

DIO5361H

42V Step-Up LED Driver with One-Wire Dimming

Features

- Drive up to 12 serial LEDs
- 32 levels One-Wire dimming
- Integrated 40V high current switch (1.65A limit)
- Wide V_{IN} Input Range: 2.8V~5.5V
- Low 200mV feedback voltage
- LED open-circuit (OVP) protection@42V
- High switching frequency@850kHz
- For Compact Solution Size
- Integrated Soft start
- < 1 μ A shutdown current
- RoHS and Green compliant
- -40 to +85°C Temperature range

Applications

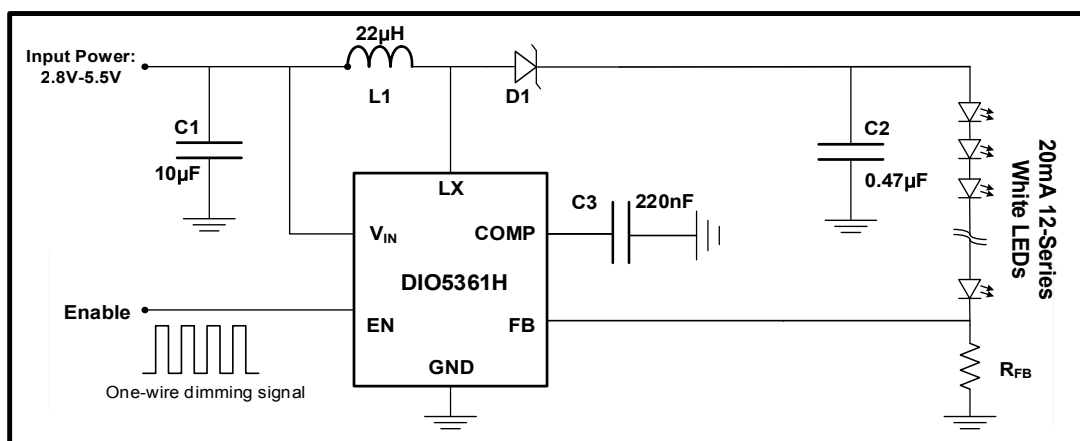
- LED backlighting
- Mobile Phones
- Handheld Devices
- Digital Photo Frames
- Automotive Navigation

Descriptions

DIO5361H is a serial white LED driver, driving up to 12 serial LEDs or a 3x13(3 LEDs in rows) LED matrix. And it adopts 32 levels one-wire dimming. The serial configuration assures the very most brightness consistency of the whole LED array. DIO5361H works on 850kHz switching frequency, which can maximize current output of 1.65A limit and achieve high current conversion efficiency and result in external compact component size. Additionally, the total external component number is minimized due to the integrated low-side power MOSFET.

DIO5361H integrates multiple protection features, such as LED open-circuit protection, thermal shutdown protection and cycle-by-cycle input current limit protection. And the built-in soft start circuit limits inrush current when the circuit starts.

DIO5361H provides with RoHS compliant DFN-6 package.



Ordering Information

Order Part Number	Top Marking		T_A	Package	
DIO5361HCD6	53	RoHS or Green	-40 to +85°C	DFN-6	Tape & Reel, 3000

Pin Assignment

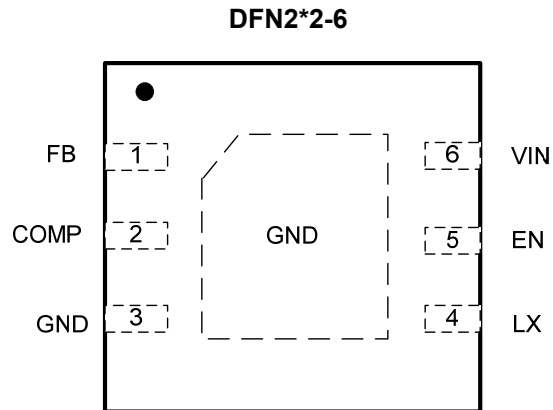


Figure 1 Top View

Pin Descriptions

Name	Description
LX	Converter switching node
GND	Converter/IC ground
FB	Output feedback voltage pin, 200mV typical
EN	IC enable and one-wire dimming control pin
COMP	Output of the trans conductance error amplifier. Connect an external capacitor to this pin to compensate the regulator.
NC	No Connect.
V _{IN}	IC supply voltage



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Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Rating" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameter		Rating	Unit
Supply Voltage/V _{IN}		-0.3 to 6.0	V
High Voltage Nodes/LX		-0.3 to 48	V
Other pins/FB, EN		-0.3 to V _{IN} +0.3	V
Operating Temperature Range / T _J		-40 to 150	°C
Storage Temperature Range / T _S		-65 to 150	°C
Lead Temperature Range / T _{LEAD}		300	°C
Thermal Resistance /θ _{JA}		140	°C/W
Thermal Resistance /θ _{JC}		20	°C/W
Maximum Power Dissipation at T _A <25°C		0.526	W
ESD	HBM, JEDEC: JESD22-A114	2	kV
	CDM, JEDEC: JESD22-C101	2	

Recommend Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended Operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not Recommend exceeding them or designing to Absolute Maximum Ratings.

Parameter		Rating	Unit
Supply Voltage		2.8 to 5.5	V
Operating Temperature Range		-40 to 85	°C



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Electrical Characteristics

Typical value: $V_{CC}=3.6V$, $T_A = 25^{\circ}C$, unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC Character						
V_{IN}	Input operating range		2.8		5.5	V
UVLO	Input under voltage lockout	Rising edge		2.5	2.6	V
UVLO _{HYST}	UVLO hysteresis			0.1		V
I_Q	IC quiescent current(non-switching)	FB=0.4V		0.3		mA
	IC quiescent current (switching)	FB=0V		0.8		mA
I_{SHDN}	V_{IN} pin shutdown current	EN=GND		0.1	1.0	μA
Boost Converter						
FB	FB pin accuracy		0.196	0.2	0.204	V
I_{FB}	FB pin bias current			0.1		μA
$R_{DS(ON)}$	NMOS on-resistance			0.6		Ω
I_{LX}	LX pin leakage current			0.1		μA
I_{LIM}	Peak NMOS current limit			1.65		A
F_{SW}	Oscillator frequency			850		kHz
D_{MAX}	Maximum duty cycle		92	95		%
OVP	Over voltage threshold	Measured at OUTPUT		42		V
T_S	Start-up time			1.5		ms
Logic Signal						
V_{TH-L}	Logic low threshold				0.4	V
V_{TH-H}	Logic high threshold		1.4			V
T_{OFF}	EN low to shutdown time			2.4		ms
Ndim	Pulse dimming steps			32		
T_{J-TH}	IC junction thermal shutdown threshold			145		$^{\circ}C$
	IC junction thermal shutdown hysteresis			20		$^{\circ}C$

Specifications subject to change without notice.

Application Circuit

In typical application, DIO5361H is competent in the below two configurations: 12 series LED-Array and 3(row)x13 LED Matrix. As depicted in following figures:

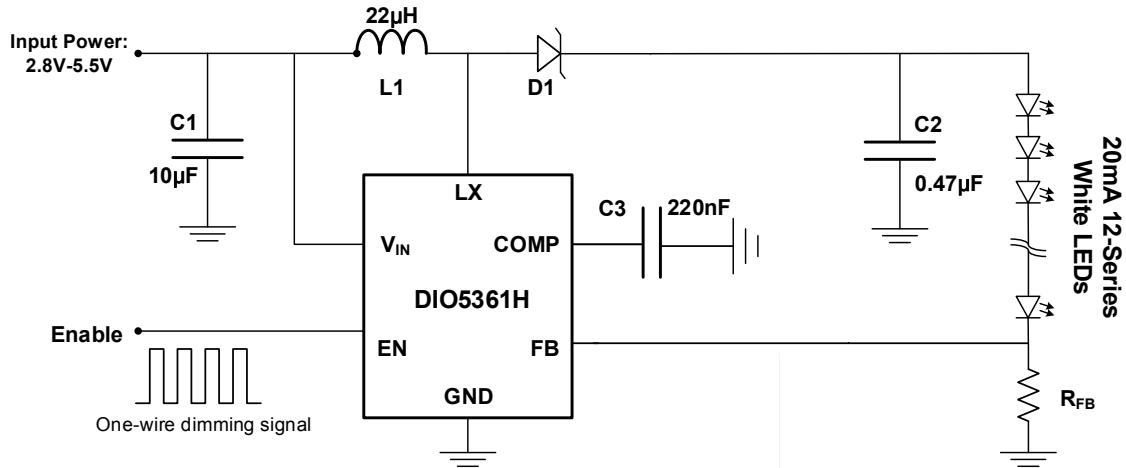


Figure 2. 12 Series LED Array Application Circuit Configuration

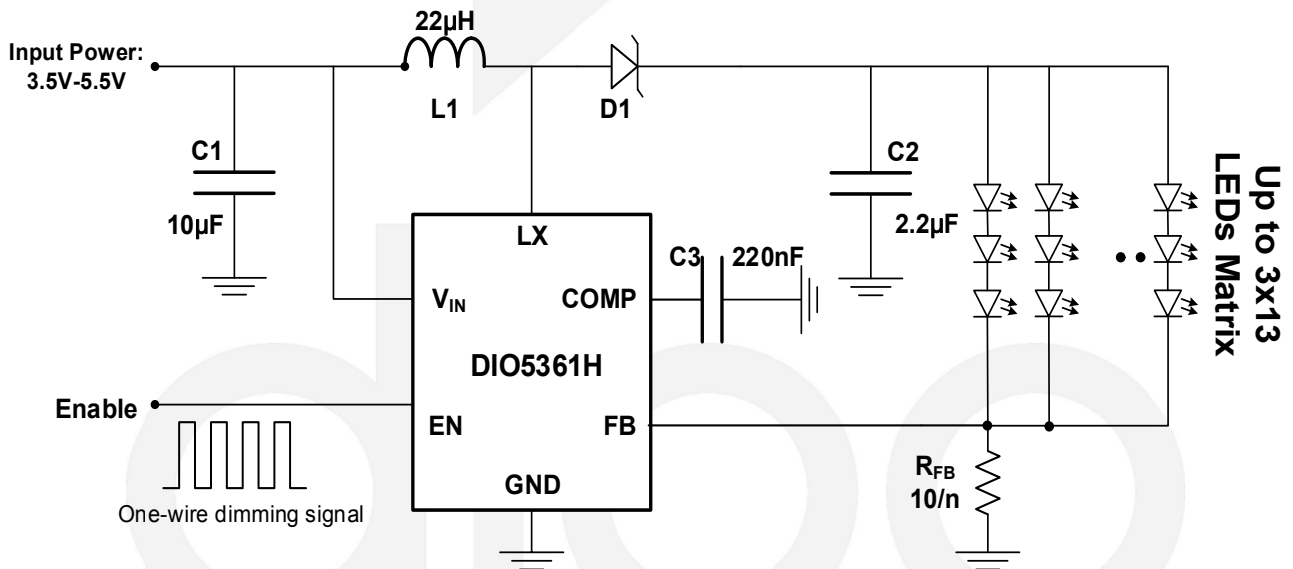


Figure 3. 3x13 (3 LEDs in row) LED Matrix Application Circuit Configuration

Functional Block Diagram

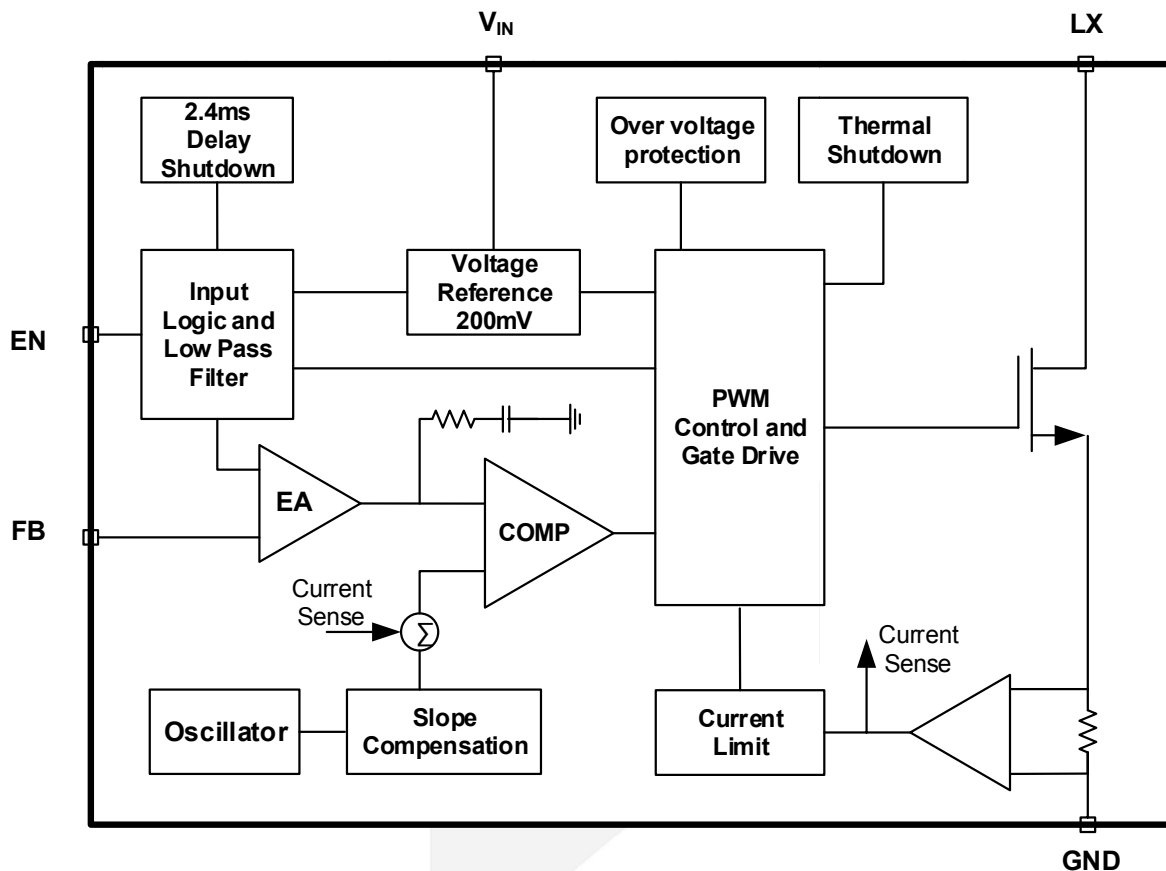


Figure 4. Functional Block Diagram



Operation Principle

DIO5361H utilizes a constant frequency current-mode boost converter architecture to power white LED strings or arrays by pumping current precisely regulated by feedback voltage V_{FB} and feedback resistor R_{FB} , illustrated in Figure 6.

As illuminated in the Functional Block Diagram above, PWM Control and Gate Drive Block periodically opens and closes the Power MOSFET synchronized with Oscillator. At the rising edge of Oscillator pulse, Power MOSFET is turned on, while closed when the comparator COMP tells the Current Sense slope signal goes above the output "difference" of error amplifier EA. The current slope is generated by Current Sense from sampling inductor charging current and compensated by Slope Compensation. And the output "difference" comes from comparing feedback voltage V_{FB} with internal reference voltage V_{REF} by Error Amplifier EA. Both the two close loops assure the output current stabilization and make feedback voltage V_{FB} in consistency with reference voltage V_{REF} .

DIO5361H integrates soft-start to limit the inrush current and the overshoot on the output. And DIO5361H also features internal protection circuits such as over-voltage protection (OVP), cycle-by-cycle current limit protection and thermal shutdown.

DIO5361H adopts one-wire dimming control by regulating the reference voltage. Pin EN listens serial pulses, counts the number of rising edges, then decodes the serial signal to 32 different levels by a 5-bit register. After powered on, the DIO5361H starts up once detecting an active high pulse longer than 1ms. And then a 3ms long low pulse will shutdown the circuit. More is illustrated in the Pin EN Timing graph.

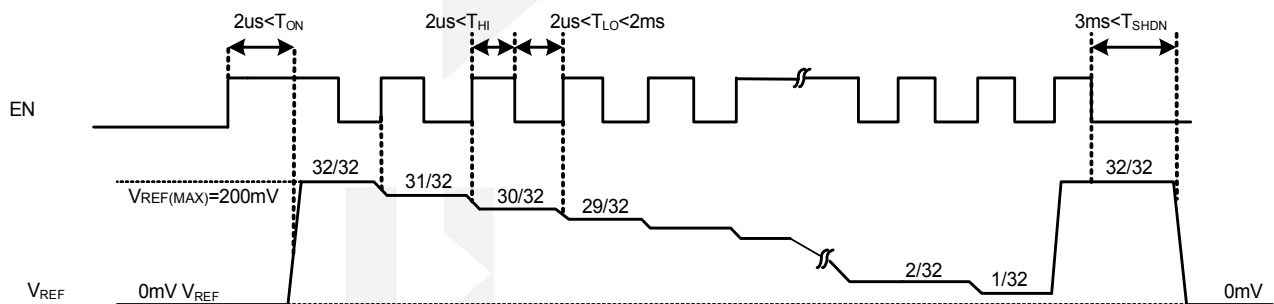


Figure 5. Timing of Pin EN

Application Notes:

MAX LED Current Settings

LED Current is determined by the current through the feedback resistor R_{FB} , as depicted in the right-hand figure. V_{FB} is a high-impedance state output feedback voltage, so no current goes through Pin FB and the built-in "boost" DC/DC has to pump current to feed I_{FB} .

$$I_{LED} = I_{FB} = V_{FB} / R_{FB}$$

V_{FB} is internally set to a maximum value of 200mV.

So

$$I_{LED(MAX)} = 200mV / R_{FB}$$

For LED current accuracy, 1% precision resistor is recommended.

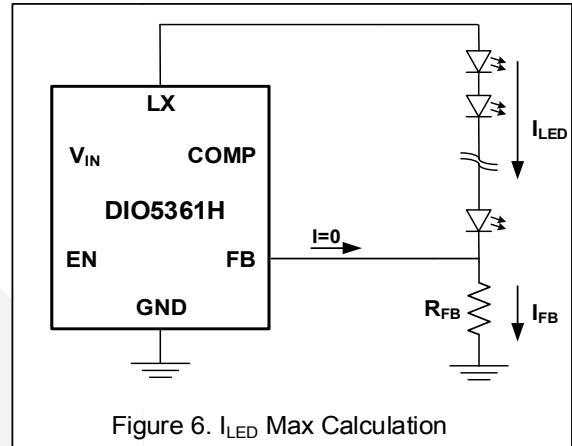


Figure 6. I_{LED} Max Calculation

Feedback Voltage V_{FB} Calculation

The feedback voltage V_{FB} is regulated by the internal reference voltage V_{REF} , So the V_{FB} is approximately same as V_{REF} in the timing, except for that V_{FB} always has a delay with respect to V_{REF} since both in the start-up or the dimming process, the system takes time to adjust V_{FB} equal to V_{REF} . if we neglect these delays, V_{FB} changes with Pin EN signal just as the V_{REF} .

Recommended LED Dimming Method for 12-LEDs series Application

If we set $R_{FB} = 10.0\Omega$, so $I_{LED(MAX)} = 20mA$, then we have I_{LED} changes with EN as the following:

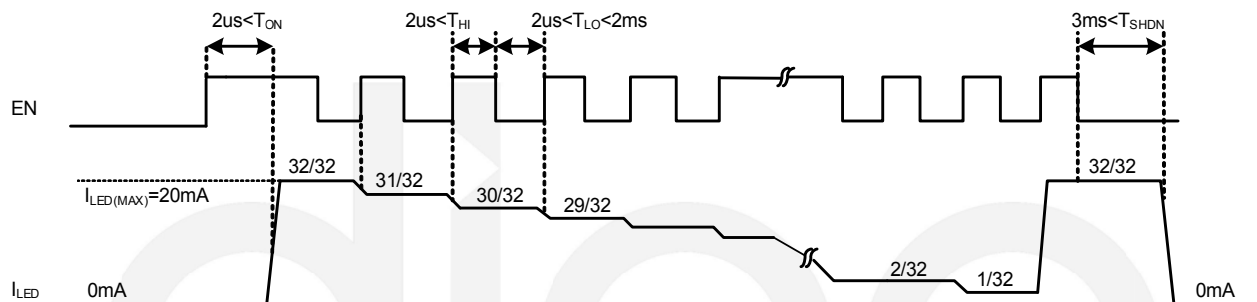


Figure 7. LED Current Setting Timing vs EN Series Signal



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Inductor Selection

A 10uH~22uH inductor is recommended for both 10/12-LED serial string and 3x13 LED matrix application. A low DCR inductor could be suggested if a high efficiency is critical. The inductor's saturation current rating should also exceed the peak input current, especially for high load current application such as 3x13 matrix.

Table 1. Inductor Selector

Application	Inductor Part Number	Value (μH)	DCR (Ω)	Saturation Current (A)	Dimensions (mm)	Manufacturer
20mA, 6LEDs	LQH3NPN100NM0	10	0.26	0.55	3.0X3.0X1.4	Murata
	LQH3NPN100NG0	10	0.57	0.5	3.0X3.0X0.9	Murata
	LQH3NPN220NM0	22	1.1	0.34	3.0X3.0X0.9	Murata
	CDR7D43MNNP-220N	22	0.085	2.85	7.6X7.5X4.5	Murata
	744043220	22	0.185	0.7	4.8X4.8X2.8	Murata
20mA, 10/12LEDS	LQH55DN220M03L	22	0.19	1.2	5.7x5.0x4.7	Murata

Capacitor Selection

Small size ceramic capacitors are recommended for DIO5361H application. A 10μF input capacitor and a 0.47μF output capacitor are recommended for 12/10/8/6-Series LED applications. Larger value output capacitors like 2.2μF are recommended in higher output current applications to minimize output ripple. Ceramic capacitor Vendors such as Murata, AVX, Taiyo Yuden are recommended.

Diode Selection

Since DIO5361H's low forward voltage drop and fast reverse recovery time, a schottky diode is recommended. The current rating of the schottky diode should exceed the peak current of the boost converter. The voltage rating should also exceed the target output voltage.

Table 2. Diode Selector

Applications	Schottky Diode Part Number	Forward Voltage/ V	Forward Current/ mA	Reverse Voltage/ V	Manufacturer
20mA, 8/10/12 Serial LEDs 42V OVP	PMEG6010CEJ	0.57	1000	60	NXP

PCB Layout Design Recommendation

It is important to well plan PCB layout for DIO5361H application in order to keep the loop stable and minimize noise, since it is a high frequency switch mode power stage. In applications of up to 7 series LEDs, an input RC filter to DIO5361H's V_{IN} pin, illustrated as below, is recommended to minimize any interference between the boost converter input and the IC input.

Moreover, the path of inductor, diode and output capacitor should be kept as short as possible to minimize noise and ringing. And the input decouple capacitor should be very close to the IC to assure best decoupling.

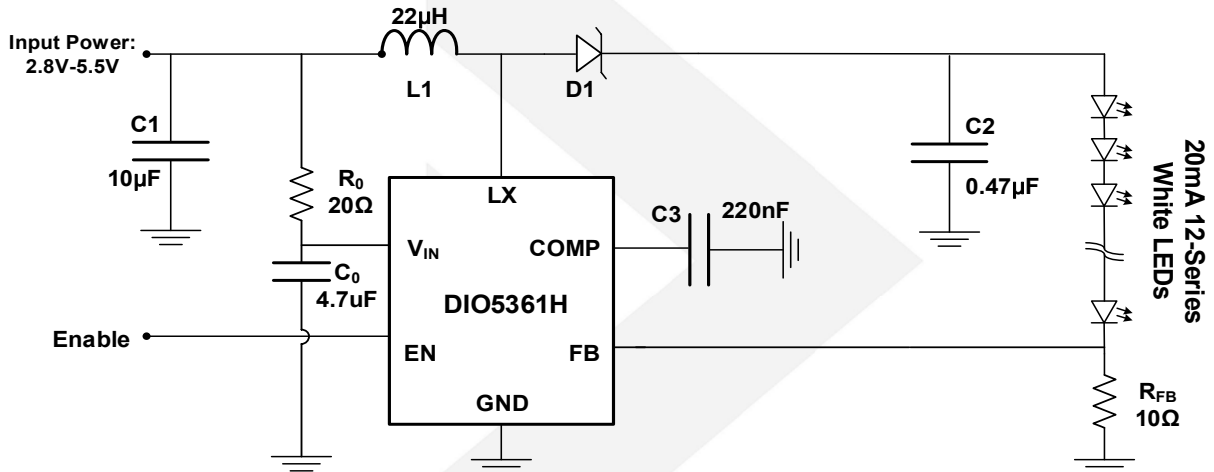
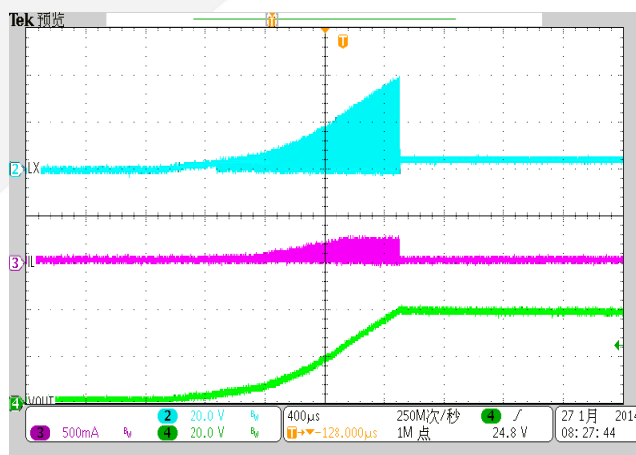
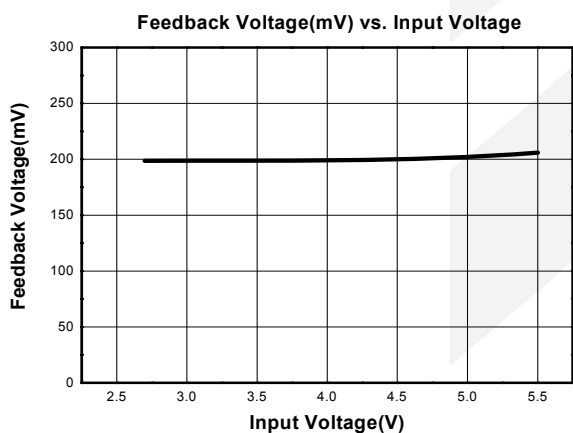
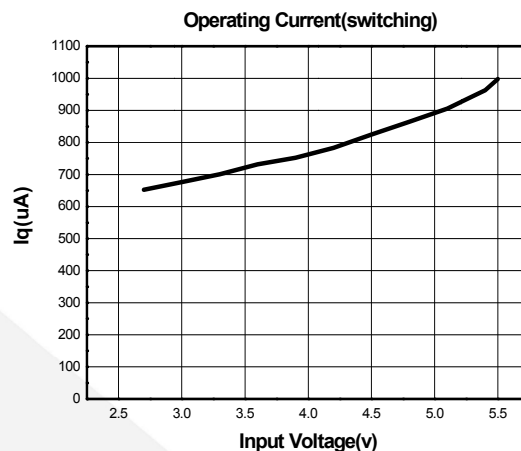
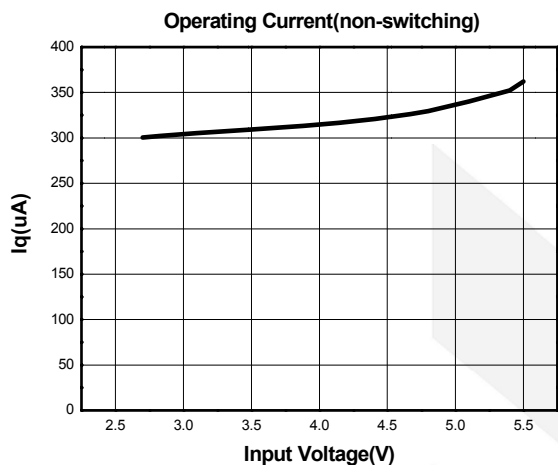


Figure 8. Application Circuit with Input RC filter

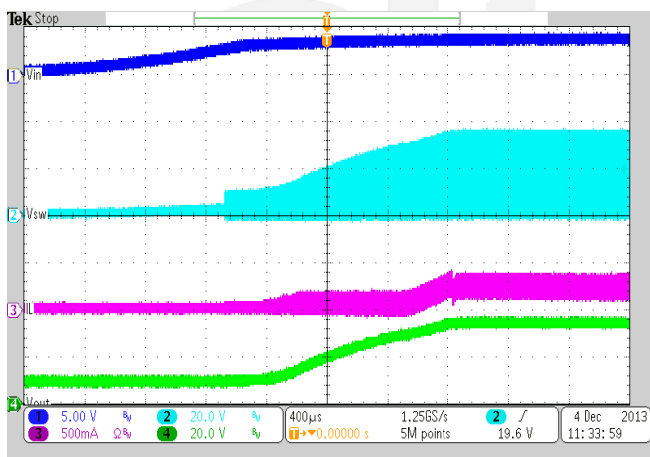


Typical Performance Characteristics

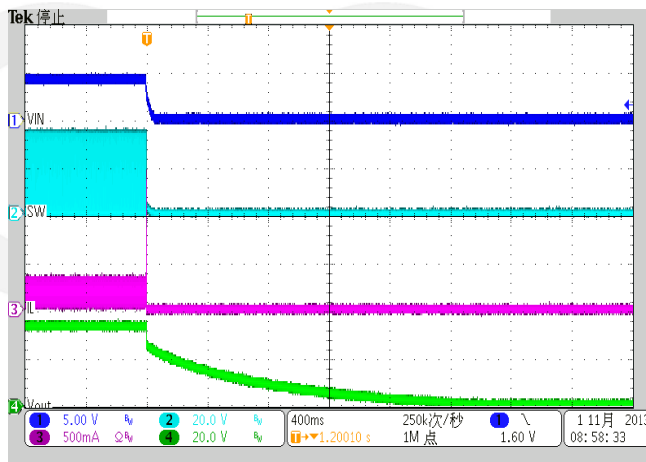
Typical value: $V_{CC}=3.6V$, $T_A = 25^{\circ}C$, unless otherwise specified.



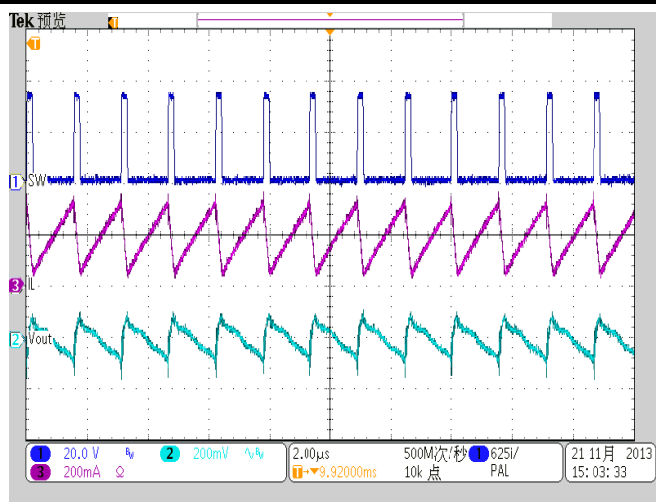
LED Open Waveform



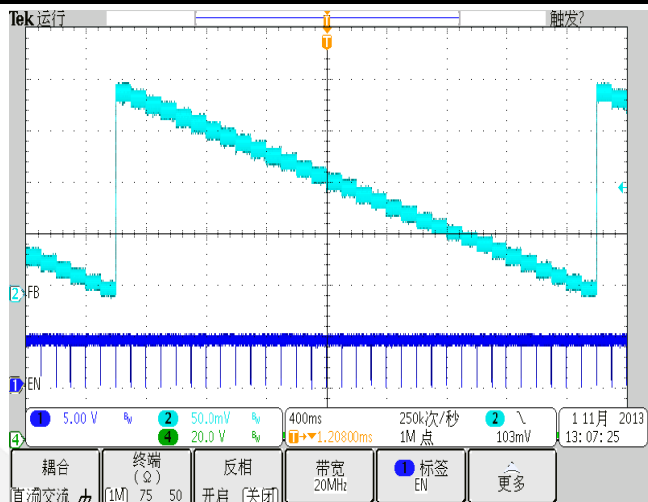
V_{IN} Start Waveform



V_{IN} Stop Waveform



Stable Operating Waveform



One-Wire Dimming Waveform



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A large, light gray watermark of the Dioo logo is centered on the page. It consists of a stylized arrow pointing right followed by the word "dioo" in a lowercase, sans-serif font.