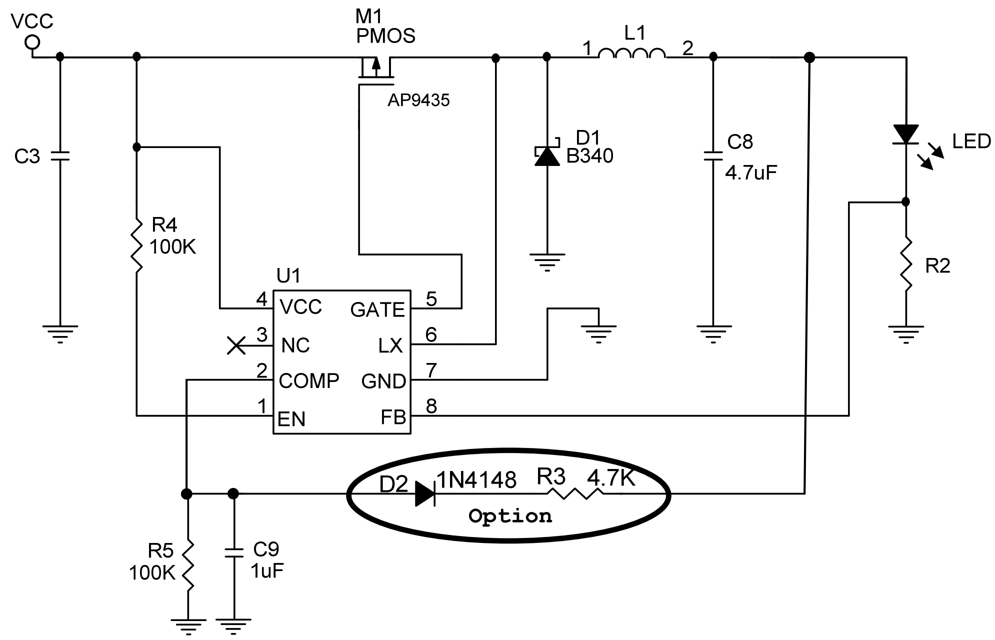
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Feedback Voltage	V_{FB}	I_{OUT}=0.1A	0.24	0.25	0.26	V
Quiescent Current	I_{CCQ}	V_{FB}=1.2V force driver off		3	5	mA
Feedback Bias Current	I_{FB}	I_{OUT}=0.1A	-	0.1	0.5	uA
Shutdown Supply Current	I_{SD}	V_{EN} =0V	-	2	10	uA
Line Regulation	$\triangle V_{OUT}/V_{OUT}$	V_{CC} = 5V~23V, I_{OUT}=0.2A	-	1	2	%
Load Regulation	$\triangle V_{OUT}/V_{OUT}$	I_{OUT} = 0.1 to 3A	-	0.2	0.5	%
Oscillation Frequency	F_{OSC1}	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}=2.5V (ON)	-	20	-	uA
	I_{SL}	V_{EN}=0.3V (OFF)	-	-10	-	uA
LX Rise Time	T_{LXR}	C_{LX}=1000pF	-	80	-	nS
LX Fall Time	T_{LXF}	C_{LX}=1000pF	-	80	-	
Efficiency (PMOS=AP9435M)	EFFI	V_{OUT} = 5V, I_{OUT} = 2A	-	92	-	%
		V_{OUT} = 5V, I_{OUT} = 3A	-	91	-	
Thermal shutdown Temp	T_{SD}		-	140	-	°C

Axelite Confidential Materials, do not copy or distribute without written consent.

Rev.1.0 Jul.07, 2010

❖ APPLICATION CIRCUIT

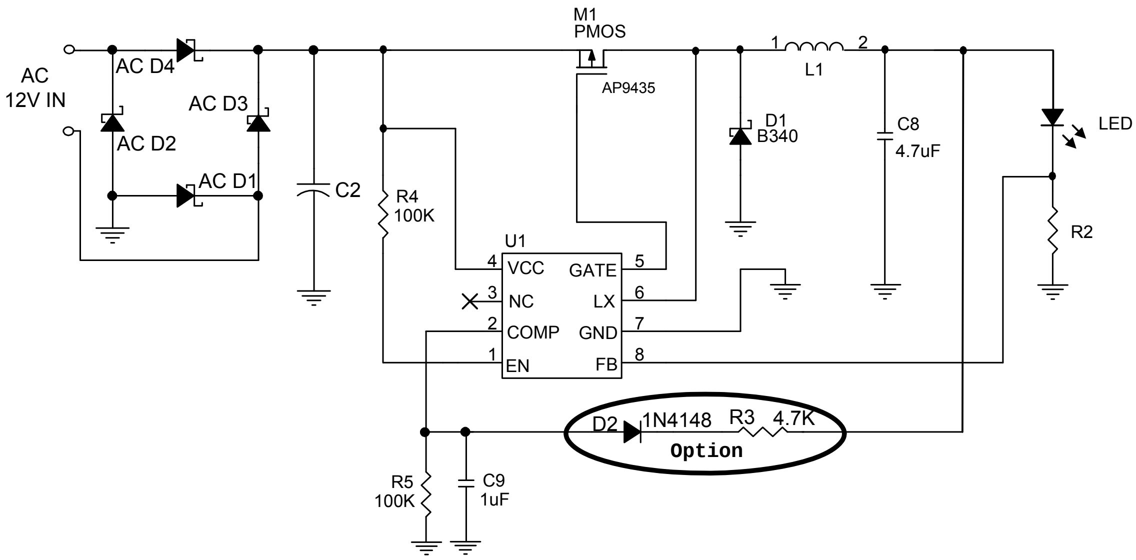
A. 1W/3W LED*1 for DC Input



Recommend Operating Conditions					
LED	I_{LED}	R2	VCC Range	Inductor (L1)	Input Capacitor (C3)
1W LED*1	350m	0.715Ω/0.125W	5~23V	22uH	10uF(MLCC) 100uF(EL)
3W LED*1	750m	0.333Ω/0.25W	5~23V	22uH	22uF(MLCC) 100uF(EL)
	900m	0.278Ω/0.5W	5~23V	22uH	22uF(MLCC) 100uF(EL)
1W+1W LED	350m	0.715Ω/0.125W	10~23V	15uH	10uF(MLCC) 100uF(EL)
3W+3W LED	750m	0.333Ω/0.25W	10~23V	15uH	22uF(MLCC) 100uF(EL)
	900m	0.278Ω/0.5W	10~23V	15uH	22uF(MLCC) 100uF(EL)
1W+1W+1W LED	350m	0.715Ω/0.125W	14~23V	10uH	10uF(MLCC) 100uF(EL)
3W+3W+3W LED	750m	0.333Ω/0.25W	14~23V	10uH	22uF(MLCC) 100uF(EL)
	900m	0.278Ω/0.5W	14~23V	10uH	22uF(MLCC) 100uF(EL)

Axelite Confidential Materials, do not copy or distribute without written consent.

B. 1W/3W LED*1 for AC Input



Recommend Operating Conditions				
LED	I_{LED}	R2	Inductor (L1)	Input Capacitor (C2)
1W LED*1	350m	0.715Ω/0.125W	22uH	220uF(EL)
3W LED*1	750m	0.333Ω/0.25W	22uH	330uF(EL)
	900m	0.278Ω/0.5W	22uH	470uF(EL)
1W+1W LED	350m	0.715Ω/0.125W	15uH	330uF(EL)
3W+3W LED	750m	0.333Ω/0.25W	15uH	820uF(EL)
	900m	0.278Ω/0.5W	15uH	1000uF(EL)

Axelite Confidential Materials, do not copy or distribute without written consent.

❖ FUNCTION DESCRIPTIONS

PWM Control

The AX2201 integrates Pulse-Width-Modulation (PWM) control circuit into a single chip. 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 controllers provide a low-ripple power over broad ranges of input voltage and load current.

Compensation

The COMP pin connects R5 and C9 to GND, The C9 use 1uF and R5 use 100KΩ for all condition. The option circuit for compensation is connecting R4 and a 4148 diode to V_{OUT}. In order to protect short circuit and thermal shutdown release for LED.

Setting the I_{LED} Current

Application circuit item shows the basic application circuit with AX2201 adjustable output version. The external resistor sets the LED output current according to the following equation:

$$I_{LED} = \left(\frac{0.25V}{R2}\right)$$

Table 1 Resistor select for LED output current setting

I_{LED}	R2	
20mA	12.5Ω	5mW
350mA	0.715Ω	87.5mW
750mA	0.333Ω	189mW
1.5A	0.167Ω	375mW

Axelite Confidential Materials, do not copy or distribute without written consent.

Inductor Selection

For most designs, Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

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

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% (setting 10% to 30%) of the maximum input 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+0.3A).

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency shall be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used.

The capacitor voltage rating should be at least 1.5 times greater than the input voltage, and often much higher voltage ratings are needed to satisfy.

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. A low ESR capacitor sized for maximum RMS current must be used. The low ESR requirements needed for low output ripple voltage.

The capacitor voltage rating should be at least 1.5 times greater than the input voltage, and often much higher voltage ratings are needed to satisfy.

Axelite Confidential Materials, do not copy or distribute without written consent.

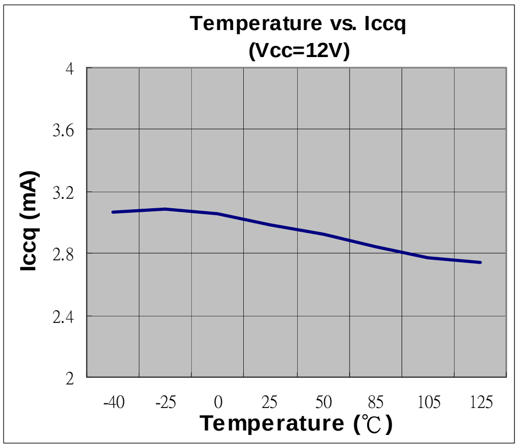
Layout Guidance

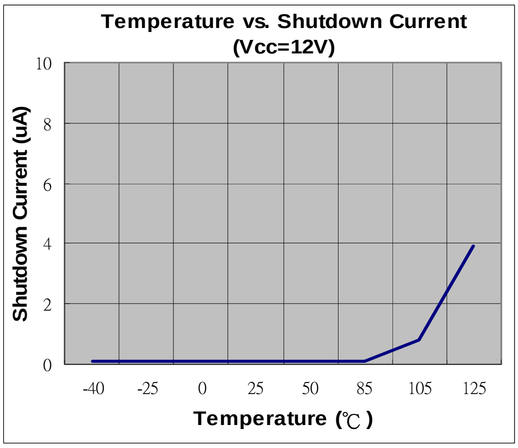
When laying out the PC board, the following suggestions should be taken to ensure proper operation of the AX2201. These items are also illustrated graphically in below.

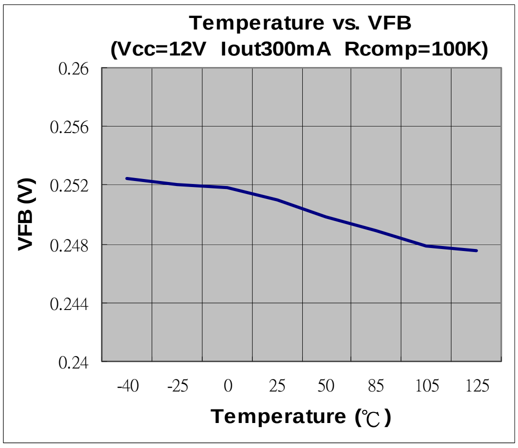
1. The power traces, including the PMOS Drain and Source trace, the Schottky and the C2 trace should be kept short, direct and wide to allow large current flow.
2. Connect the C3 to the V_{CC} pins and GND of the AX2201 as closely as possible to get good power filter effect.
3. Keep the switching node, away from the sensitive FB node.
4. Do not trace signal line under inductor.

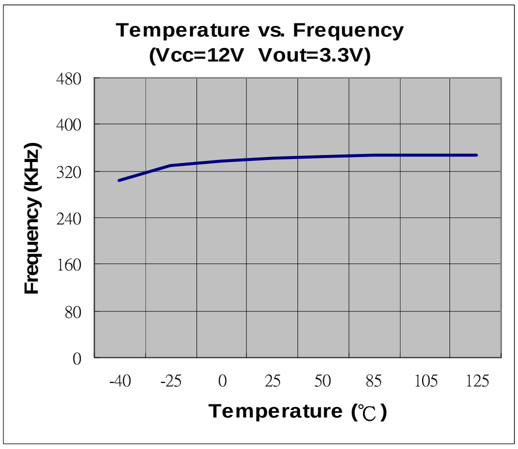
Axelite Confidential Materials, do not copy or distribute without written consent.

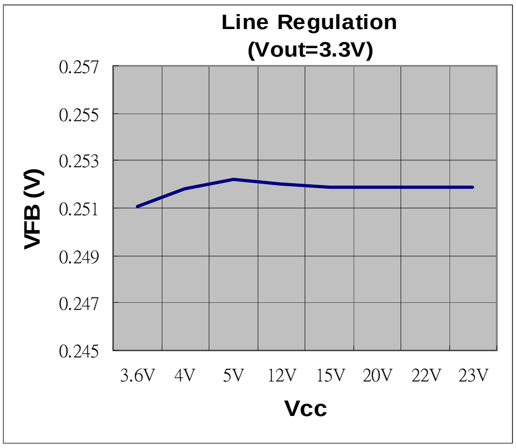
❖ TYPICAL CHARACTERISTICS

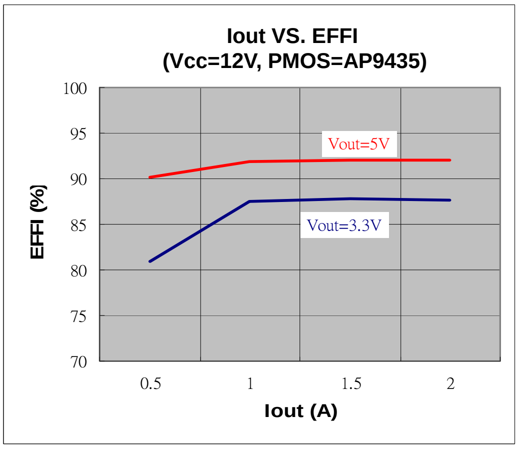








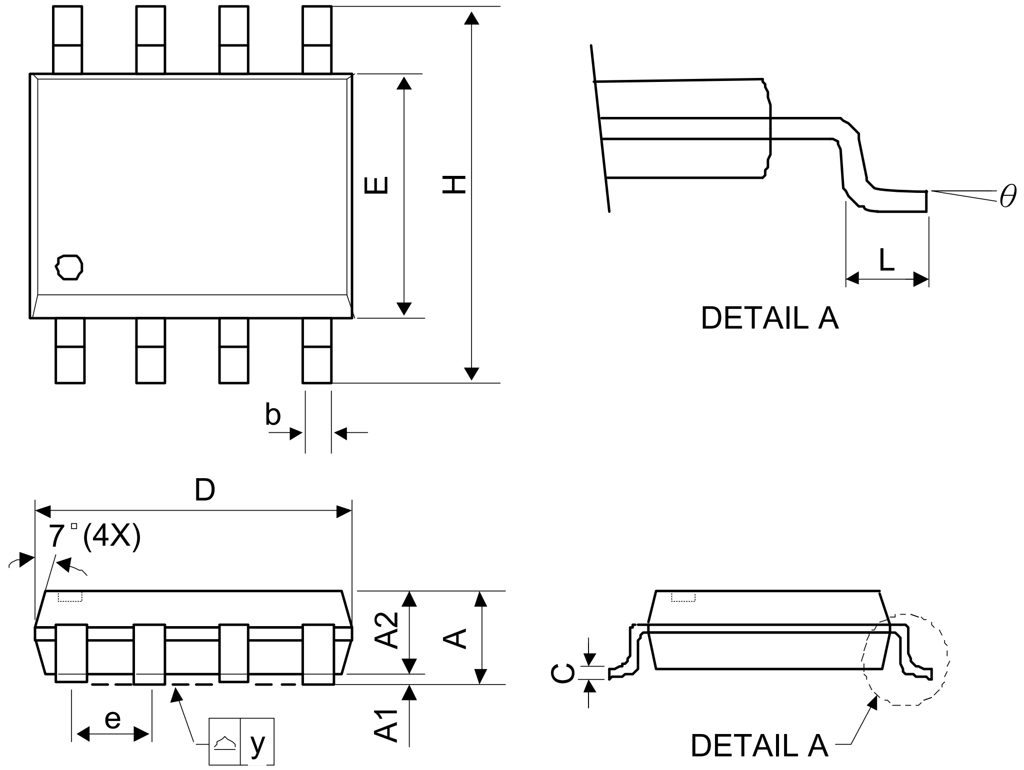




Axelite Confidential Materials, do not copy or distribute without written consent.

❖ PACKAGE OUTLINES

(1) SOP-8L

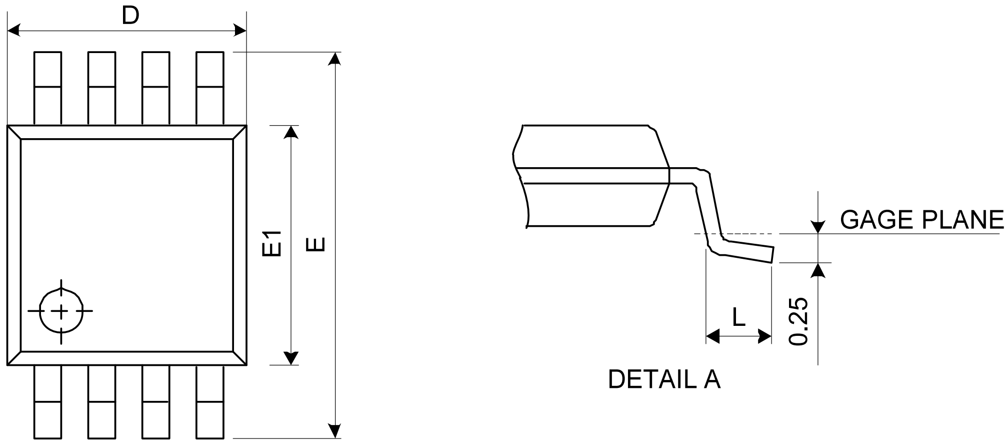


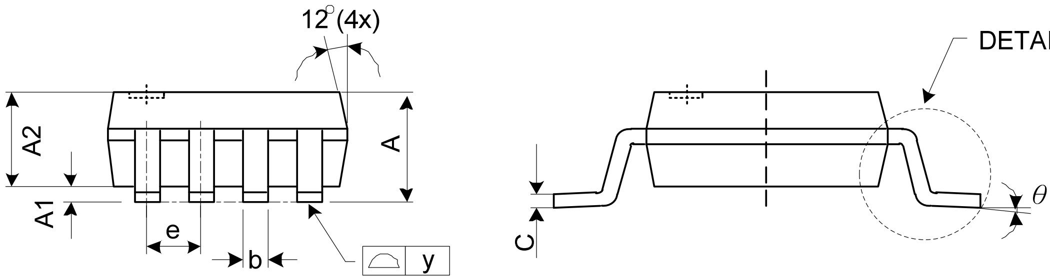
Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0.1	-	0.25	0.04	-	0.1
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	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^{o}	-	8^{o}	0^{o}	-	8^{o}

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

Axelite Confidential Materials, do not copy or distribute without written consent.

(2) MSOP-8L





Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.1	-	-	0.043
A1	0	0.08	0.15	0	0.003	0.006
A2	0.75	0.85	0.95	0.03	0.033	0.037
b	0.22	0.3	0.38	0.009	0.012	0.015
C	0.08	0.15	0.23	0.003	0.006	0.009
D	2.9	3	3.1	0.114	0.118	0.122
E	4.8	4.9	5	0.189	0.193	0.197
E1	2.9	3	3.1	0.114	0.118	0.122
e	0.65 BSC			0.026 BSC		
L	0.4	0.6	0.8	0.016	0.024	0.031
y	-	-	0.1	-	-	0.004
θ	0º	4º	8º	0º	4º	8º

JEDEC outline: MO-187 AA

Axelite Confidential Materials, do not copy or distribute without written consent.