

Description

The AP3036/A is an inductor-based DC/DC converter designed to drive up to eight white LEDs in series for backlight. Only one feedback resistor is needed to control the LED current and obtain required brightness.

A constant frequency 1.0MHz PWM control scheme is employed in this IC, which means tiny external components can be used. Specifically, 1mm tall inductor and 0.22 μ F output capacitor for a typical application is sufficient. Additionally, the Schottky diode in boost circuit is integrated on this chip. The AP3036/A also provides a disable pin to ease its use for different systems.

The output over-voltage protection is implemented in AP3036/A. When any LED is broken or in other abnormal conditions, the output voltage will be clamped.

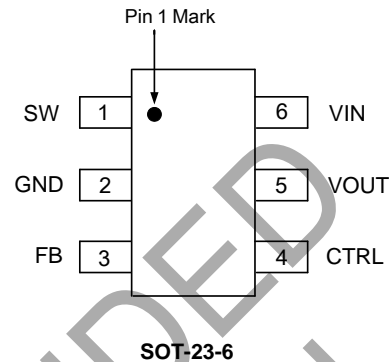
The AP3036/A is available in standard SOT-23-6 and TSOT-23-6 packages.

Features

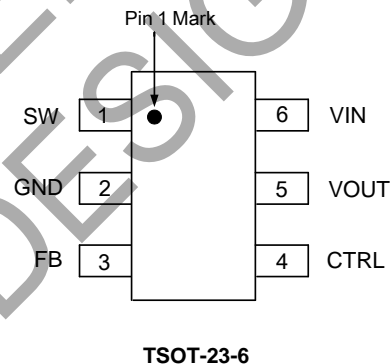
- Inherently Uniform LED Current
- High Efficiency up to 84%
- No Need for External Schottky Diode
- Output Over-voltage Protection (OVP)
- Fixed 1.0MHz Switching Frequency
- Uses Tiny 1mm Tall Inductor
- Requires Only 0.22 μ F Output Capacitor
- High Frequency Dimming Control

Pin Assignments

(Top View)



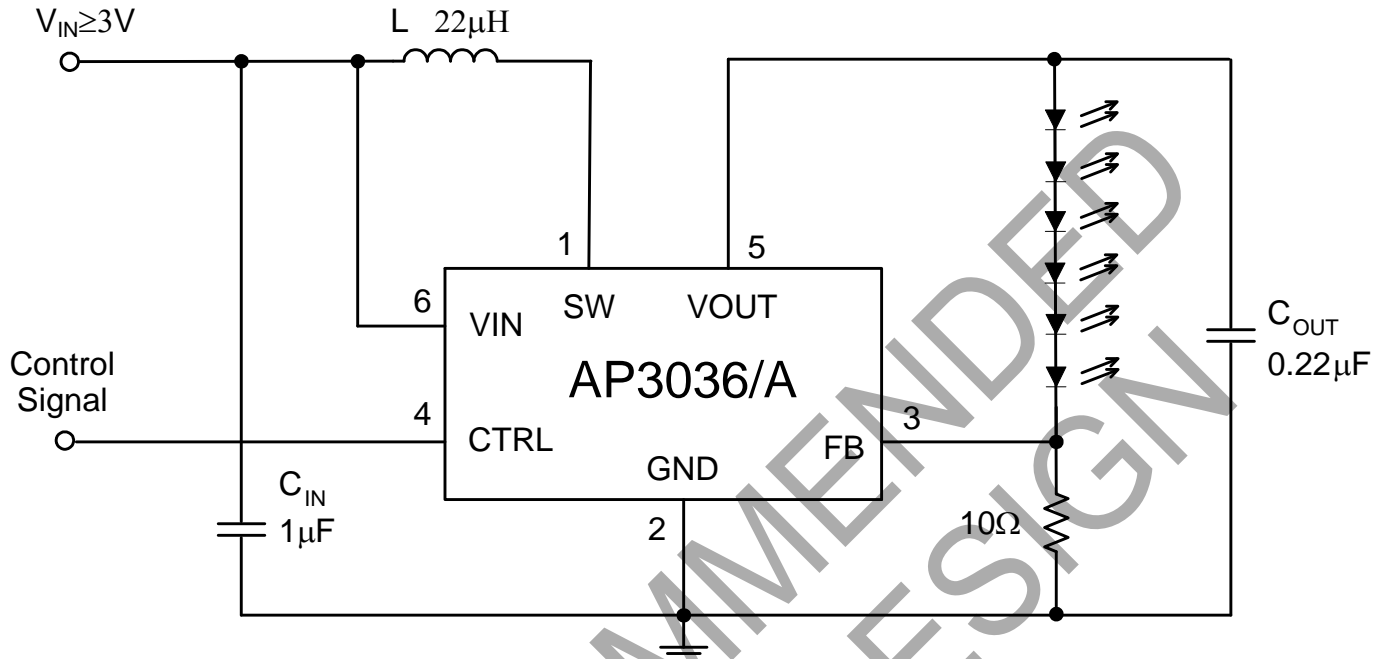
(Top View)



Applications

- Cellular Phones
- Digital Cameras
- LCD Modules
- GPS Receivers
- PDAs, Handheld Computers

Typical Applications Circuit (Note 1)

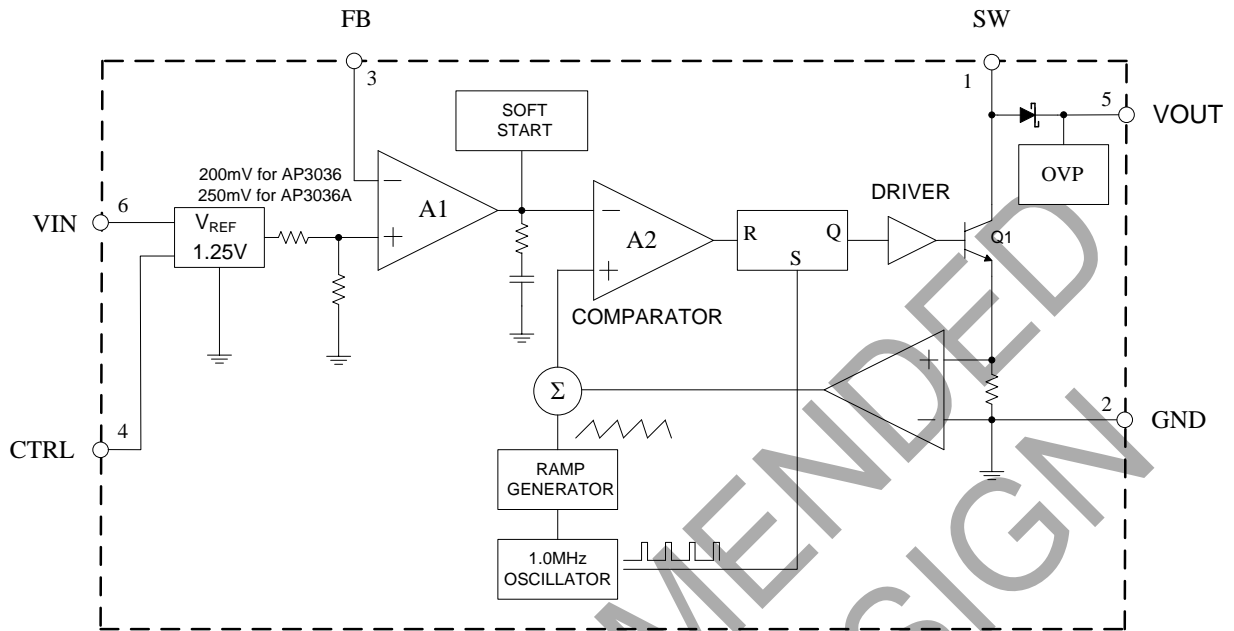


Note 1. C: X5R or X7R type dielectric, L: SUMIDA CDRH5D28R-220NC or equivalent. And, this circuit can work in full temperature.

Pin Description

| Pin Number | Pin Name | Function |
|------------|----------|---|
| 1 | SW | Switch pin. Connect external inductor |
| 2 | GND | Ground |
| 3 | FB | Voltage feedback pin. The reference voltage is 200mV for AP3036 and 250mV for AP3036A |
| 4 | CTRL | Shutdown and dimming pin. Connect to 1.8V or higher to enable device; Connect to 0.4V or less to disable device; Connect to a PWM signal to achieve LEDs brightness dimming |
| 5 | VOUT | Output pin. Connect to the cathode of internal Schottky diode |
| 6 | VIN | Input supply pin. Must be connected to a local bypass capacitor |

Functional Block Diagram



Absolute Maximum Ratings (Note 2)

| Symbol | Parameter | Rating | Unit |
|---------------|--|-------------|------|
| V_{IN} | Input Voltage | 20 | V |
| V_{SW} | SW Pin Voltage | 38 | V |
| V_{FB} | Feedback Voltage | 20 | V |
| V_{CTRL} | CTRL Pin Voltage | 20 | V |
| θ_{JA} | Thermal Resistance (Junction to Ambient, No Heat Sink) | 265 | °C/W |
| T_J | Operating Junction Temperature | +150 | °C |
| T_{STG} | Storage Temperature Range | -65 to +150 | °C |
| T_{LEAD} | Lead Temperature (Soldering, 10sec) | +260 | °C |
| — | ESD (Machine Model) | 250 | V |
| — | ESD (Human Body Model) | 2000 | V |

Note 2. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Unit |
|-------------------|-----------------------------|-----|-----|------|
| T _{OP} | Operating Temperature Range | -40 | +85 | °C |
| V _{IN} | Input Voltage | 2.5 | 16 | V |
| V _{CTRL} | CTRL Pin Voltage | - | 16 | V |

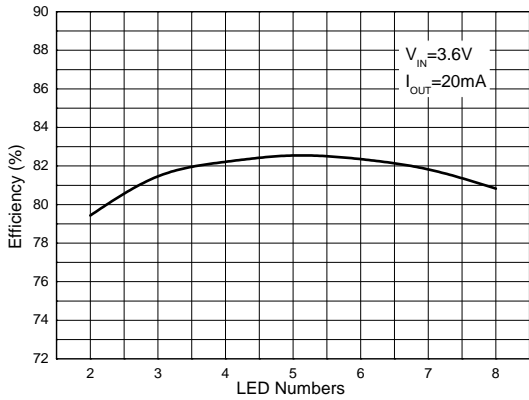
Electrical Characteristics (@V_{IN}=3V, V_{CTRL}=3V, T_A=+25°C, unless otherwise specified.)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------------|---|---|-----|------|-----|------|
| V _{IN} (Min) | Minimum Operating Voltage | - | 2.5 | - | - | V |
| V _{IN} (Max) | Maximum Operating Voltage | - | - | - | 16 | V |
| V _{FB} | Feedback Voltage | I _{OUT} =20mA, 4 LEDs | 188 | 200 | 212 | mV |
| | | | 235 | 250 | 265 | |
| I _{FB} | FB Pin Bias Current | - | - | 35 | 100 | nA |
| I _Q | Quiescent Current | V _{FB} =V _{IN} , no switching | 1.6 | 3.1 | 3.9 | mA |
| I _{SHDN} | Shutdown Quiescent Current | V _{CTRL} =0V | - | 45 | 75 | μA |
| f | Switching Frequency | - | - | 1.0 | - | MHz |
| D _{MAX} | Maximum Duty Cycle | - | 90 | 93 | - | % |
| I _{LIMIT} | Switch Current Limit (Note 3) | D=40% or 80% | - | 550 | - | mA |
| V _{CESAT} | Switch V _{CE} Saturation Voltage | I _{SW} =250mA | - | 360 | - | mV |
| - | Switch Leakage Current | V _{SW} =5V | - | 0.01 | 5 | μA |
| V _{CTRL} | CTRL Pin Voltage | High | 1.8 | - | - | V |
| | | low | - | - | 0.4 | |
| I _{CTRL} | CTRL Pin Bias Current | - | - | 100 | - | μA |
| V _{OV} | OVP Voltage | - | - | 30 | - | V |
| V _{DROP} | Schottky Forward Drop | I _D =150mA | - | 0.7 | - | V |
| - | Schottky Leakage Current | V _R (Reverse Voltage)=23V | - | 0.1 | 4 | μA |
| | | V _R (Reverse Voltage)=27V | - | - | 150 | |
| t | Soft Start Time | - | - | 100 | - | μs |
| θ _{JC} | Thermal Resistance (Junction to Case) | SOT-23-6 | - | 60 | - | °C/W |
| | | TSOT-23-6 | - | 60 | - | |

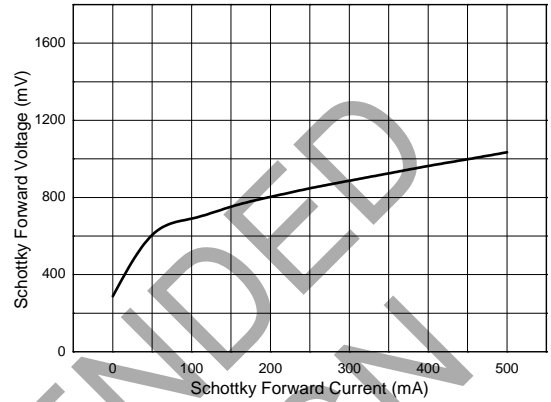
Note 3: The switch current limit is related to duty cycle. Please refer to Figure **LED Current vs. Duty** for detail.

Performance Characteristics (The WLED forward voltage (V_F) is 3.45V at $I_F=20mA$, unless otherwise noted.)

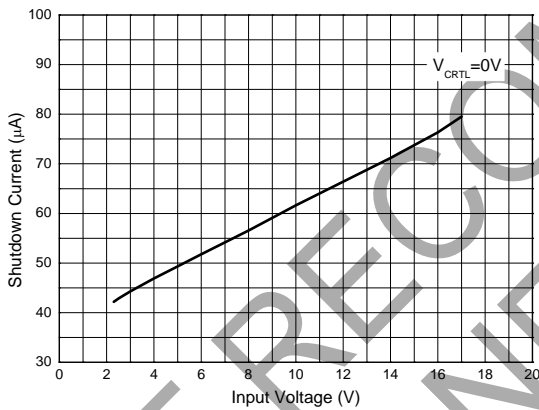
Efficiency vs. LED's Number



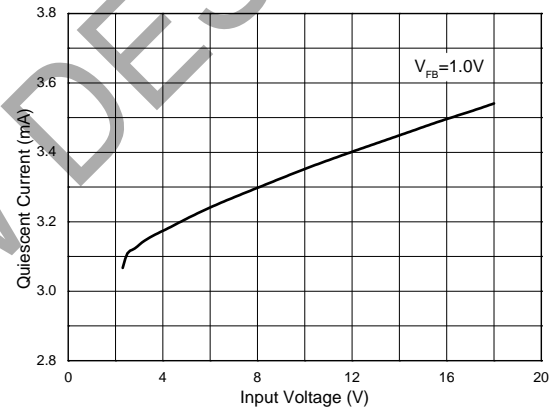
Schottky Forward Voltage vs. Schottky Forward Current



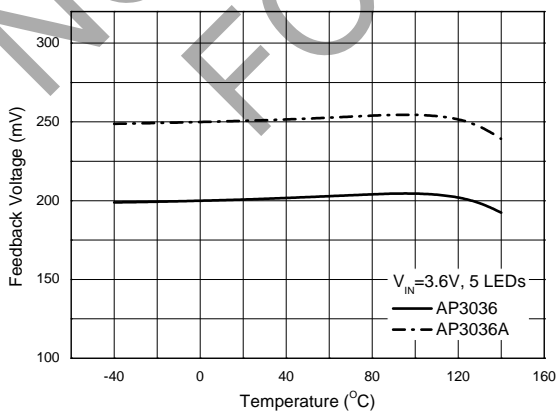
Shutdown Current vs. Input Voltage



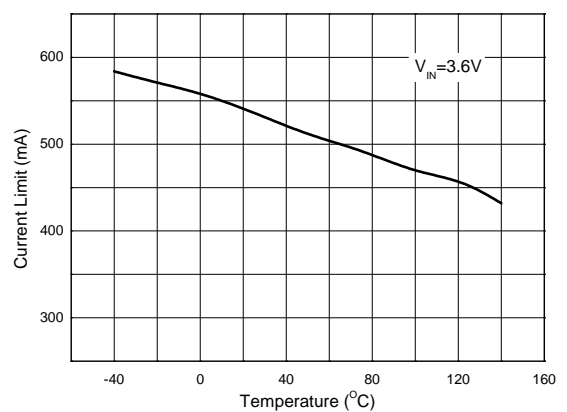
Quiescent Current vs. Input Voltage



Feedback Voltage vs. Temperature

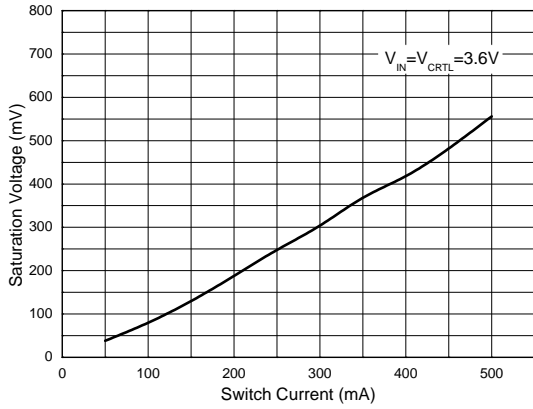


Current Limit vs. Temperature

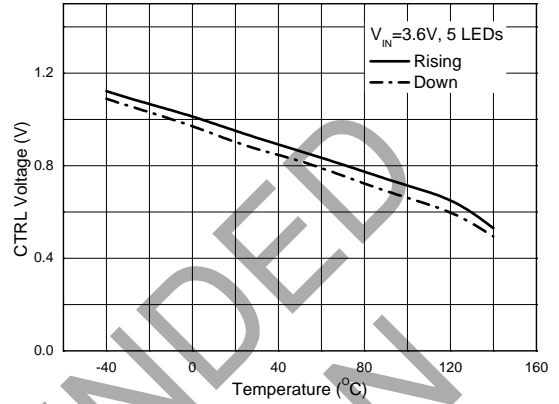


Performance Characteristics (The WLED forward voltage (V_F) is 3.45V at $I_F=20mA$, unless otherwise noted.) (Cont.)

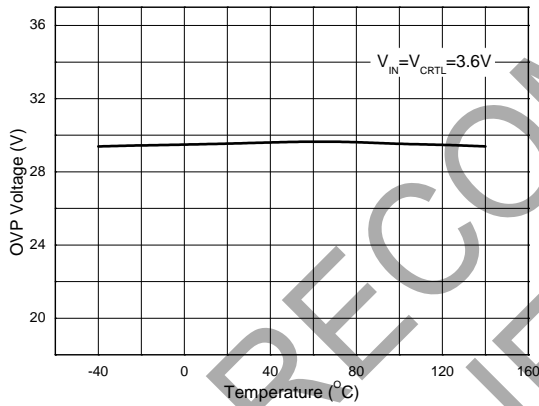
Saturation Voltage vs. Switch Current



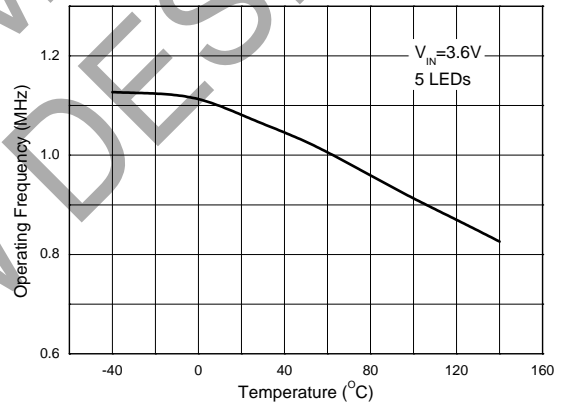
CTRL Pin Voltage vs. Temperature



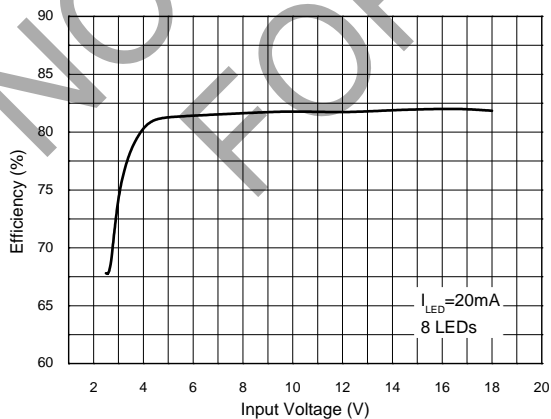
OVP Voltage vs. Temperature



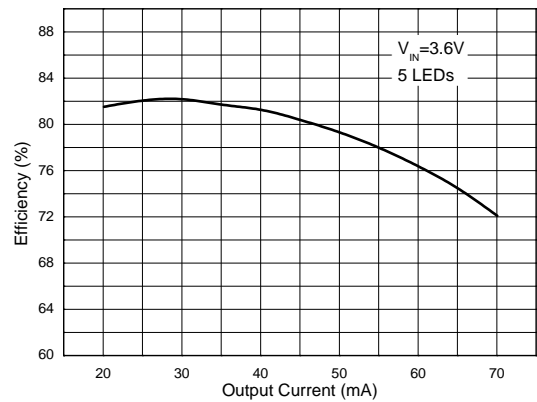
Operating Frequency vs. Temperature



Efficiency vs. Input Voltage

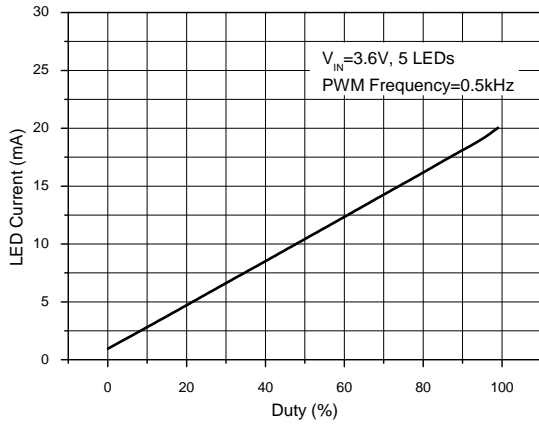


Efficiency vs. Output Current

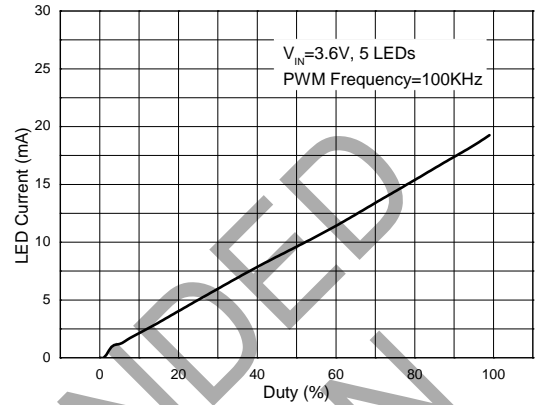


Performance Characteristics (The WLED forward voltage (V_F) is 3.45V at $I_F=20\text{mA}$, unless otherwise noted.) (Cont.)

LED Current vs. Duty

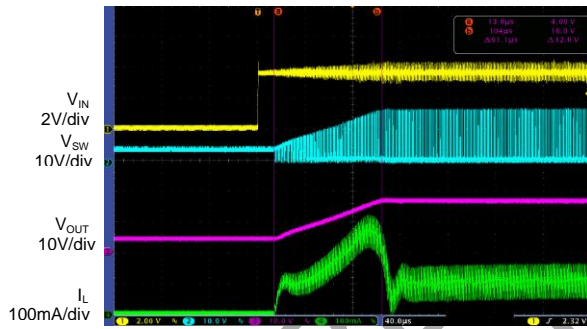


LED Current vs. Duty



Powering On

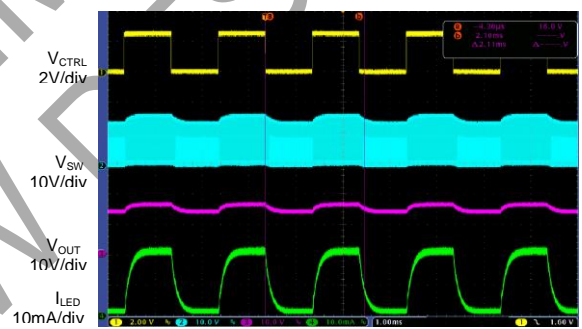
($V_{IN}=3.6\text{V}$, $V_{CTRL}=2.5\text{V}$, $I_{LED}=20\text{mA}$, 5 LEDs)



Time 40 $\mu\text{s}/\text{div}$

PWM Dimming

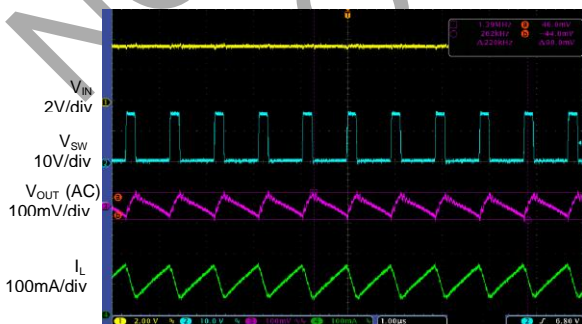
($V_{IN}=3.6\text{V}$, $V_{PWM}=2.5\text{V}$, $f_{PWM}=0.5\text{kHz}$, Duty=50%, 5 LEDs)



Time 10ms/div

Output Voltage Ripple

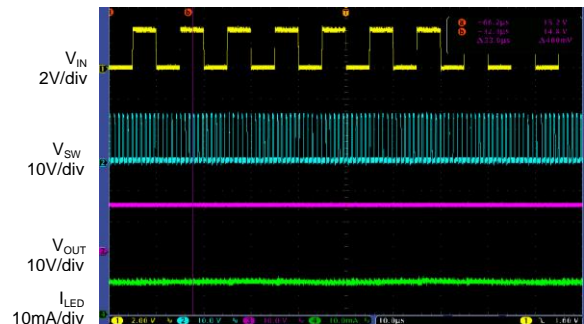
($V_{IN}=V_{CTRL}=3.6\text{V}$, $I_{LED}=20\text{mA}$, 5 LEDs)



Time 1 $\mu\text{s}/\text{div}$

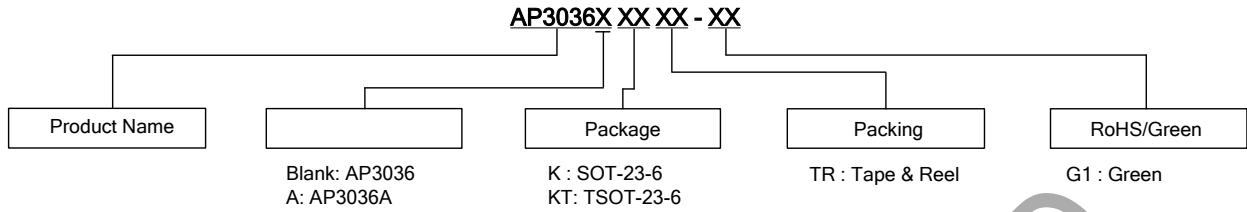
PWM Dimming

($V_{IN}=3.6\text{V}$, $V_{PWM}=2.5\text{V}$, $f_{PWM}=100\text{kHz}$, Duty=50%, 5 LEDs)



Time 10 $\mu\text{s}/\text{div}$

Ordering Information

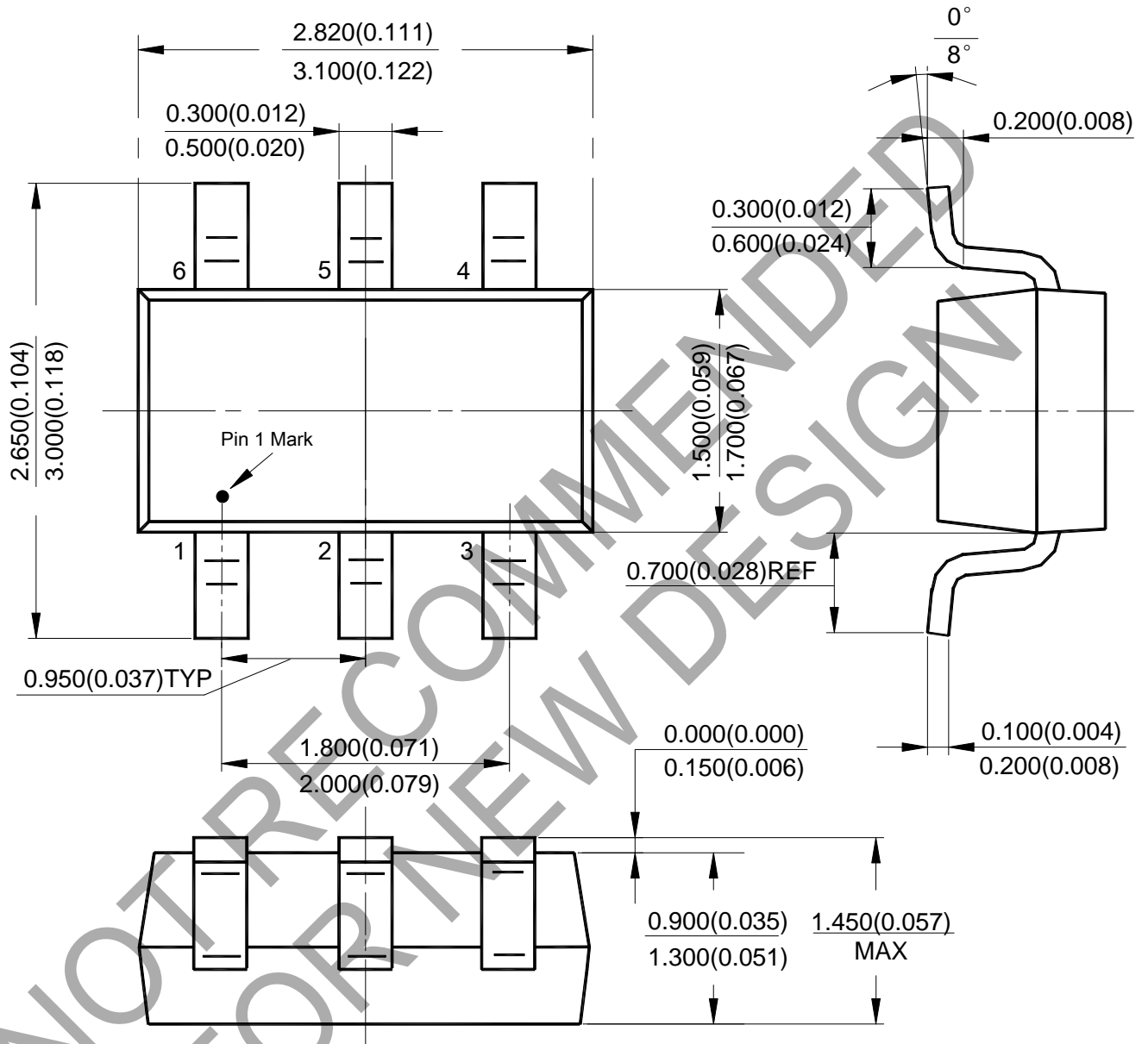


| Package | Temperature Range | Part Number | Marking ID | Packing Type |
|-----------|-------------------|----------------|------------|--------------|
| SOT-23-6 | -40 to +85°C | AP3036KTR-G1 | GHI | Tape & Reel |
| | | AP3036AKTR-G1 | GJE | Tape & Reel |
| TSOT-23-6 | | AP3036KTTR-G1 | L2C | Tape & Reel |
| | | AP3036AKTTR-G1 | L3C | Tape & Reel |

NOT RECOMMENDED FOR NEW DESIGN

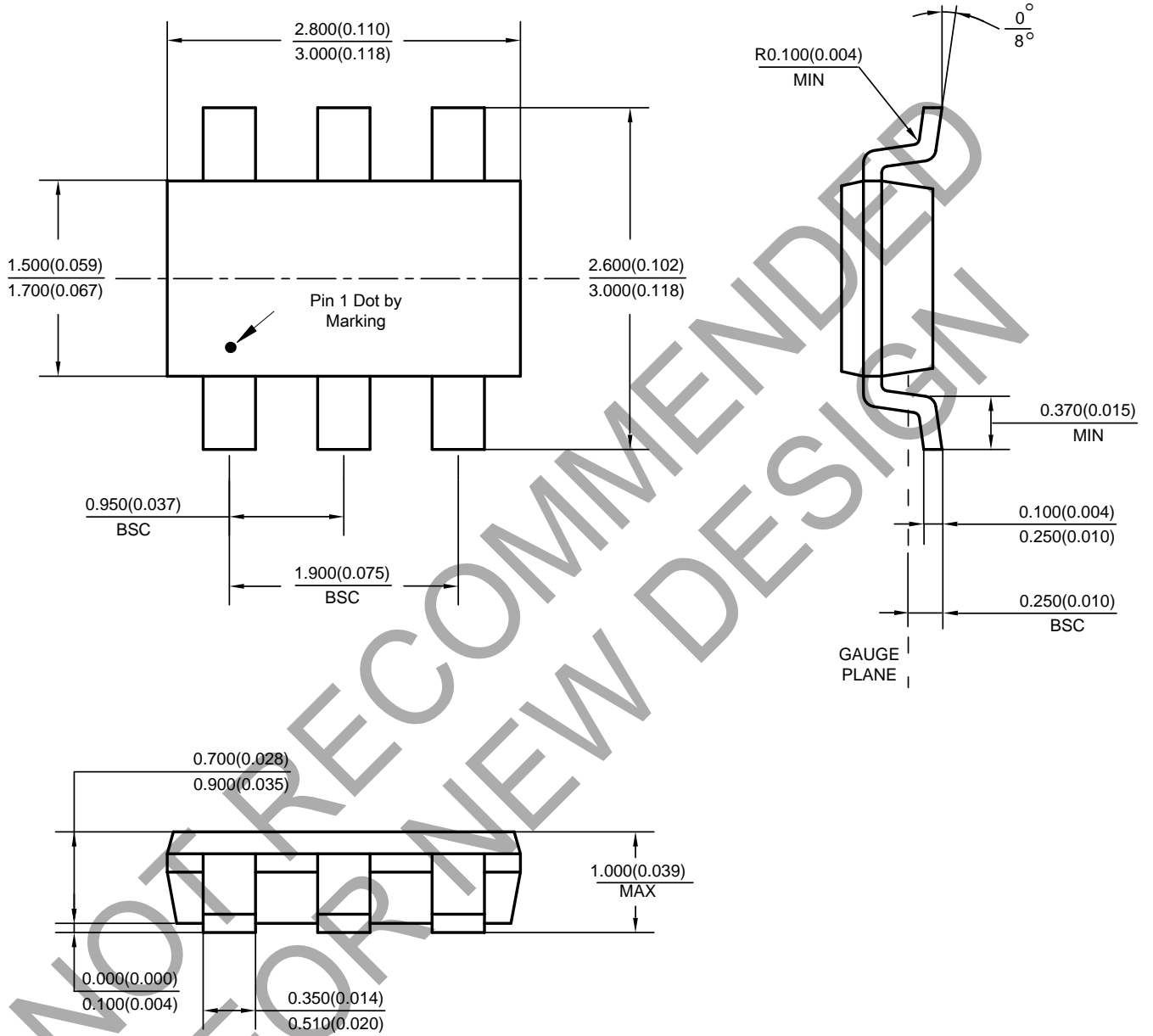
Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: SOT-23-6



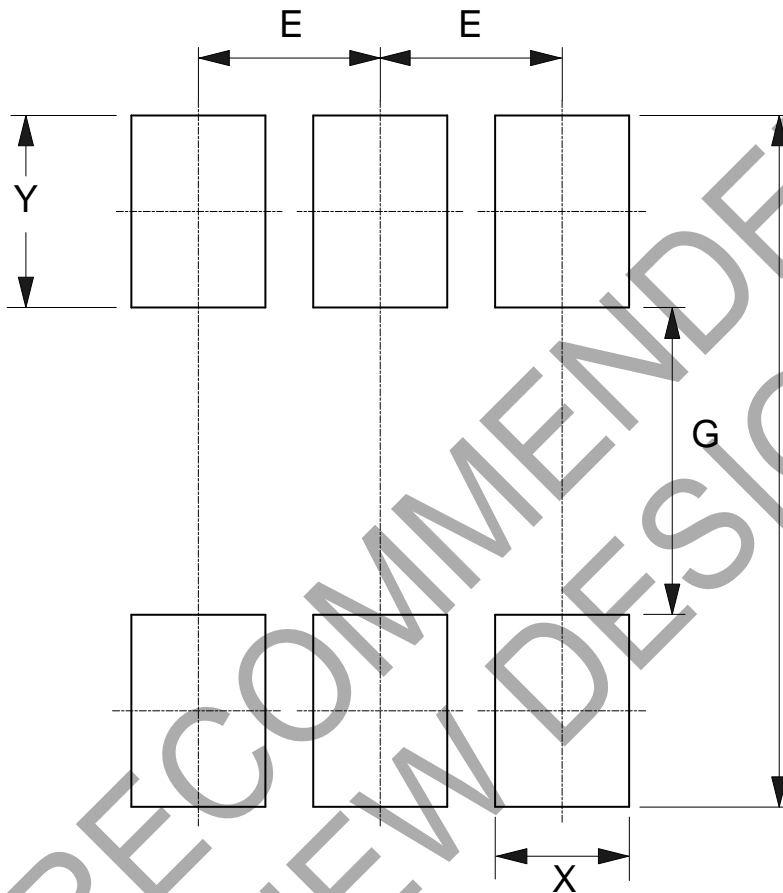
Package Outline Dimensions (All dimensions in mm(inch).) (Cont.)

(2) Package Type: TSOT-23-6



Suggested Pad Layout

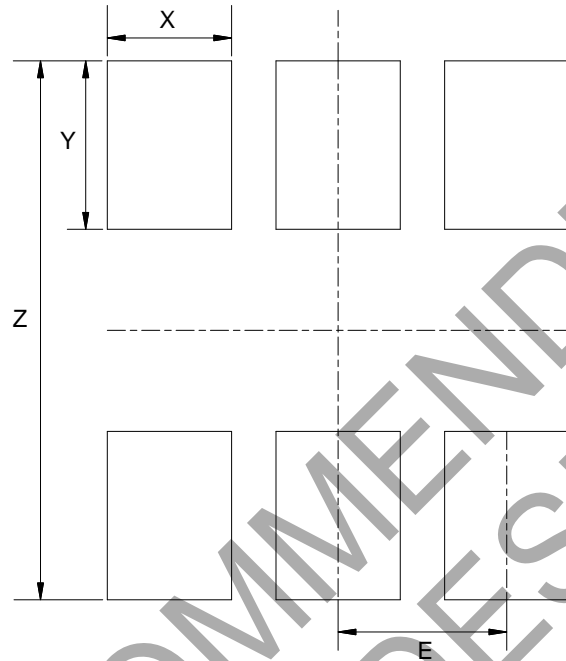
(1) Package Type: SOT-23-6



| Dimensions | Z (mm)/(inch) | G (mm)/(inch) | X (mm)/(inch) | Y (mm)/(inch) | E (mm)/(inch) |
|------------|------------------|------------------|------------------|------------------|------------------|
| Value | 3.600/0.142 | 1.600/0.063 | 0.700/0.028 | 1.000/0.039 | 0.950/0.037 |

Suggested Pad Layout (Cont.)

(2) Package Type: TSOT-23-6



| Dimensions | E (mm)/(inch) | X (mm)/(inch) | Y (mm)/(inch) | Z (mm)/(inch) |
|------------|------------------|------------------|------------------|------------------|
| Value | 0.950/0.037 | 0.700/0.028 | 1.000/0.039 | 3.199/0.126 |

NOT RECOMMENDED FOR NEW DESIGN

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel. Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
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.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2018, Diodes Incorporated

www.diodes.com