PWM WHITE LED DRIVER

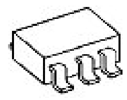
■ General Description

The NJU6043 is a high efficiency white LED driver with low input voltage. It is a PWM type DC/DC converter.

The typical output current is 20 mA. Because the switching frequency is about 1 MHz, so tiny parts such as inductor and capacitor can be used to save space.

The NJU6043 is suitable for portable electronic applications such as cell phone, digital still camera, or PDA etc..

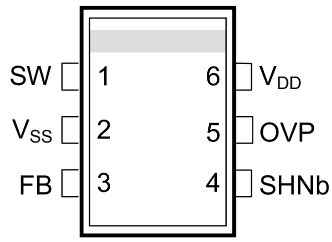
■ Package



■ Features

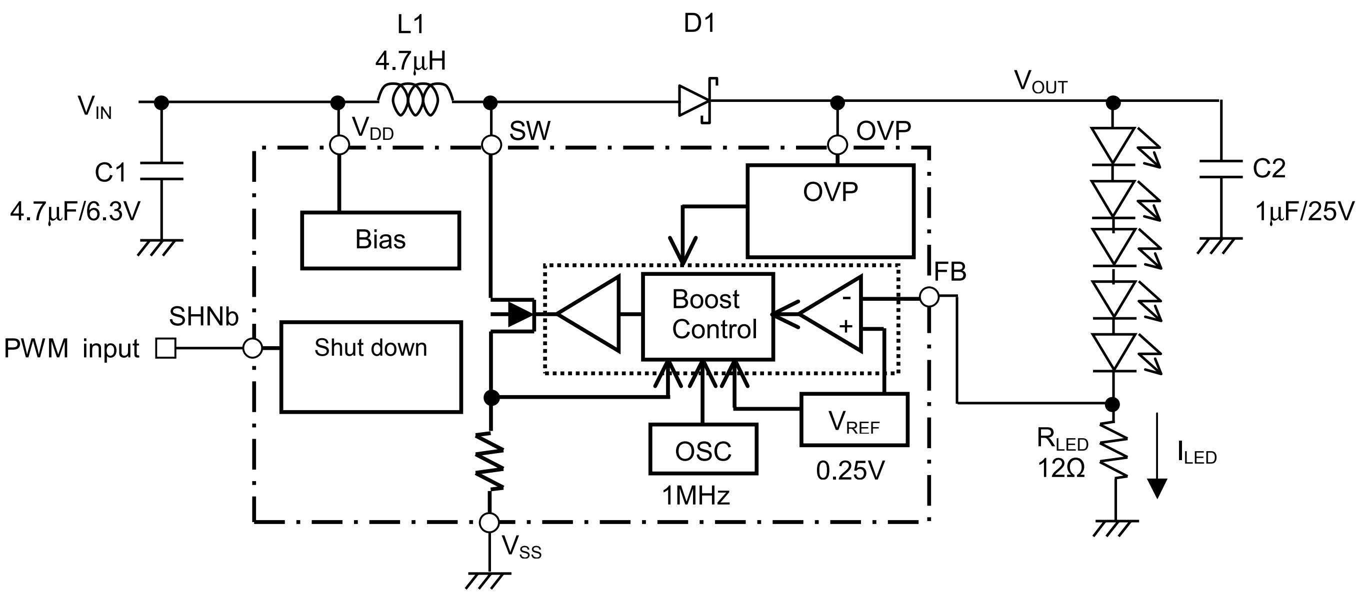
- Drive up to 5 white LEDs in series I_{OUT} = 20mA
- High Efficiency 87%
- Over Voltage Protection Circuit(OVP)19.5V
- Shut-down circuit
- Switching Frequency 1MHz (PWM)
- Under-voltage lockout circuit (UVLO)
- Low profile inductor and capacitor
- Operation Voltage V_{DD} = 2.5 ~ 5.5V
- Package SOT-23 6pin (MTP-6)
- CMOS

■ Pin Configuration



SOT-23 6pin (MTP-6)

■ Block Diagram



Pin Description

No.	Symbol	I/O	Description
1	SW	Input	Switching pin
2	V_{SS}	Power Supply	GND pin
3	FB	Input	Feedback pin
4	SHNb	Input	Shutdown pin SHNb="L", shutdown mode
5	OVP	Input	Over voltage protection sense pin If the output voltage is higher than 19.5, the internal MOS switch will remain at off position until the output voltage down below to 15V.
6	V_{DD}	Power Supply	Power supply pin V_{DD}=2.5 ~ 5.5V

Function Description

(1) Operation Description

(1-1) LED Current Control Circuit

The NJU6043 is a step-up switching regulator. The LED current I_{LED} is decided by the external resistor R_{LED} which connect FB pin and Vss pin, vice versa, R_{LED} can be calculated from the following equation if the wanted I_{LED} is determined. V_{REF} is the reference voltage to the non-inverting pin of the error comparator.

$R_{LED} = V_{REF} / I_{LED}$ V_{REF} =0.25V (typ.)

After the R_{LED} determined, the ILED will be regulated at a certain level. The IC internal operation is as below.

When the FB pin voltage is above V_{REF}, the I_{LED} will be supplied by output capacitor C2. When the FB voltage dropped below V_{REF}, the internal MOS switch will be set on and the battery start to supply current to the coil L1. When the coil current reach to a certain level (limit current), the MOS switch will be turned off, and the diode D1 will be positively biased, the coil current will flow in C2 and LEDs. This operation will be cycled until the FB pin voltage going back to the V_{REF}.

(1-2) Over Voltage Protection

Over voltage protection function is designed to prevent the damage of internal NMOS switch in case the increased impedance of the LED load (include the LED opened). Once the device detects over voltage (typical 19.5V) at the output, the internal NMOS switch is kept off until the output voltage drops below 15V.

(1-3) Shut Down Circuit

Shut Down Circuit is designed to stop the internal circuits and reduce the operating current at SHNb="L".

(2) Application Information

(2-1) Inductor Selection

A 4.7µF inductor is recommended for the NJU6043 applications. Because of the inrush current. the saturation current rating of the inductor shall be higher enough than the current limit. And the inductor with low core losses and small DCR (cooper wire resistance) shall be used to gain a high efficiency.

(2-2) Diode Selection

The diode with high current rating and backward withstand voltage is required. Schottky diodes with higher current ratings usually have lower forward voltage drop and larger diode capacitance, which can cause significant switching losses at the 1MHz switching frequency. A Schottky diode rated at 500mA is sufficient for most NJU6043 applications.

(2-3) Capacitor Selection

A decoupling capacitor shall be used on the input side. The MLCC (Multi-Layer Ceramic Capacitor) is suitable, and it should be placed as near as possible to the NJU6043.

For output capacitor, to curb the output voltage ripple, a MLCC with low ESR(Equivalent Series Resistance) is recommended.

■ Absolute Maximum Ratings

(V_{SS}=0V, Ta=25°C)

Parameter	Symbol	Conditions	Rating	Unit
Power Supply	V_{DD}		-0.3~7.0	V
SHDNb Pin Voltage	V_{SHDNb}		-0.3~7.0	V
OVP Pin Voltage	V_{OVP}		-0.3~24.0	V
SW Pin Voltage	V_{SW}		-0.3~24.0	V
FB Pin Voltage	V_{FB}		-0.3 ~V_{DD}	V
Power Dissipation	PD	SOT-23 6pin (MTP-6)	200	mW
Storage Temperature	Tstg		-65 ~ 150	°C
Operating Temperature	Topr		-40 ~ 85	°C

Note): Stress beyond those listed under "Absolute Maximum Rating" may cause permanent damage to the device.

• DC Characteristics

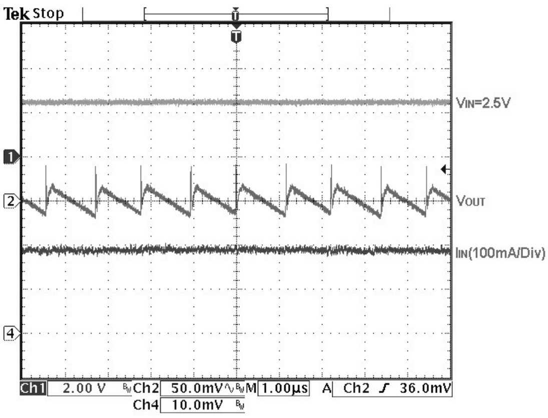
(V_{DD}=3.6V, V_{SHDNb}=3.6V, V_{SS}=0V, Ta=25°C)

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Input Voltage Range	V_{DD}	V_{DD} pin	2.5	-	5.5	V
Input Voltage UVLO	V_{UVLO}		1.7	2.0	2.3	V
Over Voltage Protection Threshold	V_{OVPTH}	Trigger	18.5	19.5	21.0	V
		Release	13.5	15	16.5	V
OVP Pin Input Current	I_{OVPIC}	V_{OVP}=16V	-	40	60	µA
Operating Current	I_{DD1}	V_{FB}=0.3V(No Switching)	-	80	120	µA
	I_{DD2}	V_{FB}=0.2V(Switching)	-	-	2	mA
Quiescent Current	I_{STBY1}	V_{SHDNb}=0V	-	0.1	1	µA
FB Voltage Range	V_{FBP}		235	250	265	mV
FB Voltage Range Temperature Coefficient	T_{FB}		-	100	-	ppm/°C
Switching Frequency	f_{SW}	V_{FB} =0.2V	0.8	1.0	1.2	MHz
Switch RDS(ON)	R_{DS}	I_{SW}=150mA	-	0.7	1.0	Ω
Switch Current Limit	I_{CL1}		500	600	700	mA
Soft Start Time	t_{SS}		-	120	-	µs
High Level SHDNb Input Voltage	V_{SHDNH}		2	-	-	V
Low Level SHDNb Input Voltage	V_{SHDNL}		-	-	0.8	V
Switch Leak Current	I_L	Switching stop, V_{SW}=20V	-	0.1	10	µA

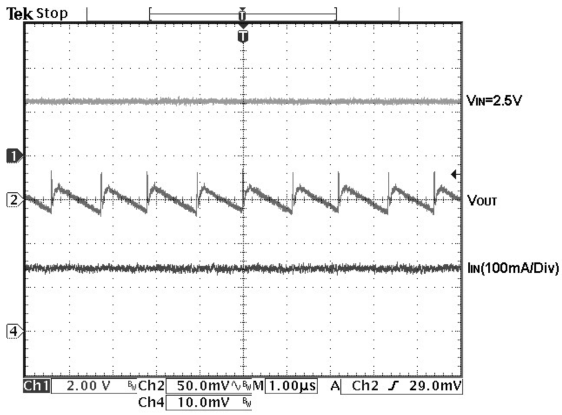
■ Typical Performance

(V_{DD}=3.6V, V_{SS}=0V, L=4.7uH, Ta=25°C)

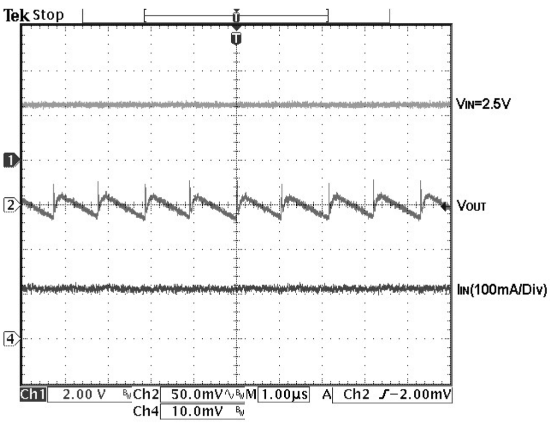
Stability for Driving 5 WLEDs



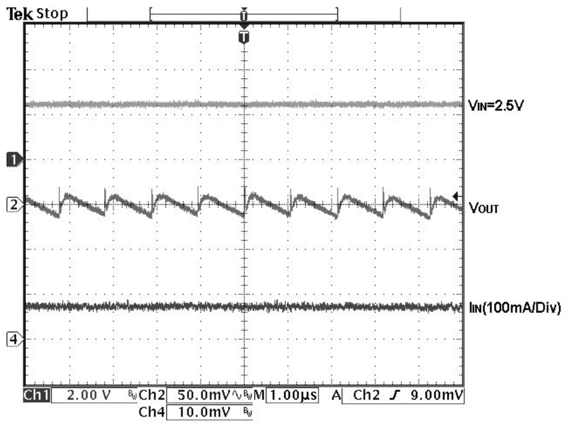
Stability for Driving 4 WLEDs



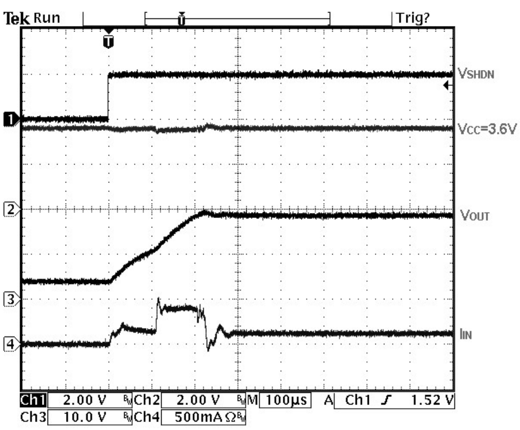
Stability for Driving 3 WLEDs



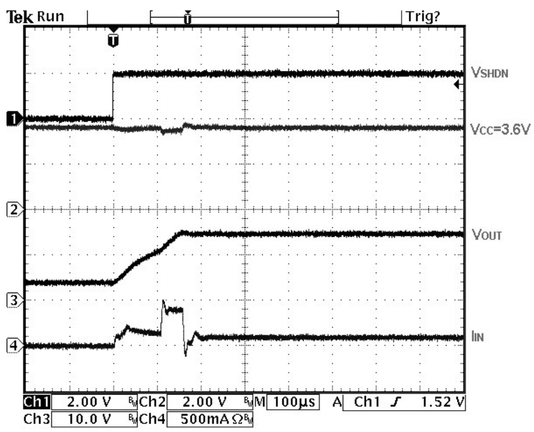
Stability for Driving 2 WLEDs



Inrush Current for Driving 5 WLEDs

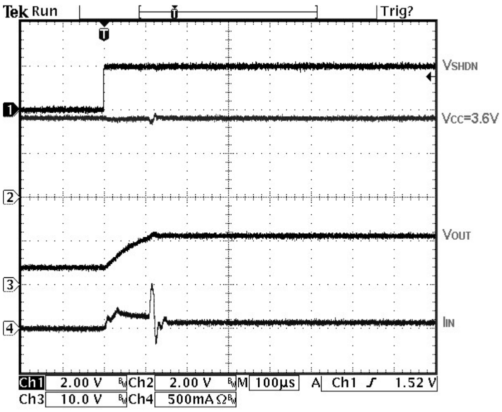


Inrush Current for Driving 4 WLEDs

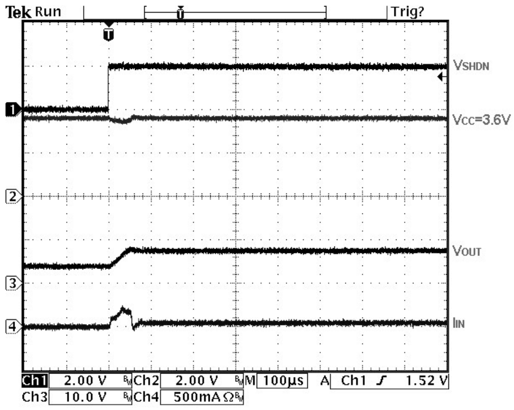


(V$_{DD}$=3.6V, V$_{SS}$=0V, L=4.7uH, Ta=25°C)

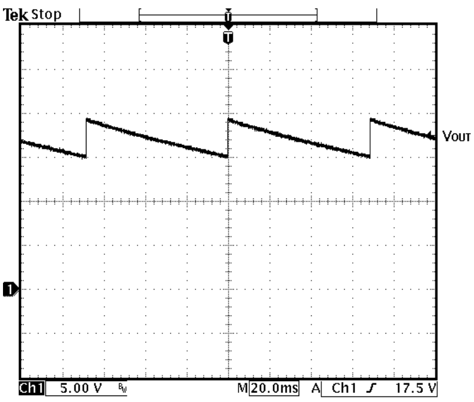
Inrush Current for Driving 3 WLEDs



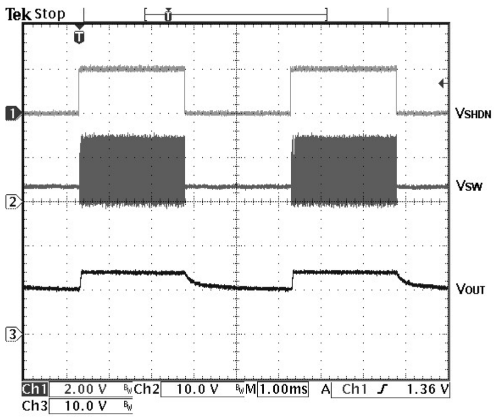
Inrush Current for Driving 2 WLEDs



OVP Waveform

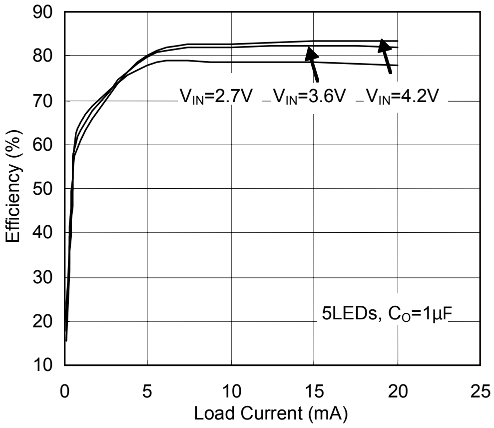


Dimming Control for Driving 4 WLEDs



(V_{DD}=3.6V, V_{SS}=0V, L=4.7uH, Ta=25°C)

Efficiency vs. Load Current



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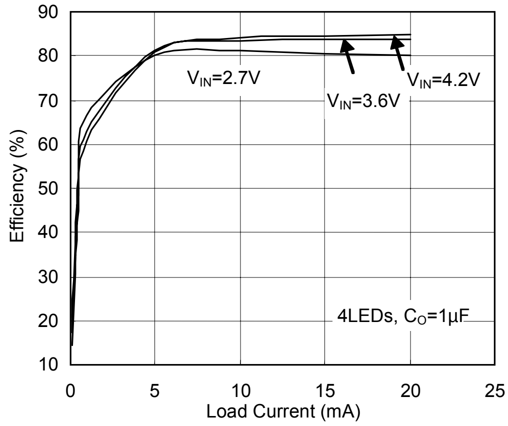

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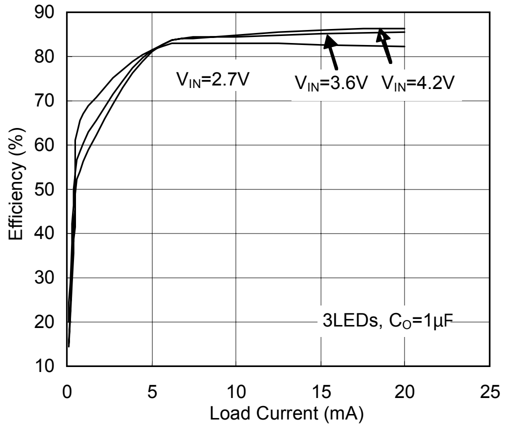

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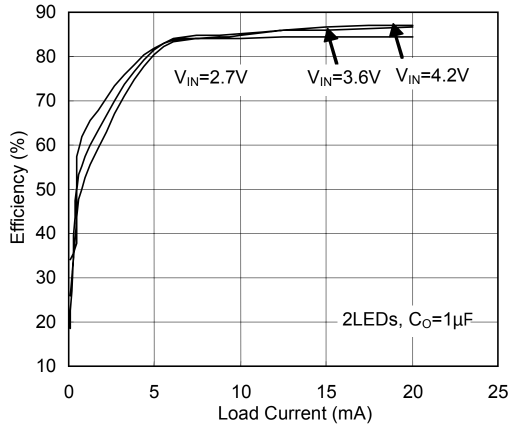
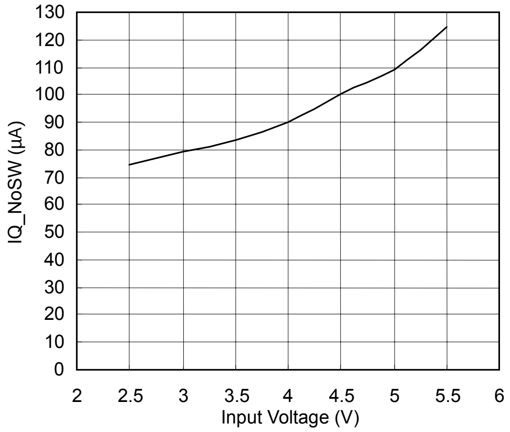
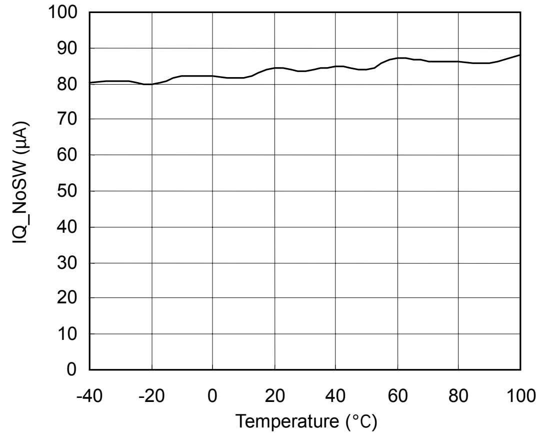


IQ_NoSW vs. Input Voltage

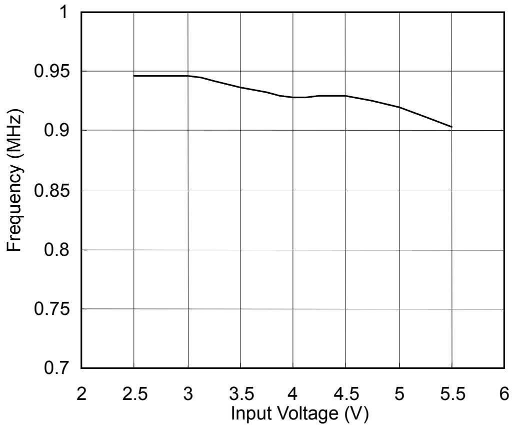


IQ_NoSW vs. Temperature

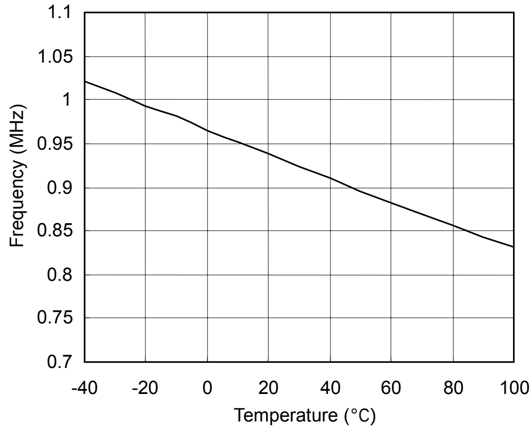


(V_{DD}=3.6V, V_{SS}=0V, L=4.7uH, Ta=25°C)

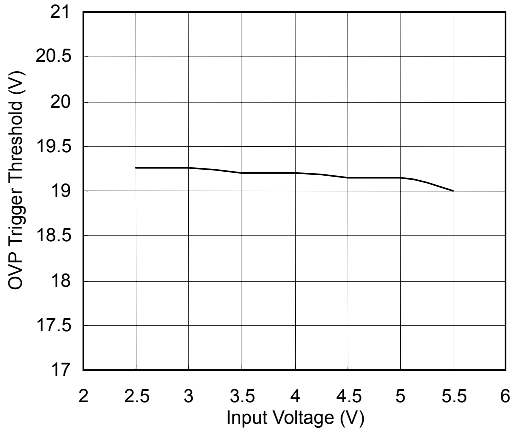
Frequency vs. Input Voltage



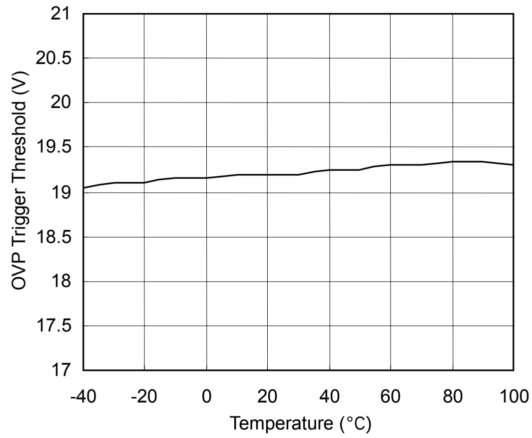
Frequency vs. Temperature



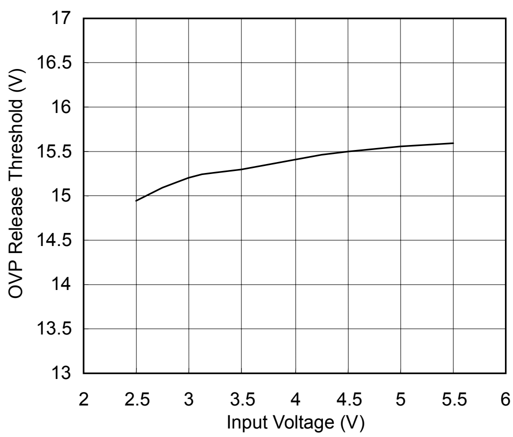
OVP Trigger Threshold vs. Input Voltage



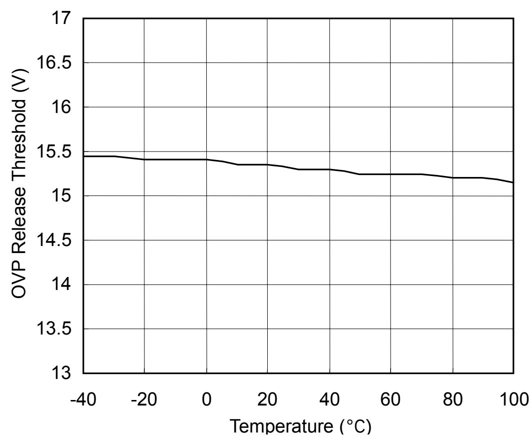
OVP Trigger Threshold vs. Temperature



OVP Release Threshold vs. Input Voltage

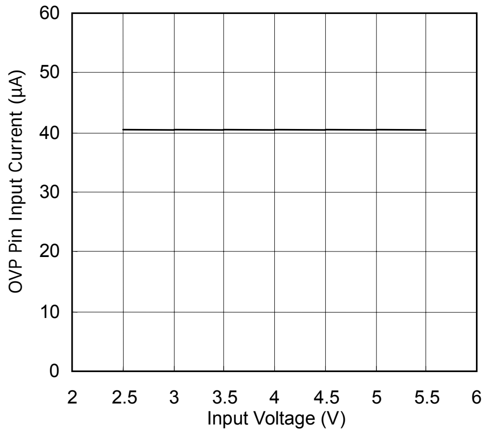


OVP Release Threshold vs. Temperature

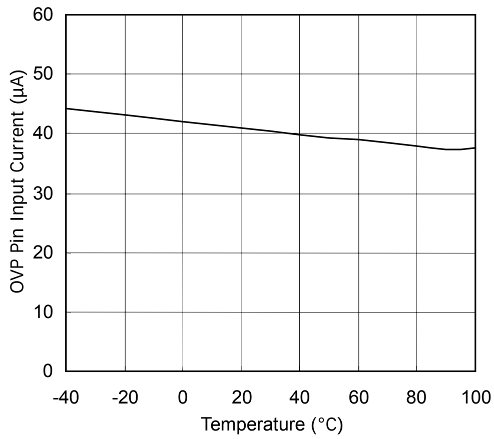


(V_{DD}=3.6V, V_{SS}=0V, L=4.7uH, Ta=25°C)

OVP Pin Input Current vs. Input Voltage

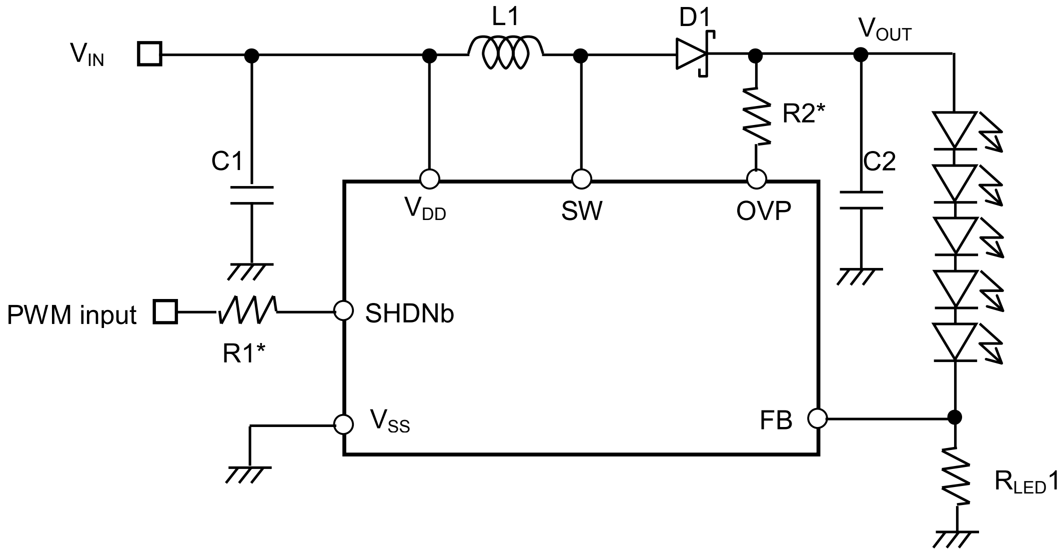


OVP Pin Input Current vs. Temperature



■ Application Circuit

(1) Using external PWM signal to adjust LED brightness



Referential List of External Components

Symbol	Component	Supplier/Parts Number	Qty	Note
IC1	White LED driver	New Japan Radio/NJU6043	1	-
L1	Inductor	TDK/VLF3010AT-4R7MR70	1	4.7uH
D1	Schottky Diode	ROHM/RB160M-30	1	-
C1	MLCC	Taiyo Yuden/JMK107 BJ475MA	1	4.7uF/6.3V
C2	Ceramic Capacitor	Taiyo Yuden/TMK107 BJ105KA	1	1uF/25V
R1	Resistor	Standard	1	10kΩ
R2	Resistor	Standard	1	10kΩ
$R_{LED}1$	Resistor	Standard	1	12Ω
LED1~5	White LED	NICHIA /NSCW215T	5	-

Note): Stress beyond those listed under “Absolute Maximum Rating” may cause permanent damage to the device. And determine the parameter of each part according actual LED number.

* To prevent over current input caused by ESD, R1 and R2 resistors should be connected with SHDNb and OVP pins respectively. By adding these two resistors, the threshold of OVP will be up 0.5V (R2=10kΩ).

[CAUTION]
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