NUD4301

Advance Information

Dual Low Dropout Voltage LED Driver/Current Source

This device is designed to replace switching regulators for driving LEDs in low voltage DC battery applications (up to 6 V). Its unique integrated circuit design provides low dropout voltage (less than 200 mV), which makes it ideal for battery applications where voltage overhead is limited. An external resistor allows the circuit designer to set the LED current for different applications needs. The device is packaged in a small surface mount leadless package (DFN8), which results in a significant reduction of both system cost and board space.

Features

- Ultra Low Dropout Voltage < 200 mV
- Programmable Output Current from 1 mA to 30 mA
- Dual Output with Independent Current Limit Set
- DC Current in LED
- Analog/Digital PWM Capability
- This is a Pb−Free Device

Typical Applications

- Portables: PDAs, Cell phones
- Li−Ion Battery Applications

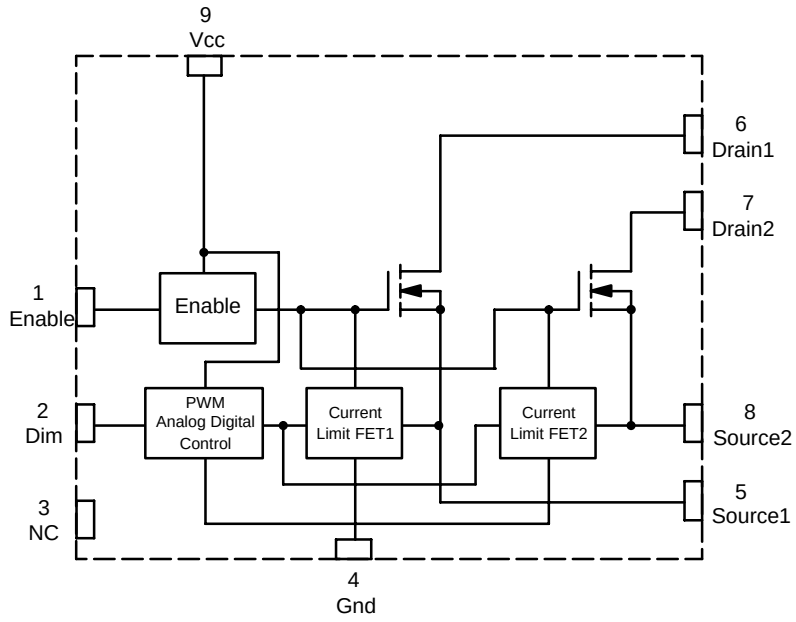


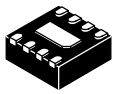
Figure 1. Block Diagram

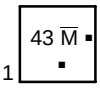
This document contains information on a new product. Specifications and information herein are subject to change without notice.

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MARKING DIAGRAM



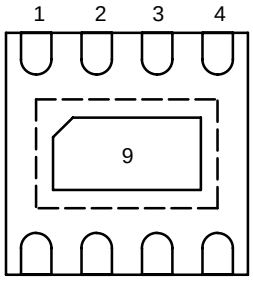


DFN8
CASE 506AQ

43 = Specific Device Code
M = Date Code
▪ = Pb−Free Package

(Note: Microdot may be in either location)

PIN CONFIGURATION



(Bottom View)

ORDERING INFORMATION

Device	Package	Shipping†
NUD4301MNT1G	DFN8 (Pb−Free)	3000/Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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FUNCTIONAL PIN DESCRIPTIONS

Pin	Function	Description
1	Enable	The device is enabled with a positive voltage signal at this pin. The enable controls both channels.
2	Dim	This pin is used for analog or PWM dimming control. An analog signal of 0 – 3.3 volts is required, or a PWM signal with an amplitude greater than 3.3 volts. The dim controls both channels.
3	N.C.	No connection.
4	Gnd	Ground Reference to the device.
5	Source1	Source terminal of the FET 1
6	Drain1	Drain terminal of the FET 1, which is also the switching node of the load 1.
7	Drain2	Drain terminal of the FET 2, which is also the switching node of the load 2.
8	Source2	Source terminal of the FET 2
9	Vcc	Input voltage to the LED driver. This voltage is compatible with any battery based systems of up to 6 V.

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Input Voltage, Operating	Steady State (V_{CC} to Gnd) Transient (1 ms)	V_{CC}	−0.3 to 6 −0.3 to 7	V
Drain Voltage, Operating	Steady State (Drain−to−Source) Transient (1 ms)	V_{DS}	−0.3 to 6 −0.3 to 7	V
Enable Voltage, Operating	Steady State	V_{EN}	−0.3 to 6	V
Dim Voltage, Operating	Steady State	V_{dim}	−0.3 to 3.6	V
Drain Current, Peak		I_{Dpk}	100	mA
Drain Current, Continuous		$I_{D(avg)}$	30	mA
Thermal Resistance, Junction−to−Air (Note 1)		Q_{JA}	365	°C/W
Power Dissipation @ T_A = 25°C (Note 1) Derating above 25°C		P_{max}	340 2.7	mW mW/°C
Operating Temperature Range		T_J	−40 to 150	°C
Non−Operating Temperature Range		T_J	−55 to 175	°C
Maximum Lead Temperature for Soldering Purposes (1.8” from case for 10 s)		T_L	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Mounted onto minimum pad board.

ELECTRICAL CHARACTERISTICS (Unless otherwise noted: V_{CC} = 3.6 V, R_{sense} = 4.7 Ω, 1%, T_A = 25°C for typical values, For min/max values T_J is the applicable junction temperature)

Characteristics	Symbol	Min	Typ	Max	Unit
Power FET (Each Channel)					
ON Resistance (V_{CC} = 3.6 V, I_D = 10 mA, R_{sense} = 4.7 Ω, V_{dim} = 3.3 V)	R_{DSon}	−	5.0	−	Ω
Zero Enable Voltage Drain Current (V_{DS} = 6 V, V_{Enable} = 0 V)	I_{DSS}	−	1.0	−	μA
Drain−to−Source Sustaining Voltage (I_D = 100 μA)	V_{BRDSS}	7.0	−	−	V
Output Capacitance (V_{DS} = 6 V, V_{Enable} = 0 V, f = 1 kHz)		−	TBD	−	pF
Voltage Drop (Note 2) (V_{CC} = 3.6 V, V_{LED} = 3.4 V, I_D = 20 mA, R_{sense} = 4.7 Ω, V_{dim} = 3.3 V)	V_{drop}	−	−	200	mV
Current Regulation Circuit (Each Channel)					
Output Current Regulation (V_{CC} = 3.6 V, V_{LED} = 3.4 V, R_{sense} = 4.7 Ω, V_{dim} = 3.3 V)	I_{out}	18	20	22	mA
Enable					
Logic Level High (Unit Operational)	V_{ENhigh}	1.7	−	−	V
Logic Level Low (Unit Shutdown)	V_{ENlow}	−	−	0.7	V
Dim					
Off Voltage (Zero Output Current), I_D = 20 μA, R_{sense} = 4.7 Ω	V_{zero}	−	−	50	mV
On Voltage (Max Output Current), I_D = I_{out}, R_{sense} = 4.7 Ω	V_{max}	3.1	3.3	3.6	V
Max PWM Frequency	f_{max}	−	10	−	kHz
Bias Supply (Complete Device)					
Bias Current (V_{CC} = 3.6 V, Device Non−Operational, V_{Enable} = 0 V)	I_{BIAS1}	−	0.1	−	μA
Bias Current (V_{CC} = 3.6 V, Device Operational, V_{Enable} = V_{CC})	I_{BIAS2}	−	1	−	mA

2. V_{drop} = V_{DS} + V_{Rsense}

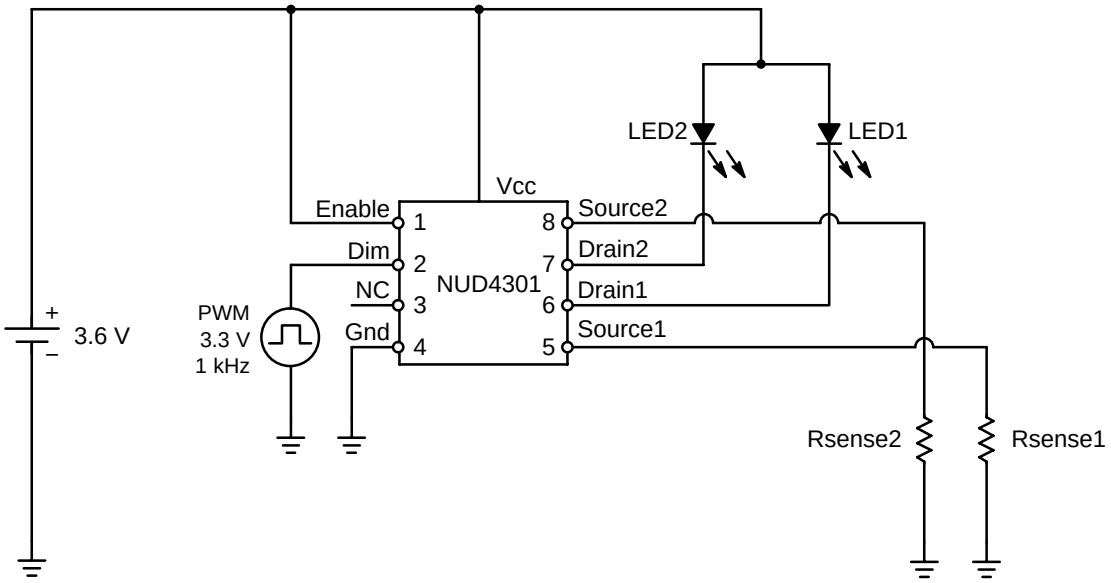


Figure 2. Typical Application Circuit

TYPICAL PERFORMANCE CURVES

(T_A = 25°C, unless otherwise noted)

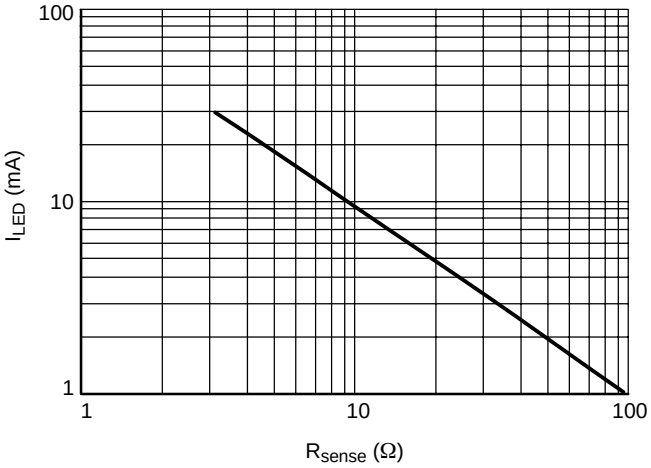


Figure 3. Current Limit Adjustment

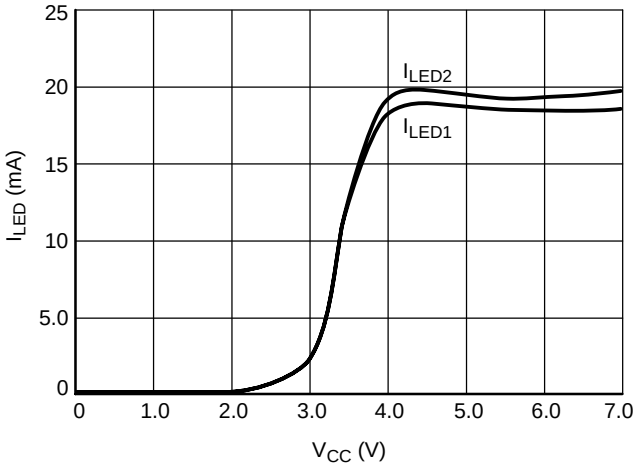


Figure 4. Typical Line Regulation Performance (V_{LED} = 3.4 V, R_{sense} = 4.7 Ω)

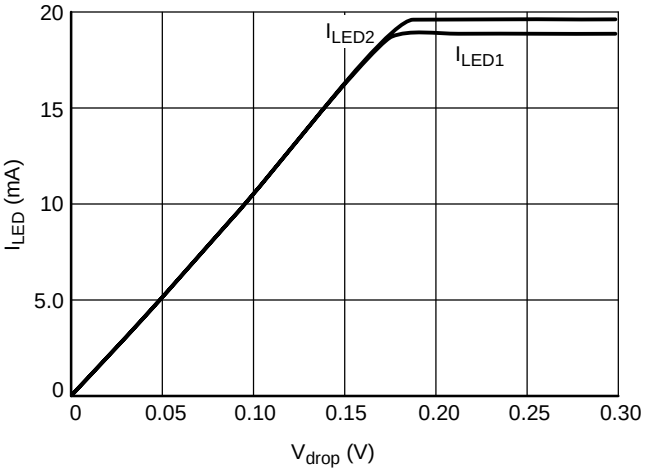


Figure 5. Typical Current Regulation vs. V_{drop} (V_{drop} = V_{DS} + V_{Rsense})

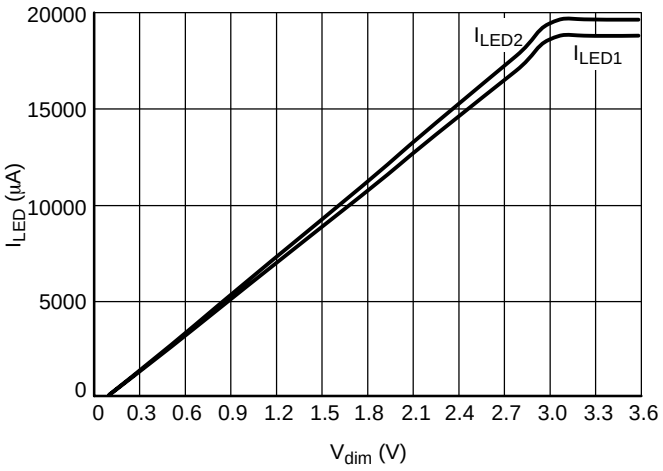


Figure 6. Typical Current Regulation vs. V_{dim} (V_{LED} = 3.4 V, R_{sense} = 4.7 Ω)

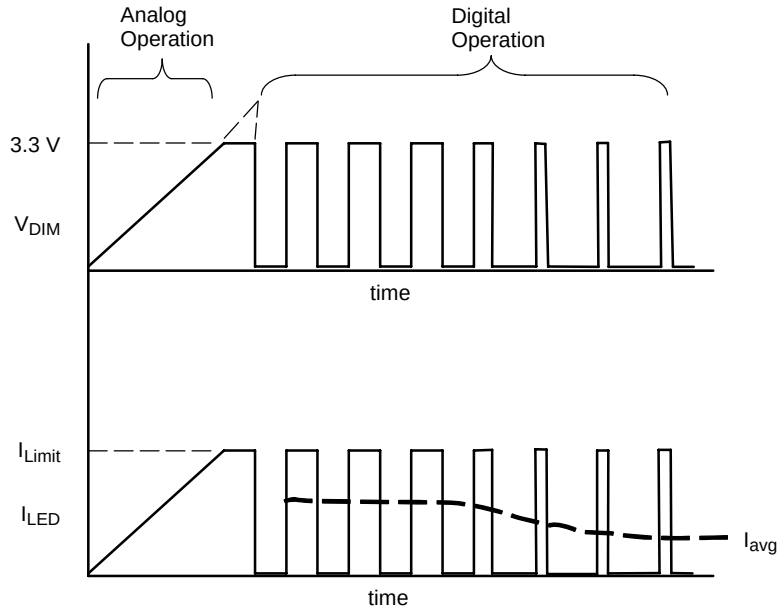


Figure 7. Dimming Operation Curves
(Graph obtained from SPICE simulations)

Theory of Operation

This device contains two LED current sources. Each channel is comprised of a lateral N−channel FET controlled by a current limit circuit that senses the voltage drop across the R_{sense} resistor and compares it with an internal voltage reference to provide the current regulation. For dimming applications, the current limit circuit operates in combination with the PWM signal applied to the dim pin of the device for control purposes.

Current Limit and PWM Circuits

With a DC voltage of 3.3 volts applied to the Dim pin of the device, the internal reference voltage of the current limit circuit is set to 93.5 mV. The R_{sense} resistor is then selected through a very simple formula: $R_{sense} = 93.5\ mV / I_{LED}$. This allows the user to set different LED currents (between 1 mA and 30 mA).

For dimming control, a PWM signal may be applied to the dim pin of the device. This PWM signal can be used to perform digital dimming.

For digital dimming, the amplitude of the PWM signal must be 3.3 V or higher. The LED current will be proportional to the duty cycle of the PWM signal.

For analog dimming, the input signal to the Dim pin must be between 0 and 3.3 volts. The resulting output current will be given by the following formula:

$$I_{LED} = \frac{(V_{dim} / 35.3)}{R_{sense}}$$

If a PWM signal is beyond the input frequency range for the Dim pin, a RC filter may be used to convert it to an analog signal.

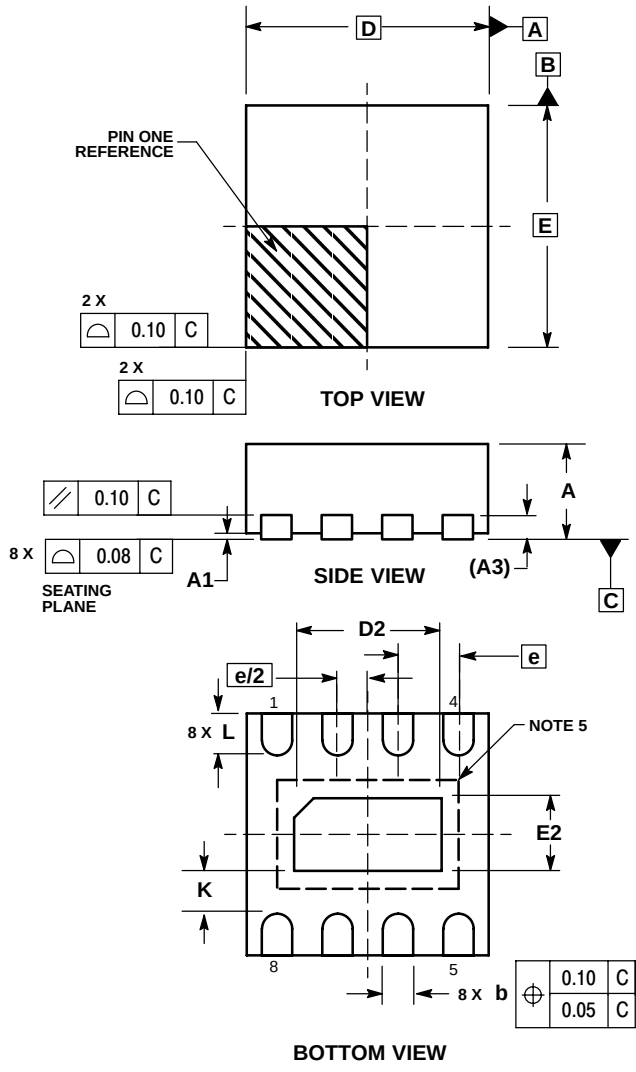
The RC filter generates an analog voltage signal, which is proportional to the duty cycle of the PWM signal applied. This analog signal is then used as the new reference voltage for the current limit circuit, which compares it with the voltage signal generated across R_{sense} to provide the current regulation.

Enable

The enable circuit turns the device on when a positive signal is applied to the enable pin. The circuit is designed to allow low current consumption (0.1 μA typical) when the device is disabled.

PACKAGE DIMENSIONS

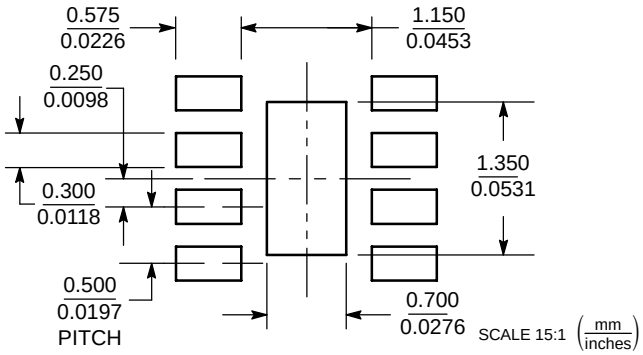
DFN8
CASE 506AQ−01
ISSUE A



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994 .
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. INTERNAL PAD SIZE: 1.5 X 0.9 MM.

	MILLIMETERS	
DIM	MIN	MAX
A	0.80	1.00
A1	0.00	0.05
A3	0.20 REF	
b	0.20	0.30
D	2.00 BSC	
D2	1.10	1.30
E	2.00 BSC	
E2	0.50	0.70
e	0.50 BSC	
K	0.20	−−−
L	0.25	0.45

SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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