



# 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  $\pm 15\%$  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

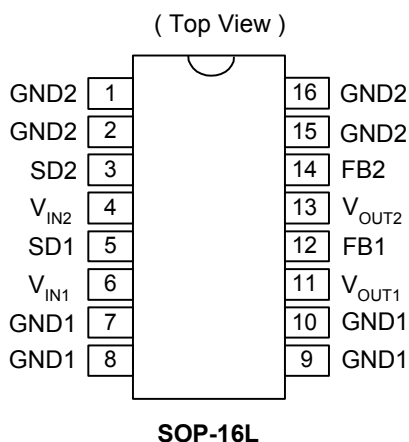
### ■ Applications

- 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  $\pm 4\%$  tolerance on output voltage under specified input voltage and output load conditions, and  $\pm 15\%$  on the oscillator frequency. The packages are available in a standard 16-lead SOP-16 package.

### ■ Pin Assignments

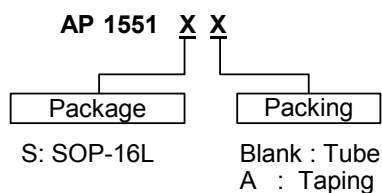


### ■ Pin Descriptions

| 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                 |

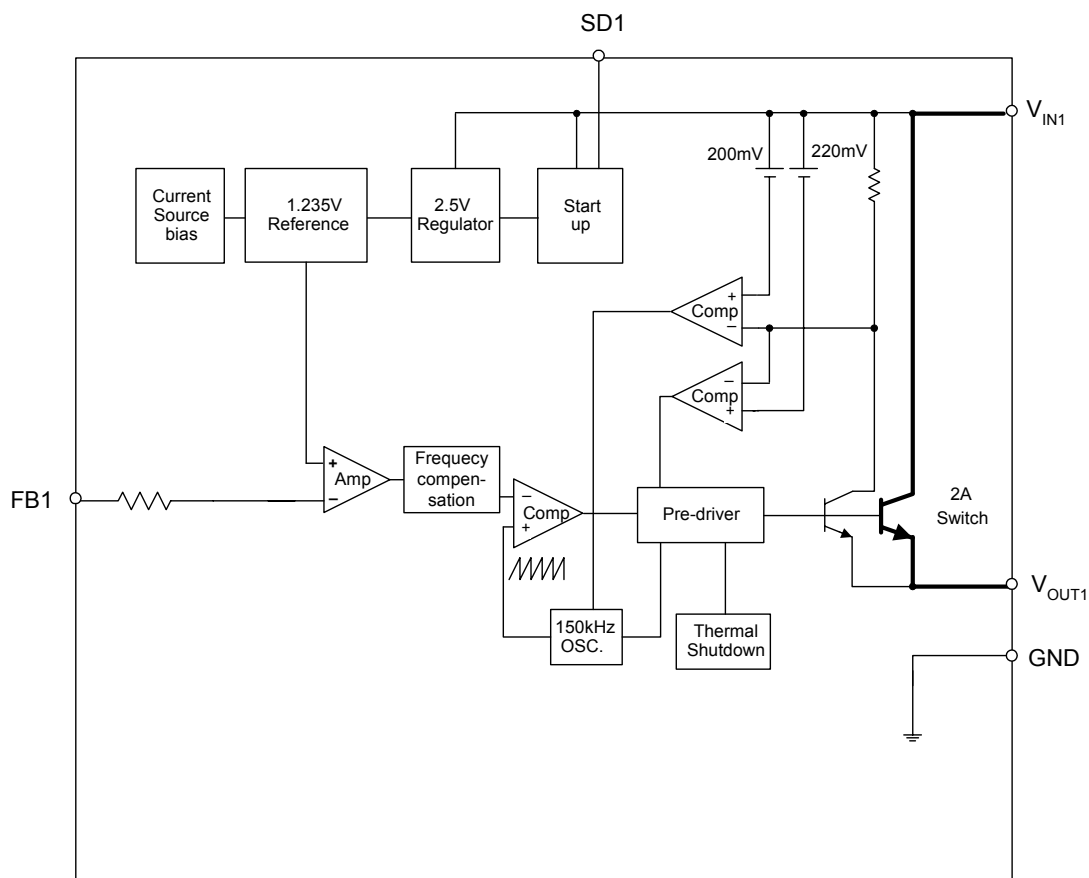
## 150KHz, Dual Channel 2A PWM Buck DC/DC Converter

### ■ Ordering Information



### ■ Block Diagram

(Channel 1 and channel 2 are the same)



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

### ■ 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,  $V_{IN}=12V$ ,  $I_{LOAD} = 0.5A$

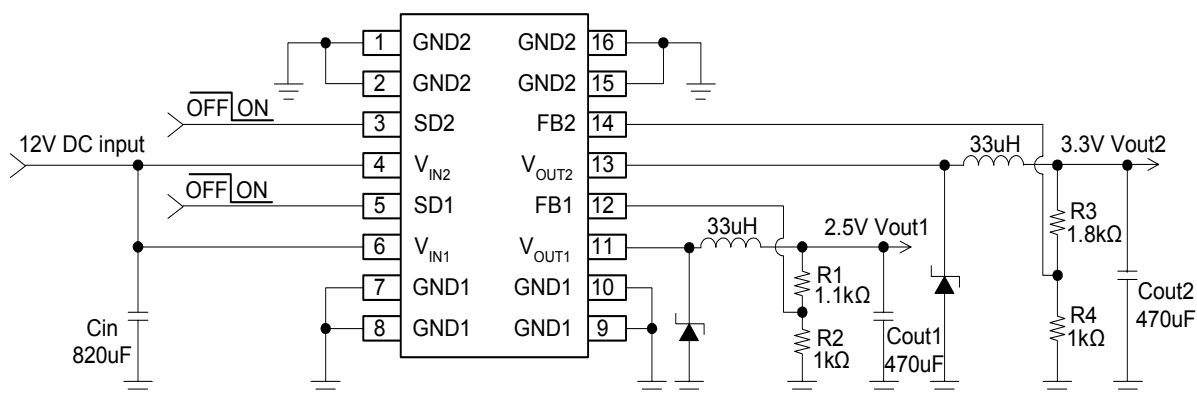
| Symbol               | Parameter                                                                 |                                          | Conditions                                                                              | Min.                | Typ.     | Max.        | Unit |      |
|----------------------|---------------------------------------------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

### ■ Electrical Characteristics (Continued)

|                  | Symbol    | Parameter       | Conditions                                                                                 | Typ. | Limit                                  | Unit                        |
|------------------|-----------|-----------------|--------------------------------------------------------------------------------------------|------|----------------------------------------|-----------------------------|
| AP1551-channel 1 | $V_{FB1}$ | Output Feedback | $4.5V \leq V_{IN} \leq 22V$<br>$0.2A \leq I_{LOAD} \leq 2A$<br>$V_{OUT}$ programmed for 3V | 1.23 | <b>1.193/1.18</b><br><b>1.267/1.28</b> | V<br>$V_{MIN}$<br>$V_{MAX}$ |
|                  | $\eta$    | Efficiency      | $V_{IN} = 12V, I_{LOAD}=2A$                                                                | 76   |                                        | %                           |
| AP1551-channel 2 | $V_{FB2}$ | Output Feedback | $4.5V < V_{IN} < 22V$<br>$0.2A < I_{LOAD} < 2A$<br>$V_{OUT}$ programmed for 3V             | 1.23 | <b>1.193/1.18</b><br><b>1.267/1.28</b> | V<br>$V_{MIN}$<br>$V_{MAX}$ |
|                  | $\eta$    | Efficiency      | $V_{IN} = 12V, I_{LOAD}=2A$                                                                | 76   |                                        | %                           |

Specifications with **boldface type** are for full operating temperature range, the other type are for  $T_J=25^{\circ}C$ .

### ■ Typical Application Circuit



$$V_{out1} = V_{FB} \times \left(1 + \frac{R1}{R2}\right);$$

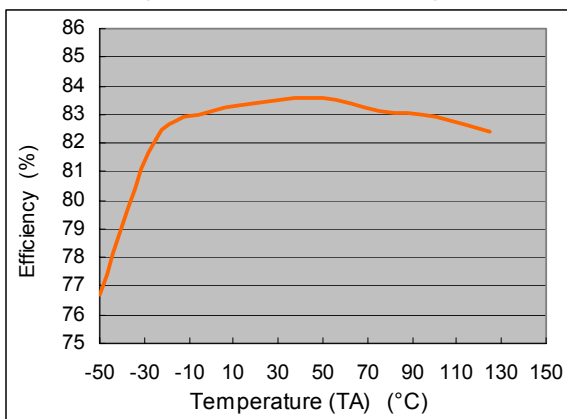
$$V_{out2} = V_{FB} \times \left(1 + \frac{R3}{R4}\right);$$

$$V_{FB} = 1.235V$$

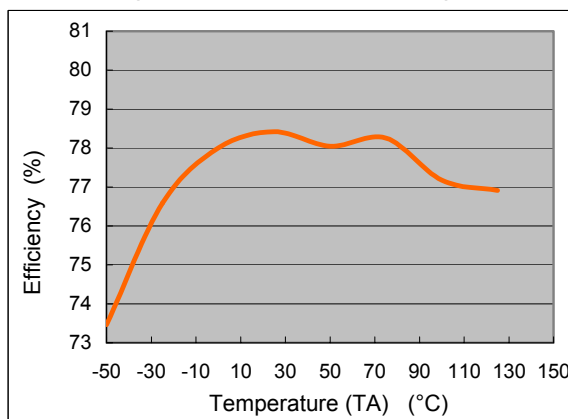
$$R2 = R4 = 1K \sim 3K$$

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

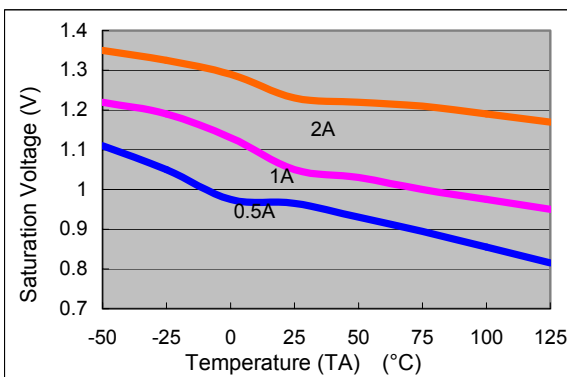
**AP1551 Efficiency v.s. Temperature**  
( $V_{in}=12V, V_{out}=5V, I_o=2A$ )



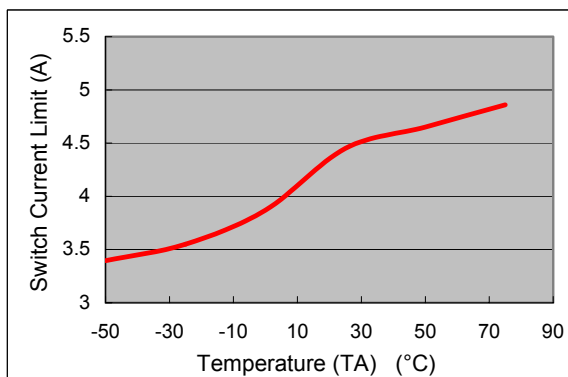
**AP1551 Efficiency v.s. Temperature**  
( $V_{in}=12V, V_{out}=3.3V, I_o=2A$ )



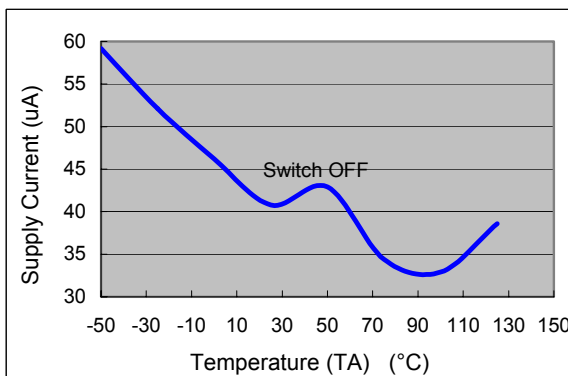
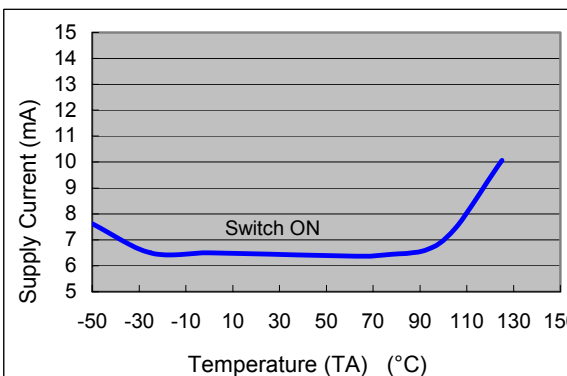
**AP1551 Saturation Voltage v.s. Temperature**  
( $V_{cc}=12V, V_{fb}=0V, V_{SD}=0$ )



**AP1551 Switch Current Limit v.s. Temperature**  
( $V_{cc}=12V, V_{fb}=0V$ )

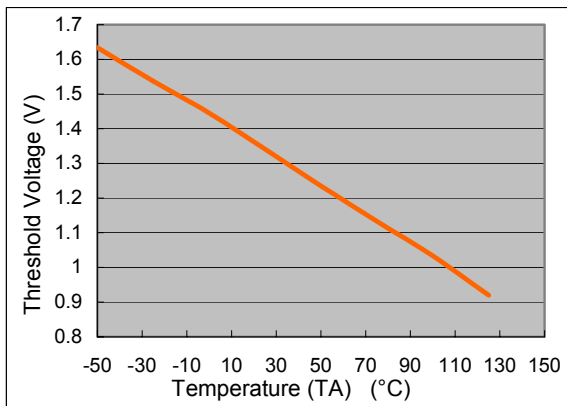


**AP1551 Supply Current v.s. Temperature**  
( $V_{cc}=12V$ , No Load,  $V_{on/off}=0V$ (Switch ON),  $V_{on/off}=5V$ (Switch OFF))

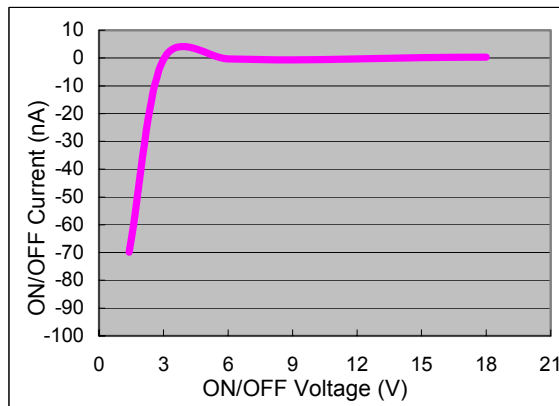


### ■ Typical Performance Characteristics (For Each Channel) (Continued)

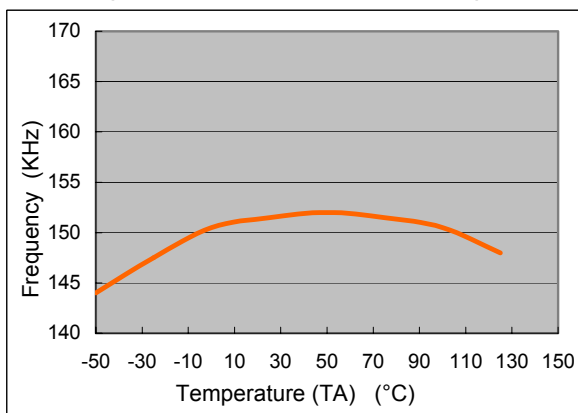
**AP1551 Threshold Voltage v.s. Temperature**  
( $V_{CC}=12V$ ,  $I_o=100mA$ )



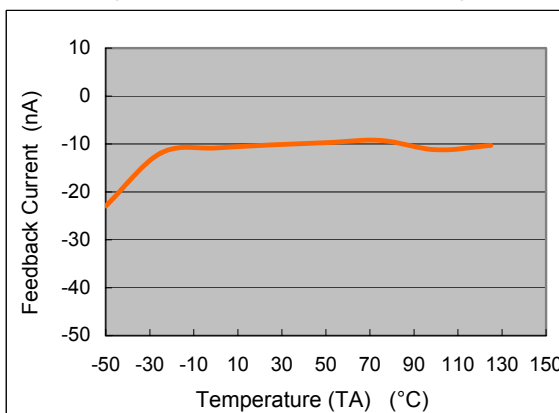
**AP1551 ON/OFF Current v.s. ON/OFF Voltage**  
( $V_{in}=12V$ )



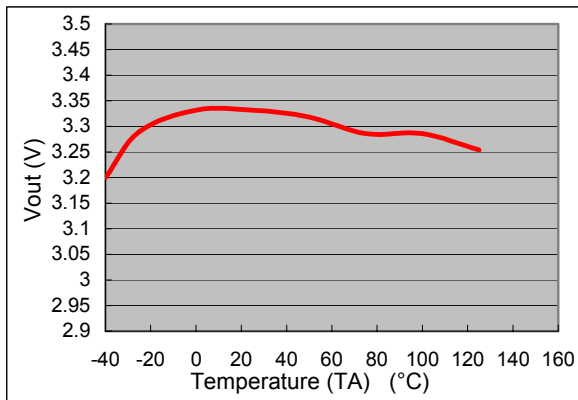
**AP1551 Frequency v.s. Temperature**  
( $V_{CC}=12V$ ,  $I_o=500mA$ ,  $V_{out}=5V$ )



**AP1551 Feedback Current v.s. Temperature**  
( $V_{CC}=12V$ ,  $V_{out}=5V$ ,  $V_{fb}=1.3V$ )



**AP1551 Output Voltage v.s. Temperature**  
( $V_{in}=12V$ ,  $I_o=2A$ )





### ■ Function Description

#### Pin Functions

##### **+V<sub>IN1/2</sub>**

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.

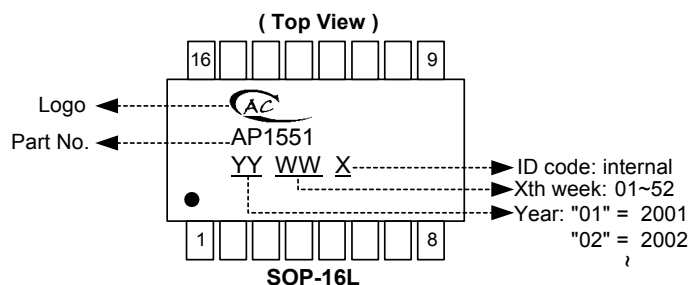
For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (Once exception to this is the output (switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower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

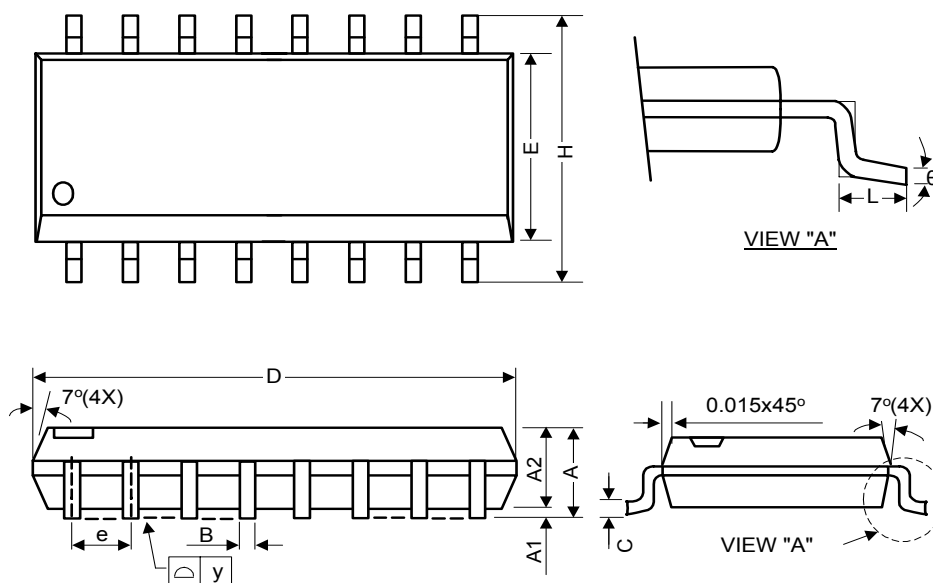
### ■ Marking Information

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      |