

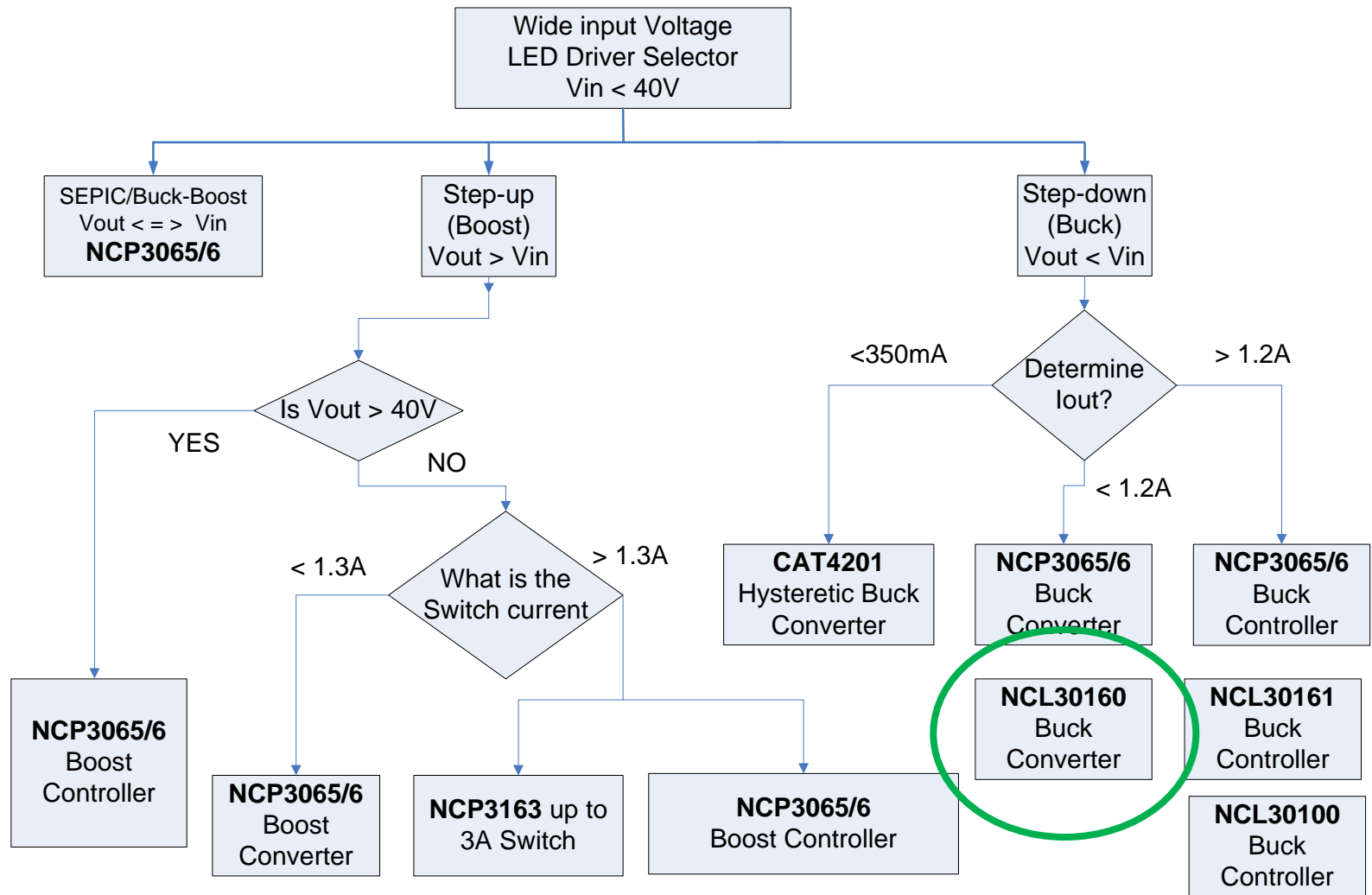


**ON Semiconductor®**

# **LED Drivers for MR16 Lamps**

## **NCL30160/NCL30161**

# LED Driver DC-DC Decision Tree



# NCL30160 – HB-LED Regulator

## Value Proposition

The NCL30160 is an NFET hysteretic step-down, constant-current driver for high power LEDs. **A dedicated PWM input (DIM)** enables wide range of pulsed dimming. **Switching frequency up to 1.4 MHz**, minimizing space and cost. Intended for continuous conduction mode operation, thus **no output capacitor is needed**

## Unique Features

- **50 mΩ integrated MOSFET**
- Capable of 100% max duty cycle
- **Input voltage from 6.3 V to 40 V input**

## Benefits

- High efficiency solution
- Wide input voltage range capability

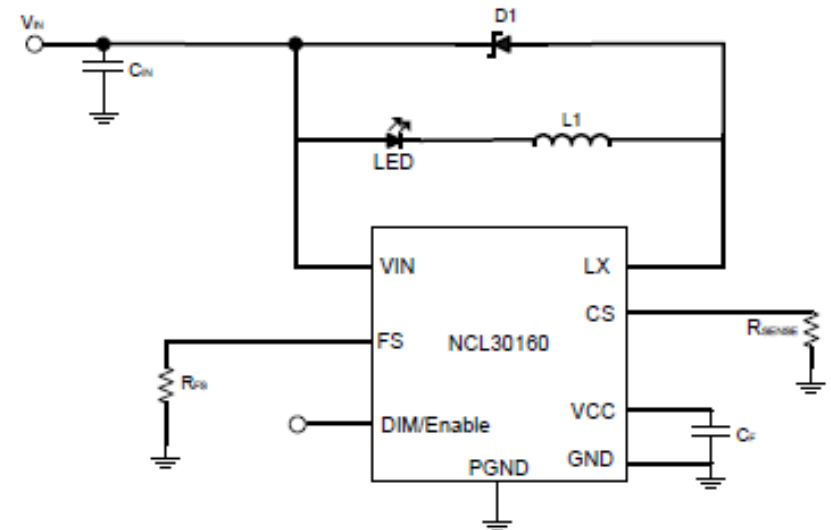
## Others Features

- Up to 1.4 MHz switching frequency
- Dedicated PWM dimming pin / low power shutdown
- No control loop compensation required
- 1.5 A average current capability

## Market & Applications

- **Architectural:** MR-16
- **Area Lighting:** Light strips, Landscape, Under-cabinet

## Application Data



High Efficiency 50mΩ  
MOSFET

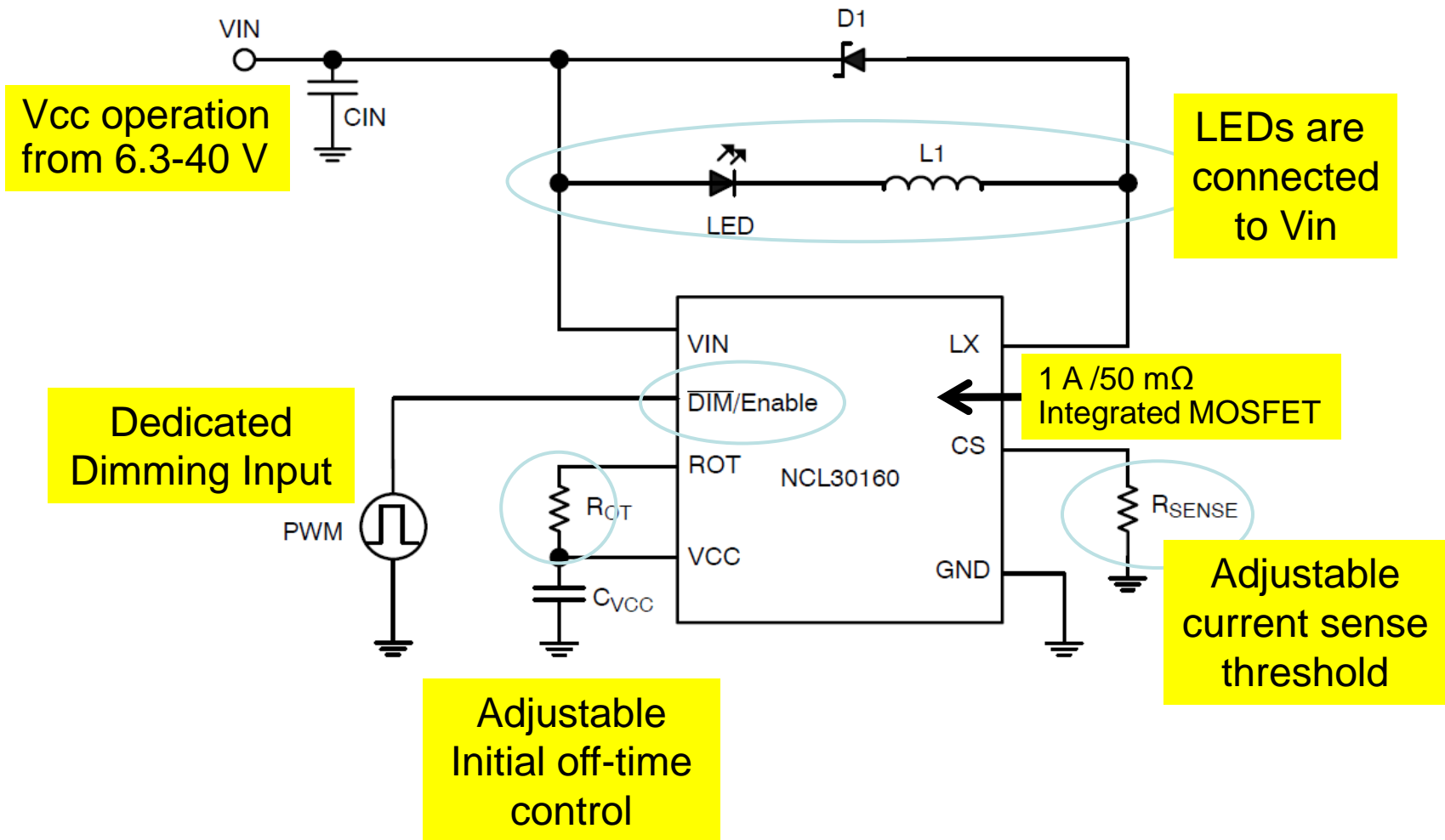
Dedicated DIM Pin

## Ordering & Package Information

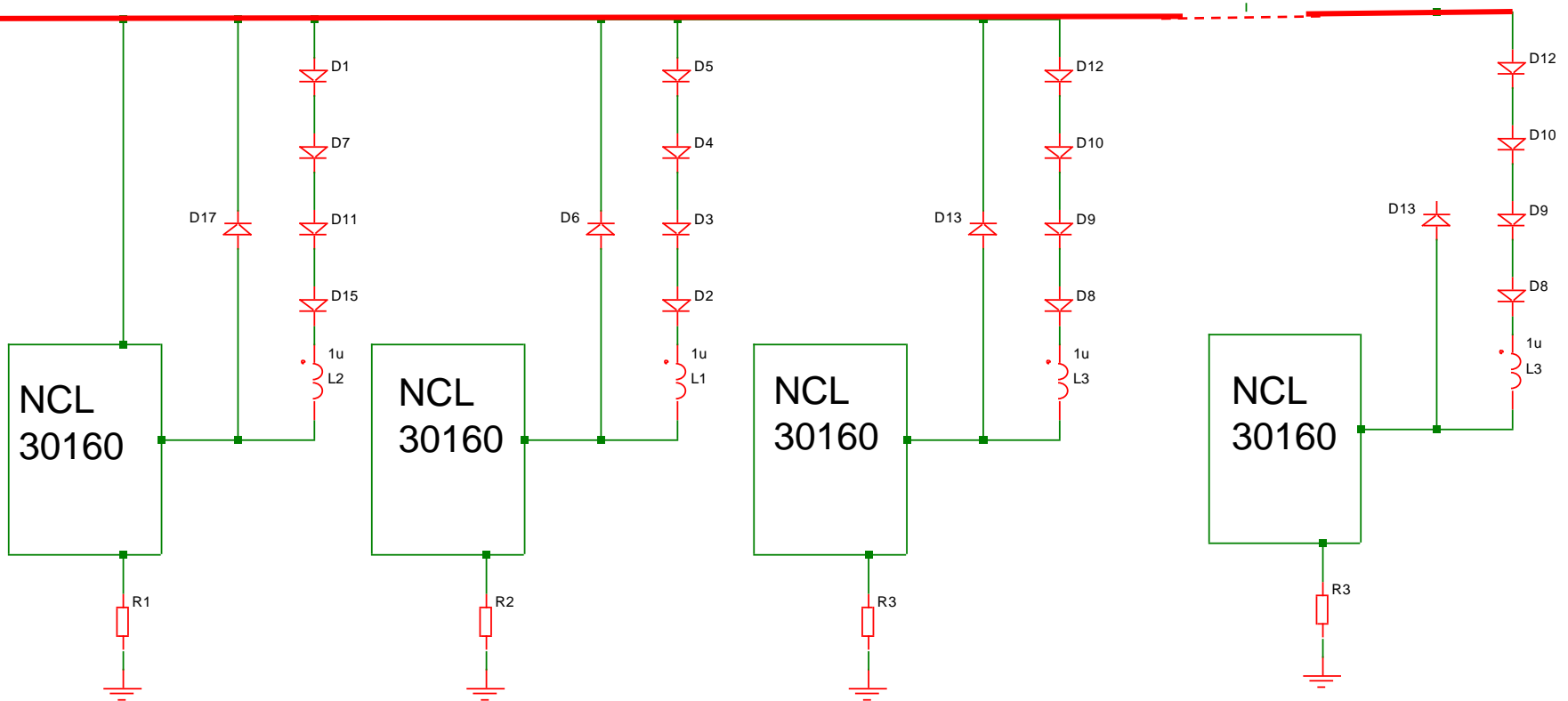
- SOIC-8
- NCL30160



# NCL30160 Key Features

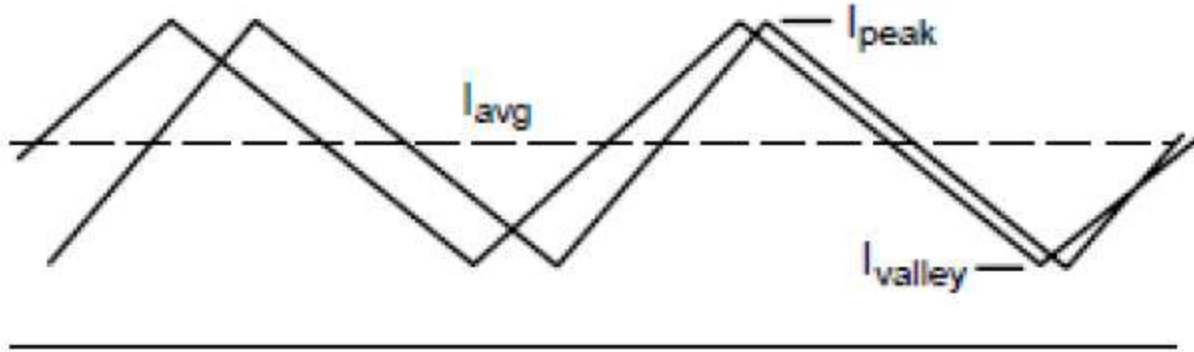


# Common Vin Multi-string Connection



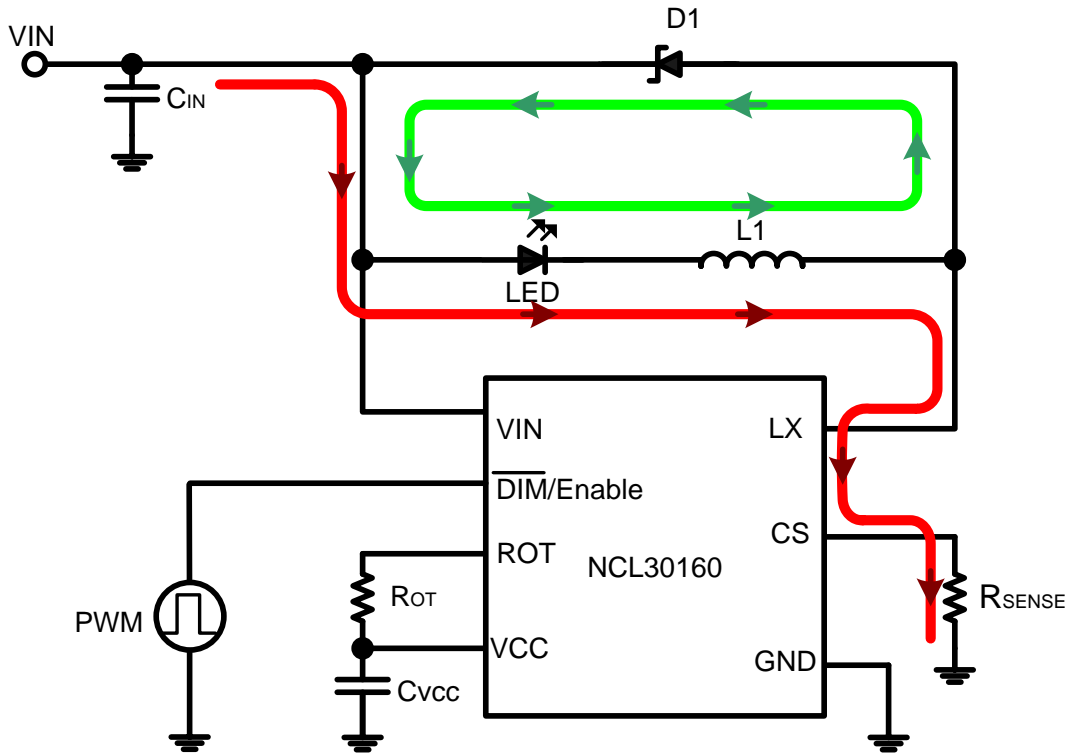
Reduce the connection lines for the multi-string LEDs

# Functional Description

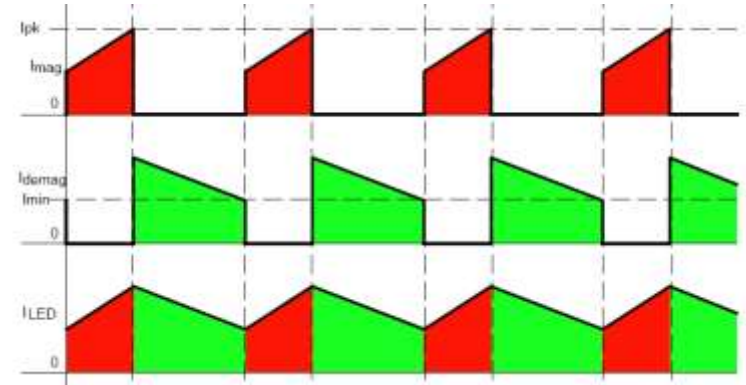


- The NCL30160 uses a hysteretic control of the output current. It aims to keep the peak and valley of the current ripple at a set threshold level.
- When the FET is on and the current is rising, the current is continuously sensed through a resistor until it sees the peak current, and then turns off.
- When the FET is off and the current is falling, a timer is used for the off-time duration. When the off-time ends, the valley current is sensed, and adjusts the next off-time if needed.

# Peak Current – Fixed Off Time Operating Principle



## No Output Cap



- **Red** Path show current flow when switch is ON
- **Green** Path shows current flow when switch is OFF

# Off-Time Setting Resistor

- Since the current is not sensed while the MOSFET is off, a timer is used to set the FET off-time duration.
- The off-time setting resistor sets the initial FET off-time only, when the part starts up. This allows the LED current to quickly reach its expected level.
- To pick the value of the off-time setting resistor:

- Calculate off-time: 
$$t_{\text{OFF}} = \frac{L \times \Delta I}{V_{\text{IN}} + V_{\text{diode}} + I_{\text{OUT}} \times \text{DCR}_L}$$

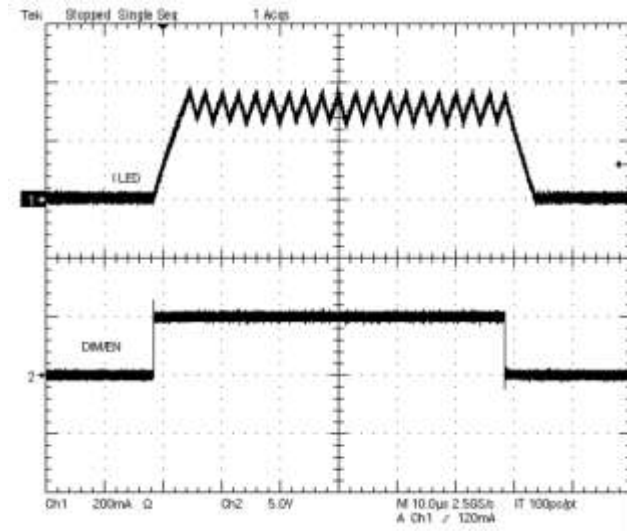
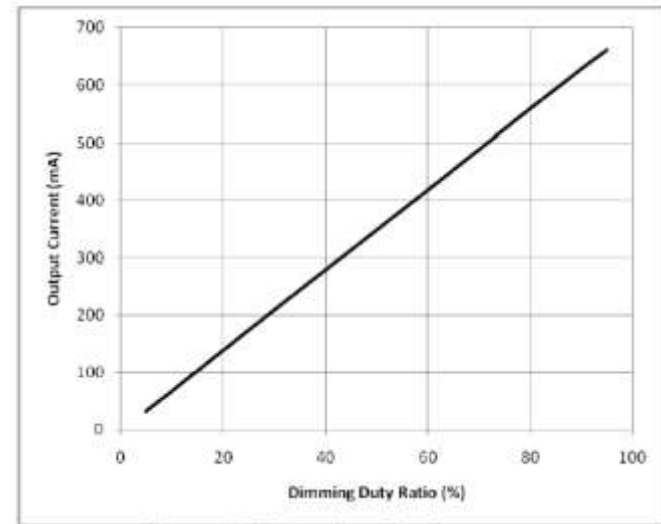
- Calculate resistor value: 
$$R_{\text{OT}} = t_{\text{OFF}} \times 10^{11} \Omega$$





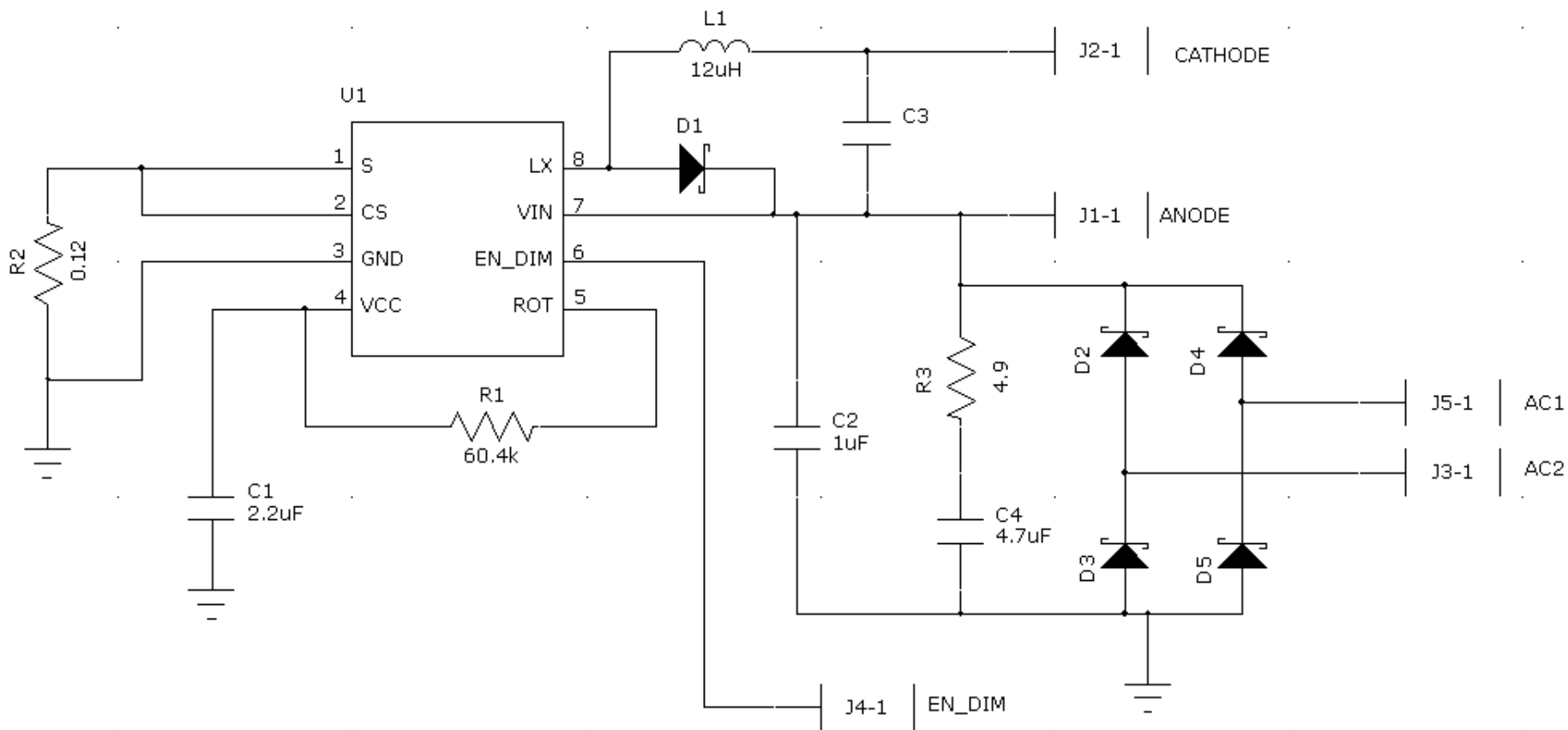
# Dimming Performance

- Dimming works by pulse-width modulation (PWM) on the DIM/Enable pin
- The duty ratio of the PWM is equivalent to the amount of dimming



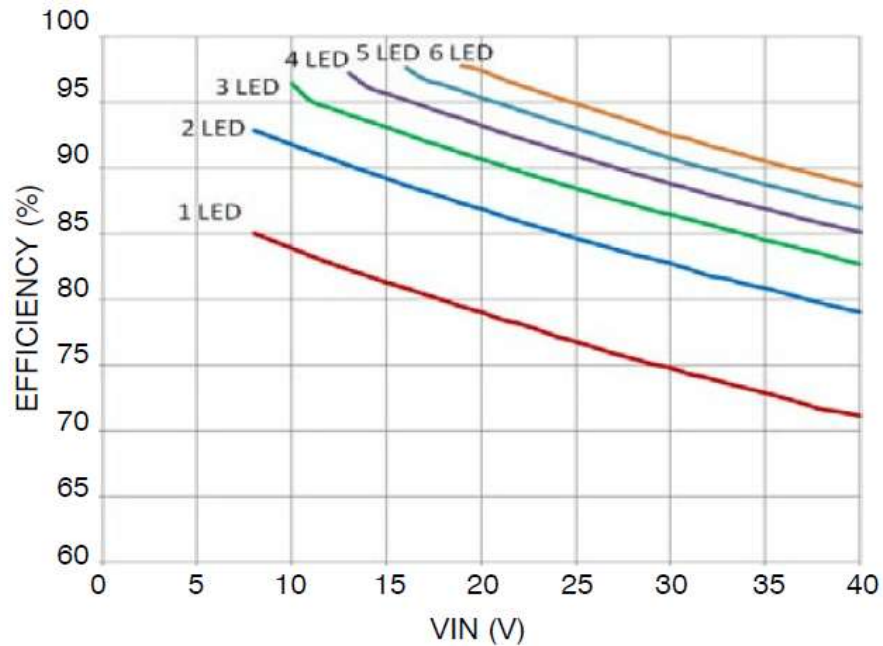
# NCL30160 Schematic

- MR-16 12 Vac / up to 1 A application

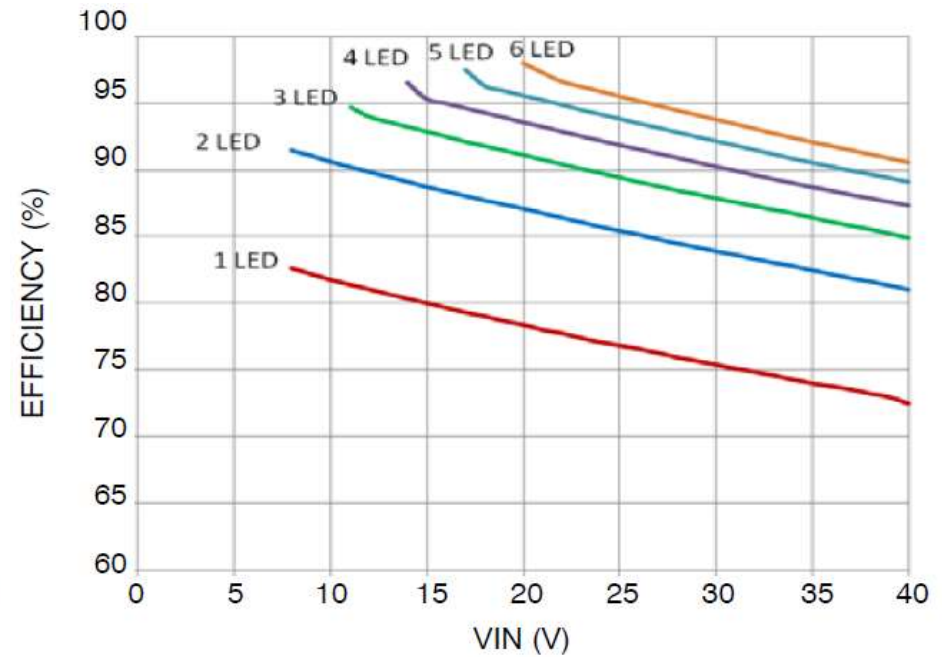


# Efficiency Performance

**350 mA / 3.5 Vf**

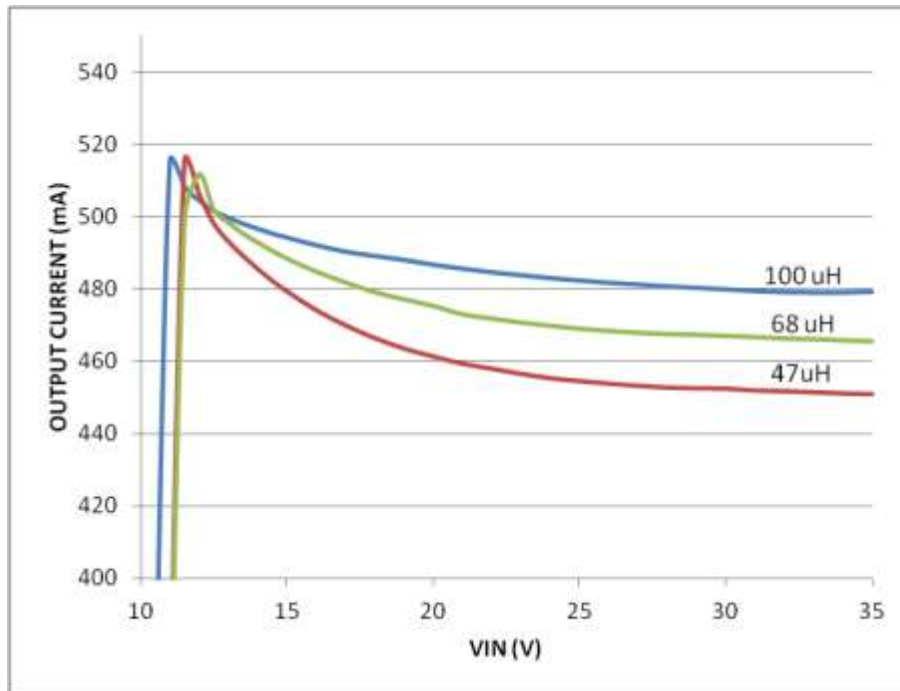


**750 mA / 3.5 Vf**

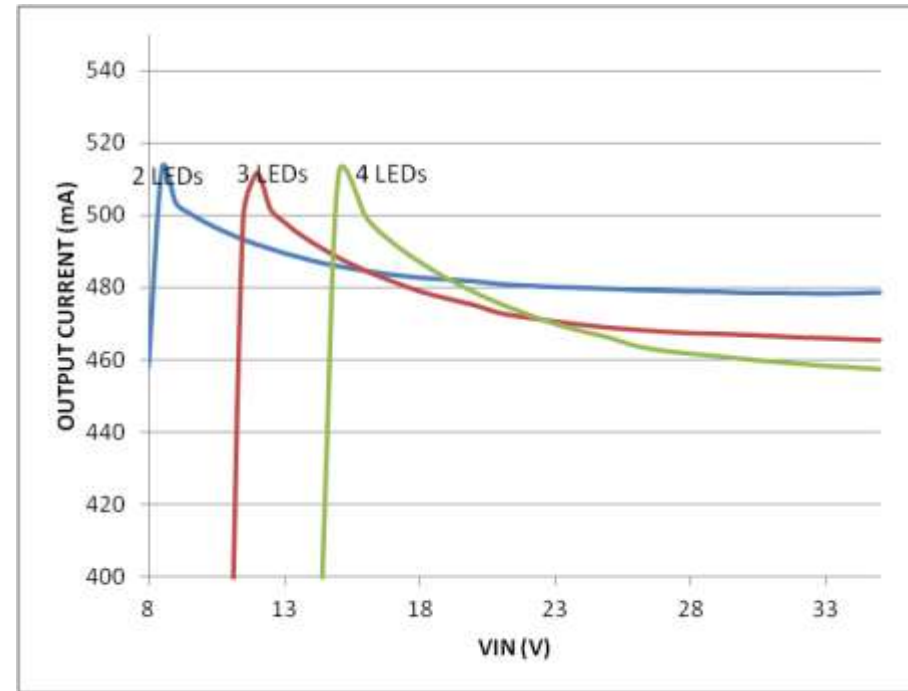


# Output Current Line Regulation

500 mA / 3 LEDs / 3.5 Vf

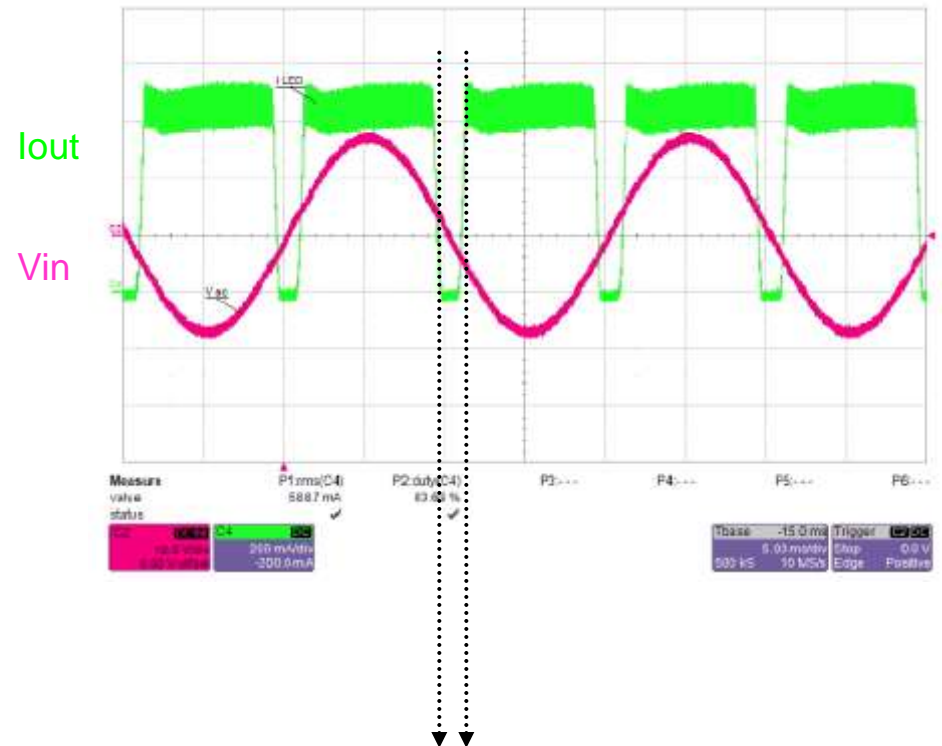


500 mA / 68 uH / 3.5 Vf



# 12 Vac Buck Operation

- Recall that in a buck topology, current only flows when  $V_{in}$  is greater than  $V_{out}$
- Since the current isn't always flowing, you will need to use a smaller  $R_{sense}$  value to reach a desired value average current.
- So, NCL30160 voltage varies with 12 Vac input waveform



No current flows  
when  $V_{in} < V_{out}$

# Electronic Ballast Compatibility Table

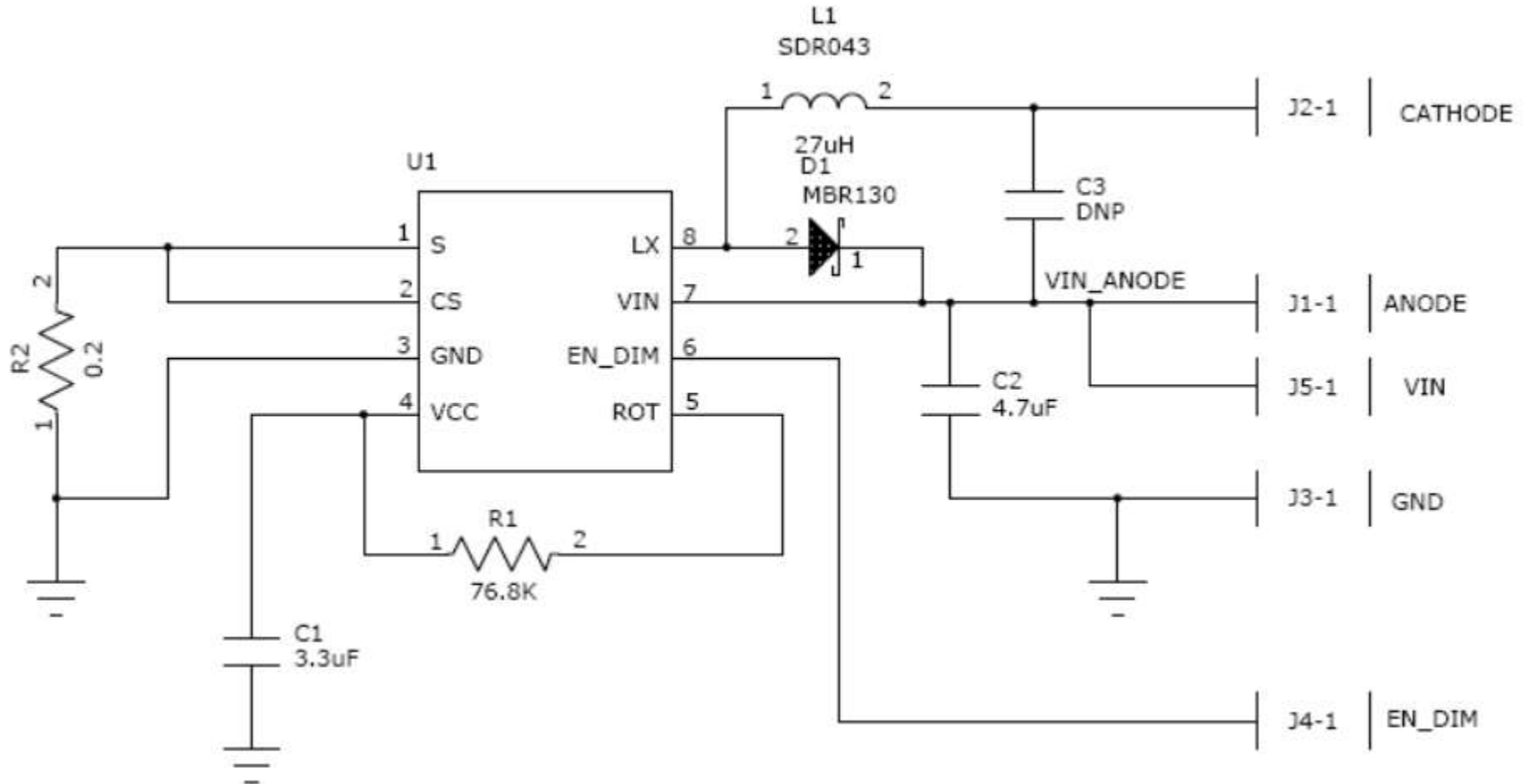
## 3 LEDs in series, 2 channels in parallel, 1 A

Parameter	Lightech LET-75	Hatch RS12-80M	Lightech LET-60	Eurofase 0084	Hatch RS12-30M-LED
$V_{IN}$	120.5 V	120.4 V	120.2 V	120.3 V	120.2 V
$I_{IN}$	72.08 mA	76.14 mA	72.65 mA	68.98 mA	83.11 mA
$P_{IN}$	7.746 W	8.254 W	7.862 W	7.244 W	9.491 W
Power Factor	0.892	0.900	0.900	0.873	0.950
$V_{LED}$	8.77 V	9.14 V	8.84 V	8.70 V	9.26 V
$I_{LED}$	0.638 A	0.685 A	0.647 A	0.606 A	0.715 A
$P_{LED}$	6.669 W	7.157 W	6.779 W	6.342 W	7.461 W
Efficiency	86.1%	86.7%	86.2%	87.6%	78.6%

## 2 LEDs in series, 2 channels in parallel, 0.7 A

Parameter	Lightech LET-75	Hatch RS12-80M	Lightech LET-60	Eurofase 0084	Hatch RS12-30M-LED
$V_{IN}$	120.2 Vac	120.1 Vac	120.1 Vac	120.0 Vac	120.1 Vac
$I_{IN}$	75.77 mA	78.26 mA	77.08 mA	73.81 mA	90.91 mA
$P_{IN}$	7.925 W	8.414 W	8.057 W	7.693 W	9.989 W
Power Factor	0.870	0.895	0.870	0.869	0.915
$V_{LED}$	4.58 V	4.97 V	4.69 V	4.53 V	5.45 V
$I_{LED}$	0.927 A	0.986 A	0.942 A	0.904 A	1.07 A
$P_{LED}$	6.589 W	7.017 W	6.703 W	6.452 W	7.618 W
Efficiency	83.1%	83.4%	83.2%	83.9%	76.3%

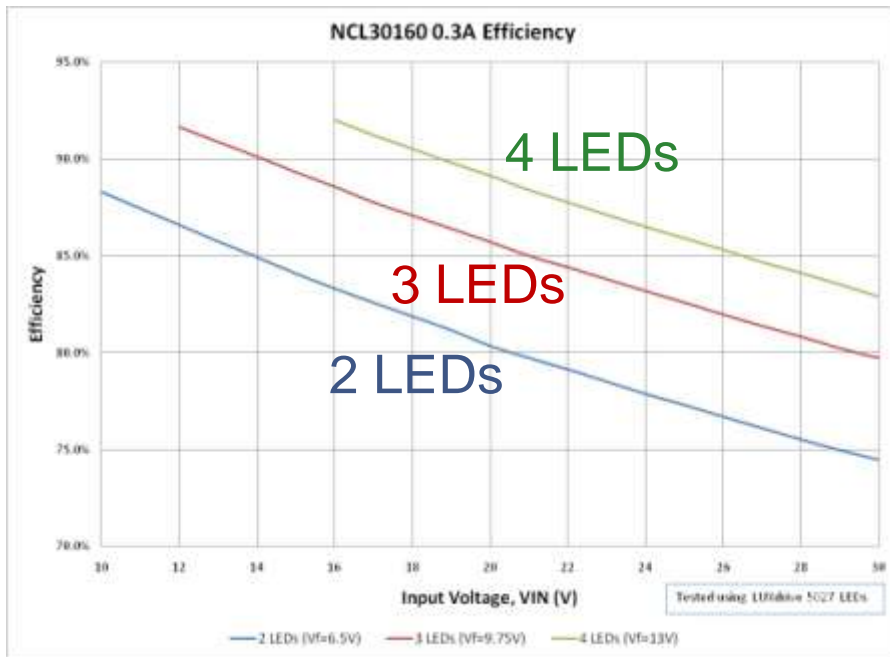
# NCL30160 Application Schematic



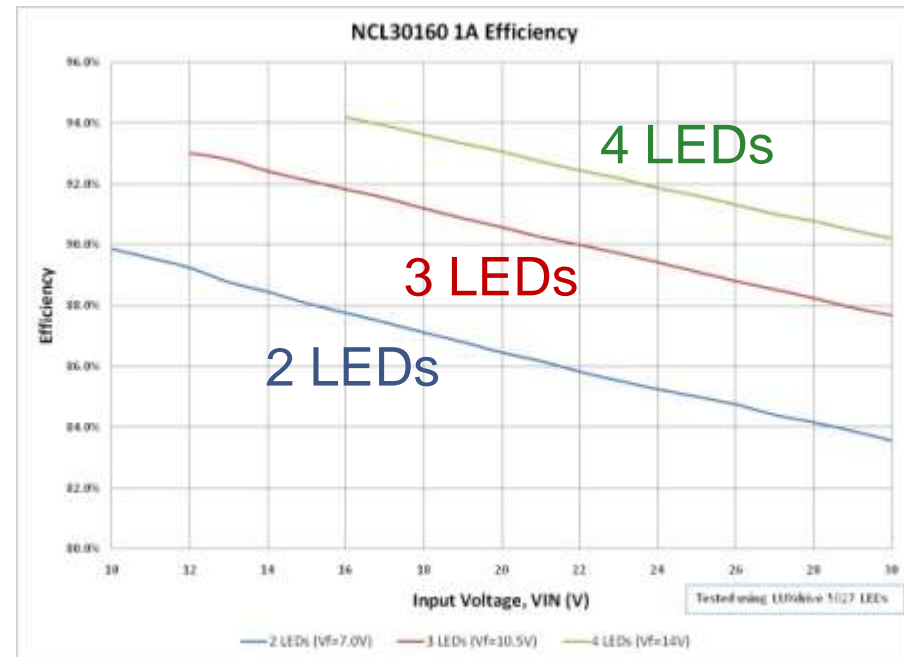
- 12 Vdc or 24 Vdc / up to 1 A application

# Efficiency Performance

300 mA



1 A





# Design Tools / Support

- Excel based tool
- Eval boards
  - NCL30160GEVB
- Design notes
  - 24 V LED Light Strip



# Comparison

	NCL30160	ZX XXXX	PT XXXX	LM XXXX		NCP3065	NCL30100
Input Voltage	6.3 - 40V	7 - 30 V	8 - 30V	6 - 42 V		3 - 40 V	6 - 18 V
Continuous Output Current	1.0 A	1.0 A	1.2 A	1.2 A		1.2 A	N/A
Switch	50mohm	1000mohm	600mohm	750mohm		1000mohm (eq)	Controller
Fsw	50 - 1400 kHz	50 - 500 kHz	100 - 1000 kHz	50 - 1000 kHz		50 - 250 kHz	50 - 500 kHz
Sense Method	Peak	Average	Peak	Peak		Average	Peak
Duty Cycle	100% max	70% max	~90% max	~ 70% max		~ 85% max	~ 85% max
FB Voltage	0.2 V	1.25 V	1.23 V	0.2 V		0.25 V	1.2 V
Topology	Buck	Buck	Buck	Buck		Buck, Boost, Buck/Boost	Buck
Package Rja	85 °C/W	125 °C/W	45 °C/W	155 / 50 °C/W		85 °C/W	178 °C/W
Package	SO-8	TSOT-23-5	SO-8EP	SO-8 / SO-8EP		SO-8 / PDIP-8 / DFN-8	TSOP-6
Controller	NO	NO	NO	NO		YES	YES
Dedicated Dimming Pin	YES	YES	YES	YES		NO	NO
Thermal Protection	YES	NO	YES	YES		YES	NO
Control Methodology	Hysteretic	Hysteretic	Hysteretic	Hysteretic		Hysteretic	Hysteretic



# NCL30161 - Buck Regulator for Driving High Power LEDs

## Value Proposition

The NCL30161 is a hysteretic step-down, constant-current driver for high power LEDs. Ideal for automotive, industrial and general lighting applications utilizing minimal external components.

## Features

- VIN Range 6.3 V to 40 V
- Short LED Shutdown Protection
- No Control Loop Compensation Required
- Adjustable LED Current
- Single Pin Brightness and Enable/Disable Control Using PWM
- Supports All-Ceramic Output Capacitors and Capacitor-less Outputs
- Thermal Shutdown Protection
- Capable of 100% Duty Cycle Operation

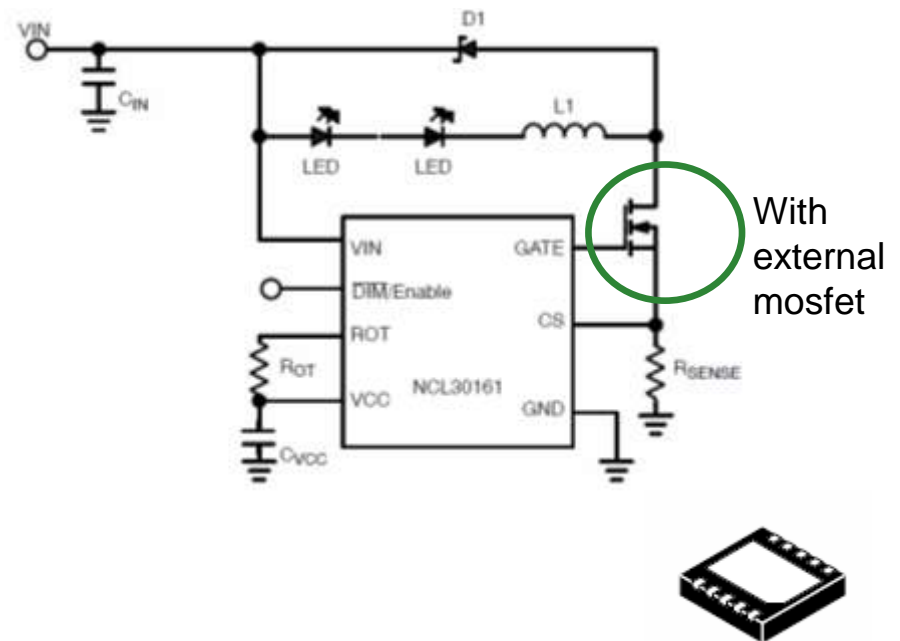
## Benefits

- Hysteretic control provides good power supply rejection and fast response during load transients
- Dedicated PWM input (DIM/EN) enables a wide range of pulsed dimming
- Uses smaller external components minimizing space and cost.
- Protection features include resistor-programmed constant LED current, shorted LED protection, under-voltage and thermal shutdown.

## Market & Applications

- LED Driver
- Constant Current Source
- Automotive Lighting
- General Illumination
- Industrial Lighting

## Typical Application diagram & Package info



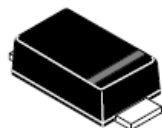
## Ordering info & Support

NCL30161MNT2G

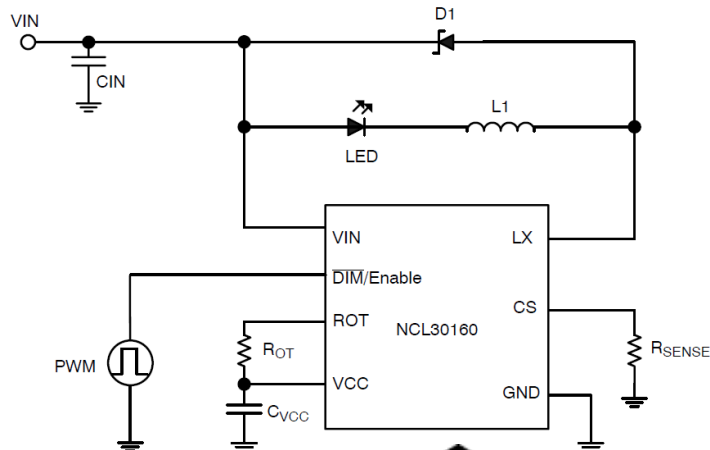
Package – 3mm x 3mm DFN10

# Smaller Size Solution

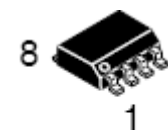
1.8 mm\*3.8 mm\*1 mm



SOD-123FL



NCL30160



SOIC-8 NB

5mm\*6mm\*1.1mm

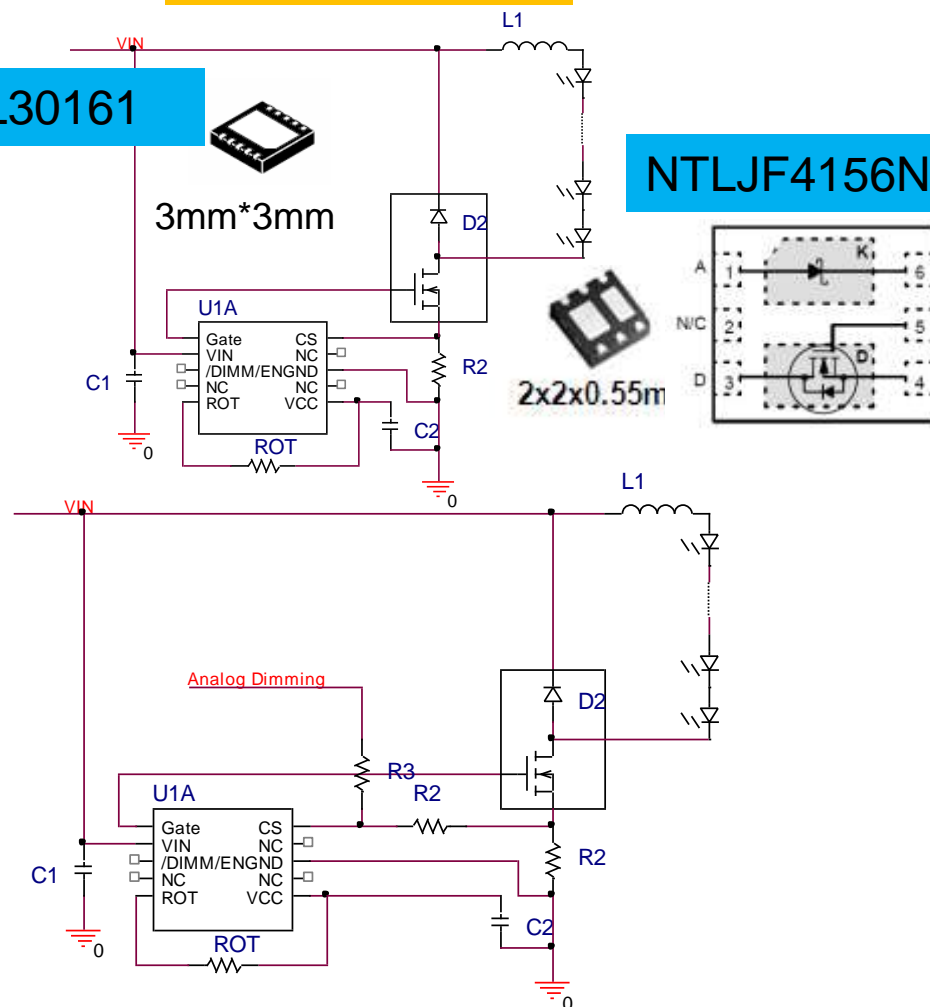
36.8 mm\*mm

13 mm\*mm

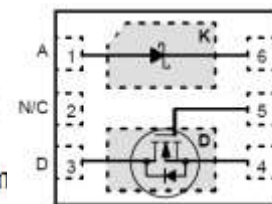
NCL30161



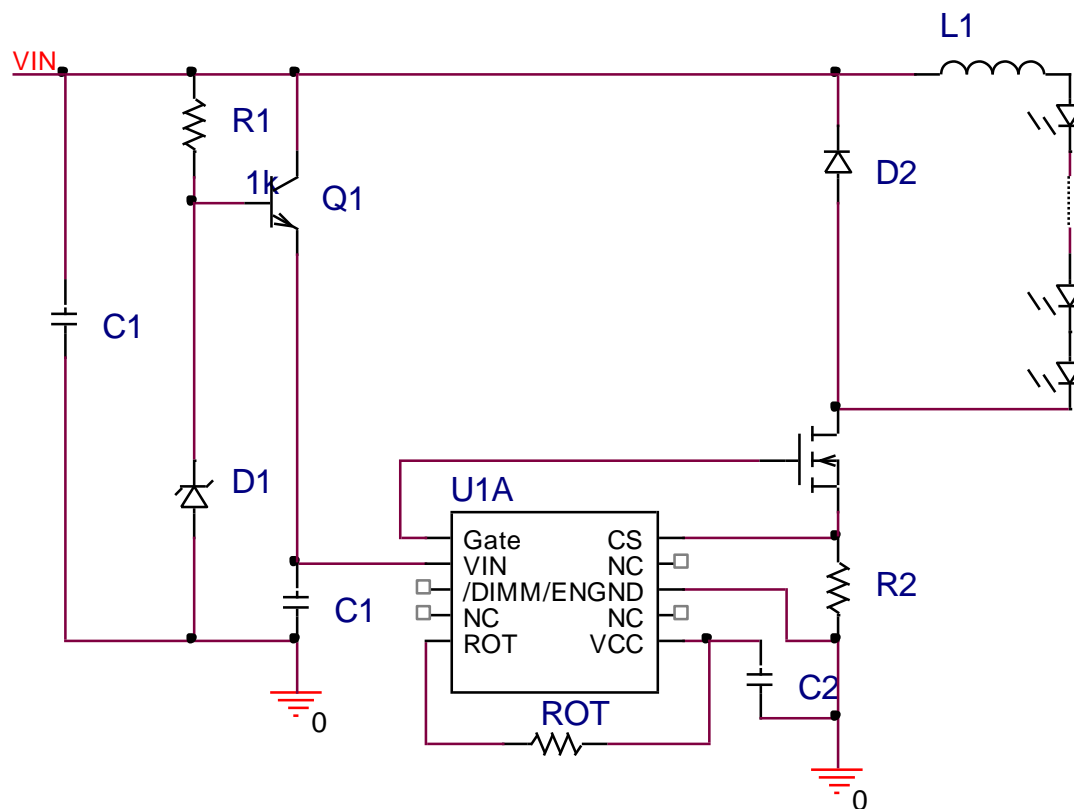
3mm\*3mm



NTLJF4156N



# Increase the input voltage



# Thank you



# Block Diagram

