

**Features**

- LED driving current up to 500mA
- Operating input voltage up to 48V
- High efficiency up to 92%
- High switching frequency up to 500kHz
- PWM/DC input for dimming control
- Built-in output open-circuit protection
- SOP-8L and MSOP-8L are available in "Green" Molding Compound (No Br, Sb)
- Lead Free Finish/RoHS Compliant (Note 1)

**General Description**

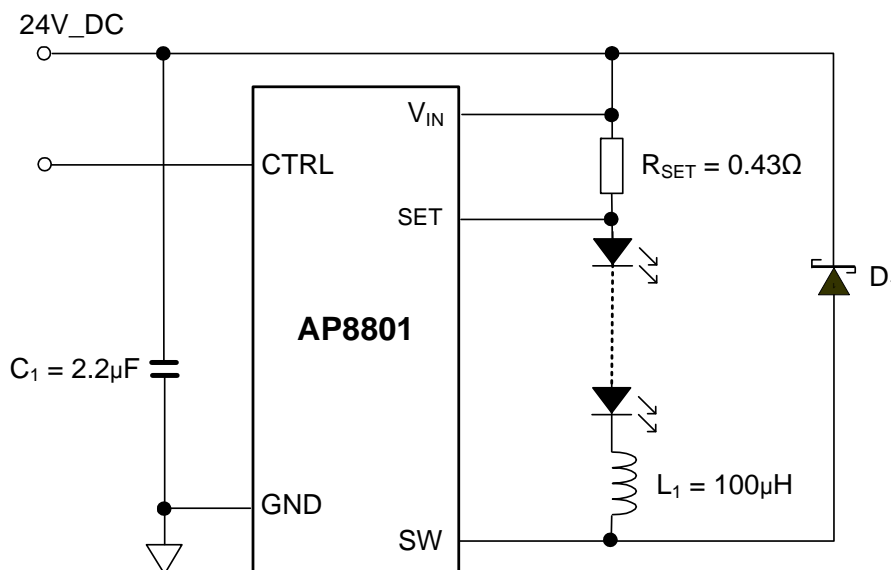
The AP8801 is a step-down DC/DC converter designed to drive LEDs with a constant current. The device can drive up to thirteen LEDs, depending on the forward voltage of the LEDs, in series from a voltage source of 8V to 48V. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. The AP8801 switches at frequency up to 500kHz. This allows the use of small size external components, hence minimizing the PCB area needed.

Maximum output current of AP8801 is set via an external resistor connected between the  $V_{IN}$  and SET input pins. Dimming is achieved by applying either a DC voltage or a PWM signal at the CTRL input pin. An input voltage of 0.2V or lower at CTRL shuts down the output at SW and puts the device into a low-current standby state.

**Applications**

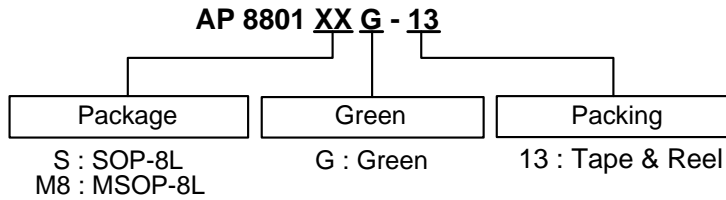
- Commercial & industrial lighting
- Small LCD panel backlight
- Appliances interior lighting
- Architecture Detail lighting

**Typical Application Circuit**



**Figure 1: Typical Application Circuit**

**Ordering Information**

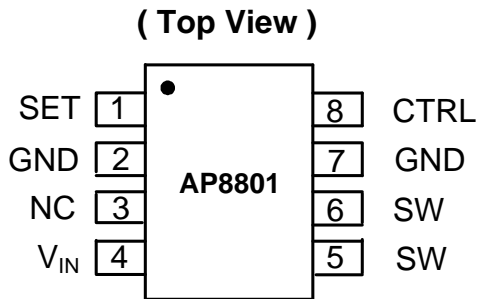


| Device       | Package Code | Packaging (Note 2) | 13" Tape and Reel |                    |
|--------------|--------------|--------------------|-------------------|--------------------|
|              |              |                    | Quantity          | Part Number Suffix |
| AP8801SG-13  | S            | SOP-8L             | 2500/Tape & Reel  | -13                |
| AP8801M8G-13 | M8           | MSOP-8L            | 2500/Tape & Reel  | -13                |

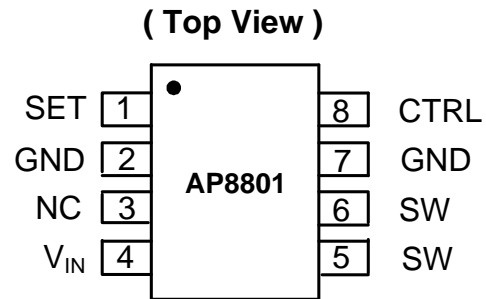
Notes: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at [http://www.diodes.com/products/lead\\_free.html](http://www.diodes.com/products/lead_free.html).  
 2. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

**Pin Assignments**

(1) SOP-8L



(2) MSOP-8L



**Pin Descriptions**

| Pin Name | Description  |
|----------|--|
| SW       | Switch Pin. Connect inductor/freewheeling diode here, minimizing track length at this pin to reduce EMI.   |
| GND      | GND pin  |
| SET      | Set Nominal Output Current Pin. Configure the output current of the device.  |
| CTRL     | Dimming and On/Off Control Input. Input voltage of 0.2V or lower forces the device into low current standby mode and shuts off the output. A PWM signal allows the output current to be adjusted above or below the level set by the resistor connected to SET input pin.<br>The input impedance is about 50kΩ, and if the pin is left open $V_{CTRL} = V_{REF}$ |
| $V_{IN}$ | Input Supply Pin. Must be locally bypassed.  |
| NC       | No connection  |

**Block Diagram**

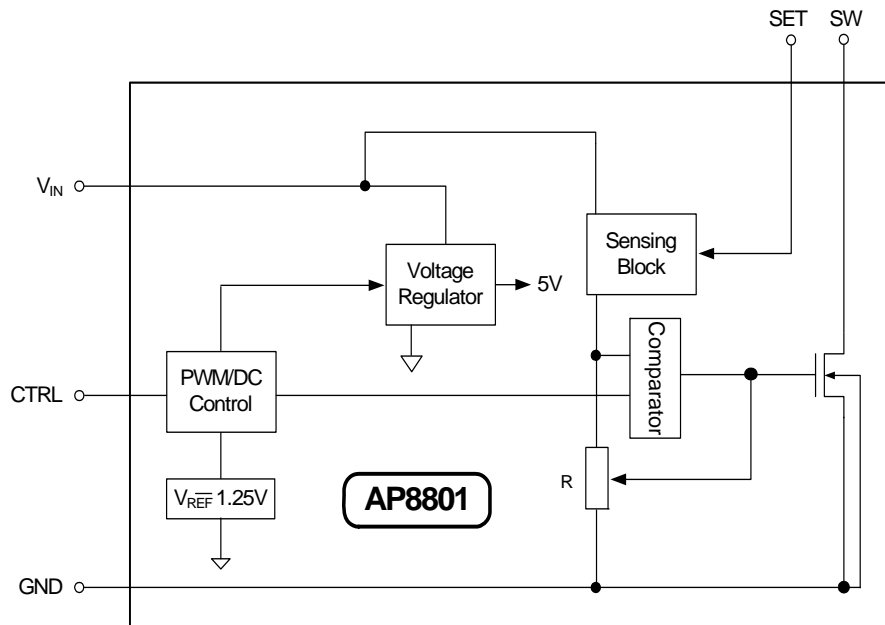


Figure 2: AP8801 Block Diagram

### Absolute Maximum Ratings

| Symbol     | Parameter                  | Rating      | Unit |
|------------|----------------------------|-------------|------|
| $V_{IN}$   | VIN pin voltage            | -0.3~50     | V    |
| $V_{SW}$   | SW voltage                 | -0.3~50     | V    |
| $T_J$      | Junction Temperature       | 150         | °C   |
| $T_{LEAD}$ | Lead Temperature Soldering | 300         | °C   |
| $T_{ST}$   | Storage Temperature Range  | -65 to +150 | °C   |

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any condition.

Semiconductor devices are ESD sensitive and may be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices

### Recommended Operating Conditions

| Symbol     | Parameter                                     | Min | Max  | Unit |
|------------|---|-----|------|------|
| $T_A$      | Ambient Temperature Range                     | -40 | 105  | °C   |
| Duty Cycle | Using Inductor $\geq 100\mu\text{H}$ (Note 3) | 0.1 | 0.95 |      |

Notes: 3. For most applications the LED current will be within 8% over the duty cycle range specified. Duty cycle accuracy is also dependent on propagation delay. Smaller size inductors can be used but LED current accuracy may be greater than 8% at extremes of duty cycle. This is most noticeable at low duty cycles (less than 0.1) or when the input voltage is high and only one LED is being driven.

### Electrical Characteristics ( $V_{IN}=24\text{V}$ , $T_A=25^\circ\text{C}$ , unless otherwise specified)

| Symbol            | Parameter                              | Conditions           | Min  | Typ. | Max  | Unit          |
|-------------------|--|----------------------|------|------|------|---------------|
| $V_{IN}$          | Operating Input Voltage                |                      | 8.0  | -    | 48   | V             |
| $I_{OUT}$         | Continuous switch current              | (Note 4)             |      |      | 500  | mA            |
| $I_Q$             | Quiescent Current                      |                      | -    | 78   | 120  | $\mu\text{A}$ |
| $F_{OSC}$         | Switching Frequency                    |                      | -    | -    | 0.5  | MHz           |
| $V_{THD}$         | Internal Threshold Voltage             |                      | 184  | 200  | 216  | mV            |
| $V_{REF}$         | Internal Reference Voltage             |                      | -    | 1.25 | -    | V             |
| SET               | SET pin input current                  | $V_{SET}=V_{IN}-0.2$ | -    | 7    | -    | $\mu\text{A}$ |
| $R_{ds(on)}$      | On Resistance of MOSFET                | $I_{SW}=0.4\text{A}$ |      | 0.7  | 1.15 | $\Omega$      |
| $I_{SW\_Leakage}$ | Switch leakage current                 |                      | -    | -    | 8    | $\mu\text{A}$ |
| EN                | Voltage High                           | ON                   | 1.25 | -    | -    | V             |
| EN                | Voltage Low                            | OFF                  | -    | -    | 0.2  | V             |
| $\theta_{JA}$     | Thermal Resistance Junction-to-Ambient | SOP-8L (Note 5)      | -    | 88   | -    | °C/W          |
|                   |  | MSOP-8L (Note 5)     | -    | 128  | -    | °C/W          |
| $\theta_{JC}$     | Thermal Resistance Junction-to-Case    | SOP-8L (Note 5)      | -    | 58   | -    | °C/W          |
|                   |  | MSOP-8L (Note 5)     | -    | 90   | -    | °C/W          |

Notes: 4. Refer to figure 6 for the device derating curve.

5. Test condition for SOP-8L and MSOP-8L: Device mounted on FR-4 PCB, 2"x2", 2oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer ground plane. For better thermal performance, larger copper pad for heat-sink is needed.

**Application Information**

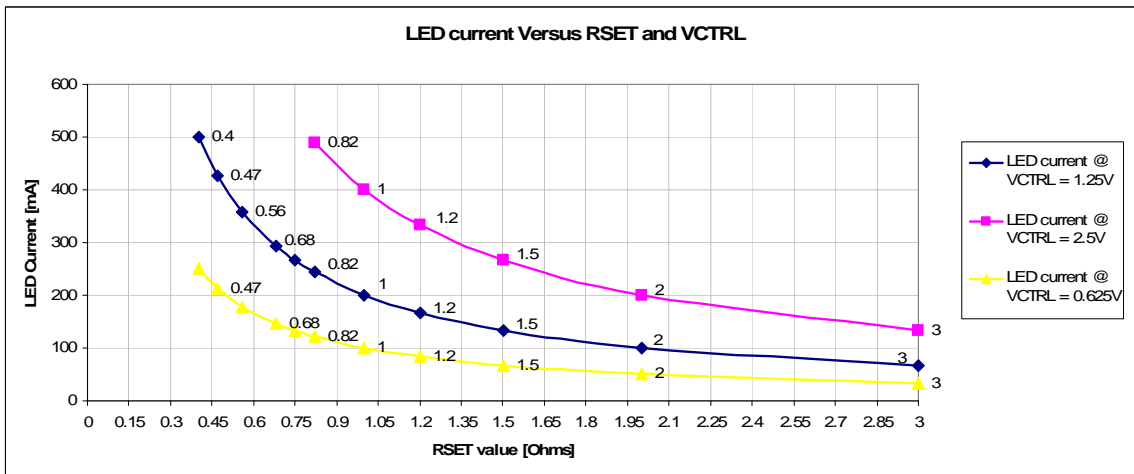
**LED Current Control**

The LED current is controlled by the resistor RSET in Figure 1 connected between VIN and SET. The nominal average output current in the LED(s) is defined as:

$$I_{LED} = \frac{V_{THD}}{R_{SET}}$$

If the CTRL pin is driven by an external voltage (lower than 2.5V), the average LED current is:

$$I_{LED} = \frac{V_{CTRL}}{V_{REF}} \frac{V_{THD}}{R_{SET}}$$

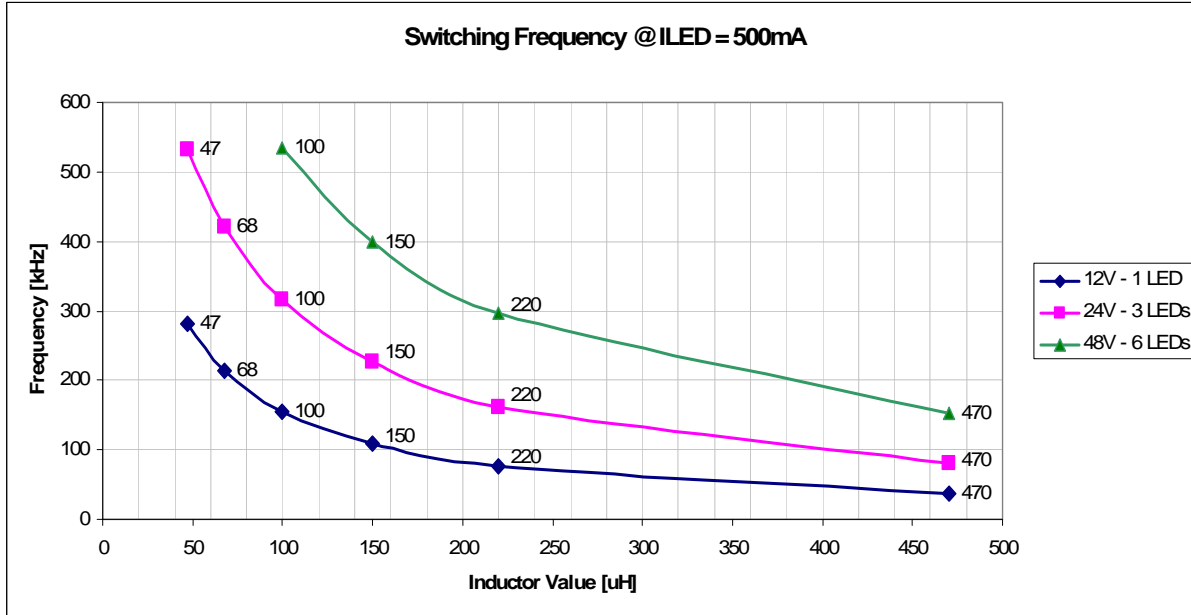


**Figure 3: LED Current setting Vs RSET and VCTRL**

**Application Information (Continued)**

**Inductor Selection**

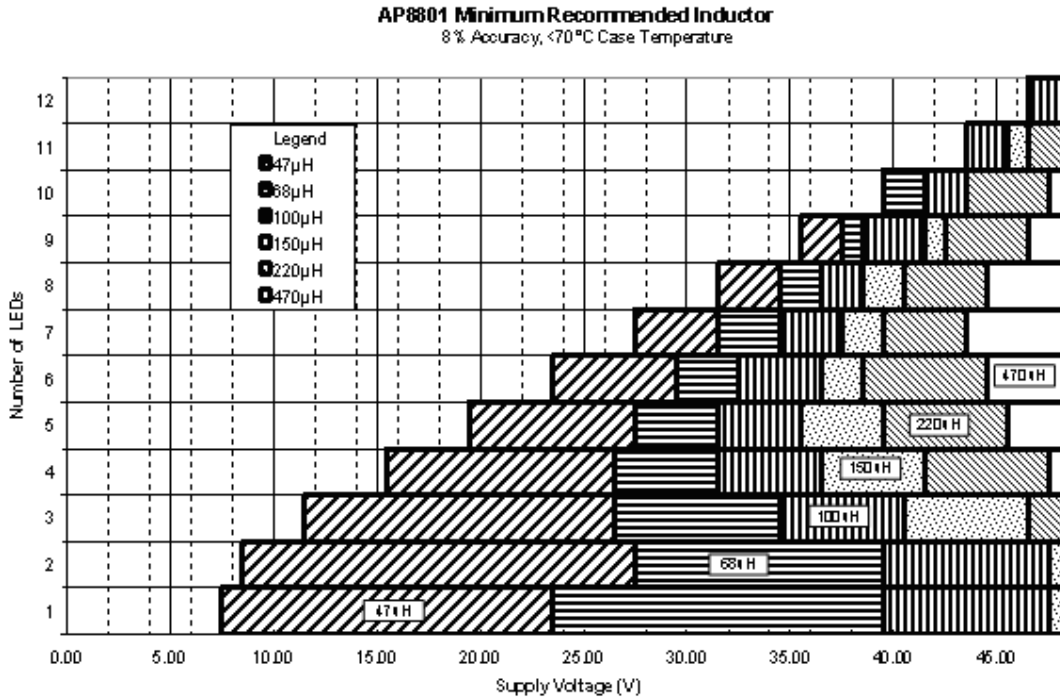
This section highlights how to select the inductor suitable for the application requirements in terms of switching frequency, LED current accuracy and temperature.



**Figure 4: Switching Frequency Vs Inductor Value**

**Application Information (Continued)**

The inductor influences the LED current accuracy that the system is able to provide. The following section highlights how to select the inductor in relation to the device packages and the LED current, while maintaining the chip temperature below 70°C.



**Figure 5: Minimum recommended inductor with 500mA LED current**

**Capacitor Selection**

The small size of ceramic capacitors makes them ideal for AP8801 applications. X5R and X7R types are recommended because they retain their capacitance over wider voltage and temperature ranges than other types such as Z5U. A 2.2µF input capacitor is sufficient for most intended applications of AP8801. A 4.7µF input capacitor is suggested for application with an input voltage equal or higher than 40V.

**Diode Selection**

Schottky diodes, e.g. B1100, with their low forward voltage drop and fast reverse recovery, are the ideal choice for AP8801 applications.

**PWM Dimming**

A Pulse Width Modulated (PWM) signal with a max resolution of 8bit, can be applied to the CTRL pin to change the output current to a value above or below the nominal average value set by resistor RSET. To achieve this resolution the PWM frequency has to be lower than 500Hz.

**Application Information (Continued)**

**Thermal Considerations**

The graph below in figure 6, gives details for power derating. This assumes the device to be mounted on a 25x25mm PCB with 1oz copper standing in still air.

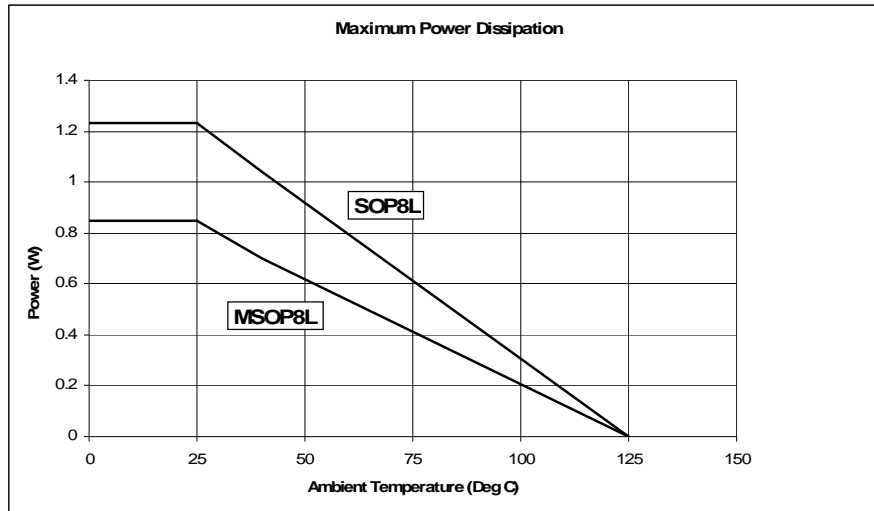


Figure 6: AP8801 derating curves

**Package Selection**

The device comes with a wide selection of packages. The suggested package is able to provide a case temperature below 70°C (with an ambient temperature of 25°C) for the combination of input voltage and load requested.

**AP8801 suggested package @  
ILED=500mA and 100µH Inductor**

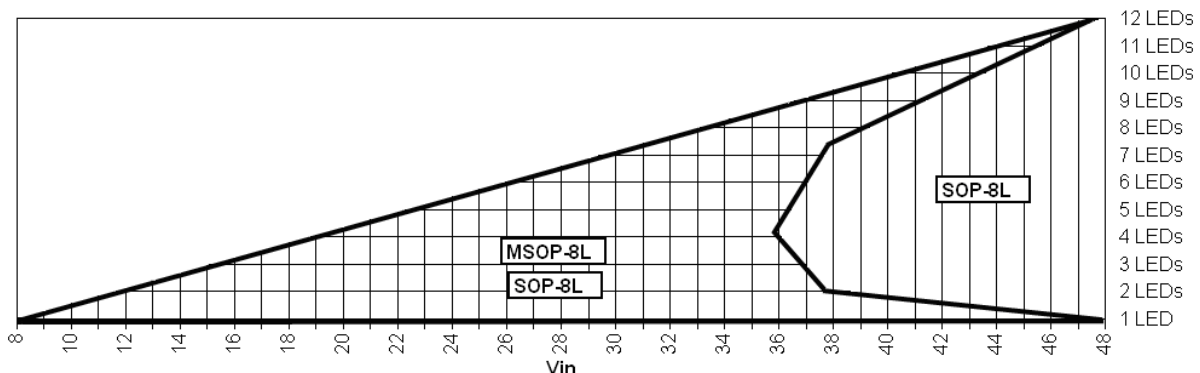
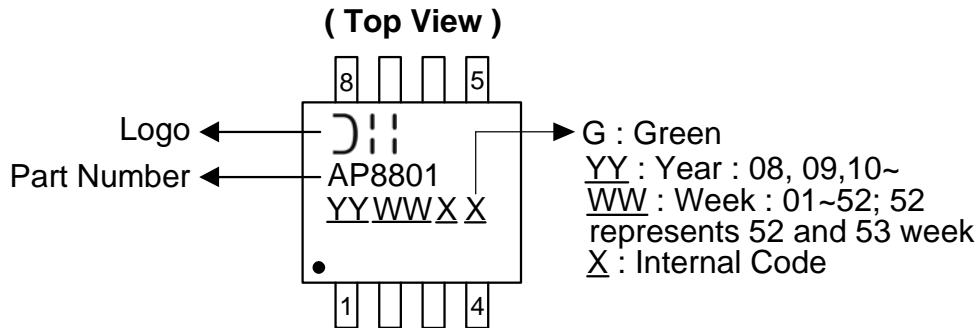


Figure 7: Suggested package for a 500mA application

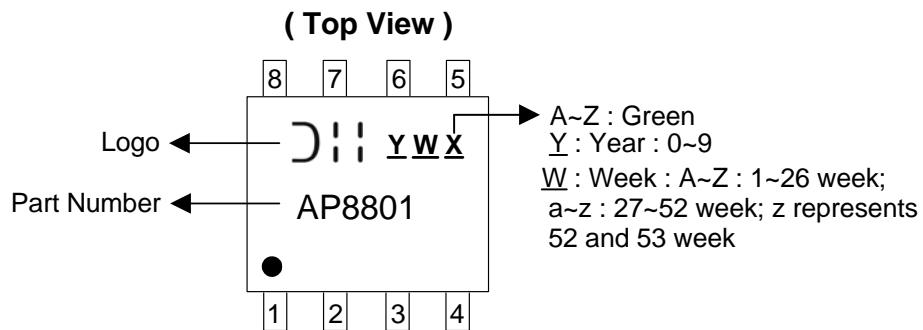


**Marking Information**

(1) SOP-8L



(2) MSOP-8L





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