80V High Efficiency Step-Down LED Driver

Description

The NDP2024 is a high-efficiency step-down LED driver controller with a wide input voltage range of 6V to 80V. It is designed to operate in continuous current mode

The NDP2024 employs a hysteretic control architecture that accurately regulates LED current with a feedback coming from an external high-side current-sense resistor. This control scheme optimizes circuit stabilization and fast response time without loop compensation. Its low 200mV average feedback voltage reduces power loss and improves the converter's efficiency.

The NDP2024 implements PWM and analog dimming together through the EN/DIM pin.

The NDP2024 also Includes thermal overload protection in case of output

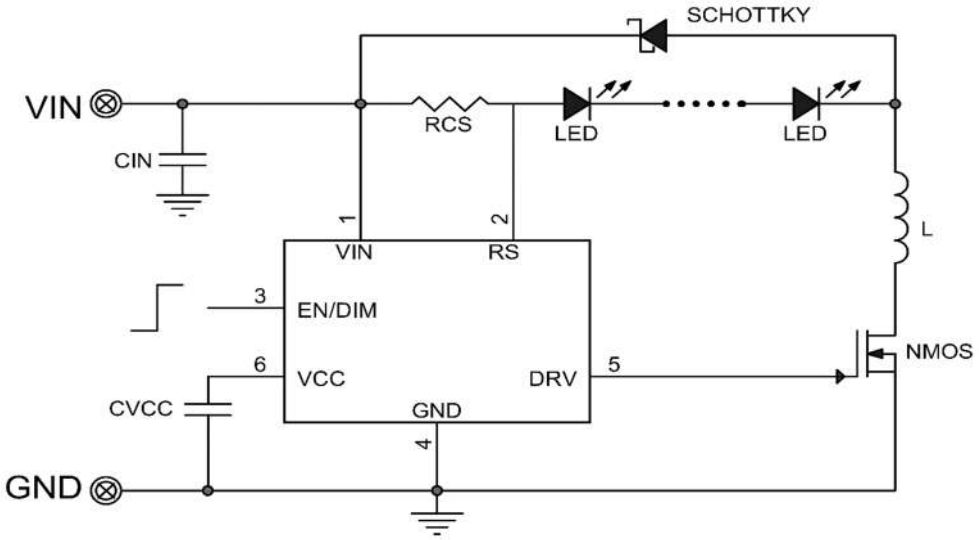
Features

- Wide 6V to 80V Input Range
- Able to Drive >1A LED Load
- Hysteresis Control
- High Efficiency (>95%)
- 2500:1 PWM Dimming Ratio
- Open LED Protection
- Short LED Protection
- Thermal Shutdown
- RoHS and Halogen free compliance.
- Available in SOT23-6 Package

Applications

- Low Voltage Halogen Replacement
- Low Voltage General Illumination
- Automotive/Decorative LED Lighting
- Emergency Lighting
- LED Backlighting

Typical Application

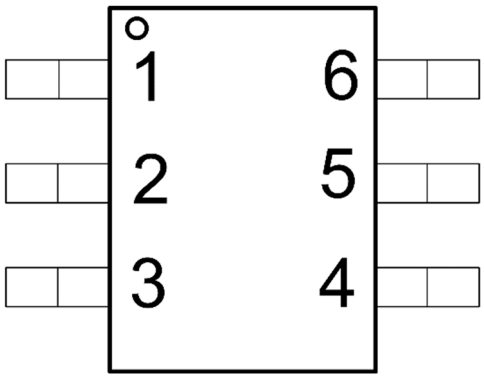


Absolute Maximum Ratings (at TA = 25°C)

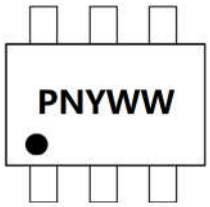
Characteristics	Symbol	Rating	Unit
VIN to GND		-0.3 to 85	V
RS to GND		VIN-0.3 to VIN	V
VCC to GND		-0.3 to +6	
EN/DIM to GND		-0.3 to +6	V
DRV to GND		-0.3 to +6	V
Junction to Ambient Thermal Resistance	$R_{\theta JA}$	180	°C/W
Junction to board thermal resistance	$R_{\theta JB}$	120	°C/W
Junction to case thermal resistance	$R_{\theta JC}$	42	°C/W

Pin Function And Descriptions

PIN	Name	Description
1	VIN	Power Input
2	RS	Connect sensor resistor between VIN and RS to set LED current
3	EN/DIM	Enable Or PWM/Analog Diming Input , Below 0.3V Shutdown
4	GND	Ground
5	DRV	NMOS Driver
6	VCC	Internal Power Supply



Order information

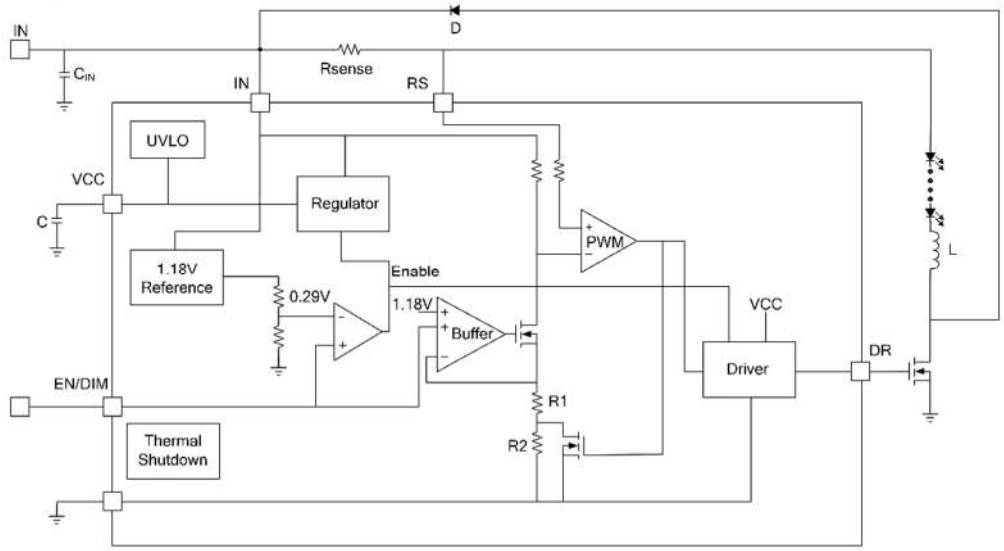
Order Information	Top Marking
NDP2024 Product Number	 PN : Part NO(CV) Y : Year (0=2020,A=2021,…) WW: Weekly (01-53)

Electrical Characteristics

TJ = 25°C. VIN = 12V, unless otherwise noted

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input voltage	V_{IN}		6		80	V
Shutdown supply current	I_{SD}			80	108	μA
Quiescent supply current	I_Q	No Switching		0.3	0.5	mA
VCC voltage	Vcc	VEN/DIM = 3.5V	5.5	6		V
Feedback average voltage (with respect to VIN)	V_{IN}-V_{RS}	VEN/DIM = 3.5V	194	200	206	mV
Feedback reference voltage hysterisis	V_{FB_HYS}			±30		mV
EN/DIM enable high voltage	V_{EN_HIGH}	V_{EN} Rising		0.29	0.34	V
EN/DIM enable hysterisis	V_{EN_HYS}		20	50	80	mV
EN/DIM pull-up current		Pull up to 5V		2.8		μA
EN/DIM pull-down current		Pull down to GND		25		μA
Min recommended pwm dimming frequency	F_{PWMmin}			0.1		kHz
Max recommended pwm dimming frequency	F_{PWMmax}			20		kHz
Gate driver source resistor	Rsrc	VGS = 5.5V		6		Ω
Gate driver sink resistor	Rsink			2		Ω
Gate driver high	V_{OH}	IDRV = 10mA	5.5			V
Gate driver low	V_{OL}	IDRV = 10mA			0.5	V
Minimum on time	T_{ON_MIN}			100		ns
Minimum off time	T_{OFF_MIN}			100		ns
maximum frequency	F_{MAX}			1		MHz
VCC UVLO threshold	V_{UVLOTH}	VCC Rising		5.6		V
VCC UVLO hysteresis	$V_{UVLOHYS}$			0.4		V
Thermal shutdown threshold		Temp Rising		150		°C
Thermal shutdown hysteresis				20		°C
Thermal Shutdown Hysteresis	T_{SH}		-	30	-	°C

Block Diagram



Operation

Steady State

The NDP2024 is a step-down LED-current controller with hysteresis control that is easily configured for a wide input that ranges from 6V to 60V input. The NDP2024 uses a high-side current-sense resistor to detect and regulate LED current. The voltage across the current- sense resistor is measured and regulated in the 200mV±30mV range.

The internal 1.18V reference voltage provides a 0.3V reference to enable the part. When VEN>0.3V, the output of the comparator goes high and enables the other blocks. The NDP2024 also provides a 5V pull-up voltage as current reference voltage when EN/DIM pin is float.

The inductor current is sensed through the high-side resistor, Rsense. When the switch is on, R2 (see Figure 1) is shorted and inductor current upper-threshold is fixed by R1. When the switch is off, inductor current lower-threshold is fixed by R1 and R2. The ratio of R1 and R2 determines the current hysteresis.

System Soft Start

The voltage on the EN/DIM pin provides the inductor current reference. An external capacitor from the EN/DIM pin to ground provides a soft-start delay. When VIN starts, internal voltage source charges the capacitor from 0V to 5V to fulfill soft-start function.

Dimming Control

The NDP2024 allows the EN/DIM pin to control both Analog and PWM dimming. Whenever the voltage on DIM is less than 0.25V, the chip turns off. For analog dimming, when the voltage on DIM is from 0.3V to 2.7V, the LED current will change from 20% to 100% of the maximum LED current. If the voltage on EN pin is higher than 2.9V, output LED current will equal the maximum LED current. For PWM dimming, the signal amplitude must exceed 3V. Choose a PWM frequency in range of 100Hz to 20kHz for good dimming linearity.

Applications Information

Setting the LED Current

The LED current is identical and set by the current sense resistor between the IN pin and RS pin.

RSENSE=200mV/ILED

For RSENSE=0.2Ω, the LED current is set to 1A

Selecting the Inductor Lower value of inductance can result in a higher switching frequency, which causes a larger switching loss. Choose a switch frequency between 100kHz to 600kHz for most application. According to switching frequency, inductor value can be estimated as:

$$L = \frac{(1-\frac{V_{OUT}}{V_{IN}}) \times V_{OUT}}{0.3 \times I_{LED} \times f_{SW}}$$

For higher efficiency, choose an inductor with a DC resistance as small as possible.

Selecting the Input Capacitor

The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. Choose a capacitor value between 10μF and 22μF for most applications. The voltage rating should be greater than the input voltage. Use a low ESR capacitor for input decoupling.

Selecting the Output Capacitor

For most applications, the output capacitor is not necessary. For applications that require that the peak-to-peak LED ripple current falls below 30% of the average current, add a capacitor across the LEDs. Higher capacitor values will result in proportionally lower ripple. A value of 2.2μF will meet most requirements.

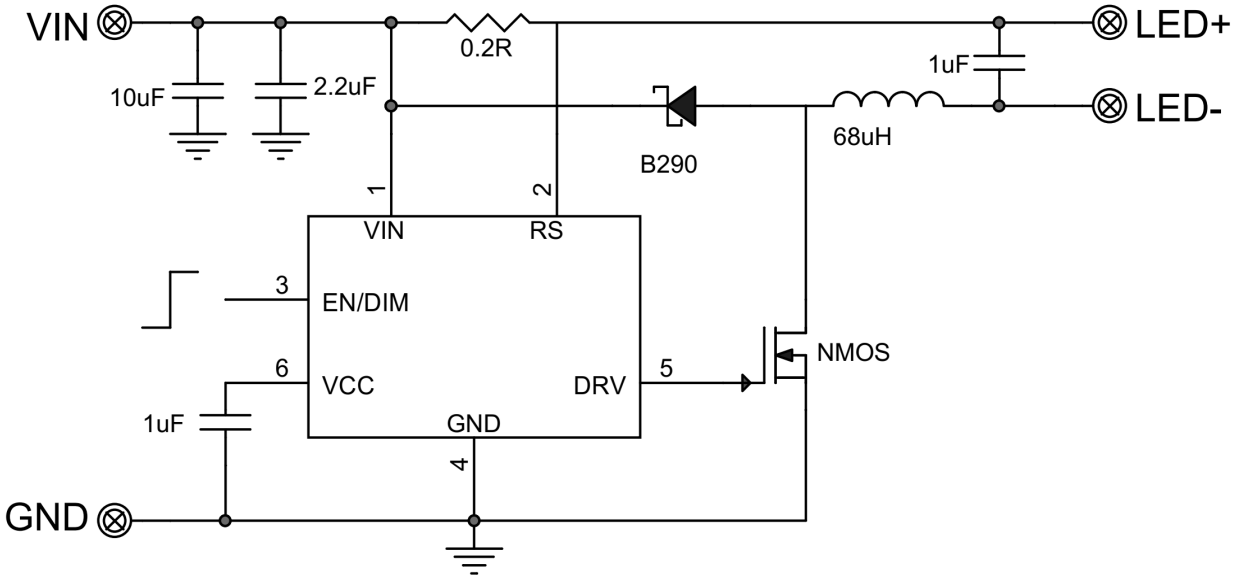
Selecting Soft-Start Capacitor

When selecting a soft-start capacitor, the delay time can be estimated as 0.2ms/nF. For PWM dimming, select C < 2.2nF to eliminate its effect on the average LED current. Dimming Control NDP2024 provides 1:2500 high-ratio PWM dimming. Apply a 100Hz to 20kHz square waveform to the EN/DIM pin. The average LED current is proportional to PWM duty cycle.

Layout Consideration

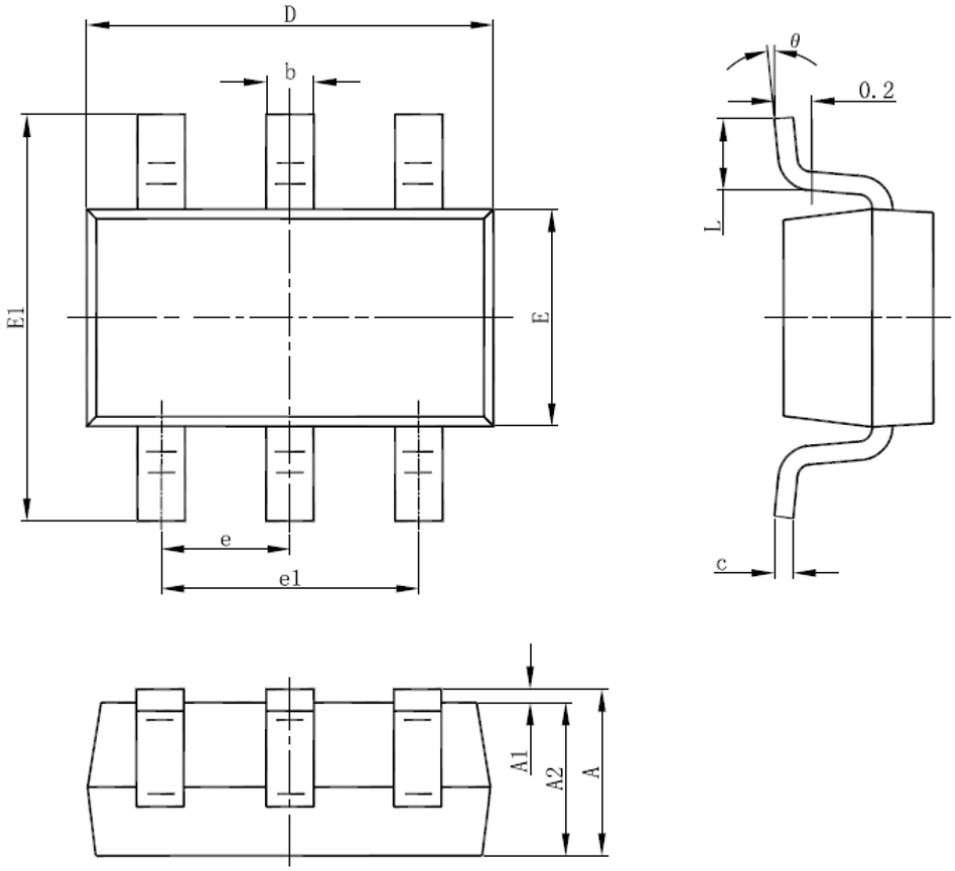
Pay careful attention to the PCB layout and component placement. RSENSE should be placed close to the IN pin and RS pin in order to minimize current sense error. The input loop—including input capacitor, Schottky diode, and MOSFET—should be as short as possible.

Typical Applications



Package Description

SOT23-6 (unit：mm)



SYMBOL	MILLIMETER		
	MIN	NOR	MAX
A	-	-	1.35
A1	0.04	-	0.15
A2	1.00	1.10	1.20
b	0.3	0.4	0.5
c	0.1	0.15	0.2
D	2.72	2.92	3.12
E	1.40	1.60	1.80
E1	2.60	2.80	3.0
e	0.95BSC		
e1	1.90BSC		
L	0.30	-	0.60
θ	0	-	8°