

## Description

The AP5724 is a step-up DC/DC converter specifically designed to drive white LEDs with a constant current. The device can drive 2 ~ 6 LEDs in series from a Li-Ion cell. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminates the need for ballast resistors. For driving higher number of LEDs, AP5724 also supports a single feedback of parallel connected multiple strings of equal number of LEDs.

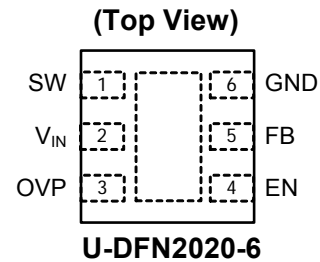
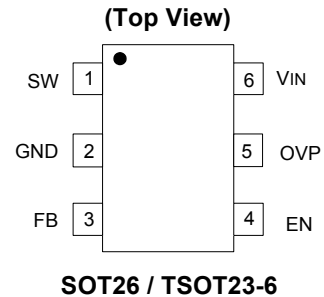
The AP5724 switches at 1.2MHz that allows the use of tiny external components. A low 0.1V feedback voltage minimizes power loss in the current setting resistor for better efficiency

## Features

- High Efficiency: 84% Typical
- Fast 1.2MHz Switching Frequency
- Current Limit and UVLO Protections
- Internal Thermal Shutdown
- Internal Over Voltage Protection
- Integrated Soft-Start Function
- SOT26, TSOT26 and U-DFN2020-6: Available in "Green" Molding Compound (No Br, Sb)
- **Lead-Free Finish; RoHS Compliant (Notes 1 & 2)**

Notes: 1. EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant. All applicable RoHS exemptions applied.  
2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.

## Pin Assignments



## Applications

- Cellular Phones
- PDAs, Hand held Computers
- Digital Cameras
- MP3 Players
- GPS Receivers

## Typical Applications Circuit

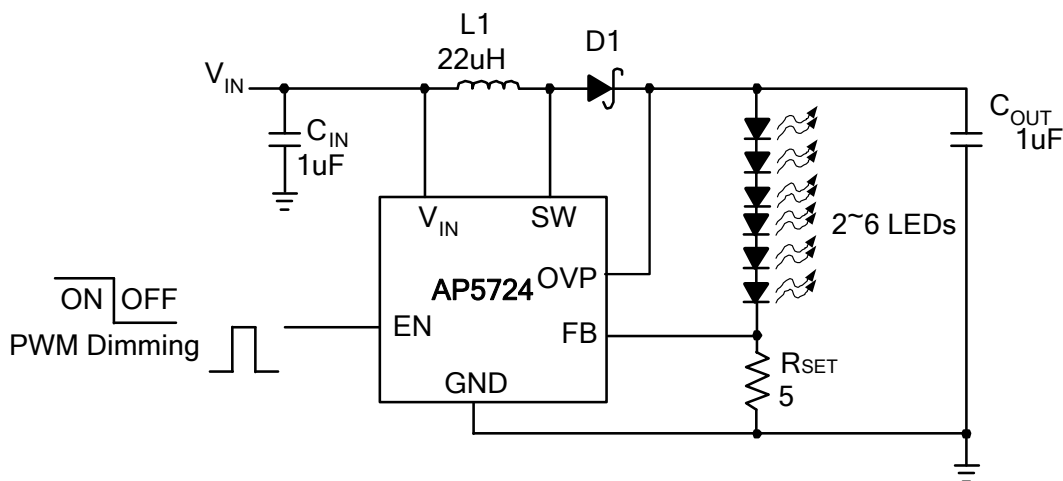
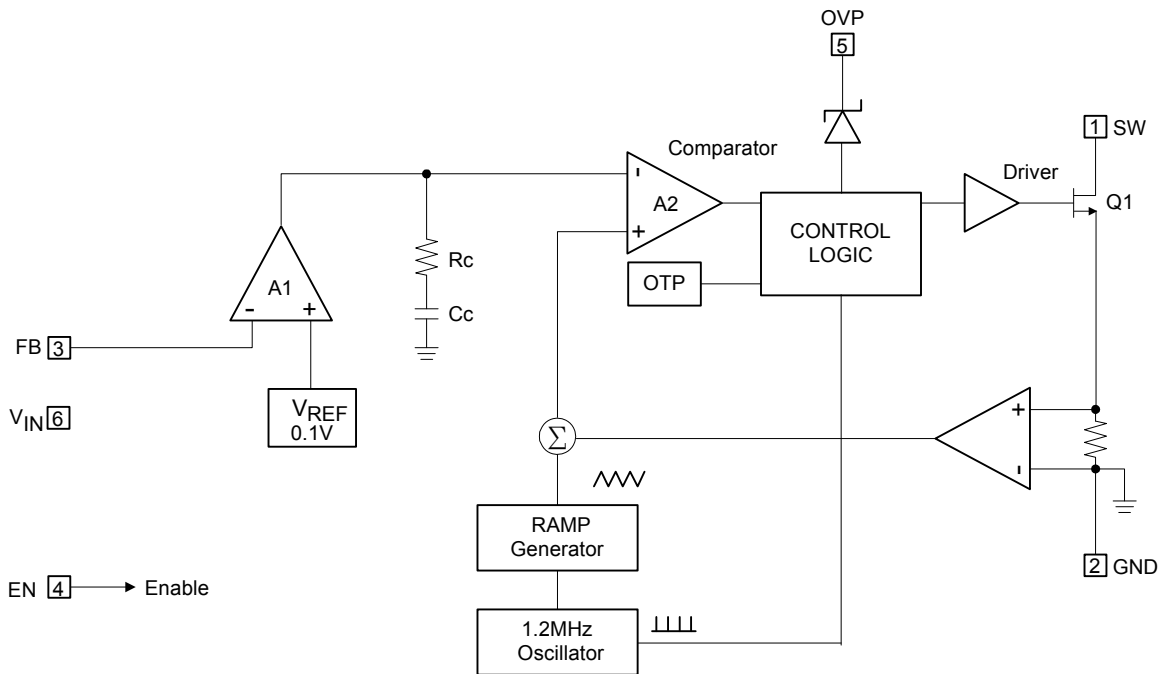


Figure 1 Typical Application Circuit

### Pin Descriptions

| Pin Name        | Functions   |
|-----------------|---|
| SW              | Switch Pin. Connect inductor/diode here. Minimize trace area at this pin to reduce EMI.   |
| GND             | GND pin.  |
| FB              | Feedback Pin. Reference voltage is 0.1V. Connect cathode of lowest LED and a sense resistor here. Calculate resistor value according to the formula: $R_{SET} = 0.1V / I_{LED}$   |
| EN              | Converter On/Off Control Input. A high input at EN turns the converter On, and a low input turns it off. If On/Off control is not needed, connect EN to the input source for automatic startup. The EN pin cannot be left floating. |
| OVP             | Output Voltage detect pin for over voltage protection.  |
| V <sub>IN</sub> | Input Supply Pin. Must be locally bypassed with 1μF or 2.2μF to reduce input noise.   |

### Functional Block Diagram



### Absolute Maximum Ratings (@T<sub>A</sub> = +25°C, unless otherwise specified.)

| Symbol              | Parameter                    | Rating      | Unit |
|---------------------|------------------------------|-------------|------|
| V <sub>IN</sub>     | V <sub>IN</sub> Pin Voltage  | -0.3 to +7  | V    |
| V <sub>SW</sub>     | SW Voltage                   | -0.3 to +34 | V    |
| V <sub>OVP</sub>    | OVP Pin Voltage              | -0.3 to +35 | V    |
| V <sub>FB</sub>     | Feedback Pin Voltage         | -0.3 to +7  | V    |
| EN                  | EN                           | -0.3 to +7  | V    |
| T <sub>J(MAX)</sub> | Maximum Junction Temperature | 150         | °C   |
| T <sub>LEAD</sub>   | Lead Temperature             | 300         | °C   |
| T <sub>ST</sub>     | Storage Temperature Range    | -65 to +150 | °C   |

Caution: Operation above the absolute maximum ratings can cause device failure. These values, therefore, must not be exceeded under any condition. Operation at the absolute maximum rating for extended periods, may reduce device reliability.

**Recommended Operating Conditions** (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

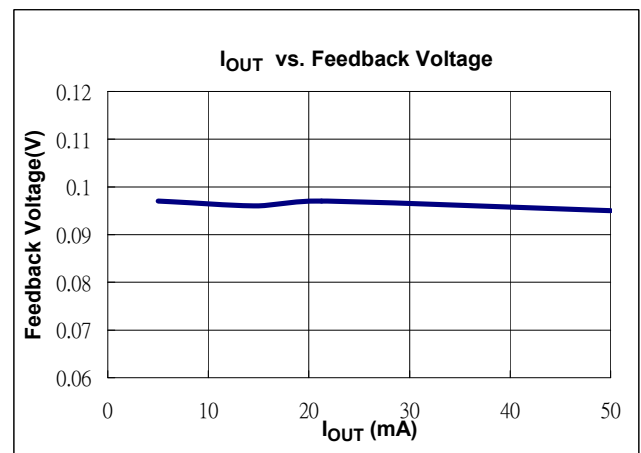
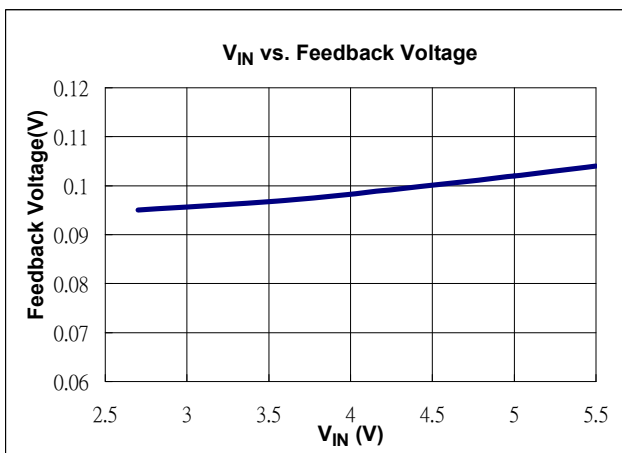
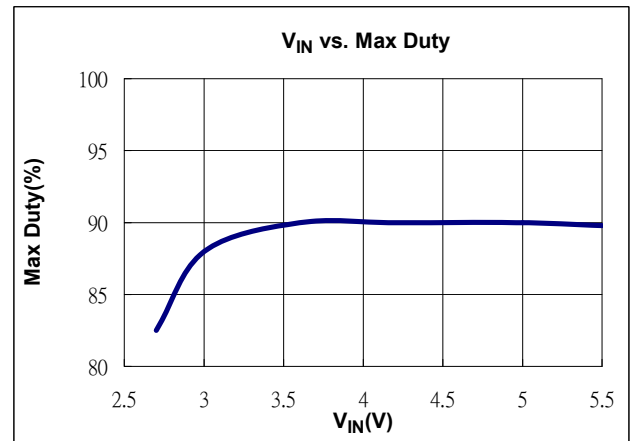
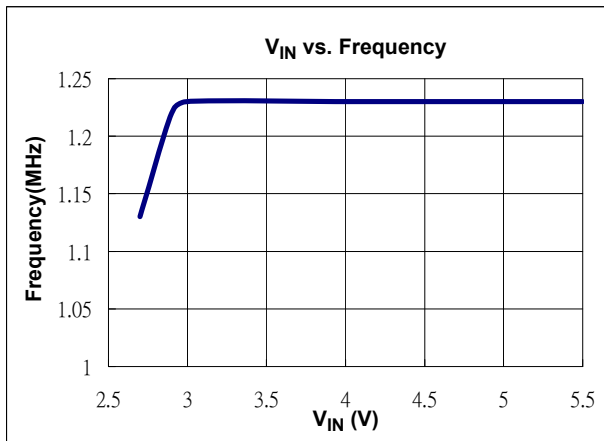
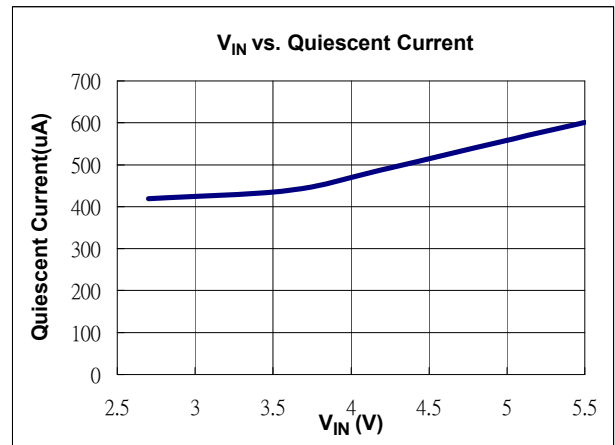
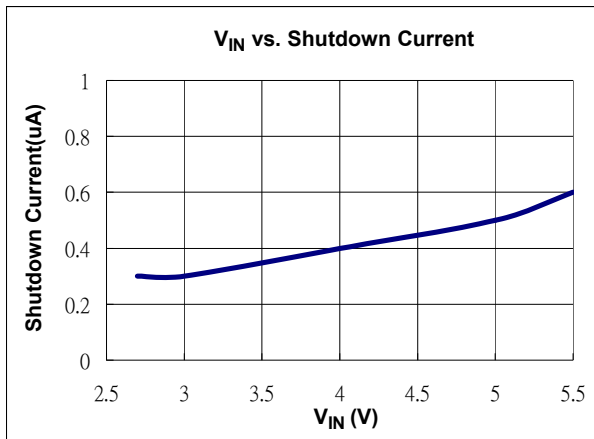
| Symbol   | Parameter                      | Min | Max | Unit             |
|----------|--------------------------------|-----|-----|------------------|
| $V_{IN}$ | Input Voltage                  | 2.7 | 5.5 | V                |
| $T_J$    | Operating Junction Temperature | -40 | 125 | $^\circ\text{C}$ |
| $T_A$    | Operating Ambient Temperature  | -40 | 85  | $^\circ\text{C}$ |

**Electrical Characteristics** (@  $V_{IN} = 3.6\text{V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

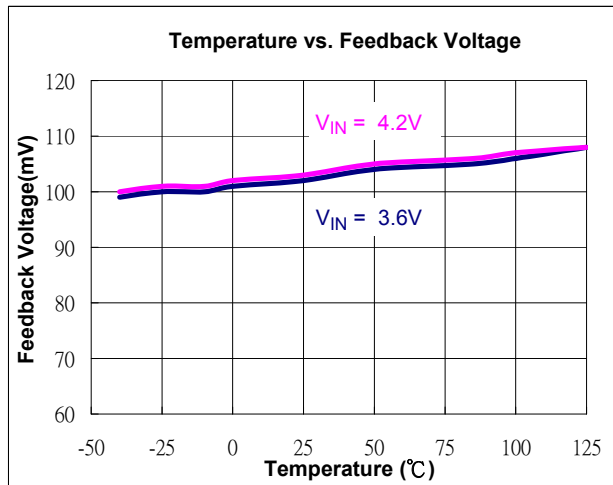
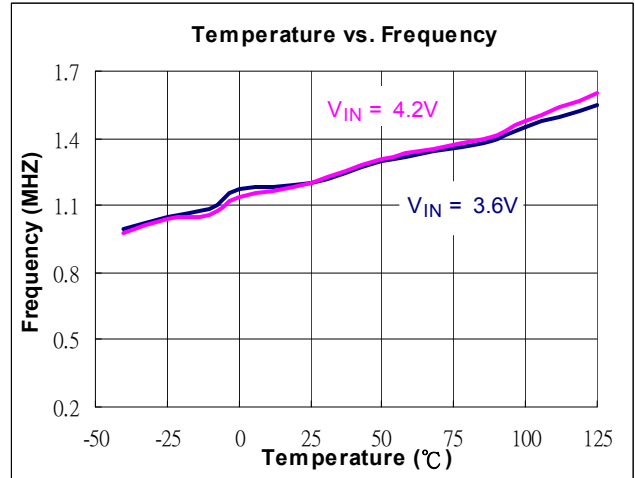
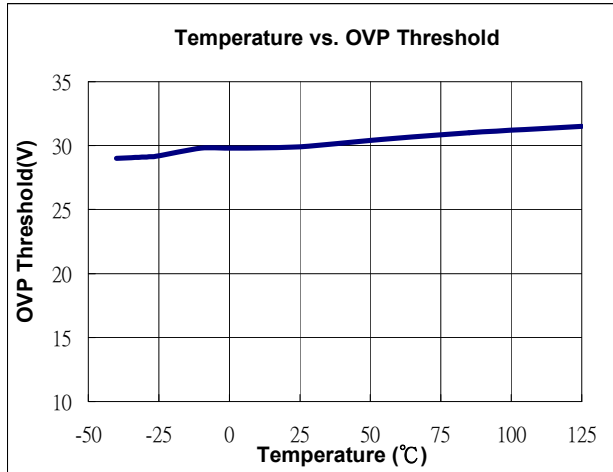
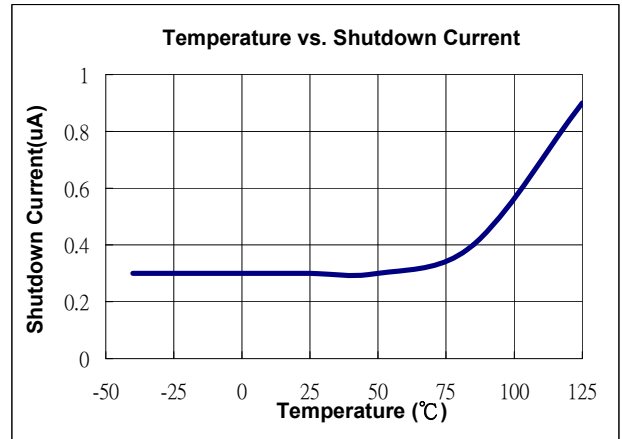
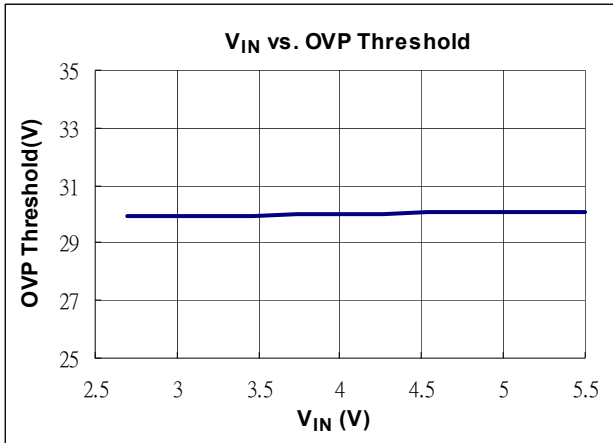
| Symbol                        | Parameter                              | Conditions              | Min  | Typ  | Max  | Unit               |
|-------------------------------|--|-------------------------|------|------|------|--------------------|
| <b>System Supply Input</b>    |  |                         |      |      |      |                    |
| $V_{IN}$                      | Operating Input Voltage                |                         | 2.7  | —    | 5.5  | V                  |
| UVLO                          | Under Voltage Lockout                  |                         | —    | 2.2  | 2.4  | V                  |
|                               | Under Voltage Lockout Hysteretic       |                         | —    | 85   | —    | mV                 |
| $I_Q$                         | Quiescent Current                      | FB = 0.2V, No Switching | —    | 500  | —    | $\mu\text{A}$      |
| $I_{SD}$                      | Shutdown Current                       | $V_{EN} < 0.4\text{V}$  | —    | 0.1  | 1    | $\mu\text{A}$      |
| <b>Oscillator</b>             |  |                         |      |      |      |                    |
| $F_{OSC}$                     | Operation Frequency                    |                         | 1    | 1.2  | 1.4  | MHz                |
| Dmax                          | Maximum Duty Cycle                     |                         | 86   | 90   | —    | %                  |
| <b>Reference Voltage</b>      |  |                         |      |      |      |                    |
| $V_{FB}$                      | Feedback Voltage                       |                         | 0.09 | 0.1  | 0.11 | V                  |
| $I_{FB}$                      | FB Pin Bias Current                    |                         | 10   | 45   | 100  | nA                 |
| <b>MOSFET</b>                 |  |                         |      |      |      |                    |
| Rds(on)                       | On Resistance of MOSFET                |                         | —    | 0.95 | 1.2  | $\Omega$           |
| $I_{OCP}$                     | Switching Current Limit                | Normal Operation        | —    | 750  | —    | mA                 |
| <b>Control and Protection</b> |  |                         |      |      |      |                    |
| EN                            | Voltage High                           | ON                      | 1.5  | —    | —    | V                  |
| EN                            | Voltage Low                            | OFF                     | —    | —    | 0.4  | V                  |
| $I_{EN}$                      | EN Pin Pull Low Current                |                         | —    | 4    | 6    | $\mu\text{A}$      |
| OVP                           | OVP Threshold                          |                         | 26   | 30   | 34   | V                  |
| $\theta_{JA}$                 | Thermal Resistance Junction-to-Ambient | SOT26 (Note 3)          | —    | 162  | —    | $^\circ\text{C/W}$ |
|                               |  | TSOT26 (Note 3)         | —    | 152  | —    |                    |
|                               |  | U-DFN2020-6 (Note 3)    | —    | 200  | —    |                    |
| $\theta_{JC}$                 | Thermal Resistance Junction-to-Case    | SOT26 (Note 3)          | —    | 36   | —    | $^\circ\text{C/W}$ |
|                               |  | TSOT26 (Note 3)         | —    | 32   | —    |                    |
|                               |  | U-DFN2020-6 (Note 3)    | —    | 30   | —    |                    |

Note: 3. Test condition for SOT26, TSOT26 and U-DFN2020-6: Device mounted on FR-4 substrate, single-layer PC board, 2oz copper, with minimum recommended pad layout

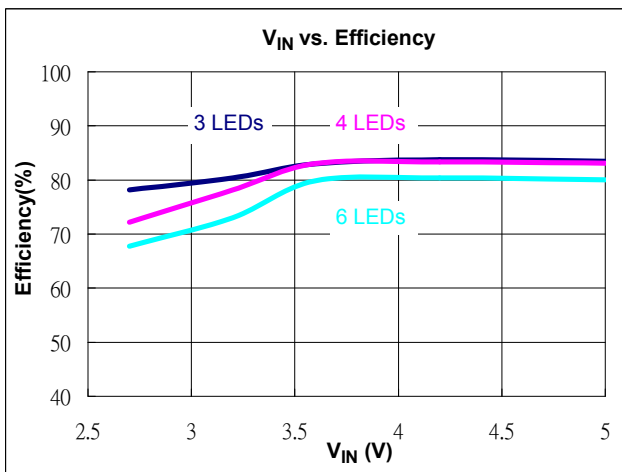
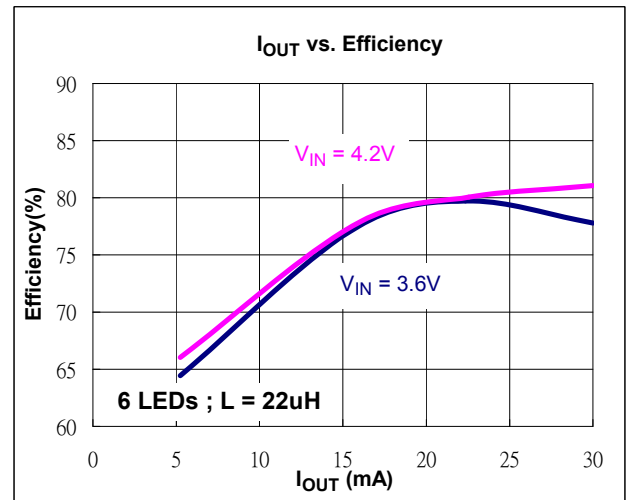
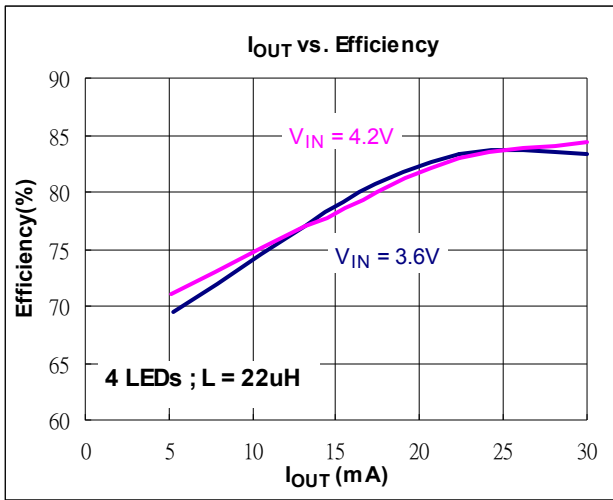
**Typical Performance Characteristics** (6 LEDs,  $V_{IN} = 3.6V$ ,  $I_{OUT} = 25mA$ )



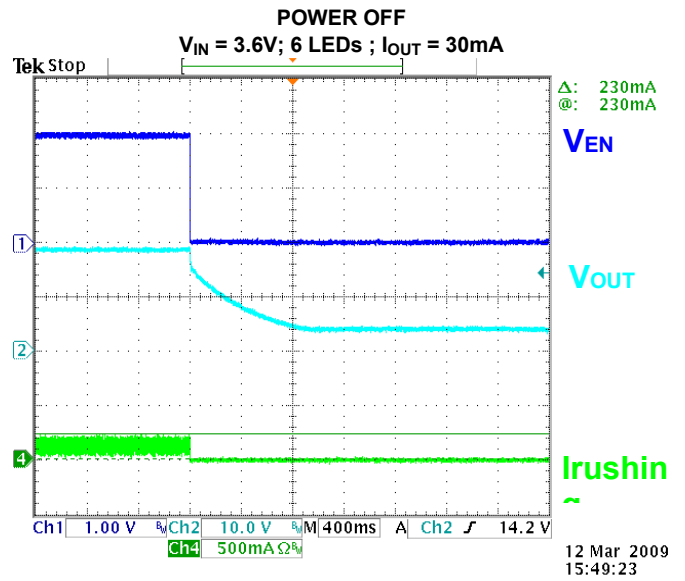
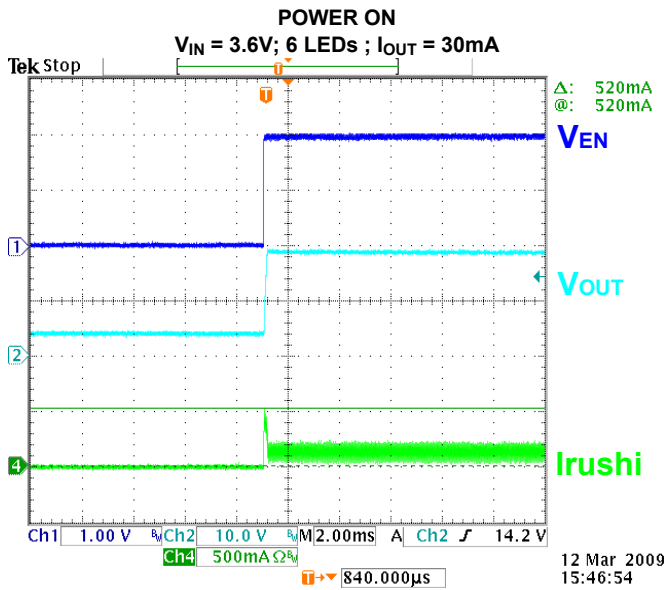
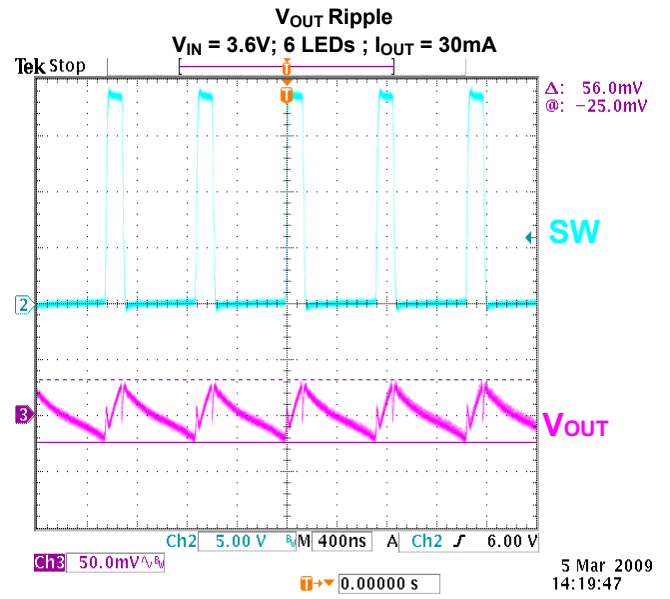
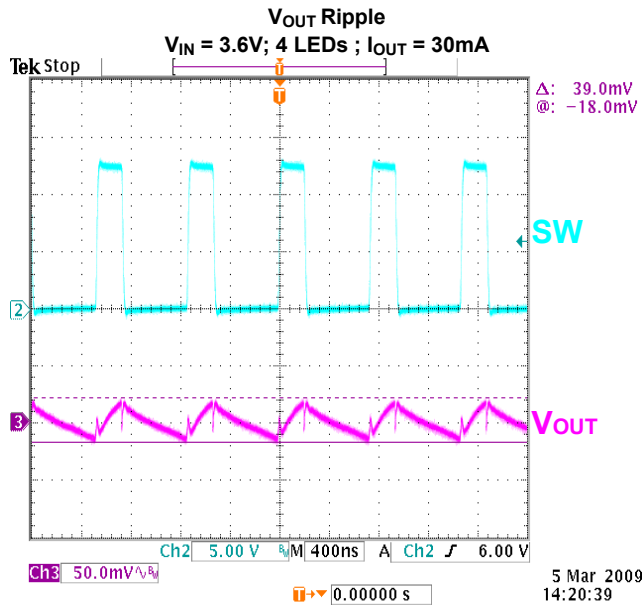
**Typical Performance Characteristics** (cont.) (6 LEDs,  $V_{IN} = 3.6V$ ,  $I_{OUT} = 25mA$ )



**Typical Performance Characteristics** (cont.) (6 LEDs,  $V_{IN} = 3.6V$ ,  $I_{OUT} = 25mA$ )



**Typical Performance Characteristics** (cont.) (6 LEDS,  $V_{IN} = 3.6V$ ,  $I_{OUT} = 25mA$ )







## Applications Information (cont.)

### Dimming Control

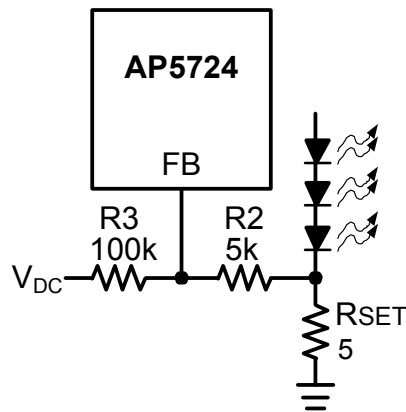
There are four different types of dimming control circuits:

#### 1. Using a PWM Signal to EN Pin

With the PWM signal applied to the EN pin, the AP5724 is turned on or off by the PWM signal. The LEDs operate at either zero or full current. The average LED current increases proportionally with the duty cycle of the PWM signal. A 0% duty cycle will turn off the AP5724 and corresponds to zero LED current. A 100% duty cycle corresponds to full current. The typical frequency range of the PWM signal is below 2 kHz.

#### 2. Using a DC Voltage

For some applications, the preferred method of brightness control is a variable DC voltage to adjust the LED current. The dimming control using a DC voltage is shown in **Figure 3**. As the DC voltage increases, the voltage drop on R2 increases and the voltage drop on R<sub>SET</sub> decreases. Thus, the LED current decreases. The selection of R2 and R3 will make the current from the variable DC source much smaller than the LED current and much larger than the FB pin bias current. For V<sub>DC</sub> range from 0V to 2V, the selection of resistors in **Figure 3** gives dimming control of LED current from 0mA to 20mA.



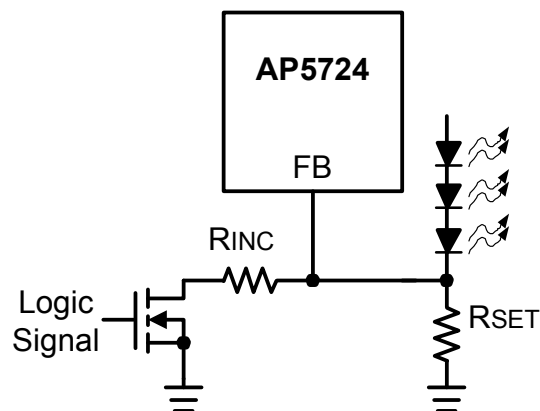
**Figure 3 Dimming Control Using a DC Voltage**

#### 3. Using a Filtered PWM Signal

The filtered PWM signal can be considered as an adjustable DC voltage. It can be used to replace the variable DC voltage source in dimming control.

#### 4. Using a Logic Signal

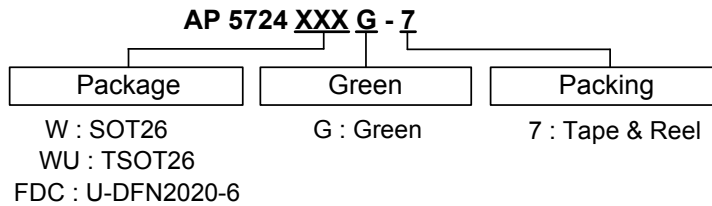
For applications that need to adjust the LED current in discrete steps, a logic signal can be used as shown in **Figure 4**. R<sub>SET</sub> sets the minimum LED current (when the NMOS is off). R<sub>SET</sub> sets how much the LED current increases when the NMOS is turned on.



**Figure 4 Dimming Control Using a Logic Signal**



## Ordering Information

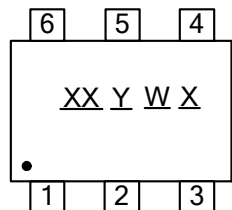


| Part Number  | Package Code | Packaging   | 7" Tape and Reel |                    |
|--------------|--------------|-------------|------------------|--------------------|
|              |              |             | Quantity         | Part Number Suffix |
| AP5724WG-7   | W            | SOT26       | 3000/Tape & Reel | -7                 |
| AP5724WUG-7  | WU           | TSOT26      | 3000/Tape & Reel | -7                 |
| AP5724FDCG-7 | FDC          | U-DFN2020-6 | 3000/Tape & Reel | -7                 |

## Marking Information

(1) SOT26 and TSOT26

( Top View )

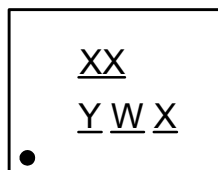


XX : Identification Code  
Y : Year 0~9  
W : Week : A~Z : 1~26 week;  
a~z : 27~52 week; z represents  
52 and 53 week  
X : A~Z : Green

| Part Number | Package | Identification Code |
|-------------|---------|---------------------|
| AP5724WG-7  | SOT26   | FB                  |
| AP5724WUG-7 | TSOT26  | GB                  |

(2) U-DFN2020-6

( Top View )



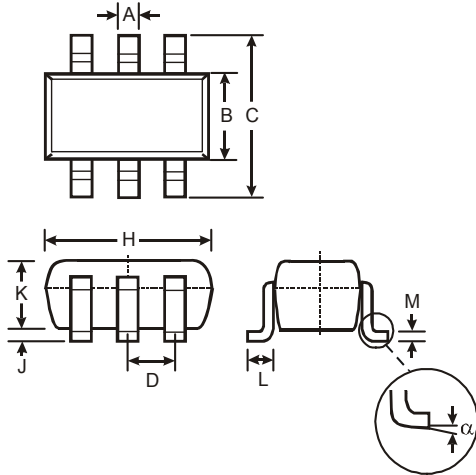
XX : Identification Code  
Y : Year : 0~9  
W : Week : A~Z : 1~26 week;  
a~z : 27~52 week; z represents  
52 and 53 week  
X : A~Z : Green

| Part Number  | Package     | Identification Code |
|--------------|-------------|---------------------|
| AP5724FDCG-7 | U-DFN2020-6 | GB                  |

**Package Outline Dimensions** (All dimensions in mm.)

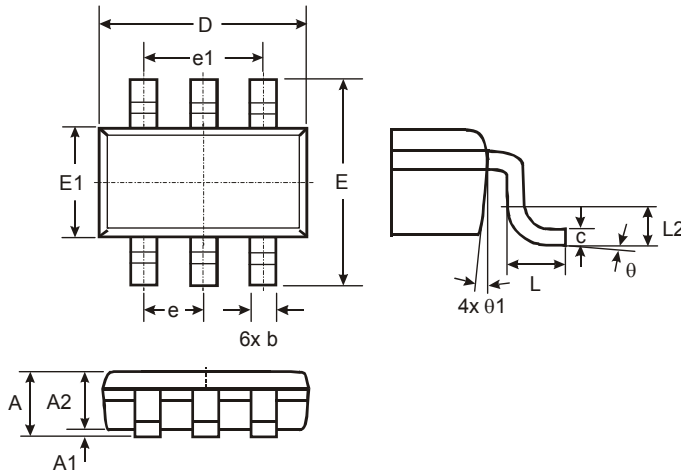
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

(1) SOT26



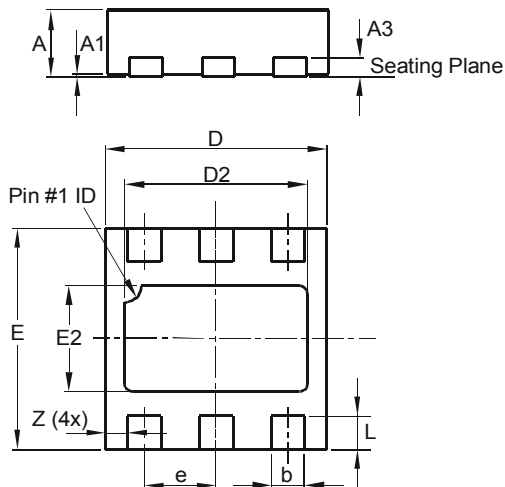
| SOT26                |       |      |      |
|----------------------|-------|------|------|
| Dim                  | Min   | Max  | Typ  |
| A                    | 0.35  | 0.50 | 0.38 |
| B                    | 1.50  | 1.70 | 1.60 |
| C                    | 2.70  | 3.00 | 2.80 |
| D                    | —     | —    | 0.95 |
| H                    | 2.90  | 3.10 | 3.00 |
| J                    | 0.013 | 0.10 | 0.05 |
| K                    | 1.00  | 1.30 | 1.10 |
| L                    | 0.35  | 0.55 | 0.40 |
| M                    | 0.10  | 0.20 | 0.15 |
| α                    | 0°    | 8°   | —    |
| All Dimensions in mm |       |      |      |

(2) TSOT26



| TSOT26               |      |      |      |
|----------------------|------|------|------|
| Dim                  | Min  | Max  | Typ  |
| A                    | —    | 1.00 | —    |
| A1                   | 0.01 | 0.10 | —    |
| A2                   | 0.84 | 0.90 | —    |
| D                    | —    | —    | 2.90 |
| E                    | —    | —    | 2.80 |
| E1                   | —    | —    | 1.60 |
| b                    | 0.30 | 0.45 | —    |
| c                    | 0.12 | 0.20 | —    |
| e                    | —    | —    | 0.95 |
| e1                   | —    | —    | 1.90 |
| L                    | 0.30 | 0.50 | —    |
| L2                   | —    | —    | 0.25 |
| θ                    | 0°   | 8°   | 4°   |
| θ1                   | 4°   | 12°  | —    |
| All Dimensions in mm |      |      |      |

(3) U-DFN2020-6 Type C

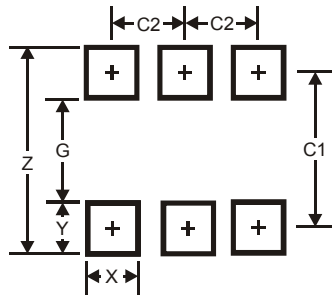


| U-DFN2020-6<br>Type C |      |       |      |
|-----------------------|------|-------|------|
| Dim                   | Min  | Max   | Typ  |
| A                     | 0.57 | 0.63  | 0.60 |
| A1                    | 0.00 | 0.05  | 0.02 |
| A3                    | —    | —     | 0.15 |
| b                     | 0.25 | 0.35  | 0.30 |
| D                     | 1.95 | 2.075 | 2.00 |
| D2                    | 1.55 | 1.75  | 1.65 |
| E                     | 1.95 | 2.075 | 2.00 |
| E2                    | 0.86 | 1.06  | 0.96 |
| e                     | —    | —     | 0.65 |
| L                     | 0.25 | 0.35  | 0.30 |
| Z                     | —    | —     | 0.20 |
| All Dimensions in mm  |      |       |      |

## Suggested Pad Layout

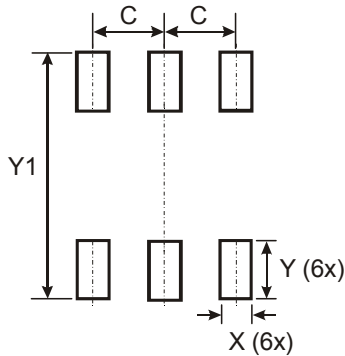
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

### (1) SOT26



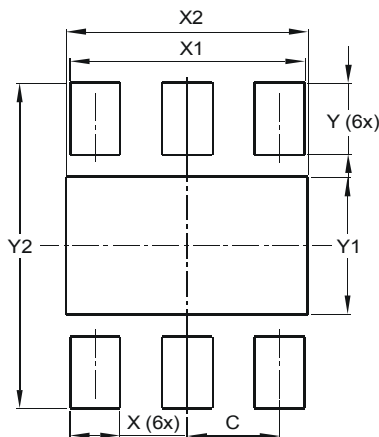
| Dimensions | Value (in mm) |
|------------|---------------|
| Z          | 3.20          |
| G          | 1.60          |
| X          | 0.55          |
| Y          | 0.80          |
| C1         | 2.40          |
| C2         | 0.95          |

### (2) TSOT26



| Dimensions | Value (in mm) |
|------------|---------------|
| C          | 0.950         |
| X          | 0.700         |
| Y          | 1.000         |
| Y1         | 3.199         |

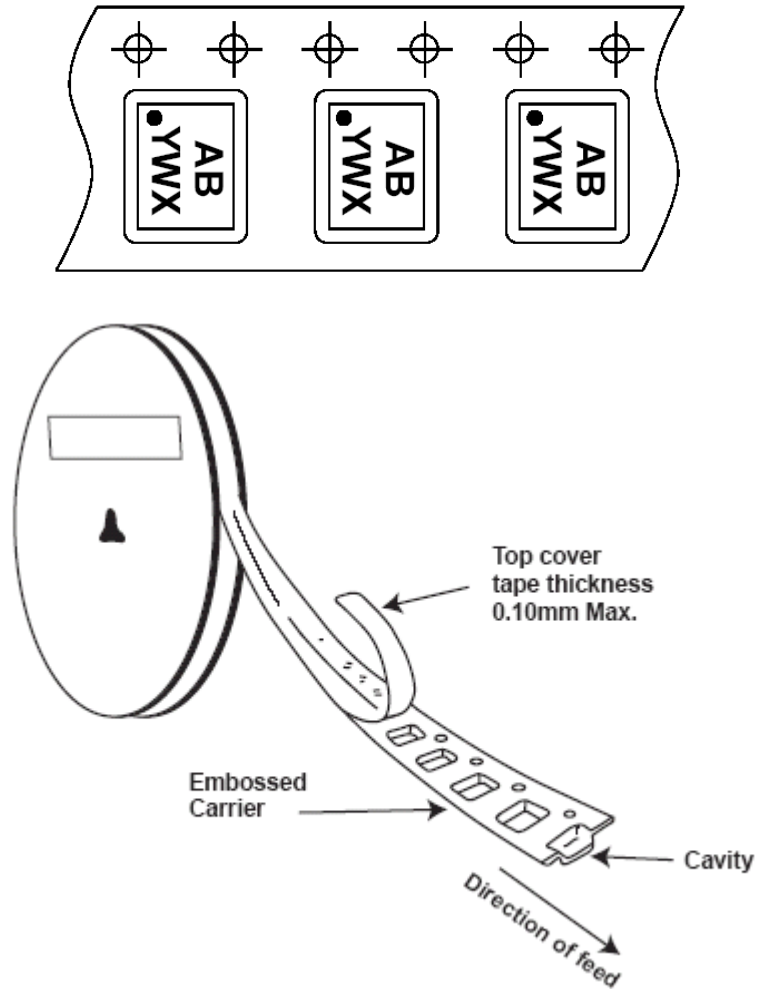
### (3) U-DFN2020-6 Type C



| Dimensions | Value (in mm) |
|------------|---------------|
| C          | 0.650         |
| X          | 0.350         |
| X1         | 1.650         |
| X2         | 1.700         |
| Y          | 0.525         |
| Y1         | 1.010         |
| Y2         | 2.400         |

## Tape Orientation

For U-DFN2020-6



Note: 4. The taping orientation of the other package type can be found on our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

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2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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