AP1551

150KHz, Dual Channel 2A PWM Buck DC/DC Converter

■ Features

- Dual adjustable output channel
- Adjustable output voltage range, 1.23V to 18V±4%
- 150KHz ±15% fixed switching frequency
- Voltage mode non-synchronous PWM control
- Thermal-shutdown and current-limit protection
- ON/OFF shutdown control input
- Operating voltage can be up to 22V
- Output load current: 2A
- SOP-16L **Pb-Free** packages
- Low power standby mode
- Built-in switching transistor on chip

■ Applications

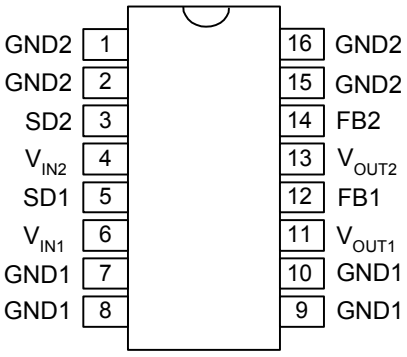
- Simple High-efficiency step-down regulator
- On-card switching regulators
- Positive to negative converter

■ General Description

The AP1551 is monolithic IC designed for dual channel step-down DC/DC converters, and own the ability of driving a 2A load each channel without additional transistor component. Due to reducing the number of external component, the board space can be saved easily. The external shutdown function can be controlled by logic level and then come into standby mode. The internal compensation makes feedback control have good line and load regulation without external design. Regarding protected function, thermal shutdown is to prevent over temperature operating from damage, and current limit is against over current operating of the output switch. If current limit function occurred and V_{FB} is down to 0.5V below, the switching frequency will be reduced. The AP1551 operates at a switching frequency of 150KHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Other features include a guaranteed ±4% tolerance on output voltage under specified input voltage and output load conditions, and ±15% on the oscillator frequency. The packages are available in a standard 16-lead SOP-16 package.

■ Pin Assignments

(Top View)

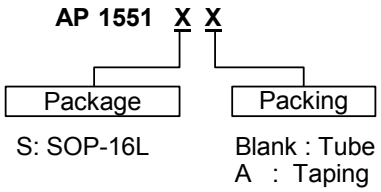


SOP-16L

■ Pin Descriptions

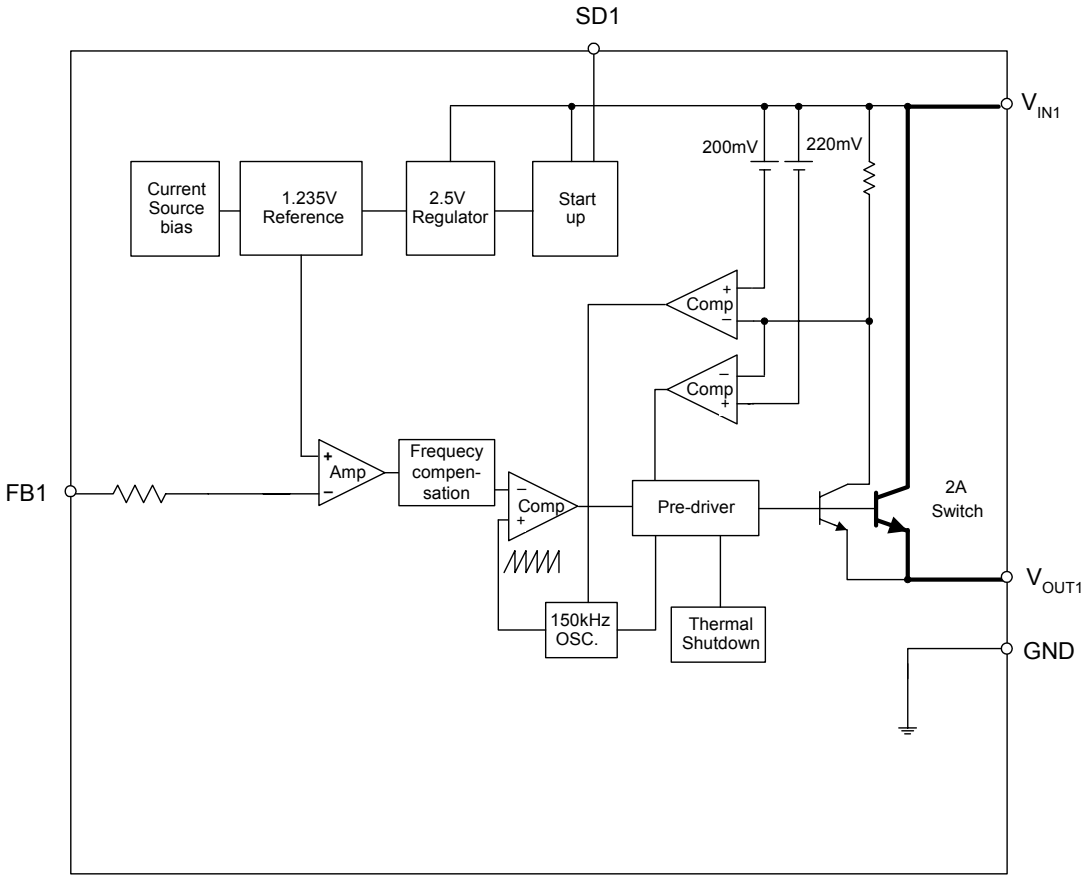
Name	Description
$V_{IN1/2}$	Operating voltage input
$V_{OUT1/2}$	Switching output
GND1/2	Ground
FB1/2	Output voltage feedback control
SD1/2	ON/OFF Shutdown

■ Ordering Information



■ Block Diagram

(Channel 1 and channel 2 are the same)



■ Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{CC}	Supply Voltage	+24	V
V_{SD}	ON/OFF Pin input voltage	-0.3 to +18	V
V_{FB}	Feedback Pin voltage	-0.3 to +18	V
V_{OUT}	Output voltage to Ground	-1	V
P_D	Power dissipation	Internally limited	W
T_{ST}	Storage temperature	-65 to +150	°C
T_{OP}	Operating temperature	-40 to +125	°C
V_{OP}	Operating voltage	+4.5 to +22	V

■ Electrical Characteristics

Unless otherwise specified, V_{IN}=12V, I_{LOAD} = 0.5A

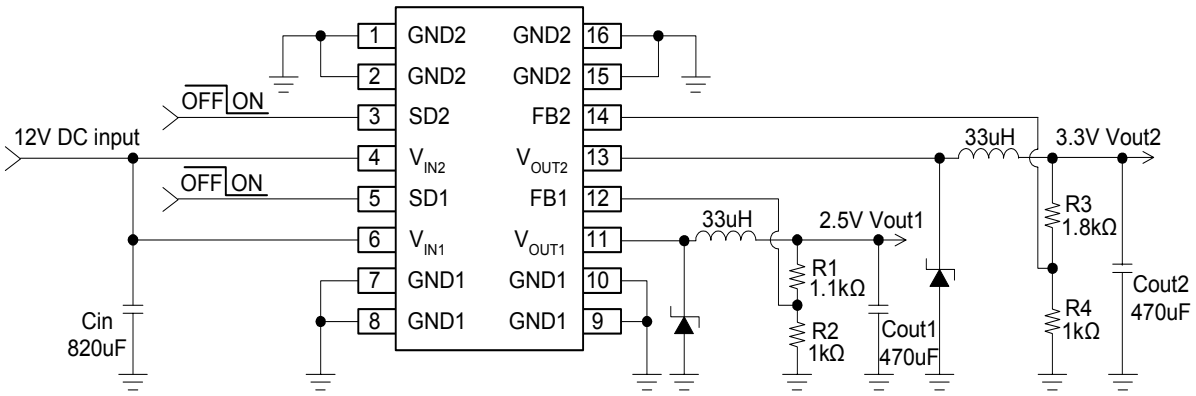
Symbol	Parameter		Conditions		Min.	Typ.	Max.	Unit
$I_{B1/2}$	Feedback bias current		$V_{FB1/2}$=1.3V (Adjustable version only)		-	-10	-50 -100	nA
F_{OSC}	Oscillator frequency				127 **110**	150 **-**	173 **173**	KHz
F_{SCP}	Oscillator frequency of short circuit protect		When current limit occurred and $V_{FB1/2}$ < 0.5V, Ta=25 °C		5	15	25	KHz
$V_{SAT1/2}$	Saturation voltage		$I_{OUT1/2}$=2A No outside circuit $V_{FB1/2}$=0V force driver on		-	1.25	1.4 **1.5**	V
DC	Max. Duty Cycle (ON)		$V_{FB1/2}$=0V force driver on		-	100	-	%
	Min. Duty Cycle (OFF)		$V_{FB1/2}$=12V force driver off		-	0	-	
$I_{CL1/2}$	Current limit for each channel		Peak current No outside circuit $V_{FB1/2}$=0V force driver on		3	-	-	A
$I_{L1/2}$	Output = 0	Output leakage current	No outside circuit $V_{FB1/2}$=12V force driver off		-	-	-200	uA
	Output = -1		$V_{IN1/2}$=22V		-	-5		mA
$I_{Q1/2}$	Quiescent Current		$V_{FB1/2}$=12V force driver off		-	5	10	mA
$I_{STBY1/2}$	Standby Quiescent Current		ON/OFF pin=5V $V_{IN1/2}$=22V		-	70	150 **200**	uA
$V_{IL1/2}$	ON/OFF pin logic input threshold voltage		Low (regulator ON)		-	1.3	0.6	V
$V_{IH1/2}$			High (regulator OFF)		2.0		-	
I_H	ON/OFF pin logic input current		V_{LOGIC}=2.5V (OFF)		-	-	-0.01	uA
I_L	ON/OFF pin input current		V_{LOGIC}=0.5V (ON)		-	-0.1	-1	
θ_{JC}	Thermal Resistance		SOP-16L	Junction to case	-	15	-	°C/W
θ_{JA}	Thermal Resistance With copper area of approximately 3 in^2		SOP-16L	Junction to ambient	-	70	-	°C/W

■ Electrical Characteristics (Continued)

	Symbol	Parameter	Conditions	Typ.	Limit	Unit
AP1551-channel 1	V_{FB1}	Output Feedback	4.5V ≤ V_{IN} ≤ 22V 0.2A ≤ I_{LOAD} ≤ 2A V_{OUT} programmed for 3V	1.23	1.193/**1.18** 1.267/**1.28**	V V_{MIN} V_{MAX}
	η	Efficiency	V_{IN} = 12V, I_{LOAD}=2A	76		%
AP1551-channel 2	V_{FB2}	Output Feedback	4.5V < V_{IN} < 22V 0.2A < I_{LOAD} < 2A V_{OUT} programmed for 3V	1.23	1.193/**1.18** 1.267/**1.28**	V VMIN VMAX
	η	Efficiency	V_{IN} = 12V, I_{LOAD}=2A	76		%

Specifications with **boldface type** are for full operating temperature range, the other type are for T_J=25ºC.

■ Typical Application Circuit



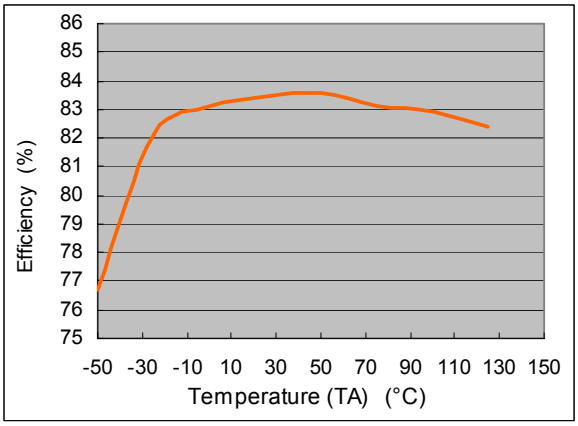
$$\textbf{Vout1} = V_{FB} \times \left(1 + \frac{R1}{R2}\right);$$

$$\textbf{Vout2} = V_{FB} \times \left(1 + \frac{R3}{R4}\right);$$

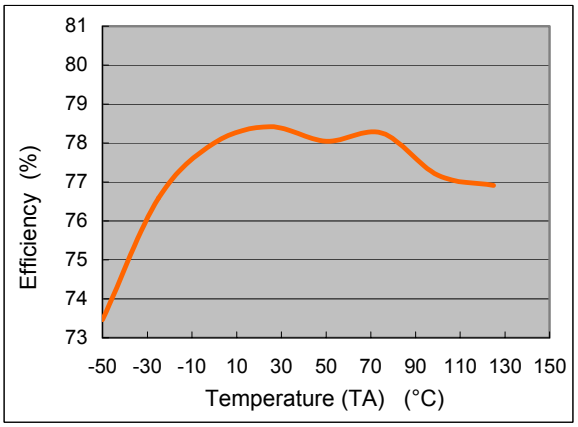
V_{FB} = 1.235V
R2 = R4 = 1K ~ 3K

■ Typical Performance Characteristics (For Each Channel)

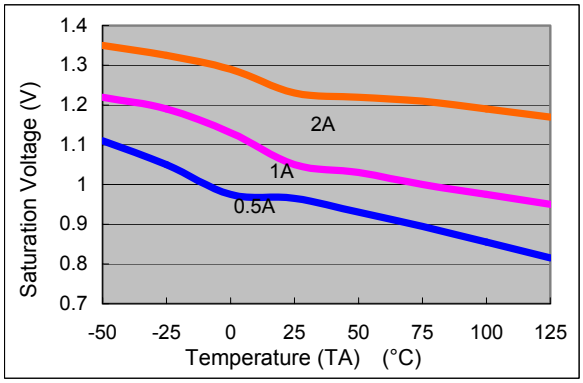
AP1551 Efficiency v.s. Temperature
(Vin=12V,Vout=5V,Io=2A)



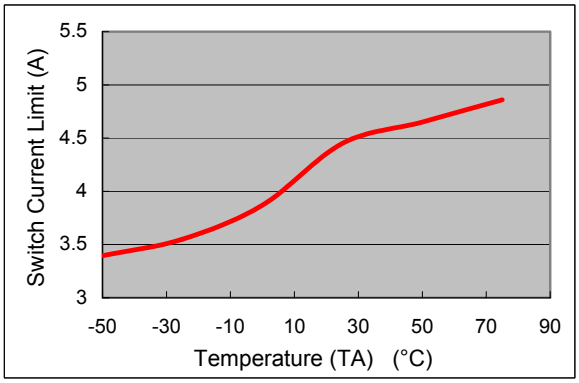
AP1551 Efficiency v.s. Temperature
(Vin=12V,Vout=3.3V,Io=2A)



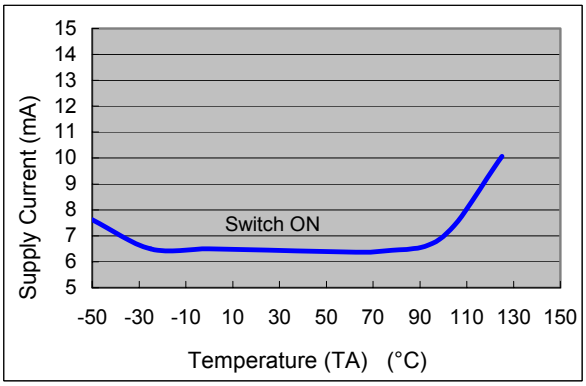
AP1551 Saturation Voltage v.s. Temperature
(Vcc=12V,Vfb=0V,VSD=0)

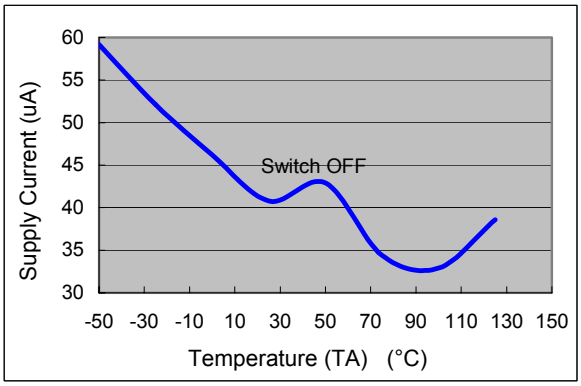


AP1551 Switch Current Limit v.s. Temperature
(Vcc=12V,Vfb=0V)



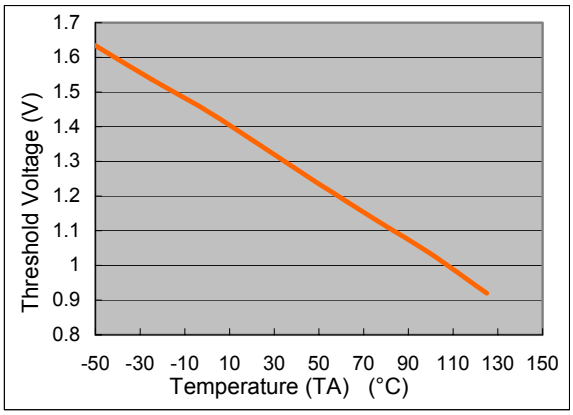
AP1551 Supply Current v.s. Temperature
(Vcc=12V , No Load ,Von/off =0V(Switch ON) ,Von/off =5V(Switch OFF))



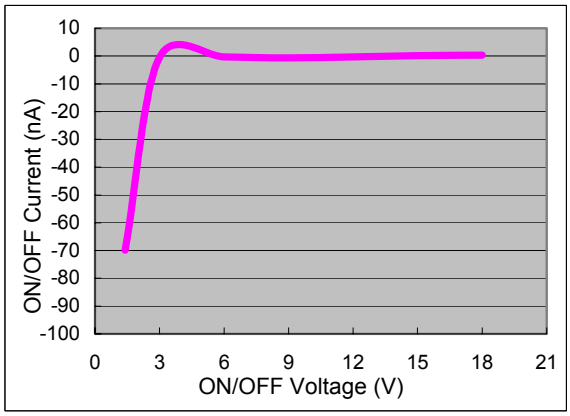


■ Typical Performance Characteristics (For Each Channel) (Continued)

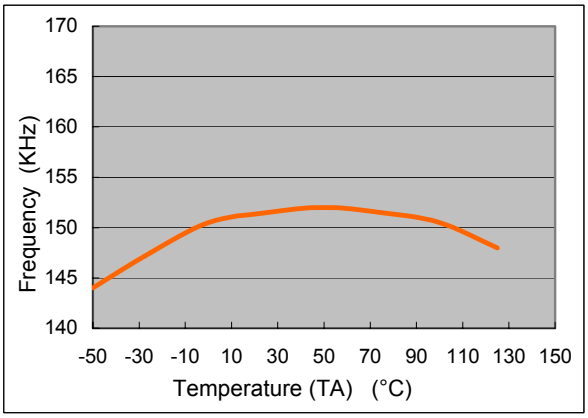
AP1551 Threshold Voltage v.s. Temperature (Vcc=12V , Io=100mA)



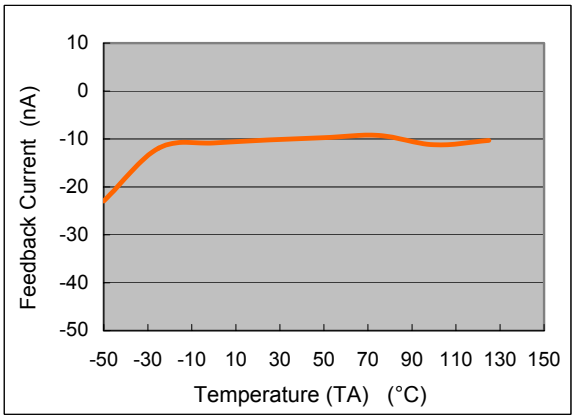
AP1551 ON/OFF Current v.s. ON/OFF Voltage (Vin=12V)



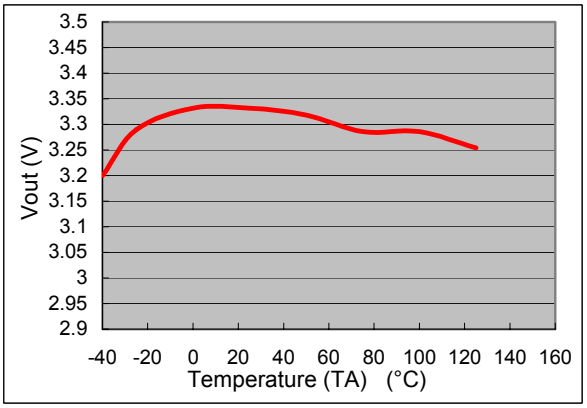
AP1551 Frequency v.s. Temperature (Vcc=12V , Io=500mA ,Vout=5V)



AP1551 Feedback Current v.s. Temperature (Vcc=12V , Vout=5V,Vfb=1.3V)



AP1551 Output Voltage v.s. Temperature (Vin=12V ,Io=2A)



■ Function Description

Pin Functions

+$V_{IN1/2}$

This is the positive input supply for the IC switching regulator. A suitable input bypass capacitor must be present at this pin to minimize voltage transients and to supply the switching currents needed by the regulator.

Ground1/2

Circuit ground.

Output

Internal switch. The voltage at this pin switches between (+V_{IN} – V_{SAT}) and approximately – 0.5V, with a duty cycle of approximately V_{OUT} / V_{IN}. To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be kept a minimum.

Feedback1/2

Senses the regulated output voltage to complete the feedback loop.

SD1/2

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supply current to approximately 150uA. Pulling this pin below a threshold voltage of approximately 1.3V turns the regulator on, and pulling this pin above 1.3V (up to a maximum of 18V) shuts the regulator down. If this shutdown feature is not needed, the SD pin can be wired to the ground pin or it can be left open, in either case the regulator will be in the ON condition.

Thermal Considerations

The SOP-16 package needs a heat sink under most conditions. The size of the heatsink depends on the input voltage, the output voltage, the load current and the ambient temperature. The AP1551 junction temperature rises above ambient temperature for each channel with a 2A load and different input and output voltages. The data for these curves was taken with the AP1551 (SOP-16 package) operating as a buck-switching regulator in an ambient temperature of 25°C (still air). These temperature rise numbers are all approximate and there are many factors that can affect these temperatures. Higher ambient temperatures require more heat sinking.

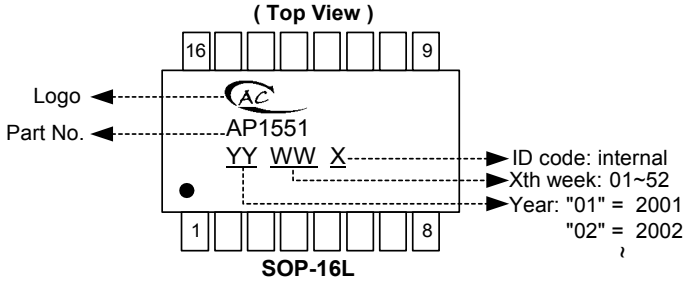
For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (Once exception to this is the output (switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower thermal resistance) to the surrounding air, and moving air lowers the thermal resistance even further.

Package thermal resistance and junction temperature rise numbers are all approximate, and there are many factors that will affect these numbers. Some of these factors include board size, shape, thickness, position, location, and even board temperature. Other factors are, trace width, total printed circuit copper area, copper thickness, single or double-sided, multi-layer board and the amount of solder on the board.

The effectiveness of the PC board to dissipate heat also depends on the size, quantity and spacing of other components on the board, as well as whether the surrounding air is still or moving. Furthermore, some of these components such as the catch diode will add heat to the PC board and the heat can vary as the input voltage changes. For the inductor, depending on the physical size, type of core material and the DC resistance, it could either act as a heat sink taking heat away from the board, or it could add heat to the board.

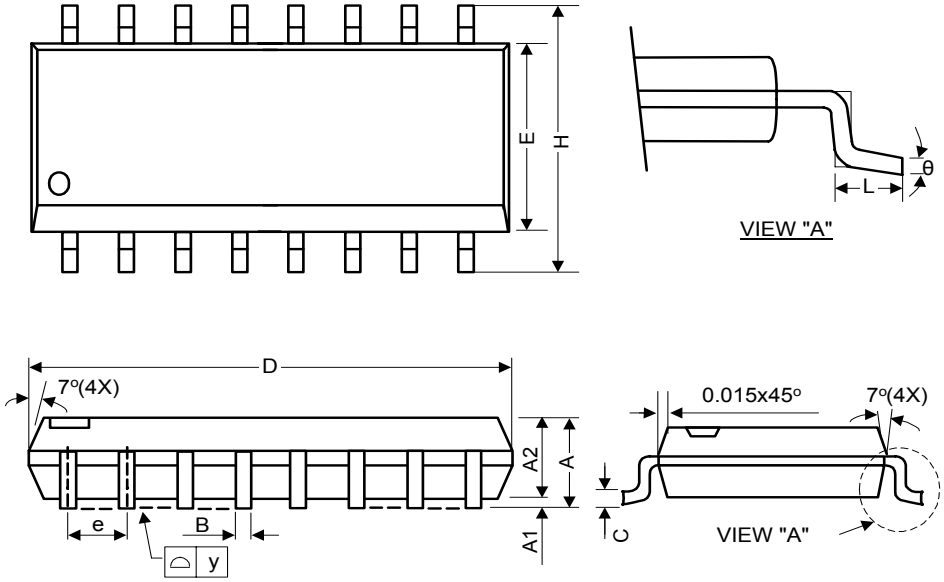
■ Marking Information

SOP-16L



■ Package Information

Package Type: SOP-16L



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.40	1.60	1.75	0.055	0.063	0.069
A1	0.10	-	0.25	0.040	-	0.010
A2	1.30	1.45	1.50	0.051	0.057	0.059
B	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.0098
D	9.80	9.90	10.00	0.386	0.390	0.394
E	3.80	3.90	4.00	0.150	0.154	0.157
e	-	1.27	-	-	0.050	-
H	5.80	6.00	6.20	0.228	0.236	0.244
L	0.38	0.71	1.27	0.015	0.028	0.050
θ	0	-	8	0	-	8