

1.9A Fixed Frequency White LED Driver

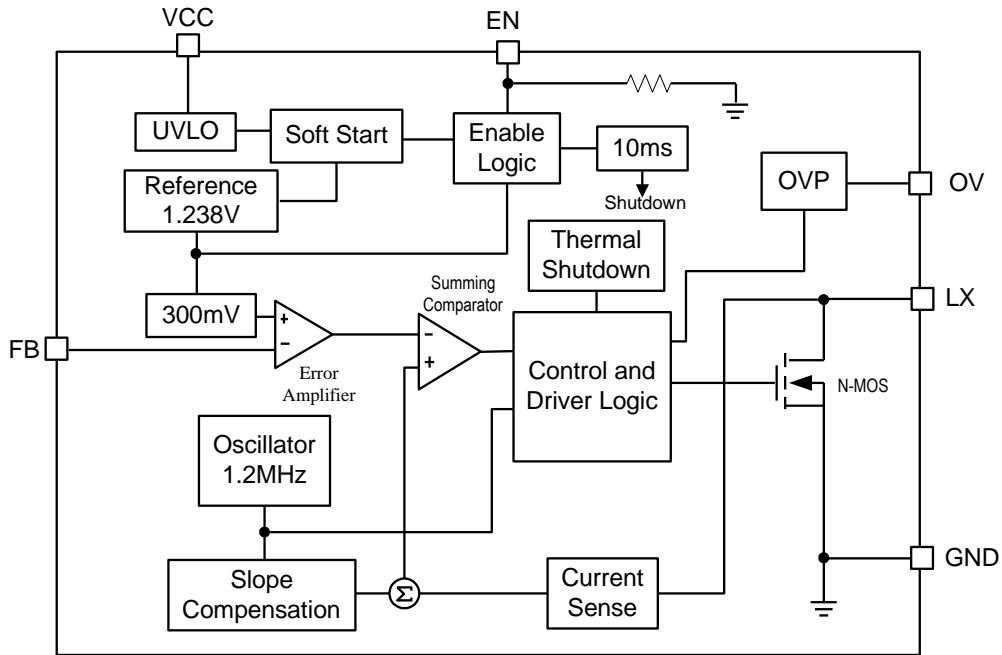
❖ GENERAL DESCRIPTION

The AX2012 is a step-up converter designed for driving up to 8 series white LEDs for backlighting application. The AX2012 uses current mode, 1.2MHz fixed frequency architecture to regulate the LED current, which is set through an external current sense resistor. Its low 300mV feedback voltage reduces power loss and improves efficiency. The OV pin monitors the output voltage and turns off the converter if an over-voltage condition is present due to an open circuit condition. The AX2012 includes under-voltage lockout, current limiting and thermal shutdown protection preventing damage in the event of an output overload. The driver is available in small 6-pin TSOT-23 and 8-pin TDFN (2mm x 2mm) packages.

❖ FEATURES

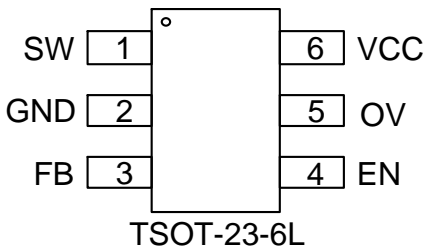
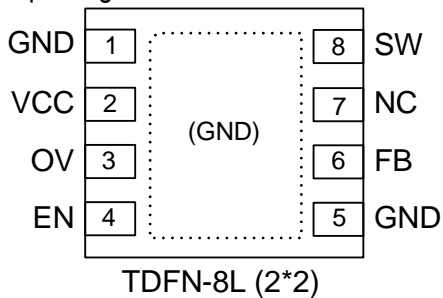
- 2.5V to 5.5 V operating input voltage range
- Drives up to 8 series White LEDs
- 1.2MHz Fixed Switching Frequency
- Wide range for PWM dimming (200Hz to 200KHz)
- Internal 1.9A switching current limit
- Over Voltage Protection (OVP)
- Internal Soft-start Function
- Current limit and Thermal shutdown protection
- Under voltage Lockout
- Available in the 6-pin TSOT-23 and 8-pin TDFN Packages

❖ BLOCK DIAGRAM



❖ PIN ASSIGNMENT

The packages of AX2012 are TSOT-23-6L and TDFN-8L; the pin assignment is given by:



| Name | Description |
|------------|---------------------------------------------------------------|
| GND | Ground Pin |
| VCC | Power Input Pin |
| OV | OVP Sense Pin |
| EN | Enable with Dimming Pin; Internal Pull-Low; Logic High Active |
| FB | Feedback Pin; Put a Resistor to GND to Setting the Current |
| NC | No Connect Pin |
| SW | Switch Output Pin |

❖ **ORDER/MARKING INFORMATION**

| Order Information | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>AX2012 XX X</p> <p>Package Type Packing CT: TSOT-23-6L Blank : Bag Z8: TDFN-8L (2*2) A : Taping</p> | |
| Top Marking (TSOT-23-6L) | Top Marking (TDFN-8L) |
| <p>J A Y W X → ID Code: Internal Week: 01~26(A~Z) 27~52(a~z) Year : A = 2010 1 = 2011 ⋮ 9 = 2019</p> <p>AX2012</p> | <p>J A → AX2012 Y W X → ID Code: Internal Week: 01~26(A~Z) 27~52(a~z) Year : A = 2010 1 = 2011 ⋮ 9 = 2019</p> |

❖ **ABSOLUTE MAXIMUM RATINGS** (at T_A=25°C)

| Characteristics | Symbol | Rating | Unit |
|---------------------------------------------|-----------------|-----------------------------------------------------|------|
| V _{CC} Pin Voltage | V _{CC} | GND - 0.3 to GND + 6 | V |
| EN,FB, OV Pin Voltage | | GND - 0.3 to V _{CC} + 0.3 | V |
| SW, OV Pin Voltage | V _{SW} | 30 | V |
| Power Dissipation | PD | (T _J -T _A) / θ _{JA} | mW |
| Storage Temperature Range | T _{ST} | -65 to +150 | °C |
| Operating Junction Temperature Range | T _{OP} | -40 to +125 | °C |
| Thermal Resistance from Junction to case | TSOT-23-6L | 180 | °C/W |
| | TDFN-8L | 25 | |
| Thermal Resistance from Junction to ambient | TSOT-23-6L | 250 | °C/W |
| | TDFN-8L | 120 | |

Note: θ_{JA} is measured with the PCB copper area of approximately 1 in²(Multi-layer).

❖ ELECTRICAL CHARACTERISTICS

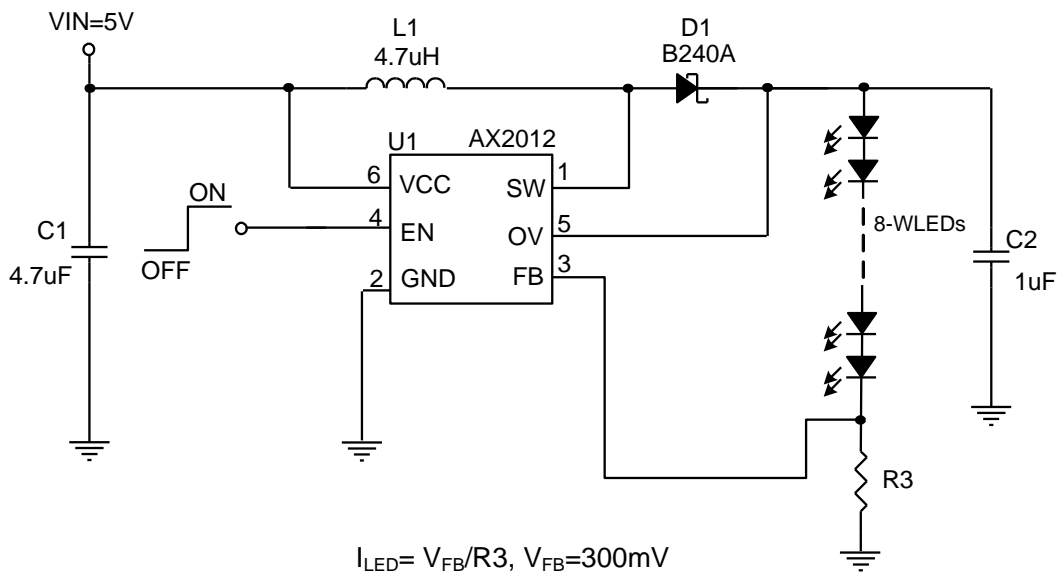
($V_{CC}=5V$, $I_{OUT} = 20mA$, $T_A = 25^{\circ}C$, unless otherwise noted)

| Characteristics | | Symbol | Conditions | Min | Typ | Max | Units |
|----------------------------------------|--------------------|---------------|---------------------------------|------|------|------|-------------|
| Input Voltage Range | | V_{CC} | | 2.5 | - | 5.5 | V |
| Step-Up Voltage Range | | V_{OUT} | | 3 | - | 27 | V |
| OV Sense Voltage | | V_{OV} | | 27.5 | 29 | 30.5 | V |
| Under Voltage Lockout | | U_{VLO} | Rising | - | 2.25 | 2.45 | V |
| UVLO Hysteresis | | | | - | 100 | - | mV |
| Feedback Voltage | | V_{FB} | | 285 | 300 | 315 | mV |
| EN Threshold | Logic-High Voltage | V_{IH} | | 1.4 | - | - | V |
| | Logic-Low Voltage | V_{IL} | | - | - | 0.4 | V |
| EN Hysteresis | | | | - | 200 | - | mV |
| Operating Quiescent Current | | I_{CCQ} | $I_{OUT}= 0mA$, $V_{FB} =0.5V$ | - | 170 | - | μA |
| Shutdown Current | | I_{SD} | $V_{EN}=0V$, $t_{EN} > 20ms$ | - | - | 1 | μA |
| N-Channel MOSFET Current Limit (Note1) | | I_{LIM} | Duty=50% | - | 1.9 | - | A |
| MOSFET On-Resistance (Note1) | | $R_{DS(on)}$ | $V_{CC}=3V$, $I_{SW}=1A$ | - | 0.6 | - | Ω |
| | | | $V_{CC}=5V$, $I_{SW}=1A$ | - | 0.45 | - | |
| Maximum Duty Cycle | | D_{MAX} | | 85 | 90 | - | % |
| Line Regulation | | | $V_{CC} = 3V$ to $5V$ | - | 1 | - | % |
| Switching Frequency | | F_{OSC} | | 0.9 | 1.2 | 1.5 | MHz |
| Dimming Clock Rate | | F_{DIM} | | 0.2 | - | 200 | KHz |
| FB Input Leakage Current | | I_{FB-LKG} | $V_{FB} = 0.5V$ | - | 0.01 | 100 | nA |
| SW Leakage Current | | I_{SWL} | $V_{sw} = 27V$, $V_{FB} =0.5V$ | - | - | 1 | μA |
| EN Input Leakage Current | | $I_{EN-LKG1}$ | $V_{EN}= V_{CC}$ | - | 1.5 | 3 | μA |
| | | $I_{EN-LKG2}$ | $V_{EN}= GND$ | - | 0.01 | 0.1 | μA |
| Shutdown Delay | | T_{SHDN} | | - | 10 | - | mS |
| Thermal Shutdown | | T_{SD} | | - | 150 | - | $^{\circ}C$ |
| Thermal Shutdown Hysteresis | | T_{SH} | | - | 30 | - | |

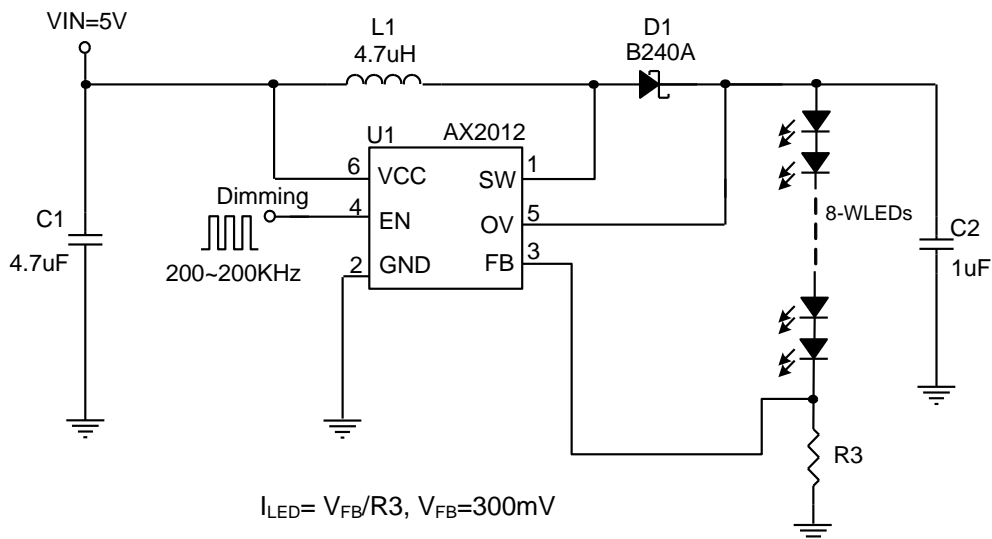
Note1: Guaranteed by design.

❖ APPLICATION CIRCUIT

(1) 8 series LED application



(2) LED Dimming application



❖ **APPLICATION INFORMATION**

Setting the I_{LED} Current

Application circuit item shows the basic application circuit with AX2012 adjustable output version. The external resistor sets the LED output current according to the following equation:

$$I_{LED} = \left(\frac{300mV}{R3} \right)$$

| I _{LED} | R3 | |
|------------------|--------|-------|
| 20mA | 15Ω | 6mW |
| 350mA | 0.857Ω | 105mW |

Over Voltage Protection

OV measure the output voltage for open circuit protection. Connect OV pin to the output at the top of the LED string. If V_{OUT} above 29V, the OVP protection is happened that stops the internal driver until V_{OUT} below 29V.

Under Voltage Lockout (UVLO)

To avoid mis-operation of the device at low input voltages an under voltage lockout is included that disables the device, if the input voltage falls below (2.25V-100mV).

Input Capacitor Selection

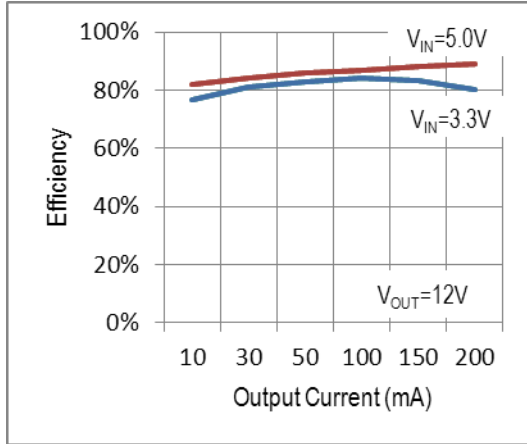
The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency shall be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 4.7μF ceramic capacitor for most applications is sufficient. For a lower output power requirement application, this value can be decreased.

Output Capacitor Selection

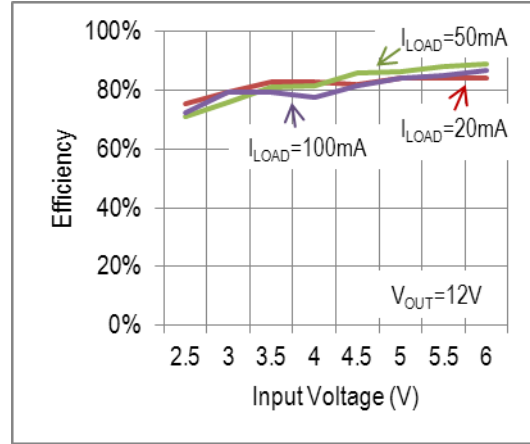
The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current. A 1uF ceramic capacitors works for most of the applications. Higher capacitor values can be used to improve the load transient response.

❖ TYPICAL CHARACTERISTICS

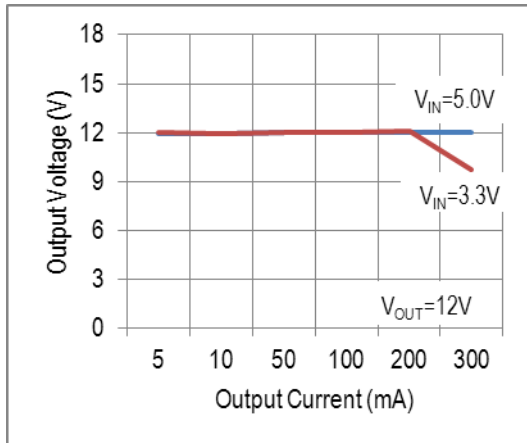
Efficiency vs. Output Current



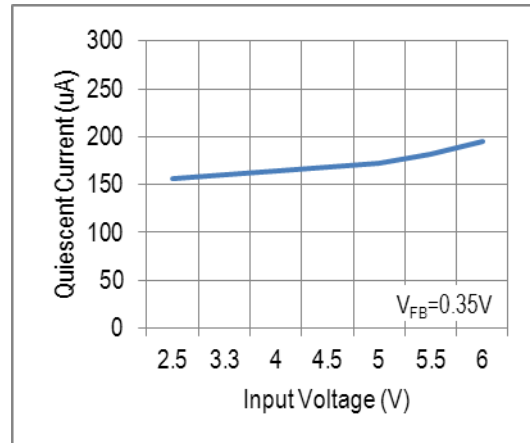
Efficiency vs. Input Voltage



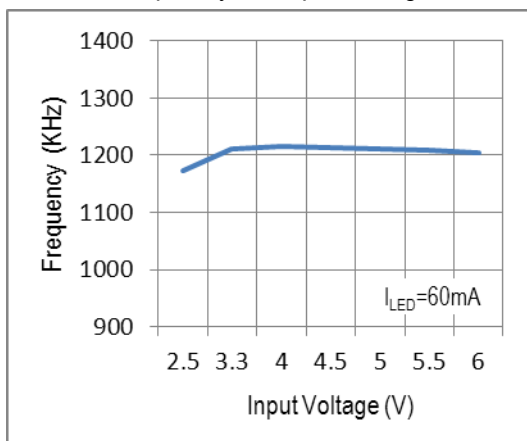
Output Voltage vs. Output Current



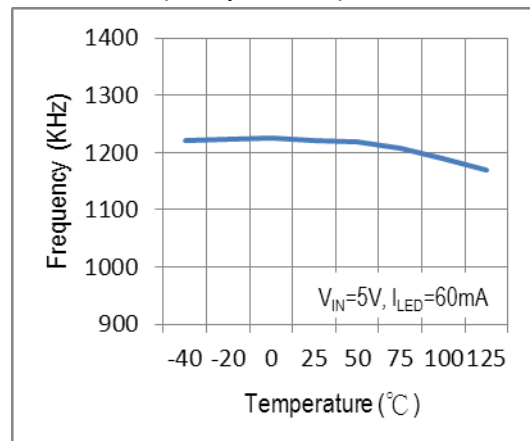
Quiescent Current vs. Input Voltage



Frequency vs. Input Voltage

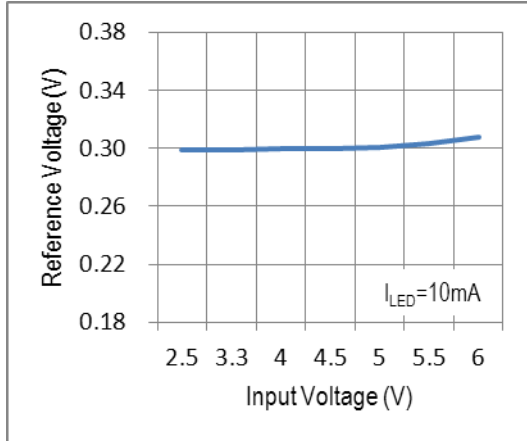


Frequency vs. Temperature

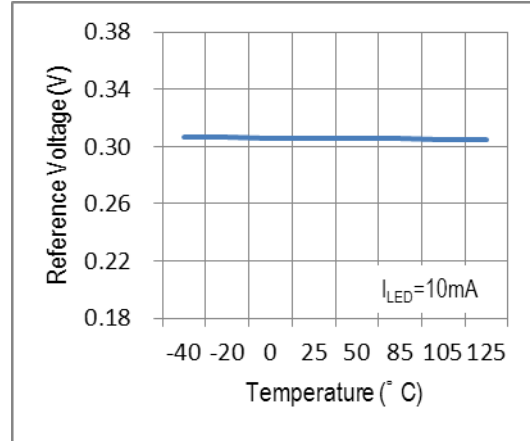


❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

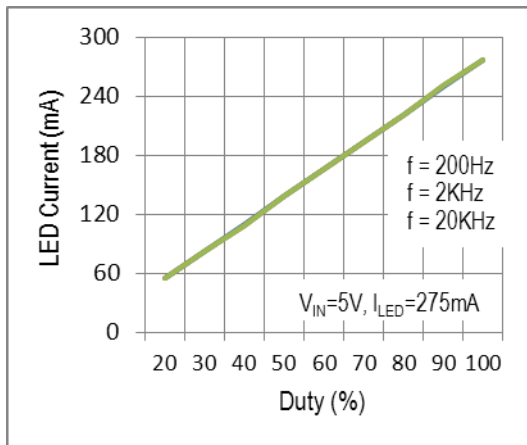
Reference Voltage vs. Input Voltage



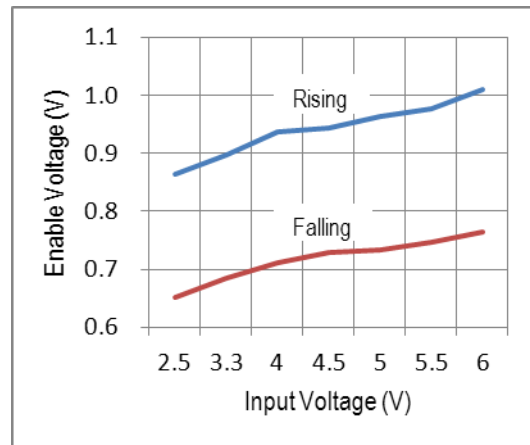
Reference Voltage vs. Temperature



LED Current vs. Duty

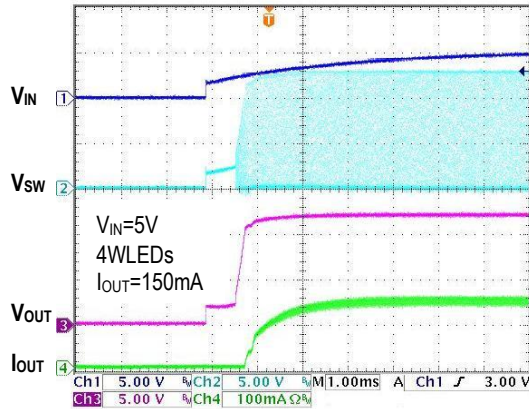


Enable Threshold vs. Input Voltage

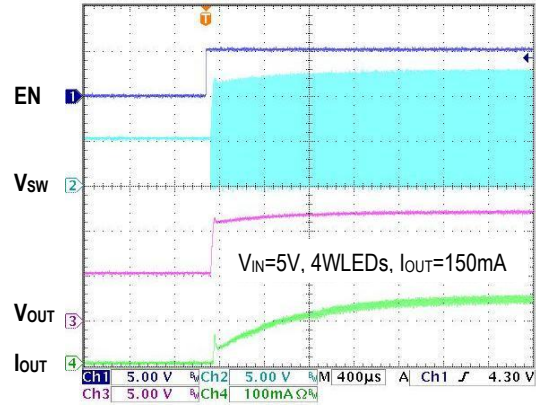


❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

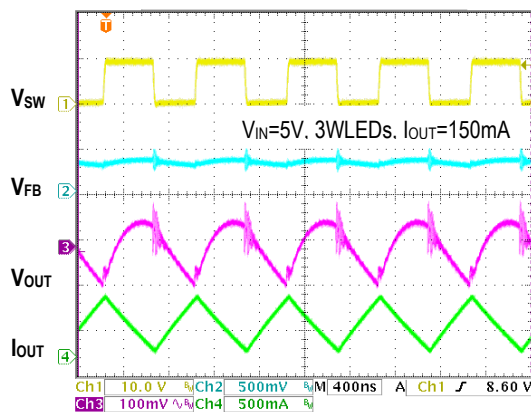
Power ON from V_{IN}



Power ON from EN

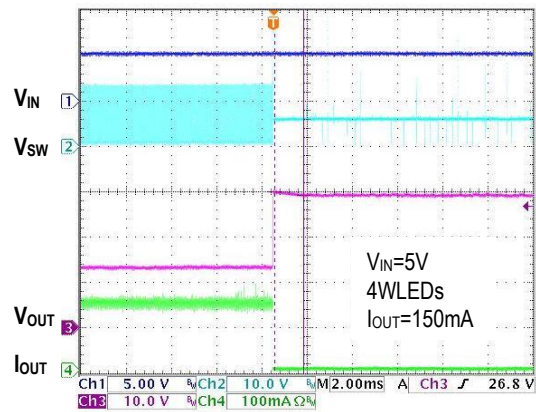


Steady State Operation

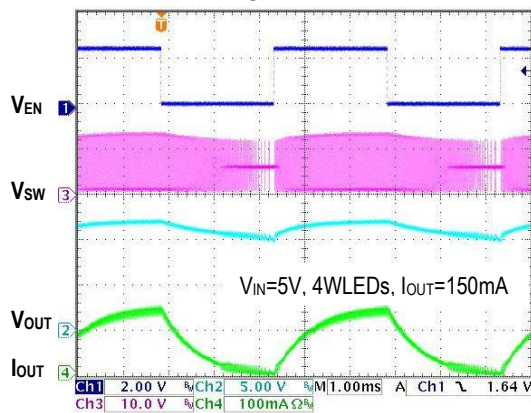


(V_{OUT} , I_{OUT} : measured by AC coupled mode)

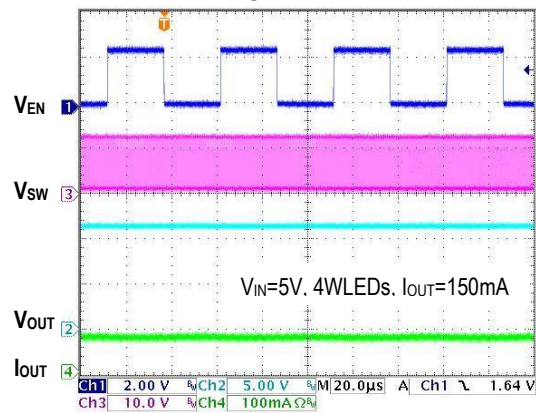
Normal Operation into OVP



PWM Dimming from EN (200Hz)

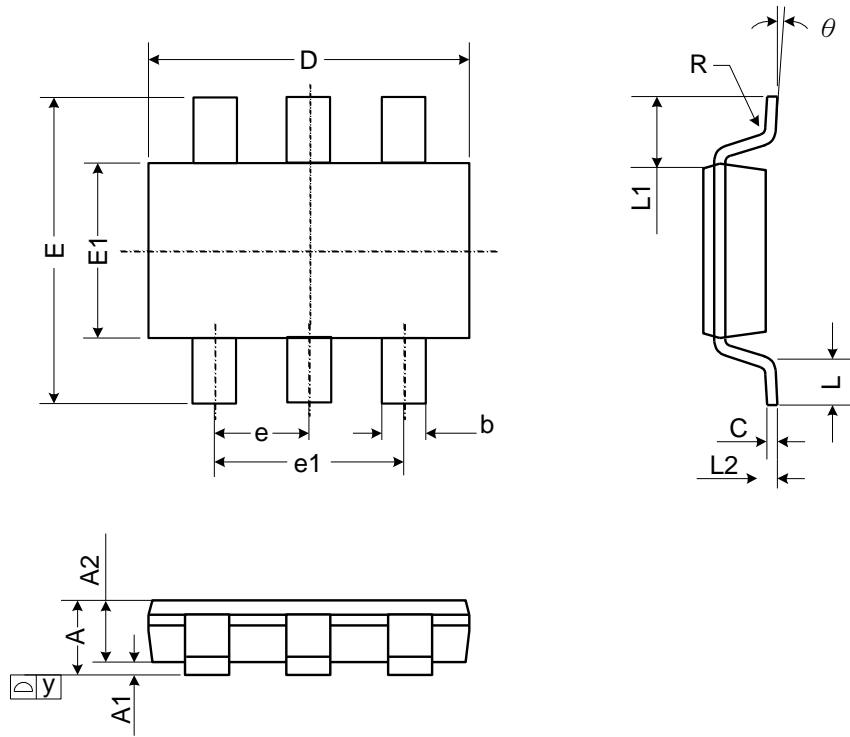


PWM Dimming from EN (20KHz)



❖ PACKAGE OUTLINES

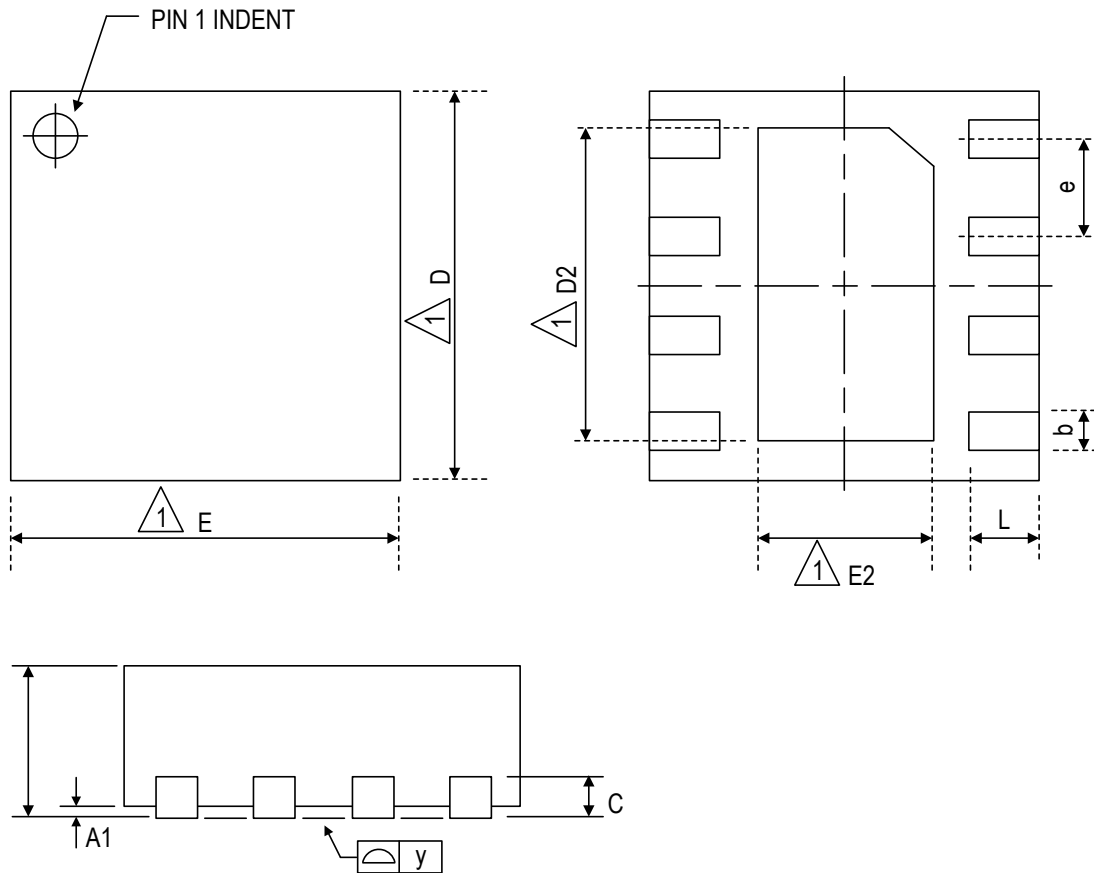
(1) TSOT-23-6L



| Symbol | Dimensions in Millimeters | | | Dimensions in Inches | | |
|--------|---------------------------|------|------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | - | - | 1.10 | - | - | 0.043 |
| A1 | 0.00 | - | 0.10 | 0 | - | 0.004 |
| A2 | 0.70 | 0.90 | 1.00 | 0.028 | 0.035 | 0.039 |
| b | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| C | 0.08 | 0.14 | 0.20 | 0.003 | 0.006 | 0.008 |
| D | 2.80 | 2.90 | 3.00 | 0.110 | 0.114 | 0.118 |
| E | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| E1 | 1.50 | 1.60 | 1.70 | 0.059 | 0.063 | 0.067 |
| e | 0.95 BSC. | | | 0.037 BSC. | | |
| e1 | 1.90 BSC. | | | 0.075 BSC. | | |
| L | 0.30 | 0.45 | 0.60 | 0.012 | 0.018 | 0.024 |
| L1 | 0.60 REF. | | | 0.024 REF. | | |
| L2 | 0.25 BSC. | | | 0.010 BSC. | | |
| y | - | - | 0.10 | - | - | 0.004 |
| R | 0.10 | - | - | 0.004 | - | - |
| θ | 0° | - | 8° | 0° | - | 8° |

JEDEC outline: MO-193 AA

(2) TDFN-8L (2*2 0.75mm)



| Symbol | Dimensions in Millimeters | | | Dimensions in Inches | | |
|--------|---------------------------|------|-------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 0.70 | 0.75 | 0.80 | 0.028 | 0.030 | 0.031 |
| A1 | 0.00 | 0.02 | 0.05 | 0 | 0.001 | 0.002 |
| b | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| C | 0.19 | 0.20 | 0.25 | 0.007 | 0.008 | 0.010 |
| D | 1.90 | 2.00 | 2.10 | 0.075 | 0.079 | 0.082 |
| D2 | 1.55 | 1.60 | 1.65 | 0.061 | 0.063 | 0.065 |
| E | 1.90 | 2.00 | 2.10 | 0.075 | 0.079 | 0.082 |
| E2 | 0.85 | 0.90 | 0.95 | 0.033 | 0.035 | 0.037 |
| e | - | 0.50 | - | - | 0.020 | - |
| L | 0.30 | 0.35 | 0.40 | 0.012 | 0.014 | 0.016 |
| y | 0.00 | - | 0.075 | 0 | - | 0.003 |