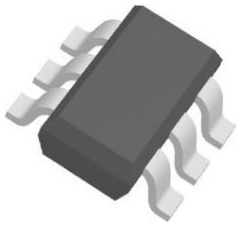
80V High Efficiency Step-Down LED Driver

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 the 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. NDP2024 also Includes thermal overload protection in case of output overload.



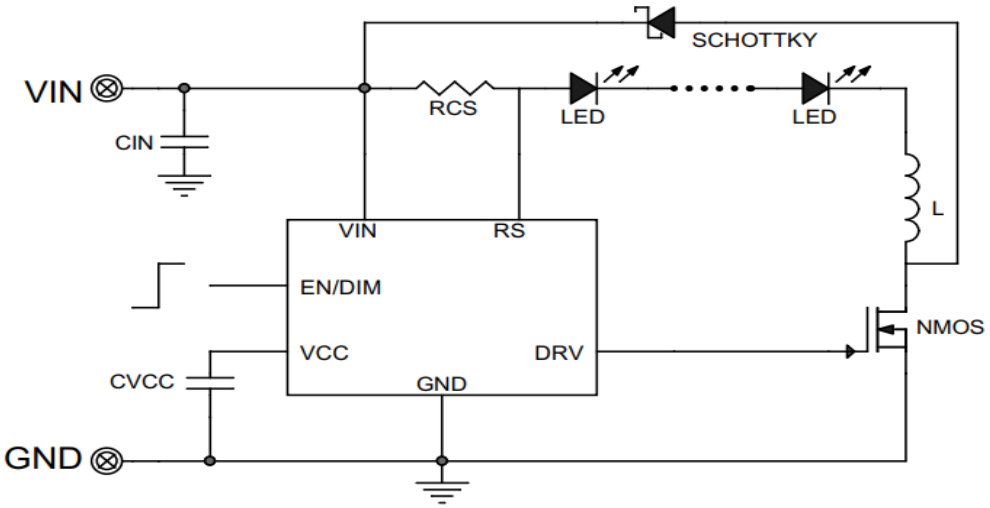
Features

- Wide Input Range：6V to 80V
- Able to Drive >1A LED Load
- Hysteresis Control
- High Efficiency (>95%)
- Open LED Protection
- Short LED Protection
- Current Decreases with Increasing Temperature
- 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



Order Information

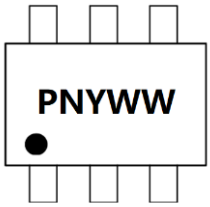
Orderable Device	Package Type	Packing Qty/Reel	MSL- Peak Temp -Floor Life	Eco Std	Marking Information
NDP2024	SOT23-6	3000	MSL3-260℃-168hrs	RoHS & Green	PNYWW

Product Naming

NDP2024

Product Number

Top Side Marking



PN: Part NO.(NDP2024=CV)
Y: Year (A=2021, B=2022…)
WW: Weekly (01-53)

Notes:

(1) **RoHS**: Quoted from **RoHS Detective (EU) 2015/863**, Deep-Pool defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. Deep-Pool may reference these types of products as "**Pb-Free**".

(2) **RoHS Exempt:** Deep-Pool defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

(3) **Green**: Deep-Pool defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JEDEC (**JS709C**) low halogen requirements of <=1000ppm threshold.

(4) **MSL**, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC (**J-STD-020F**) industry standard classifications, as well as the peak solder temperature of SMT and the floor life after unpacking, which customers should pay attention and strictly comply with the standard to use.

(5) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

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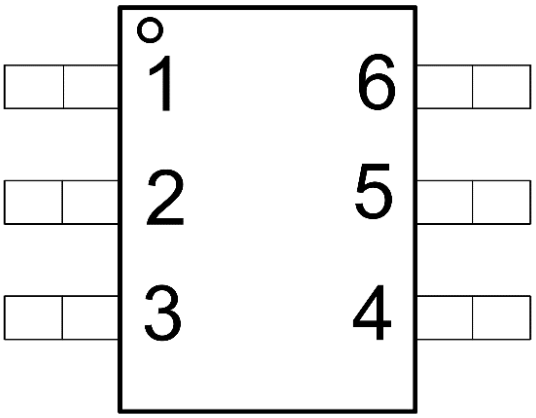
Pin Function and Definition

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 Regulator Output



Absolute Maximum Ratings (at T_A= 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 6.5	V
EN/DIM to GND		-0.3 to 6	V
DRV to GND		-0.3 to 6	V
Junction to Ambient Thermal Resistance	$R_{\theta JA}$	100	°C/W
Junction to case thermal resistance	$R_{\theta JC}$	55	°C/W

Notes:

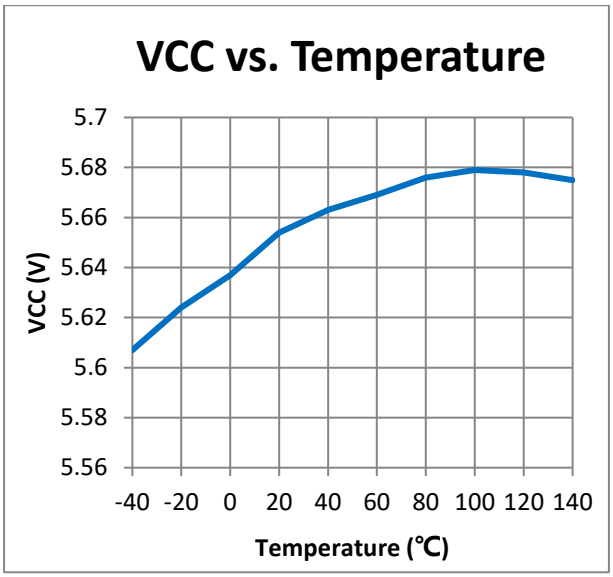
Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

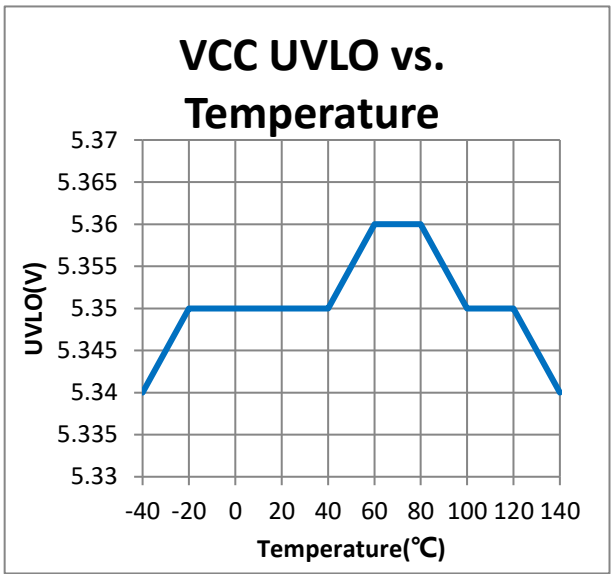
Electrical Characteristics

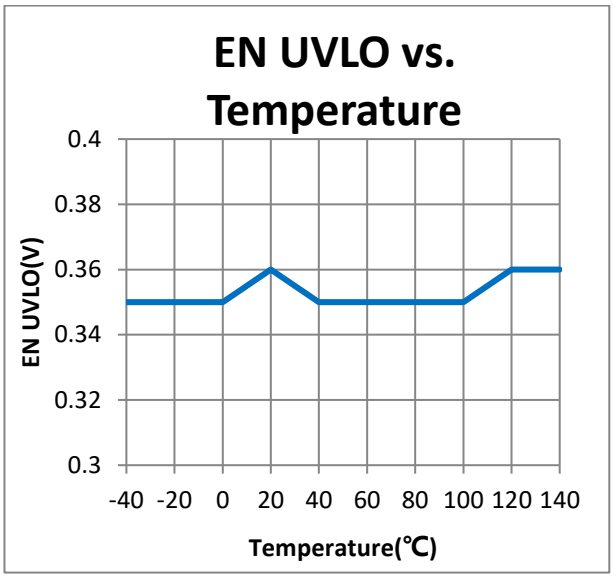
TJ = 25°C, V_{IN} = 12V, unless otherwise noted.

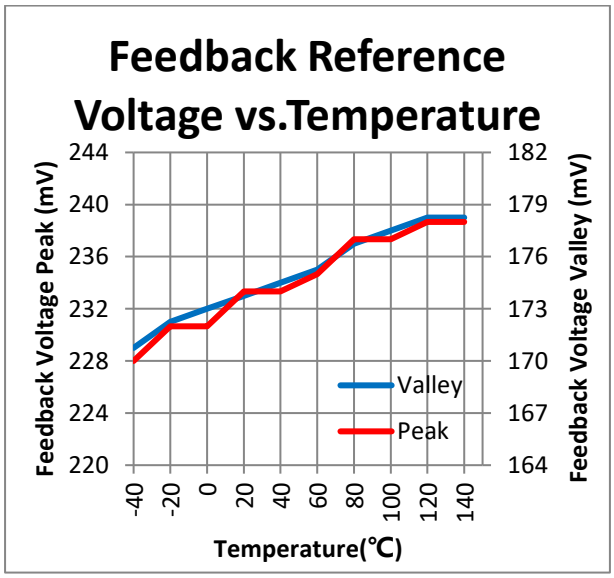
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage	V_{IN}		6		80	V
Shutdown Supply Current	I_{SD}			80	108	μA
Quiescent Supply Current	I_Q	No Switching		0.3	0.5	mA
VCC Voltage	V_{CC}	$V_{EN/DIM}$ = 3.5V	5.5	6		V
Feedback Average Voltage (with Respect to VIN)	V_{IN}-V_{RS}	$V_{EN/DIM}$ = 3.5V	194	200	206	mV
Feedback Reference Voltage Hysteresis	V_{FB_HYS}			±30		mV
EN/DIM Enable High Voltage	V_{EN_HIGH}	V_{EN} Rising		0.35		V
EN/DIM Enable Hysteresis	V_{EN_HYS}		20	50	80	mV
EN/DIM Pull-Down Current		Pull down to GND		2.8		μA
Min Recommended PWM Dimming Frequency	F_{PWM_MIN}			0.1		kHz
Max Recommended PWM Dimming Frequency	F_{PWM_MAX}			20		kHz
Gate Driver Source Resistor	R_{SRC}	V_{GS} = 5.5V		4		Ω
Gate Driver Sink Resistor	R_{SINK}			1.5		Ω
Gate Driver High	V_{OH}	I_{DRV} = 10mA	5.5			V
Gate Driver Low	V_{OL}	I_{DRV} = 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_{UVLO_TH}	V_{CC} Rising		5.6		V
VCC UVLO Hysteresis	V_{UVLO_HYS}			0.4		V
Thermal Shutdown Threshold		Temp. Rising		160		°C

TYPICAL CHARACTERISTICS





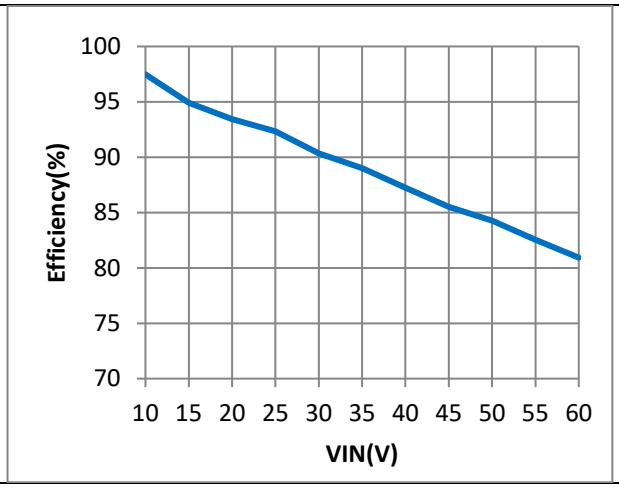




TYPICAL PERFORMANCE CHARACTERISTICS

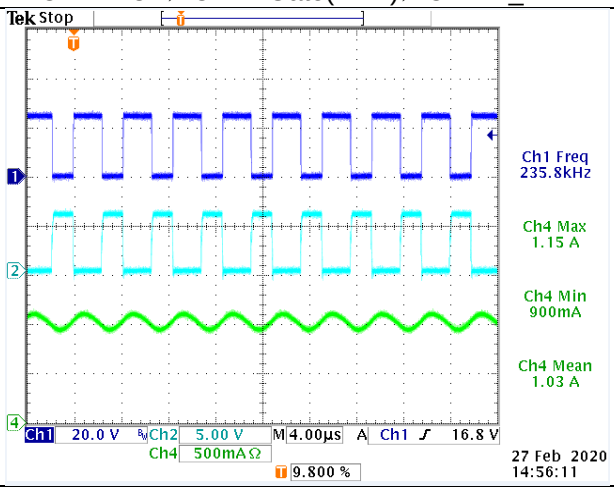
V_{IN} = 24V, 3LEDs, I_{OUT} = 1A, R_S=200mΩ,L=68uH,T_A = 25°C, unless otherwise noted.

Efficiency



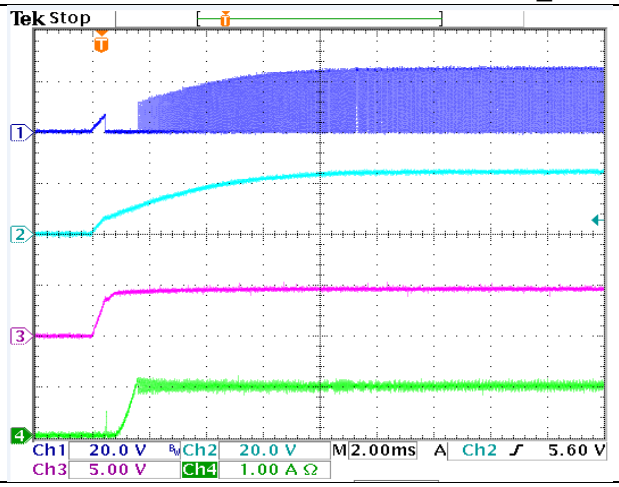
Steady State

CH1 : Vsw，CH2 : Gate(DRV)，CH4 : I_LED



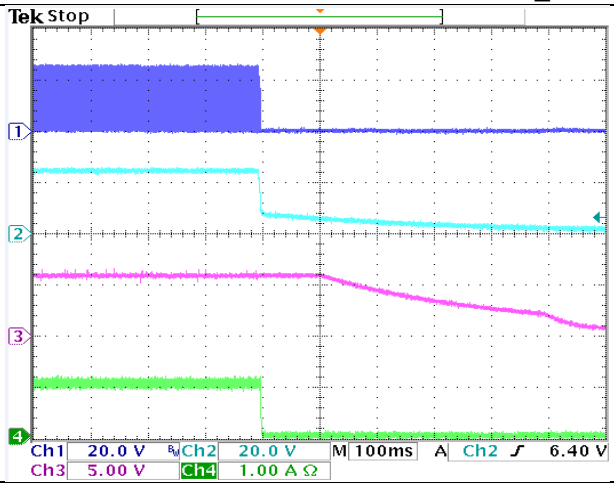
Input Power On

CH1 : Vsw，CH2 : VIN，CH3 : EN，CH4 : I_LED



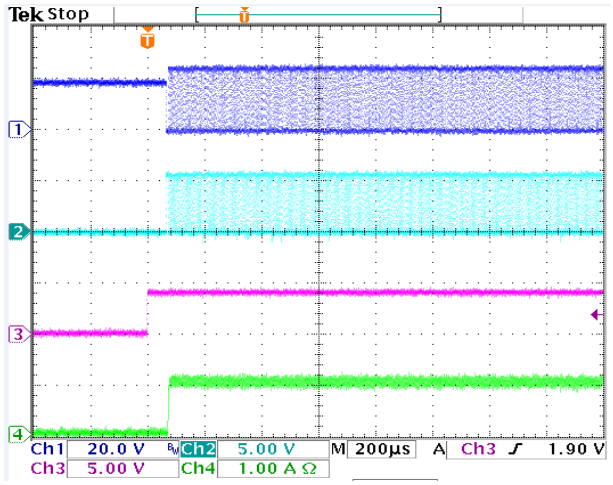
Input Power Off

CH1 : Vsw，CH2 : VIN，CH3 : EN，CH4 : I_LED



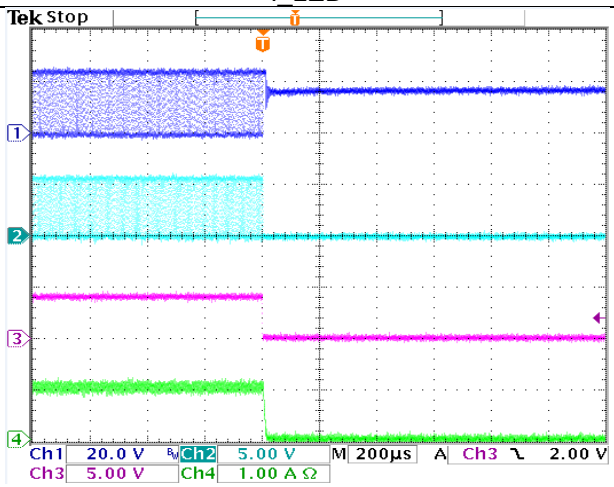
EN Power On

CH1 : Vsw，CH2 : Gate(DRV)，CH3 : EN，CH4 : I_LED



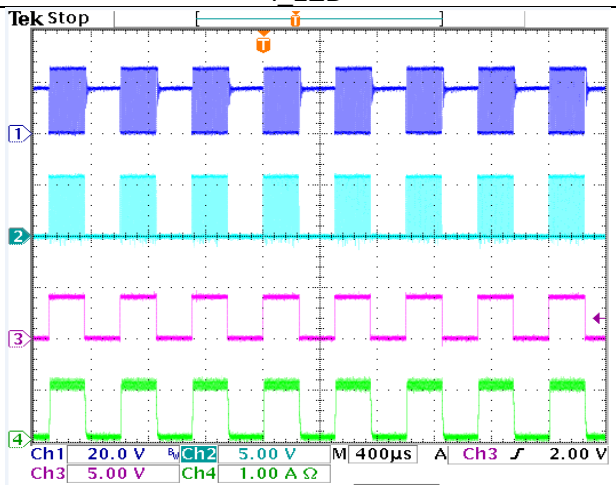
EN Power Off

CH1 : Vsw，CH2 : Gate(DRV)，CH3 : EN，CH4 : I_LED



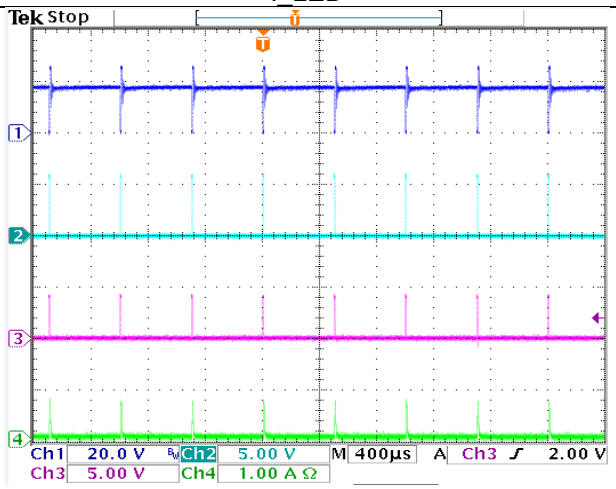
PWM Dimming(2kHz,50%)

CH1 : Vsw，CH2 : Gate(DRV)，CH3 : EN，CH4 : I_LED



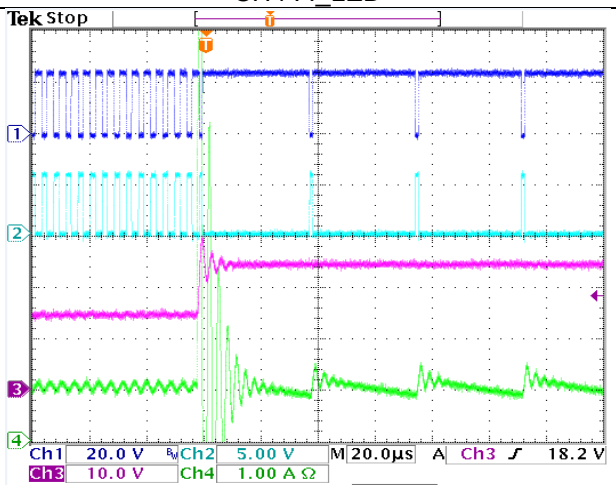
PWM Dimming(2kHz,1%)

CH1 : Vsw，CH2 : Gate(DRV)，CH3 : EN，CH4 : I_LED



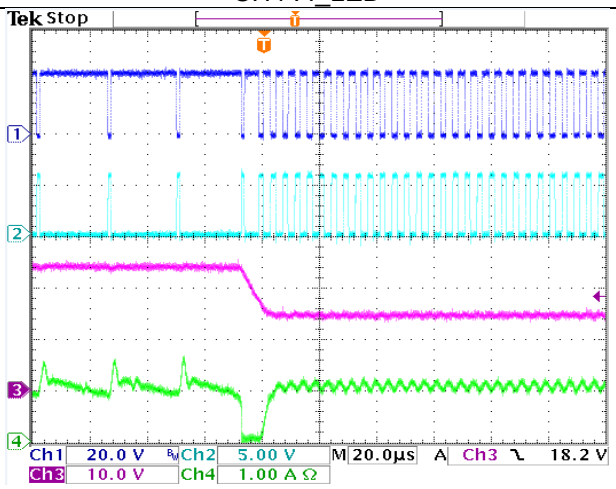
Short LED+ to LED- Protection

CH1 : Vsw，CH2 : Gate(DRV)，CH3 : V_LED，CH4 : I_LED



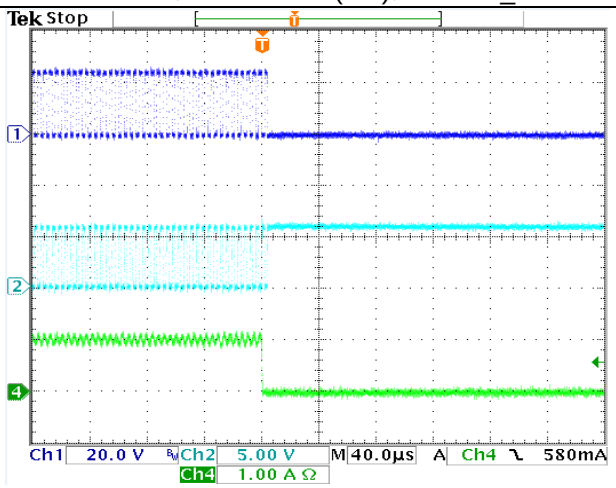
Short LED+ to LED- Recovery

CH1 : Vsw，CH2 : Gate(DRV)，CH3 : V_LED，CH4 : I_LED



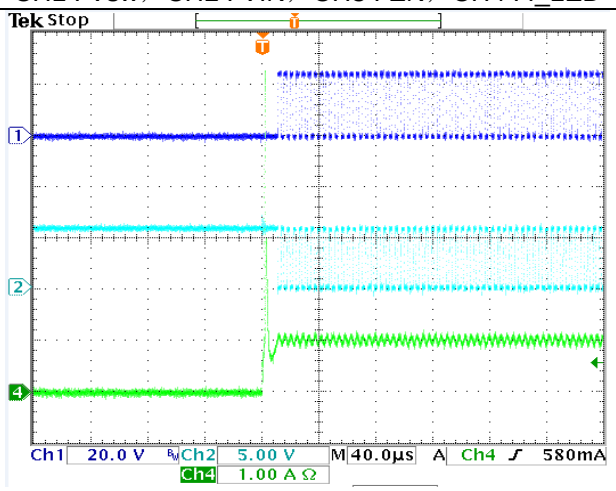
Open LED Load Protection

CH1 : Vsw，CH2 : Gate(DR)，CH4 : I_LED



Open LED Load Recovery

CH1 : Vsw，CH2 : VIN，CH3 : EN，CH4 : I_LED



Block Diagram

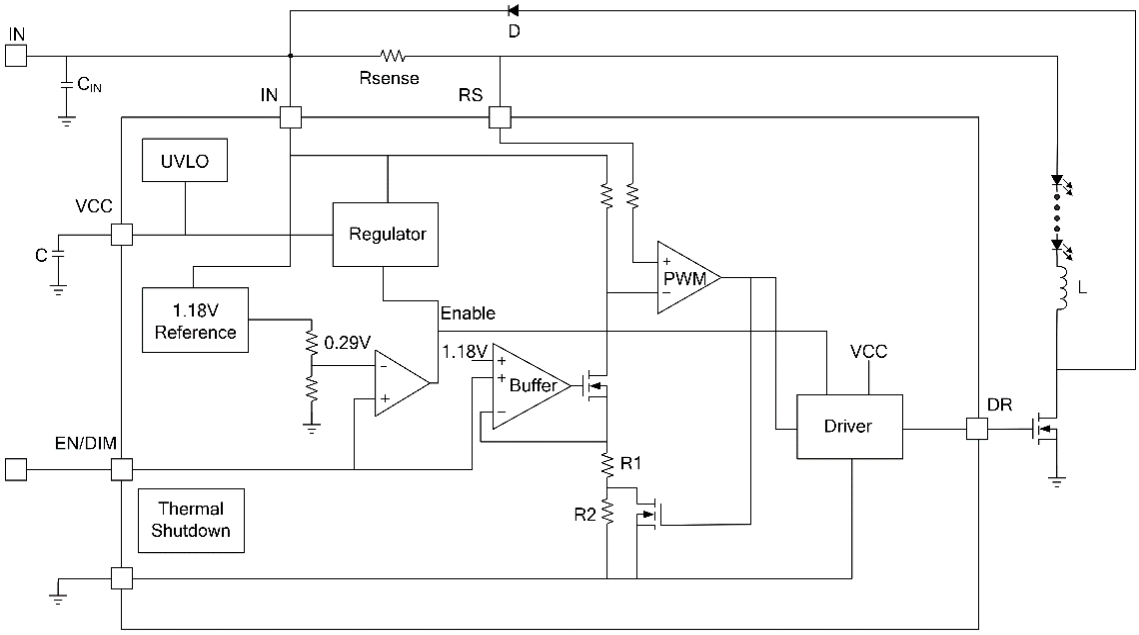


Figure 1—NDP2024 Functional Block Diagram

Operational

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 80V 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 0.35V reference to enable the part. When VEN>0.35V, the output of the comparator goes high and enables the other blocks. The NDP2024 also provides a 5.6V 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 0.3V, the chip turns off. For analog dimming, when the voltage on DIM is from 0.35V to 2V, the LED current will change from 20% to 100% of the maximum LED current. If the voltage on EN pin is higher than 2.2V, output LED current will equal the maximum LED current. For PWM dimming, the signal amplitude must exceed 2.5V. 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.

$$R_{SENSE}=200mV/I_{LED}$$

For R_{SENSE}=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.

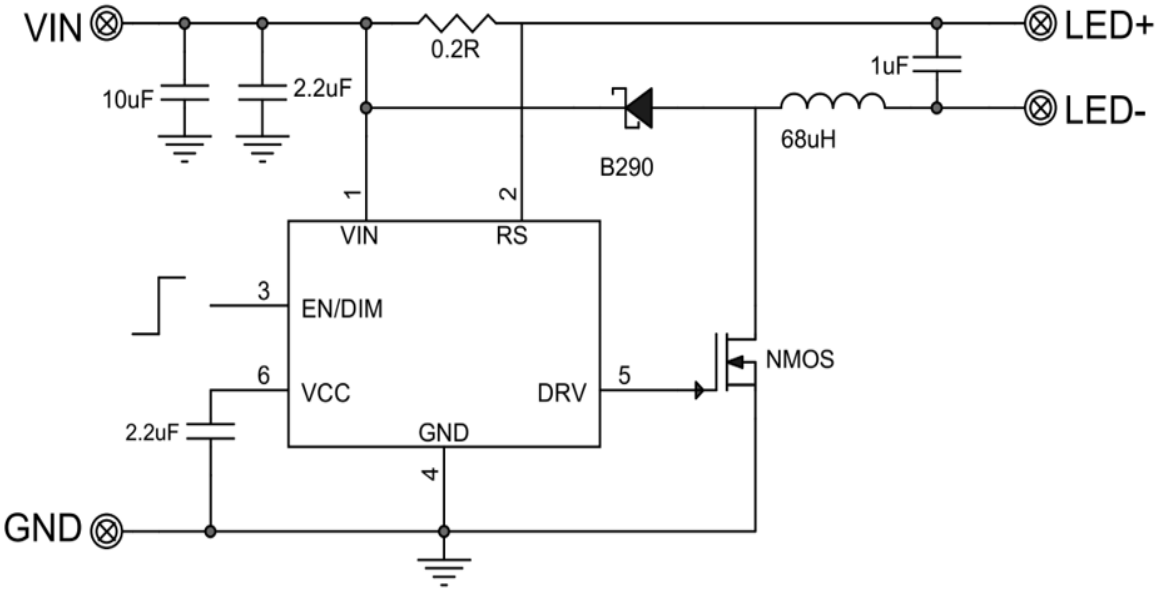
Selecting the Output Capacitor

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.

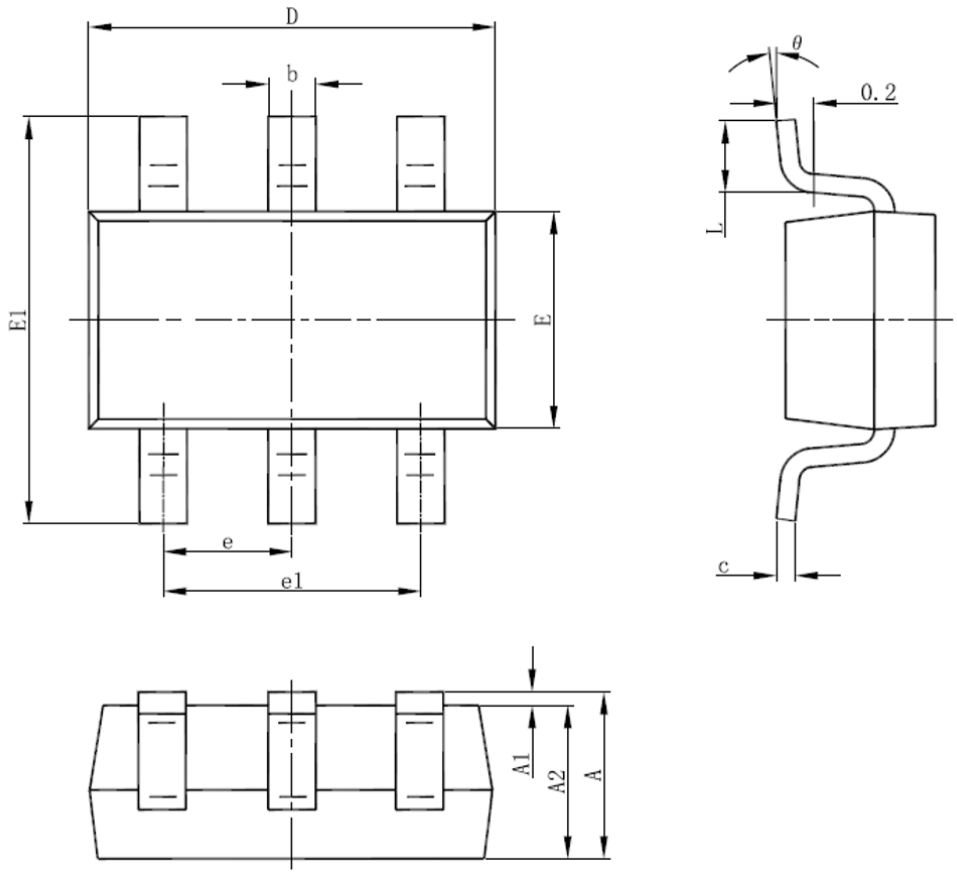
Layout Consideration

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

Typical Applications



Package Outline Drawing



SYMBOL	MILLIMETER (UNIT：mm)		
	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°

Notes

1. Use millimeters as the primary measurement
2. Dimensioning and tolerances conform to ASME Y14.5M. – 1994
3. These dimensions do not include mold flash or protrusions.
4. Mold flash or protrusions shall not exceed 0.15mm

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