NCV30161

Constant-Current Buck Regulator for Driving High Power LEDs

The NCV30161 is a hysteretic step−down, constant−current driver for high power LEDs. Ideal for industrial and automotive applications utilizing minimal external components. The NCV30161 operates with an input voltage range from 6.3 V to 40 V. The hysteretic control gives good power supply rejection and fast response during load transients and PWM dimming to LED arrays of varying number and type. A dedicated PWM input ($\overline{DIM}$/EN) enables a wide range of pulsed dimming, and a high switching frequency allows the use of smaller external components minimizing space and cost. Protection features include resistor−programmed constant LED current, shorted LED protection, under−voltage and thermal shutdown. The NCV30161 is available in a DFN10 3 mm x 3 mm package with wettable flanks.

Features

- VIN R6.2 (ion,)[(external)525 /C22 1 TfdOi1 1 TTf12 0 0.24f 0 Tc 0 Tw 5.917 -1.155 T.ss8001 -6. ive1Thea DTT1w22m (24f 0

PIN FUNCTION DESCRIPTION

Pin	Pin Name	Description	Application Information
1	CS	Current Sense feedback pin	Set the current through the LED array by connecting a resistor from this pin to ground.
2, 4, 7	NC	No Connect	
3	GND	Ground Pin	Ground. Reference point for all voltages
5	VCC	Output of Internal 5 V linear regulator	PTe LCC.

MAXIMUM RATINGS

Rating	Symbol	Min	Max	Unit
VIN to GND	VIN	−0.3	40	V
Driver Output Voltage to GND	GATE	−0.3	6.5	V
VCC to GND	VCC	−0.3	6	V
$\overline{\text{DIM}}$/EN to GND	DIM	−0.3	6	V
CS to GND	CS	−0.3	6	V
ROT to GND	ROT	−0.3	6	V
Absolute Maximum junction temperature	$T_{J(MAX)}$	150		°C
Operating Junction Temperature Range	TJ	−40	125	°C
Storage Temperature Range	T_{stg}	−55 to +125		°C
Thermal Characteristics DFN10 3x3 Plastic Package Maximum Power Dissipation @ T_A = 25°C (Note 1)	PD	1.46		W
Thermal Resistance Junction−to−Ambient (Note 2)	$R_{\theta JA}$	86		°C/W
Lead Temperature Soldering (10 sec): Reflow (SMD styles only) Pb−Free (Note 3)	TL	260		°C
Moisture Sensitivity Level (Note 4)	MSL	1		−

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. The maximum package power dissipation limit must not be exceeded.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

2. When mounted on a multi−layer board with 35 mm^2 copper area, using 1 oz Cu.
3. 60−180 seconds minimum above 237°C.
4. Moisture Sensitivity Level (MSL): 1 per IPC/JEDEC standard: J−STD−020A.

ELECTRICAL CHARACTERISTICS (Unless otherwise noted: V_{IN} = 12 V, T_A = −40°C to +125°C. Typical values at T_A = 25°C)

Symbol	Characteristics		Min	Typ	Max	Unit
SYSTEM PARAMETERS						
V_{IN}	Input Supply Voltage Range	Normal Operation	8.0		40	V
		Functional (Note 5)	6.3			
I_{Q_IN}	Quiescent Current into V_{IN}		0.075	1.5	2.15	mA
V_{CC}						

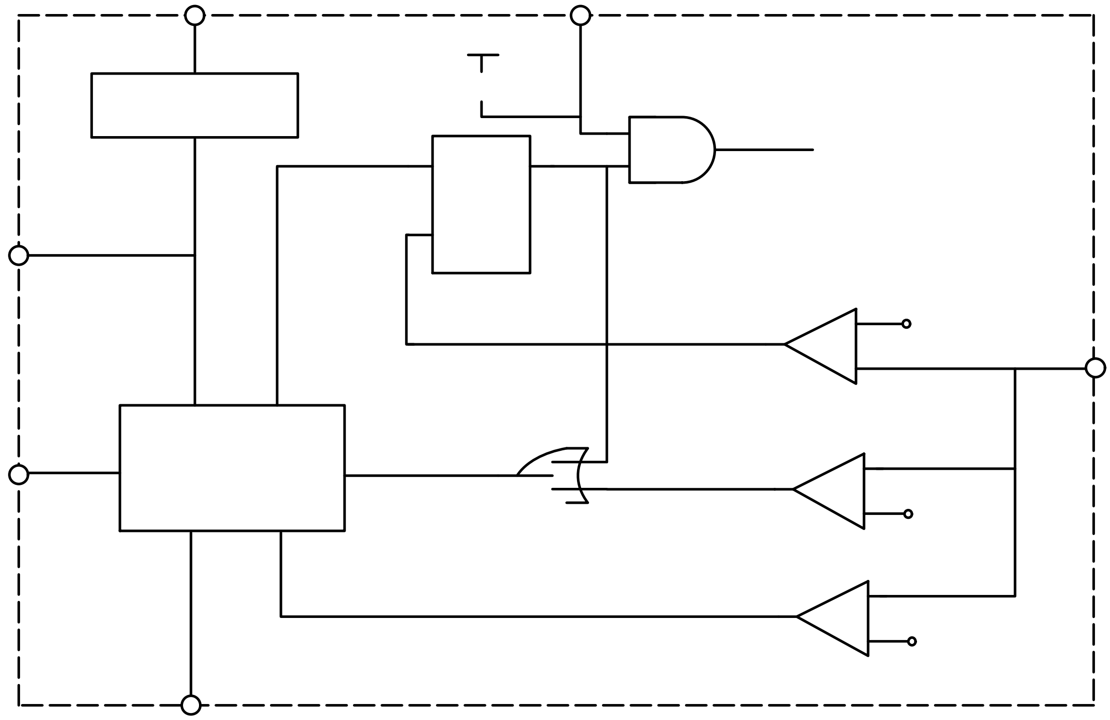

Figure 2. Simplified Block Diagram

Theory of Operation

This switching power supply is comprised of an inverted buck regulator controlled by a current mode, hysteretic control circuit. The buck regulator operates exactly like a conventional buck regulator except the power device placement has been inverted to allow for a low side power FET. Referring to Figure 1, when the FET is conducting, current flows from the input, through the inductor, the LED and the FET to ground.

When the FET shuts off, current continues to flow through the inductor and LED, but is diverted through the diode

Inductor Selection

The inductor that is used directly affects the switching frequency the driver operates at. The value of the inductor sets the slope at which the output current rises and falls during the switching operation. The slope of the current, in turn, determines how long it takes the current to go from the valley point of the current ripple to the peak when the FET is on and the current and rising, and how long it takes the current to go from the peak point of the current to the valley when the FET is off and the current is falling. These times can be approximated from the following equations:

$$t_{ON} = \frac{L \times \Delta I}{VIN - V_{LED} - I_{OUT} \times \left(FET_{R_{DS}}(on) + DCR_L + R_{SENSE} \right)}$$

$$t_{OFF} = \frac{L \times \Delta I}{V_{LED} + V_{diode} + I_{OUT} \times DCR_L}$$

Where DCR_L is the dc resistance of the inductor, V_{LED} is the forward voltages of the LEDs, $FET_{RDS(ON)}$ is the on−resistance of the power MOSFET, and V_{diode} is the forward voltage of the catch diode.

The switching frequency can then be approximated from the following:

$$f_{SW} = \frac{1}{t_{ON} + t_{OFF}}$$

Higher values of inductance lead to slower rates of rise and fall of the output current. This allows for smaller discrepancies between the expected and actual output current ripple due to propagation delays between sensing at the CS pin and the turning on and off of the power MOSFET. However, the inductor value should be chosen such that the peak output current value does not exceed the rated saturation current of the inductor.

Catch Diode Selection

The catch diode needs to be selected such that the average current through the diode does not exceed the rated average forward current of the diode. The average current through

Dimming Event

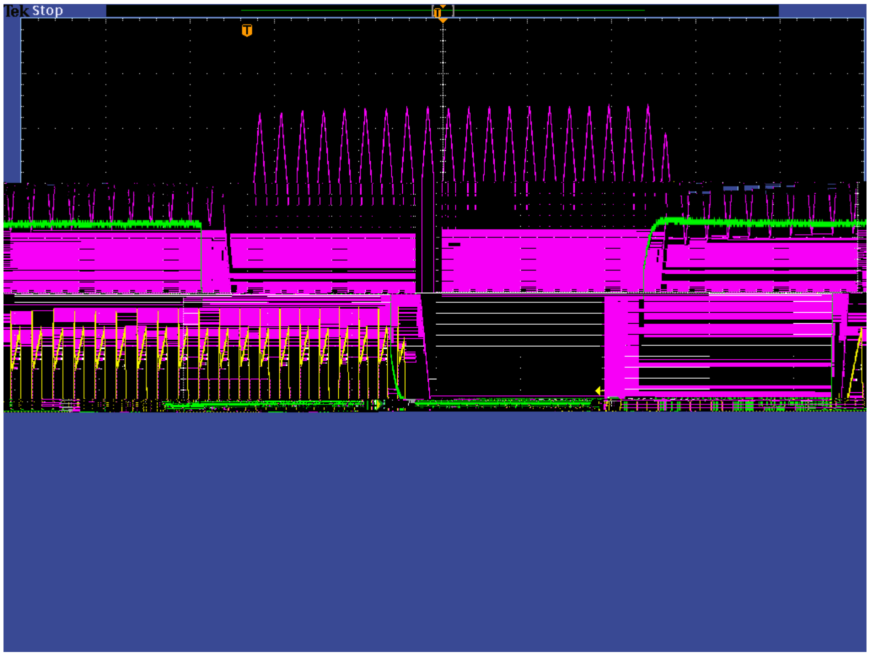

Figure 6. 12 Vin, 3.3 μH, 2 LEDs, 200 mΩ R_{sense}, 1 Khz F_{DIM}
Purple: LED Current, Yellow: CS Pin, Green: DIM Pin

100% Duty Cycle Event at 1 A LED Current

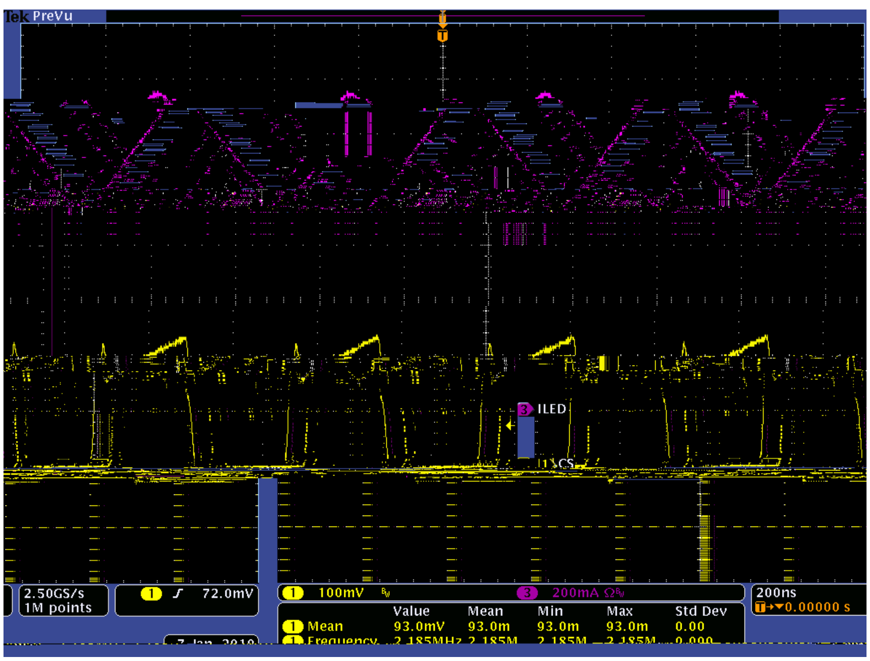

Figure 7. 12 Vin, 3.3 μH, 200 mΩ R_{sense} , 2 LEDs V_F ~ 3.5 V
Purple: LED Current, Yellow: CS Pin