1.9A Fixed Frequency White LED Driver

❖ GENERAL DESCRIPTION

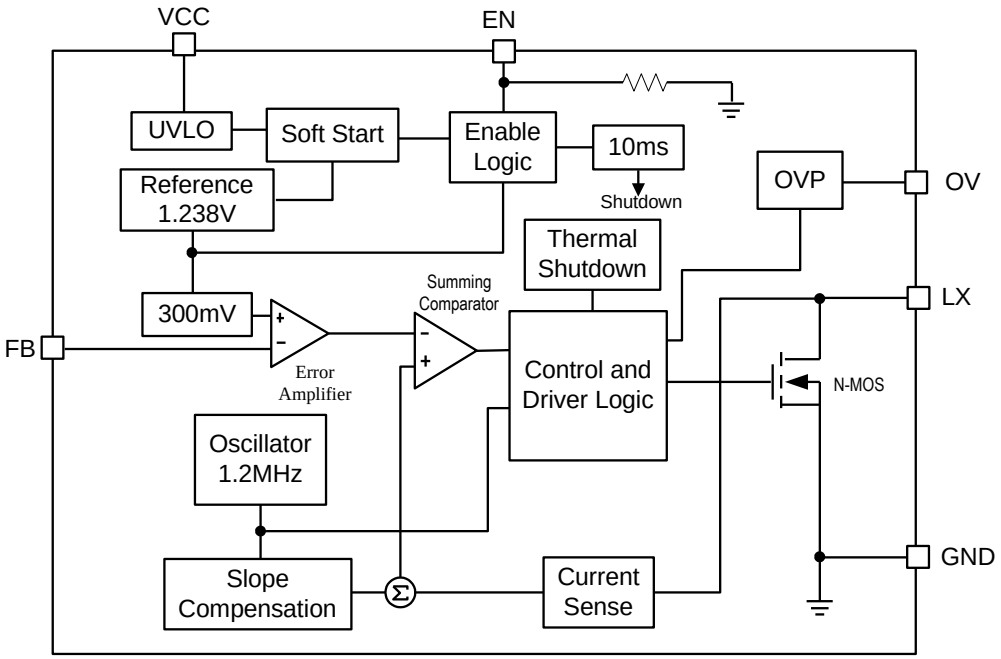
The AX2012 is a step-up converter designed for driving up to 8 series white LEDs for backlighting application. The AX2012 uses current mode, 1.2MHz fixed frequency architecture to regulate the LED current, which is set through an external current sense resistor. Its low 300mV feedback voltage reduces 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

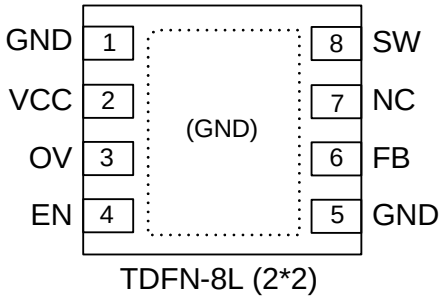
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❖ BLOCK DIAGRAM



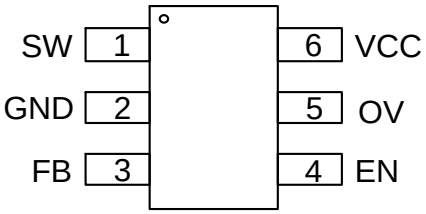
❖ PIN ASSIGNMENT

The packages of AX2012 are TSOT23-6L and TDFN-8L; the pin assignment is given by:



TDFN-8L (2*2)

(Top View)



TSOT-23-6L

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

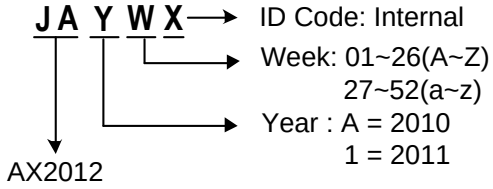
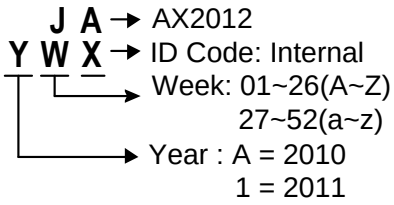
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❖ ORDER/MARKING INFORMATION

Order Information

AX2012 XX X

- XX — Package Type: CT: TSOT-23-6L; Z8: TDFN-8L (2*2)
- X — Packing: Blank : Bag; A : Taping

Top Marking (TSOT-23-6L)	Top Marking (TDFN-8L)
	

❖ 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	θ_{JC}	180	°C/W
	TDFN-8L		25	
Thermal Resistance from Junction to ambient	TSOT-23-6L	θ_{JA}	250	°C/W
	TDFN-8L		120	

Note: θ_{JA} is measured with the PCB copper area of approximately 1 in^2(Multi-layer).

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❖ ELECTRICAL CHARACTERUSTICS

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

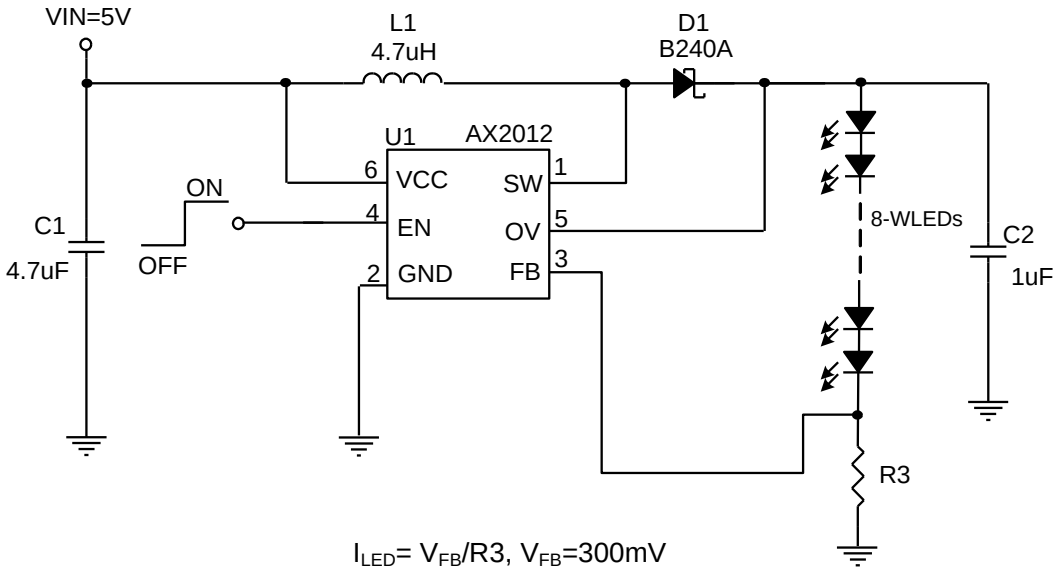
Characteristics		Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range		V_{CC}		2.5	-	5.5	V
Step-Up Voltage Range		V_{OUT}		3	-	27	V
OV Sense Voltage		V_{OV}		27.5	29	30.5	V
Under Voltage Lockout		U_{VLO}	Rising	-	2.25	2.45	V
UVLO Hysteresis				-	100	-	mV
Feedback Voltage		V_{FB}		285	300	315	mV
EN 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	-	°C
Thermal Shutdown Hysteresis		T_{SH}		-	30	-	

Note1: Guaranteed by design.

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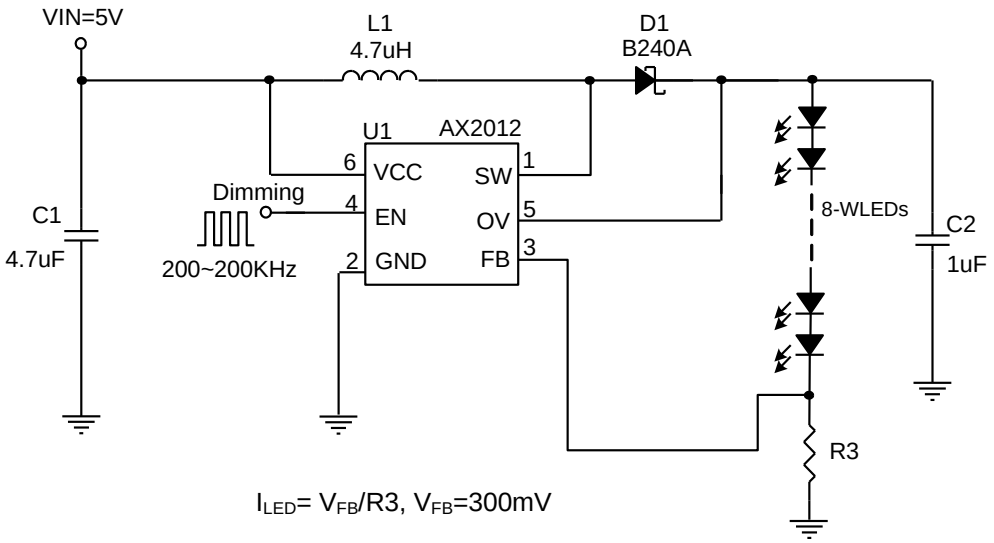
❖ APPLICATION CIRCUIT

(1) 8 series LED application



$I_{LED}= V_{FB}/R3$, $V_{FB}=300mV$

(2) LED Dimming application



$I_{LED}= V_{FB}/R3$, $V_{FB}=300mV$

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❖ 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:

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

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.

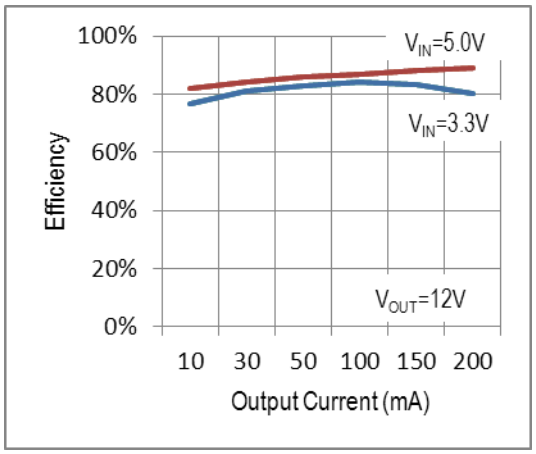
Output Capacitor Selection

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.

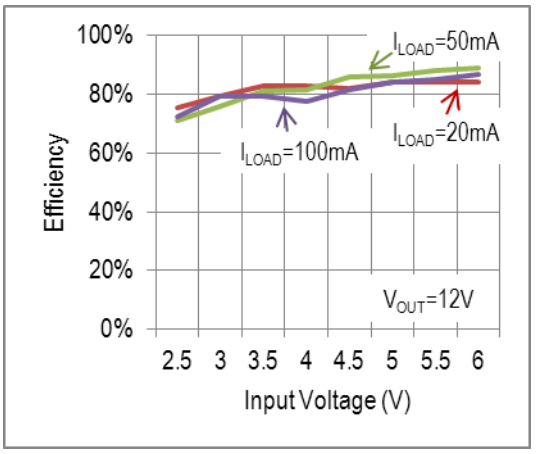
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❖ TYPICAL CHARACTERISTICS

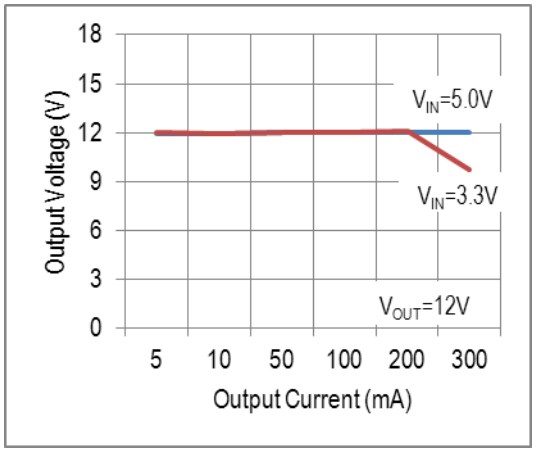
Efficiency vs. Output Current



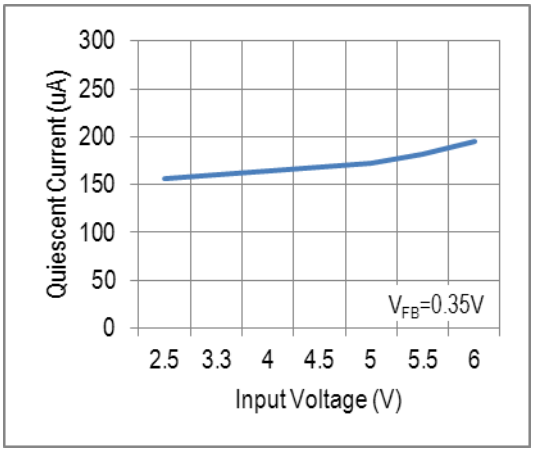
Efficiency vs. Input Voltage



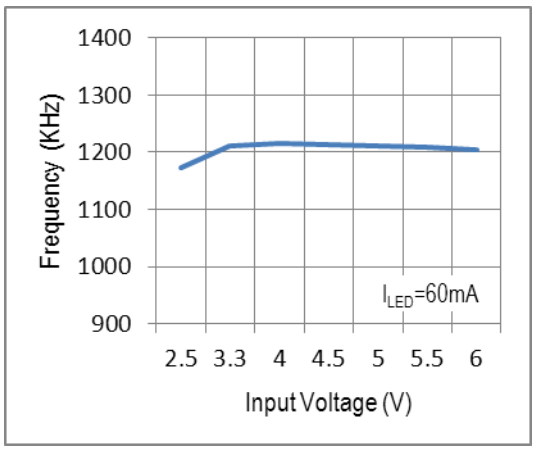
Output Voltage vs. Output Current



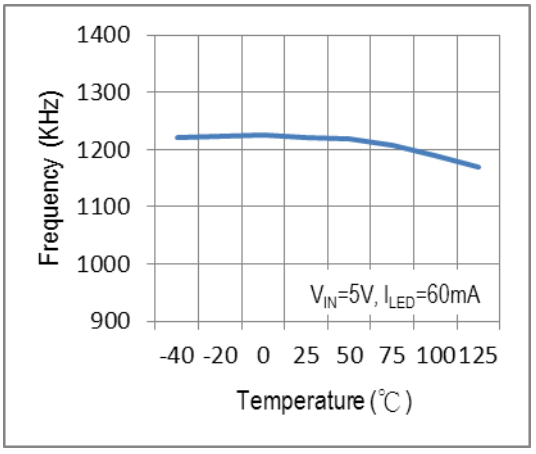
Quiescent Current vs. Input Voltage



Frequency vs. Input Voltage



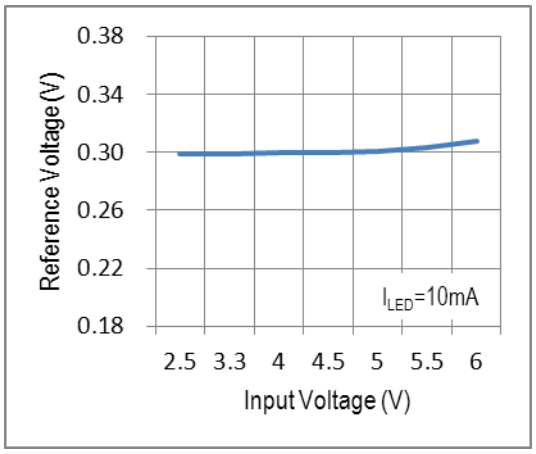
Frequency vs. Temperature



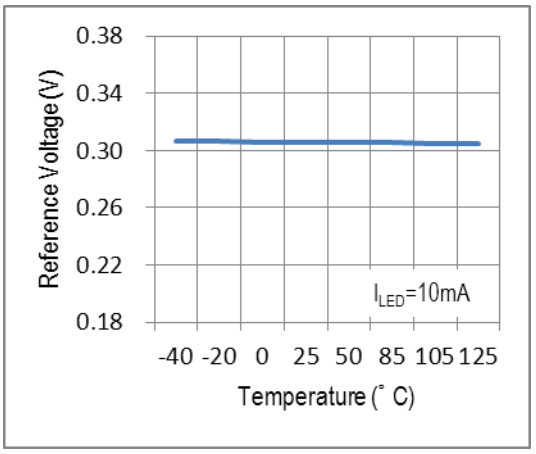
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❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

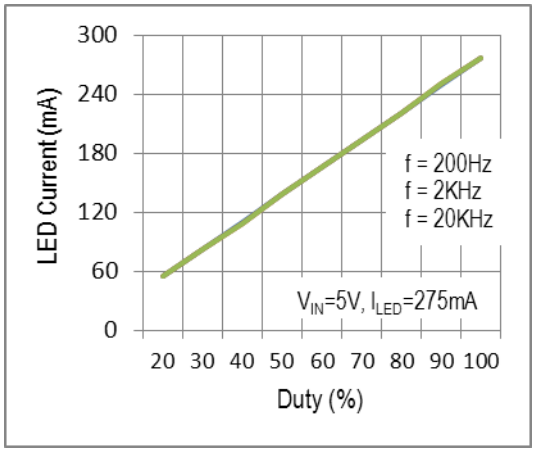
Reference Voltage vs. Input Voltage



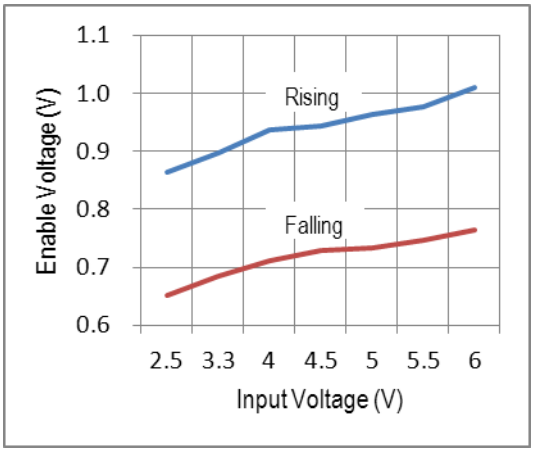
Reference Voltage vs. Temperature



LED Current vs. Duty



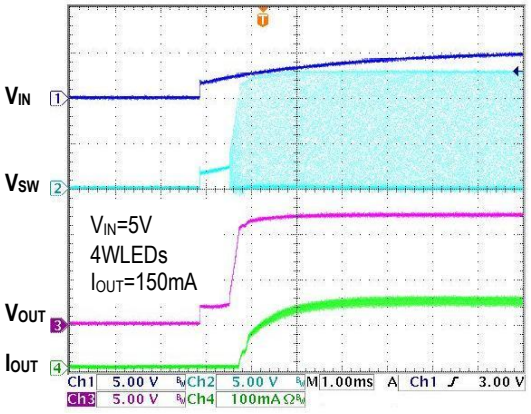
Enable Threshold vs. Input Voltage



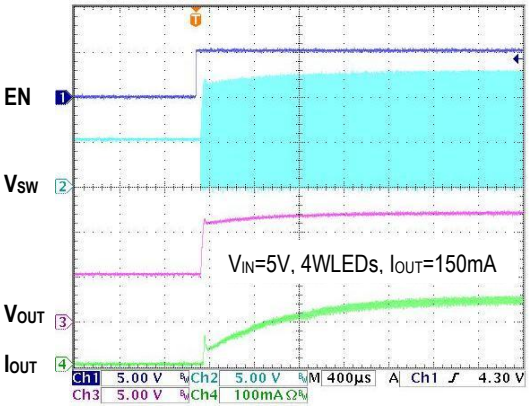
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❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

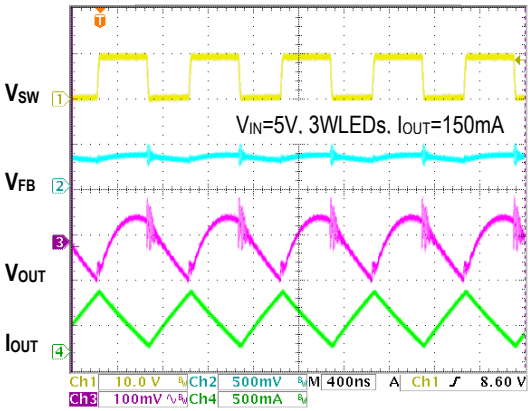
Power ON from V_{IN}



Power ON from EN

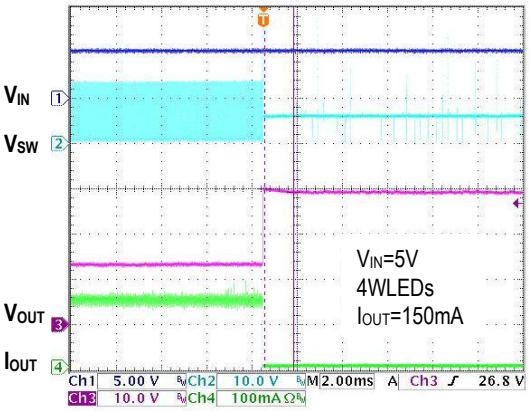


Steady State Operation

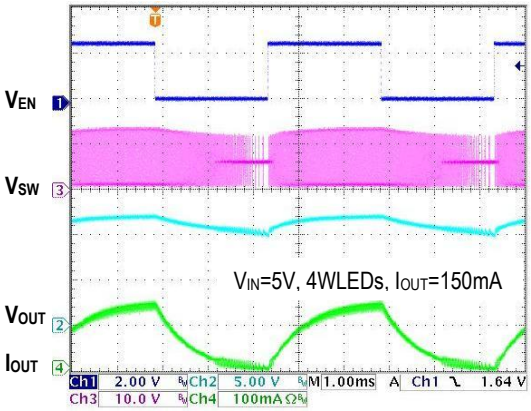


(V_{OUT}, I_{OUT}: measured by AC coupled mode)

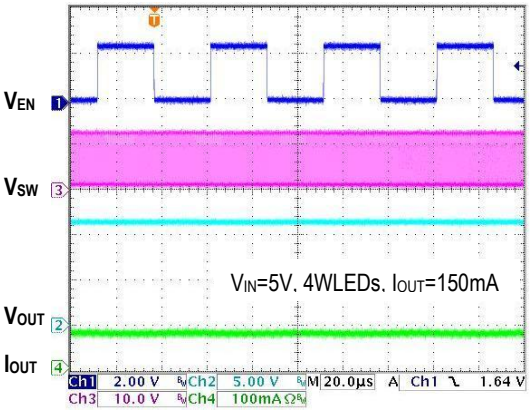
Normal Operation into OVP



PWM Dimming from EN (200Hz)



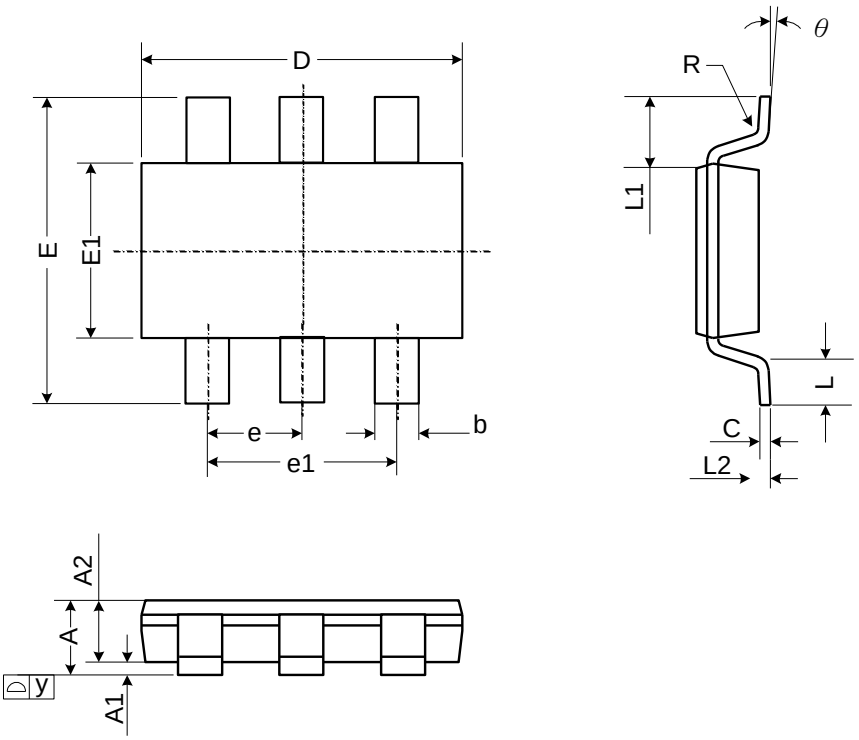
PWM Dimming from EN (20KHz)



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❖ PACKAGE OUTLINES

(1) TSOT-23-6L

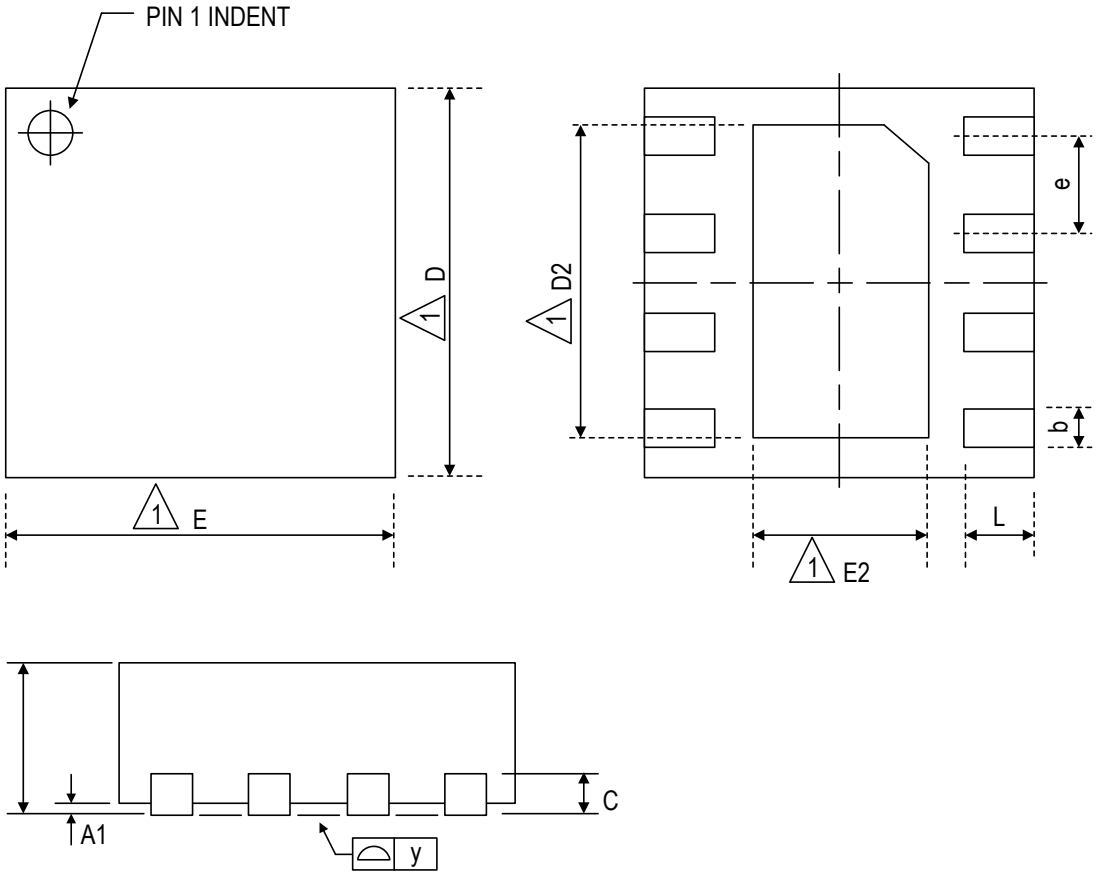


Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.10	-	-	0.043
A1	0.00	-	0.10	0	-	0.004
A2	0.70	0.90	1.00	0.028	0.035	0.039
b	0.30	0.40	0.50	0.012	0.016	0.020
C	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
E	2.60	2.80	3.00	0.102	0.110	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

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(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

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