High Power Factor & Accuracy Constant Current LED Driver

Features

- High Power Factor by One Cycle Control
- Accuracy Constant Current
- Low BOM Cost
- Linear Dimming on DIM Pin
- Average Current / Fixed Frequency Control
- Gate Output Voltage Clamp
- LED Open Protection (OVP)
- LED Short Protection (SCP)
- Over Current Protection (OCP)
- Internal OTP Protection
- 300mA Driving Capability for OUT Pin
- Fast Start Current

Applications

- E26/27, T5/T8 LED Lamp
- Others LED Lighting Applications

Package Type

- SOT 26

Product Description

The NU311 is a highly-integrated, low startup current, average current mode, one cycle control PFC and fixed switching frequency PWM controller. These functions enable the LED driver to easily meet the accuracy average LED current and high power factor requirements. The integrated functions also include the LED short protection, open protection, and internal over temperature protection. The COMP pin controls the duty by connected an RC compensation network to ground and forming the closed loop feedback control. To protect the external power MOSFET from being damaged by supply over voltage, the NU311 OUT pin voltage is clamped to about 15V.

The NU311 improves the performance and reduces the cost of the LED driver. It is a 6-pin SOT-26 package.

Pin Description

Pin No.	Name	Function
1	VCC	Power Supply Pin
2	GND	Ground Pin
3	OUT	The Output Driver for Driving The External MOSFET
4	DIM	Dimming Control Pin by Input a DC Voltage
5	COMP	Feedback Compensation Network
6	CS	Current Sense Pin, Connect to Sense The MOSFET Current

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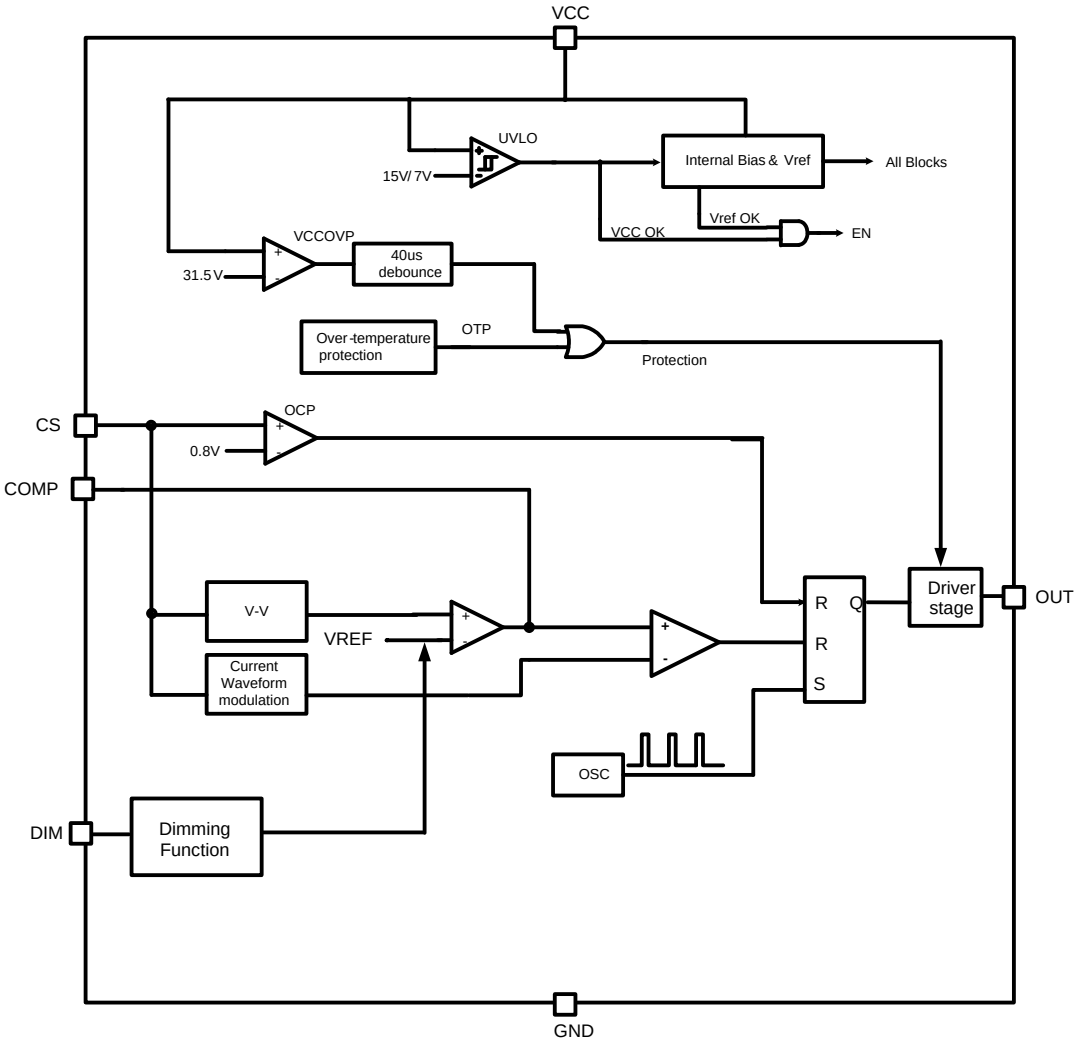
Block Diagram



Maximum Ratings (T = 25˚C)

Characteristic	Symbol	Rating	Unit
Supply voltage	V_{CC}	0 ~ 30	V
Output voltage(DIM,COMP,CS)	V_{DIM}, V_{COMP},V_{CS}	-0.3 ~ 7	V
Output voltage(OUT)	V_{OUT}	15	V
Power Dissipation (Ta=25°C)	PD	0.25	W
Thermal Resistance (On PCB, Ta=25°C)	$R_{TH(j-a)}$	250	°C /W
ESD Voltage Protection, Human Body Model	ESD_{HUM}	2	KV
ESD Voltage Protection, Machine Model	ESD_{MACH}	200	V
Junction Temperature	Tj	150	°C
Operating temperature	T_{OPR}	-20~+85	°C
Lead Temperature(soldering,10 sec)	T_{LEAD}	+260	°C
Storage temperature	T_{STG}	-65~+150	°C

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Electrical Characteristics and Recommended Operating Conditions

Electrical Characteristics (VCC = 15.0V & TA = +25℃, unless otherwise specified.)

Parameter	Pin	Min.	Typ.	Max.	Unit
SUPPLY VOLTAGE					
Startup Current (VCC=UVLO on - 1V)	1		8	15	uA
Operating Current (with 1nF load on OUT pin), Vcomp = 2.5V	1		2	3	mA
Operating Current (with 1nF load on OUT pin), Protection Tripped (OCP, OVP, SCP, OTP)	1		0.7	1	mA
UVLO(off)	1	6	7	8	V
UVLO(on)	1	14	15	16	V
OVP Level on VCC Pin	1	29.5	31.5	33.5	V
OVP De-Bounce Time	1		40		us
VOLTAGE FEEDBACK					
Feedback Reference Voltage	5	0.195	0.200	0.205	V
Tran-Conductance	5		120		uS
Output Sink Current	5		12		uA
Output Source Current	5		12		uA
CURRENT SENSING					
Input Over Voltage Protection	6	0.7	0.80	0.9	V
Open Loop Voltage, CS Pin Open	6		5		V
Leading-Edge Blanking Time	6		410		nS
Delay to Output	6		100	220	nS
SWITCHING FREQUENCY					
Switching Frequency	-	42	45	48	KHz
Maximum Duty	-	90			%
Frequency Jitter Range			+/-4		%
Temp. Stability (-40°C ~ 125°C)	-			6	%
Voltage Stability (VCC = 11V~25V)	-			1	%
GATE DRIVER OUTPUT					
Rising Time, Load Capacitance = 1000pF	3		160	320	nS
Falling Time, Load Capacitance = 1000pF	3		80	160	nS
VGATE-Clamp (VCC = 25V)	3		13.5	15	V
DIM INPUT SECTION					
Saturation Threshold Voltage	4	3.0			V
Linear Dimming Range	4	0.3		3.0	V
LED Current off Threshold Voltage	4			0.5	V

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Current Source	4	270	300	330	uA

OTP SECTION

OTP Trip Point	-		150		℃
OTP Release Point	-		130		℃
OTP Threshold Level	-		20		℃
OTP De-Bounce Time	-		80		uS

Note:

1. OVP, OCP, SCP, OTP: Auto Recovery Type

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Typical Performance Characteristics

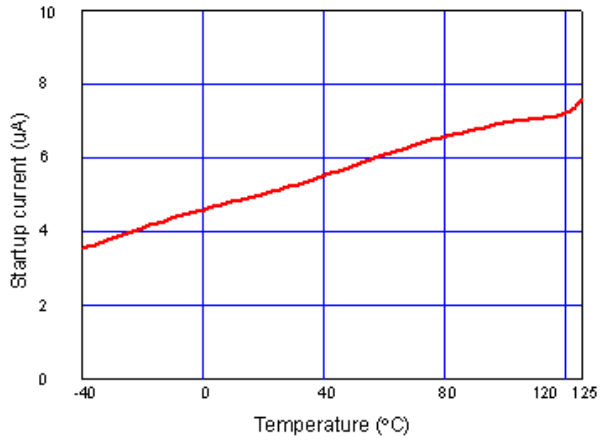

Fig. 1 Startup current vs. Temperature

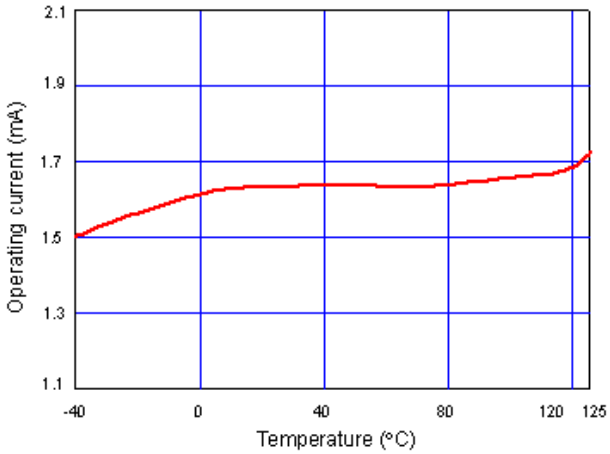

Fig. 2 Operating current vs. Temperature

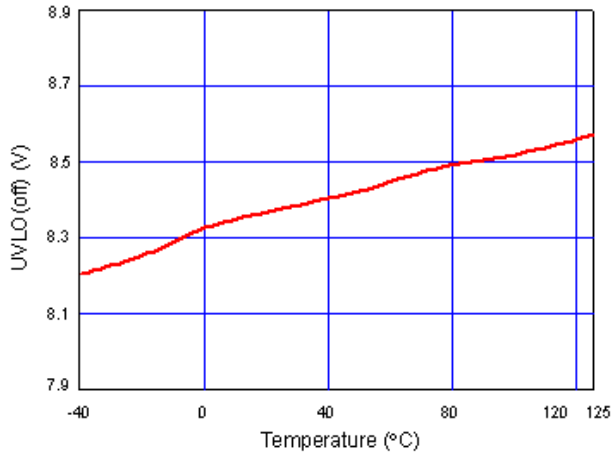

Fig. 3 UVLO(off) vs. Temperature

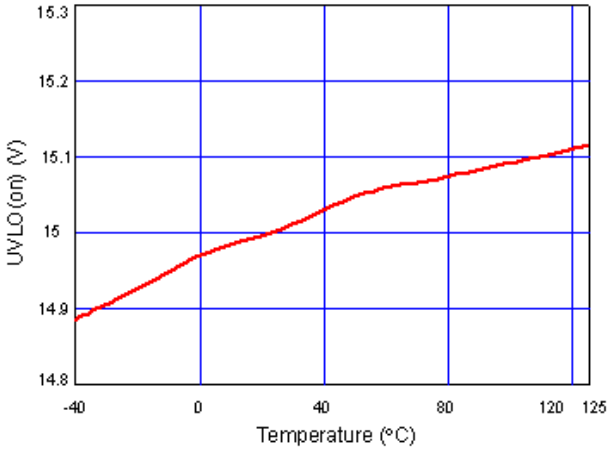

Fig. 4 UVLO(on) vs. Temperature

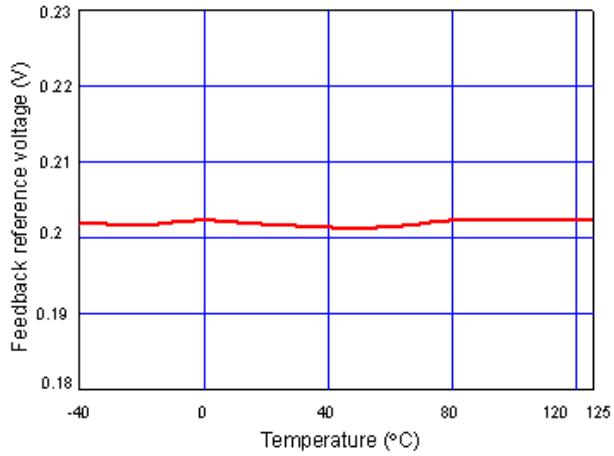

Fig. 5 Feedback reference voltage vs. Temperature

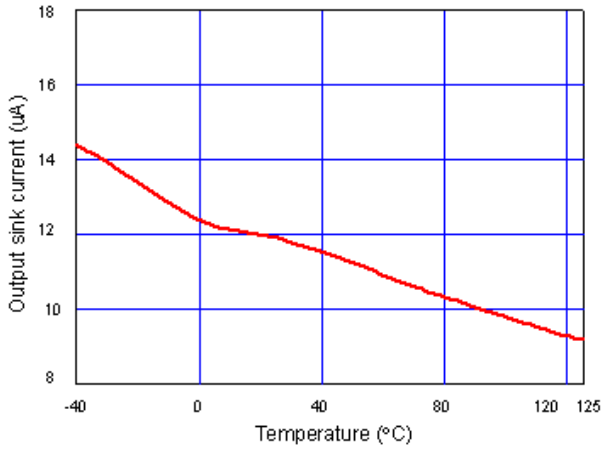

Fig. 6 Output sink current vs. Temperature

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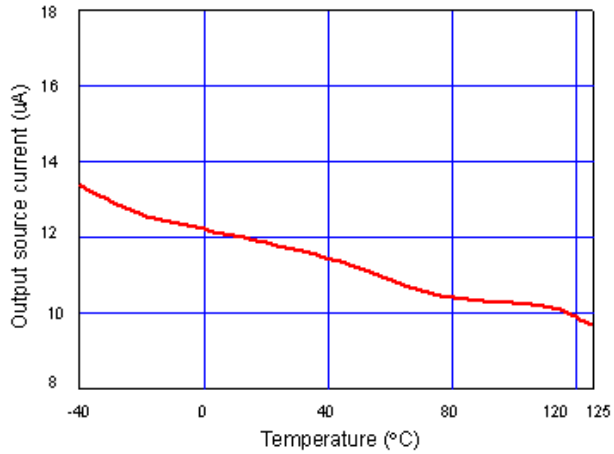

Fig. 7 Output source current vs. Temperature

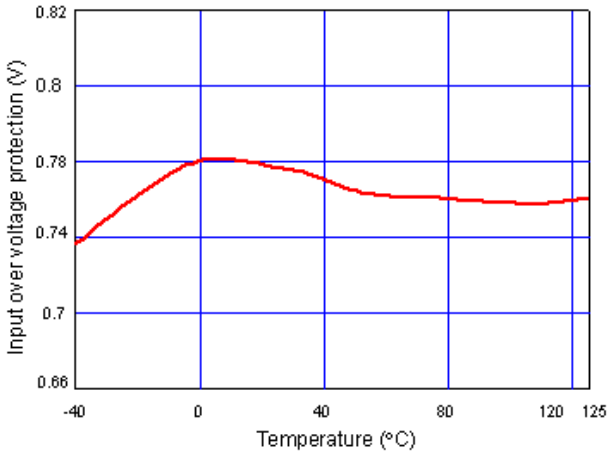

Fig. 8 Input over voltage protection vs. Temperature

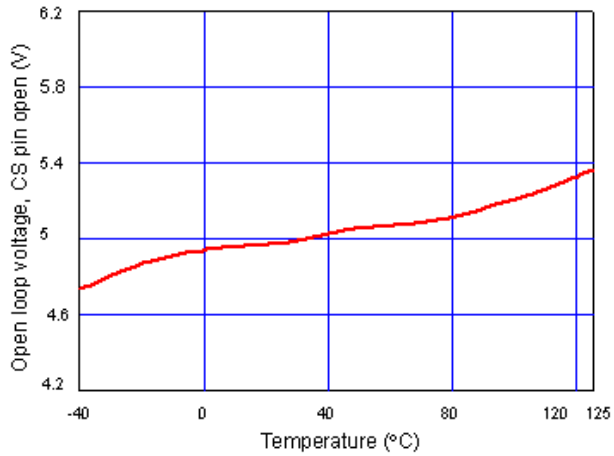

Fig. 9 Open loop voltage, CS pin open vs. Temperature

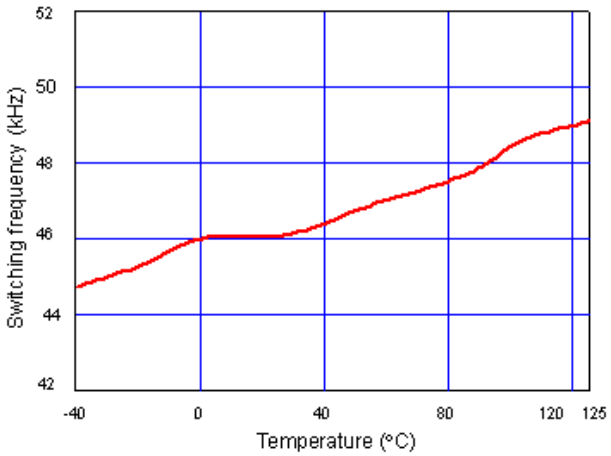

Fig. 10 Switching frequency vs. Temperature

Application Information

Start-up Current

The typical start-up current is around 8uA. Very low start-up current allows the PWM controller to increase the value of start-up resistor and then reduce the power dissipation on it.

UVLO (Under Voltage Lockout)

A hysteresis UVLO comparator is implemented in NU311, then the turn-on and turn-off thresholds level are fixed at 15V and 7V respectively. This hysteresis ensures that the start-up capacitor will be adequate to supply the chip during start-up. For quickly startup the LED driver, the start-up resistor should be matched with the startup capacitor. Due to the low UVLO on level, so the turn-on delay time will also never greater than the general PWM IC.

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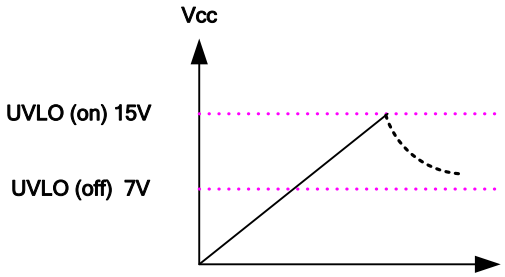


Oscillator

The maximum duty-cycle of internal oscillator is up to 90% for driving high LED voltage string. The frequency of the oscillator is fixed to 45KHz by internal setting.

LEB (Leading-Edge Blanking)

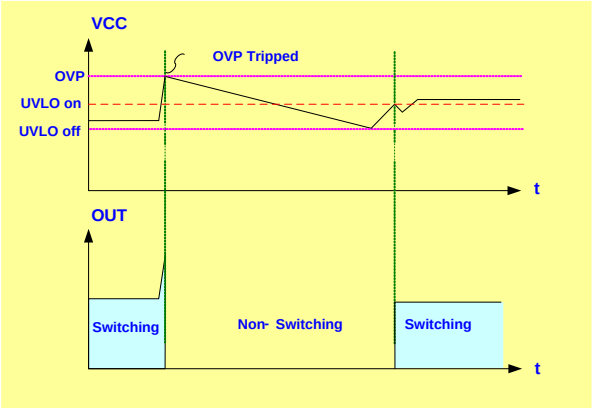
Each time the power MOSFET is switched on, a turn-on spike will inevitably occur at the sense resistor. To avoid fault trigger, a 410ns leading-edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current-limit comparator is disabled and can not switch off the gate driver.

OCP (Over Current Protection)

The NU311 has an over current protection function on CS pin. An internal circuit detects the current level, when the current is larger than a threshold level, the gate output will keep on low level. Then VCC decreases below UVLO off level, the controller resets again.

OVP (Over Voltage Protection) on VCC

To prevent the LED driver from being damaged, the NU311 is implemented an OVP function on VCC. When the VCC voltage is higher than the OVP threshold voltage 31.5V, the output gate driver circuit will be shut down immediately to stop the switching of power MOSFET. The VCC pin OVP function is an auto recovery type protection (latch off type optional). If the OVP condition happens, the pulses will be stopped and never recovery unless the VCC pin voltage is down to the UVLO off level. The NU311 is working in an auto-recovery mode.



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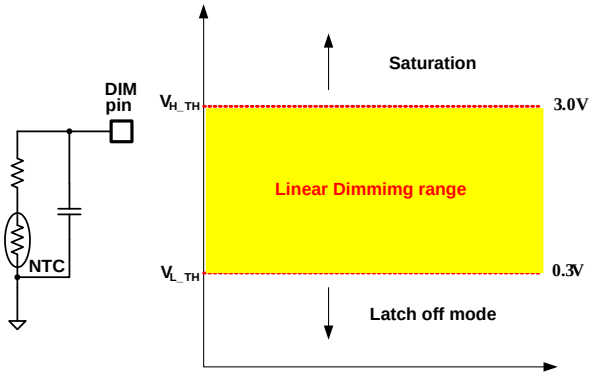
Gate Clamp/Soft Driving

Driver is clamped to 15V by an internal clamping circuit. Those damages usually come from undesired over-voltage gate signals. Under the conditions listed below, the gate output will turn off immediately to protect the power circuit. The NU311 also has soft driving function to minimize EMI.

Over Temperature Protection/Dimming Function



The NTC thermistor is setting as an external OTP protection. In the DIM pin, there is one comparator for latch-off mode protection. While the voltage on this pin is lower than 0.3V, the NU311 will shut down. When the voltage is in the range of 0.3 to 3.0V, the NU311 is operating on the linear dimming range. While the voltage is higher than 3.0V, the NU311 is operating on the normal status. It also could let this Pin open when the function is not required for the user.

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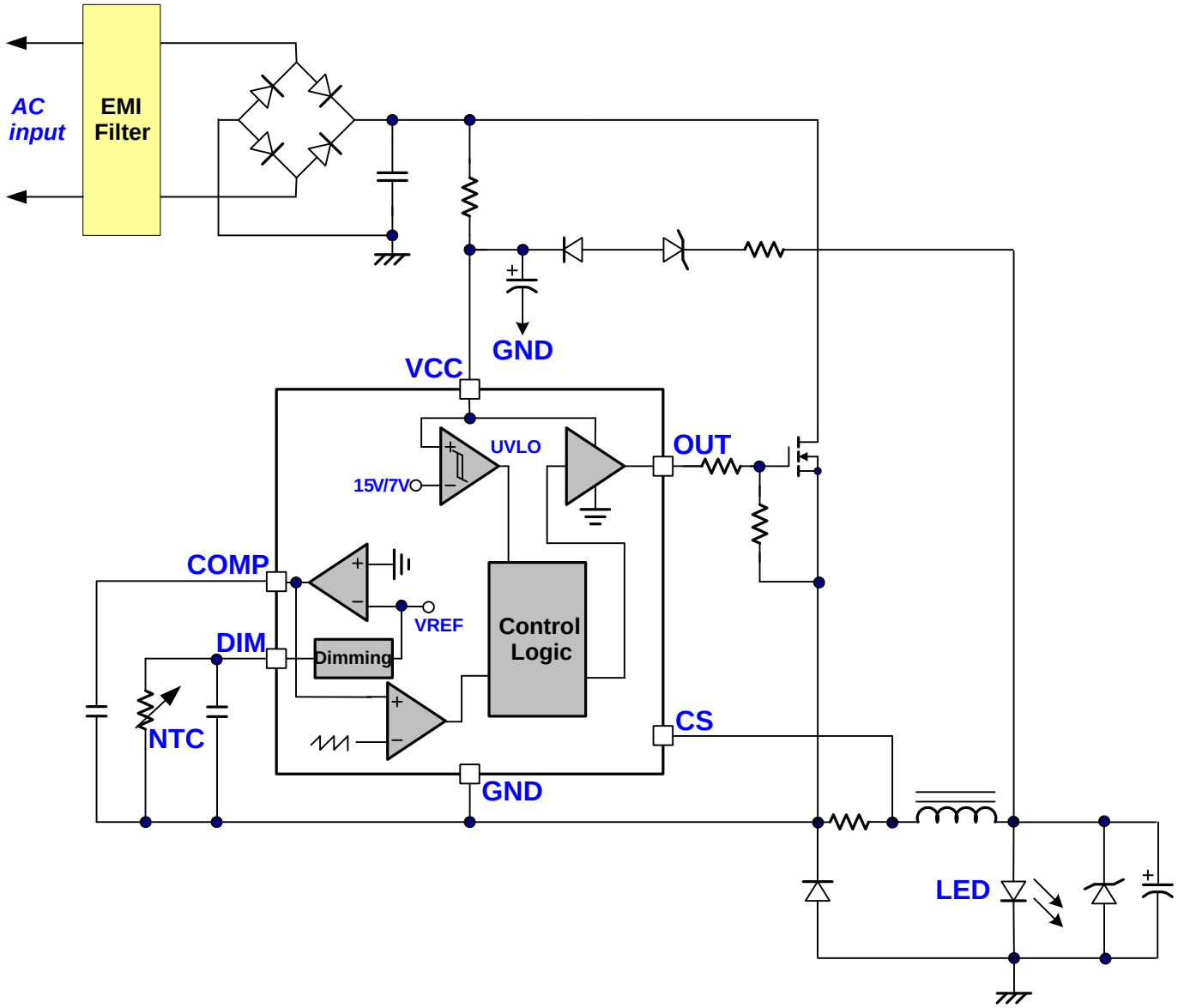
Application Circuits



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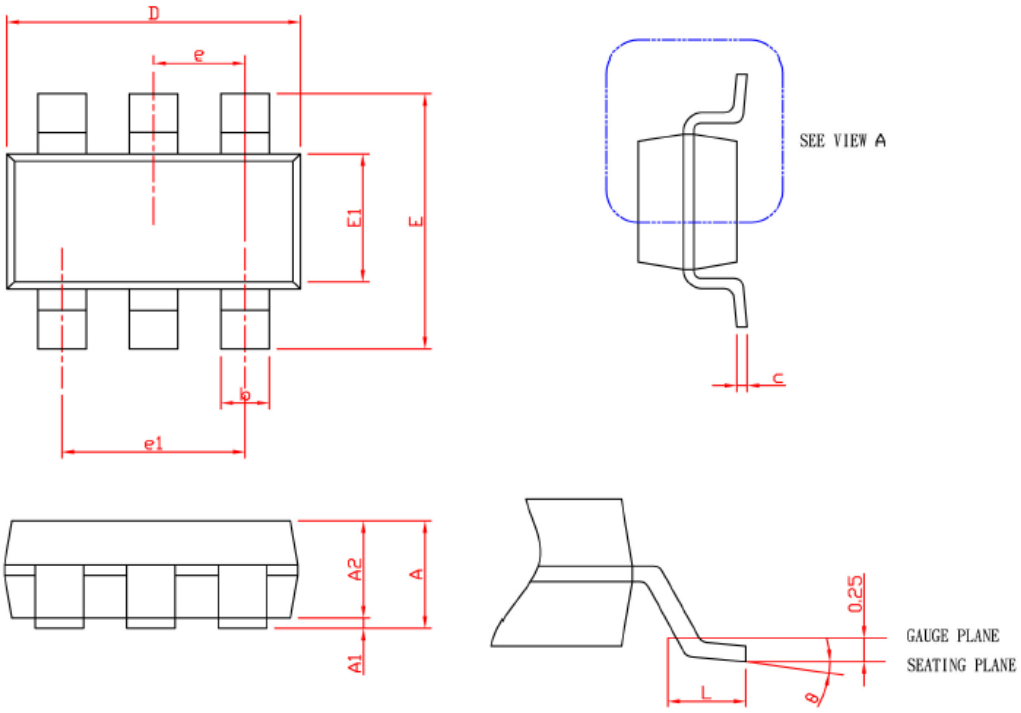
Package Dimensions

- SOT26



SYMBOL	SOT-26			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.45		0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

Note: 1. Followed from JEDEC TO-178 AB.

2. Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 10 mil per side

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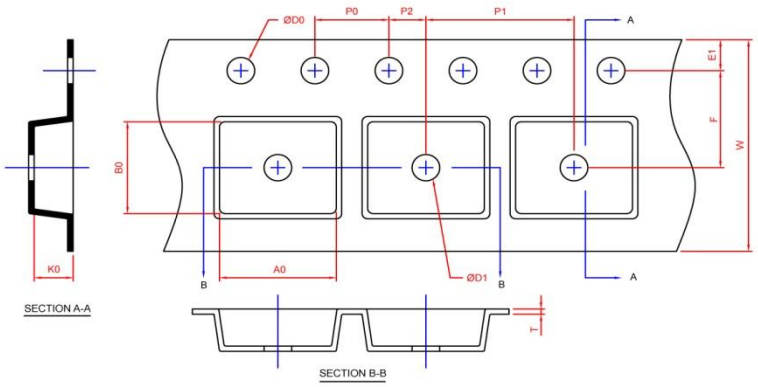
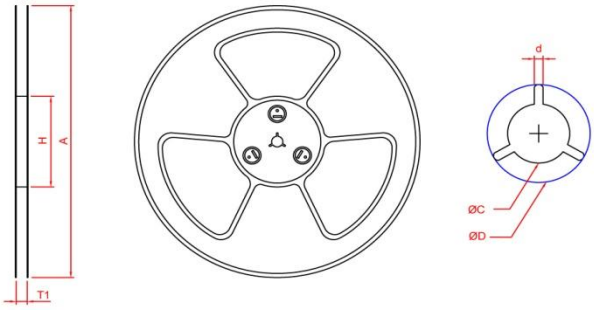
Carrier Tape & Reel Dimensions

- SOT26





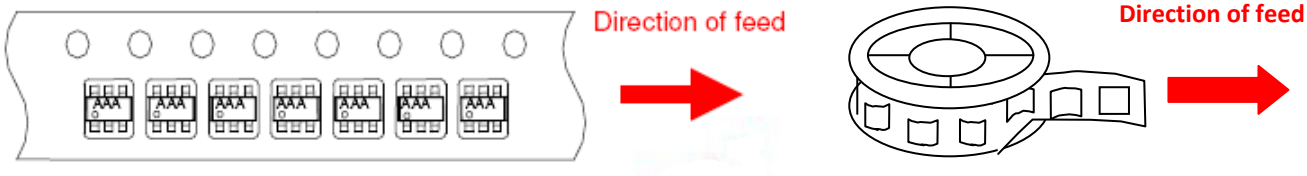
Application	A	H	T1	C	d	D	W	E1	F
SOT-26	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.30	1.75±0.10	3.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	4.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.0 MIN.	0.6+0.00 -0.40	3.20±0.20	3.10±0.20	1.50±0.20

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOT -26	8	5.3	3000

Unit: mm

Tape and Specification Reel

- SOT26



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