

## High Efficiency White LED Driver

### ■ GENERAL DESCRIPTION

The **NJU6048** is a high-efficiency white LED driver. It contains a high-efficiency step-up DC/DC converter and an output driver. The IC can output max.18V and drive as many as 4 white LEDs in series with a constant current, which guarantees the LEDs with uniform brightness.

The high frequency of the step-up converter permits the use of small, low-profile inductors and capacitors to minimize the footprint in space-conscious applications. The NJU6048 also features low operating voltage of 1.7V and the small package SOT-23 (MTP-5).

All of these benefits make the **NJU6048** suitable for the battery-powered portable applications such as cellular phones, camcorders, PDAs, etc.

### ■ PACKAGE OUTLINE

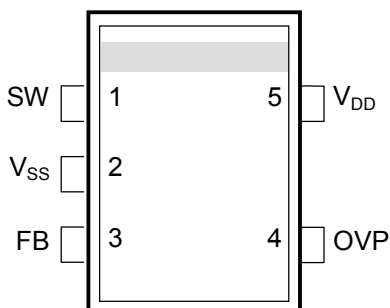


NJU6048F

### ■ FEATURES

- Drives Up to 4White LEDs in Series  
 $I_{OUT} = 20mA(\text{typical})$
- Uses Small Inductor and Capacitors
- 1.7V to 6.5V Operating Voltage for Step-up Circuits ( $V_{DD}$ )
- Low Switch  $R_{DS} (ON)$   
 $V_{SW} = 18V, R_{DS}=0.8\Omega (I_{SW}=150mA)$
- OVP Function
- CMOS Technology
- Package : SOT-23 5 pin (MTP-5)

### ■ PIN CONFIGURATION (TOP VIEW)



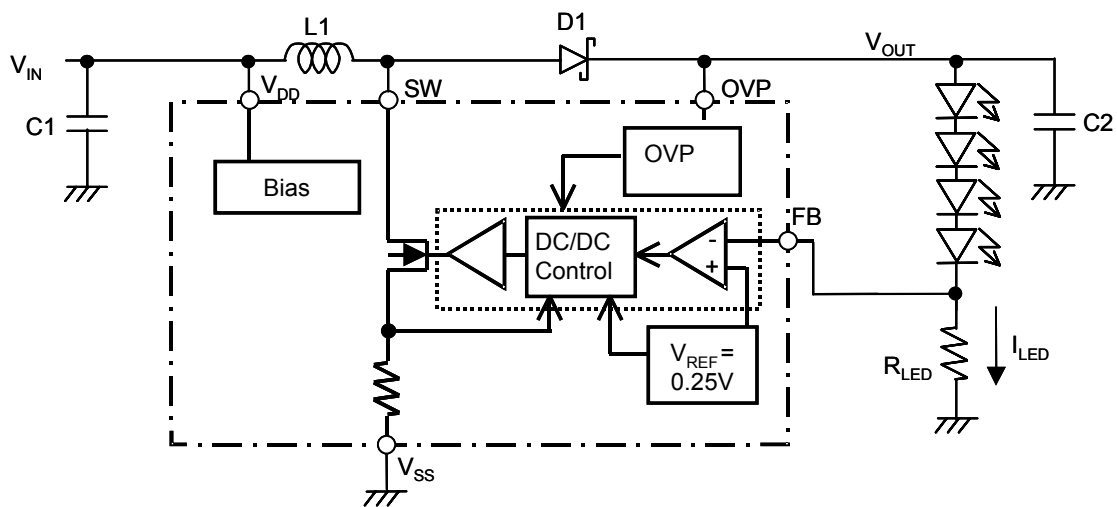
# NJU6048

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## PIN DESCRIPTIONS

No.	SYMBOL	TYPE	DESCRIPTION
1	SW	Input	Switch Terminal
2	V <sub>SS</sub>	Power	Ground Terminal
3	FB	Input	Feedback Terminal
4	OVP	Input	Over Voltage protection Terminal
5	V <sub>DD</sub>	Power	Power Supply terminal

## BLOCK DIAGRAM



## ■ FUNCTIONAL DESCRIPTIONS

### (1) LED Current Control and Resistor $R_{LED}$ Selection

The NJU6048 incorporates the LED current control to regulate the LED current ( $I_{LED}$ ), which is programmed by the feedback resistor ( $R_{LED}$ ) connected between the FB and the  $V_{SS}$  terminals. Typically, the reference voltage  $V_{REF}$  is internally regulated to 0.25V and is used as the positive input of the built-in comparator. Formula (1) is used to choose the value of the  $R_{LED}$ , as shown below.

$$R_{LED} = \frac{V_{REF}}{I_{LED}} \quad \text{--- Formula (1)}$$

$$V_{REF} = 0.25 \text{ (typical)}$$

The  $I_{LED}$  is the constant current programmed by the  $R_{LED}$ . When the feedback voltage on the FB terminal reaches above the reference voltage  $V_{REF}$  (i.e.,  $I_{LED}$  is above the level programmed by  $R_{LED}$ ), the output capacitor C2 delivers the  $I_{LED}$ . Once the feedback voltage drops below the reference voltage (i.e.,  $I_{LED}$  drops below the level programmed by the  $R_{LED}$ ), the MOS switch is turned on, then the current of the inductor L1 begins increasing. When the switch current reaches 250mA, the MOS switch is turned off, then the L1 delivers current to the output through the diode D1 as the inductor current drops. After that, the MOS switch is turned on again and the switch current increases up to 250mA. This switching cycle continues until the  $I_{LED}$  reaches the level programmed by the  $R_{LED}$ , then the  $I_{LED}$  current is maintained constant.

### (2) Over Voltage Protection

OVP is designed to prevent the damage of internal NMOS switch in case the increased impedance of the LED load (including the LED opened). Once the device detects over voltage at the output, the internal NMOS switch is kept off until the output voltage drops below 14V.

### (3) Inductor Selection

A 10uH inductor is recommended for most application. The selected inductor must have a saturation current that meets the maximum peak current of the converter. Another important inductor parameter is the DC resistance. The lower DC resistance the device has higher efficiency.

### (4) Diode Selection

A Schottky diode with a low forward-voltage-drop and a fast switching-speed is ideal for the D1. And the D1 must have a rating greater than the output voltage and output current in the system.

### (5) Capacitor Selection

A low ESR (Equivalent Series Resistance) capacitor should be used as the output capacitor C2 to minimize output ripples. A multi-layer ceramic capacitor is the best selection for the NJU6048 application because of not only the low ESR but also small package. Application requires good line regulation  $\pm 1\%$ (typ) should use output capacitor larger than 1uF. A ceramic capacitor is also recommended for the input decoupling-capacitor C1, and should be placed as close to the NJU6048 as possible. A 4.7uF is sufficient for most applications.

## ■ ABSOLUTE MAXIMUM RATINGS

Ta=25°C

PARAMETERS	SYMBOL	CONDITIONS	RATINGS	UNIT
V <sub>DD</sub> Power Supply	V <sub>DD</sub>		-0.3 to +7.0	V
OVP Terminal to GND	V <sub>OVP</sub>		-0.3 to 18.0V	
SW Terminal Voltage	V <sub>SW</sub>	SW terminal	-0.3 to +18.0	V
FB Terminal Voltage	V <sub>FB</sub>	FB terminal	-0.3 to V <sub>DD</sub>	V
Power Dissipation	PD	MTP-5	200	mW
Operating Temperature	T <sub>opr</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-65 to +150	°C

Note1) All voltages are relative to V<sub>SS</sub> = 0V reference.

Note2) Do not exceed the absolute maximum ratings, otherwise the stress may cause a permanent damage to the IC. It is also recommended that the IC be used in the range specified in the DC electrical characteristics, or the electrical stress may cause malfunctions and impact on the reliability.

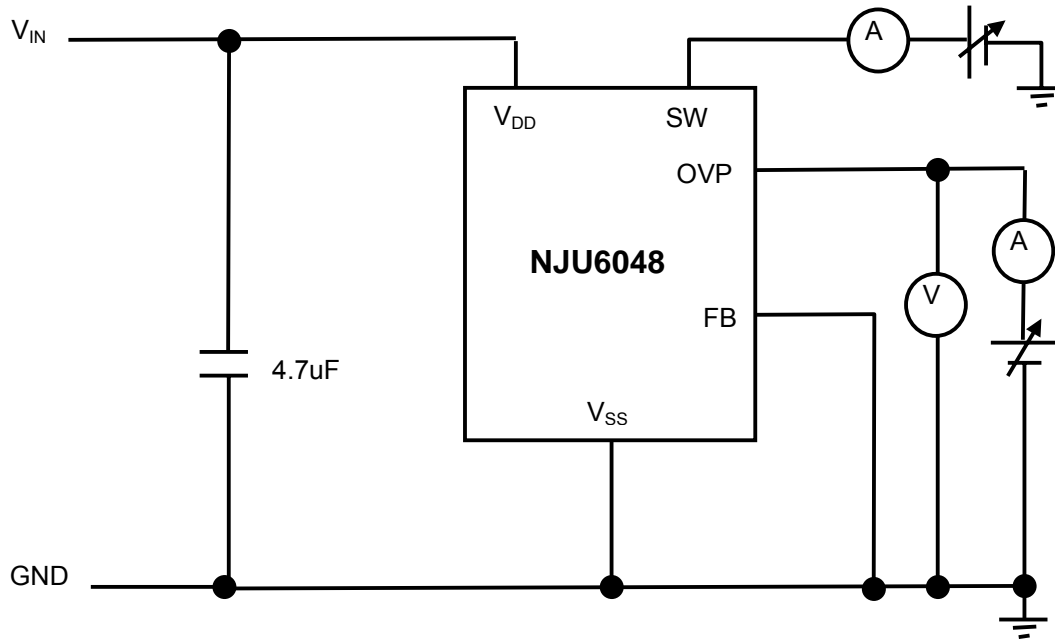
## ■ DC ELECTRICAL CHARACTERISTICS

(V<sub>DD</sub>=3.6V, V<sub>SS</sub>=0V, Ta=25°C)

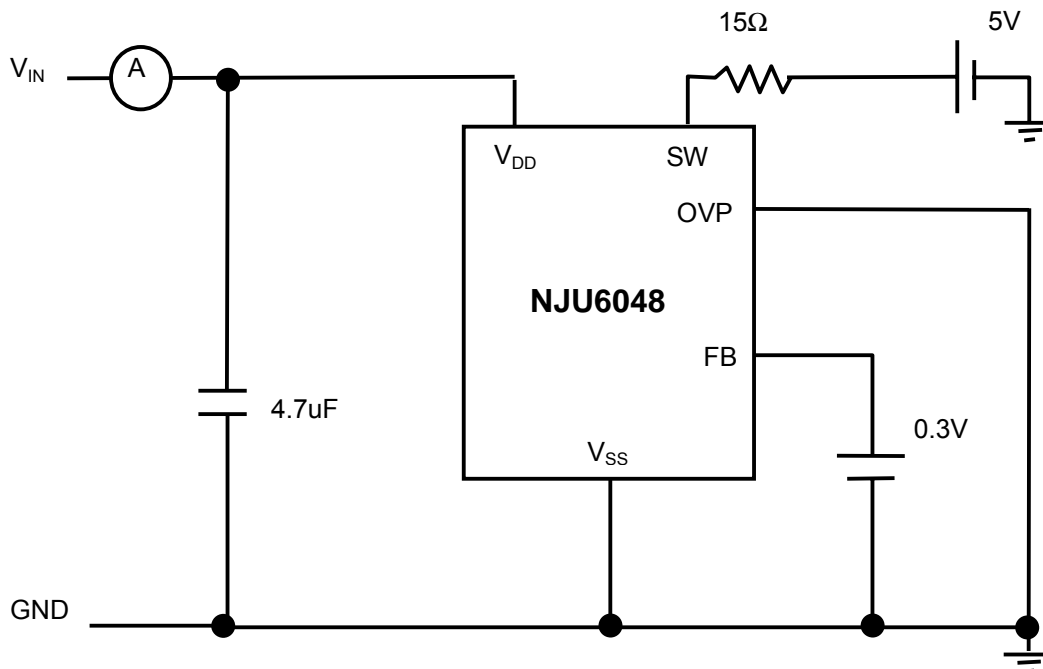
PARAMETERS	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	Unit
V <sub>DD</sub> Power Supply	V <sub>DD</sub>		1.7		6.5	V
OVP Threshold	V <sub>OVP</sub> TH	Trigger	15	16	17	V
		Release			14	V
OVP Pin Input Current	I <sub>OVPIC</sub>	V <sub>OVP</sub> =16V		10	15	μA
Quiescent Current	I <sub>STBY1</sub>	V <sub>FB</sub> =0.3V			80	μA
FB Comparator Trip point	V <sub>F</sub> BP		242	250	258	mV
Switch Off Time	t <sub>OFF</sub>	V <sub>FB</sub> =0V		400		ns
Switch R <sub>DS</sub> (ON)	R <sub>DS</sub>	I <sub>SW</sub> =150mA		0.8	1.2	Ω
Switch Current Limit	I <sub>CL</sub>		200	250	300	mA
Switch Leakage Current	I <sub>L</sub>	Switch Off, V <sub>SW</sub> =18V		0.1	5.0	μA

## • TEST CIRCUITS

### OVP Threshold Voltage



### Quiescent Current

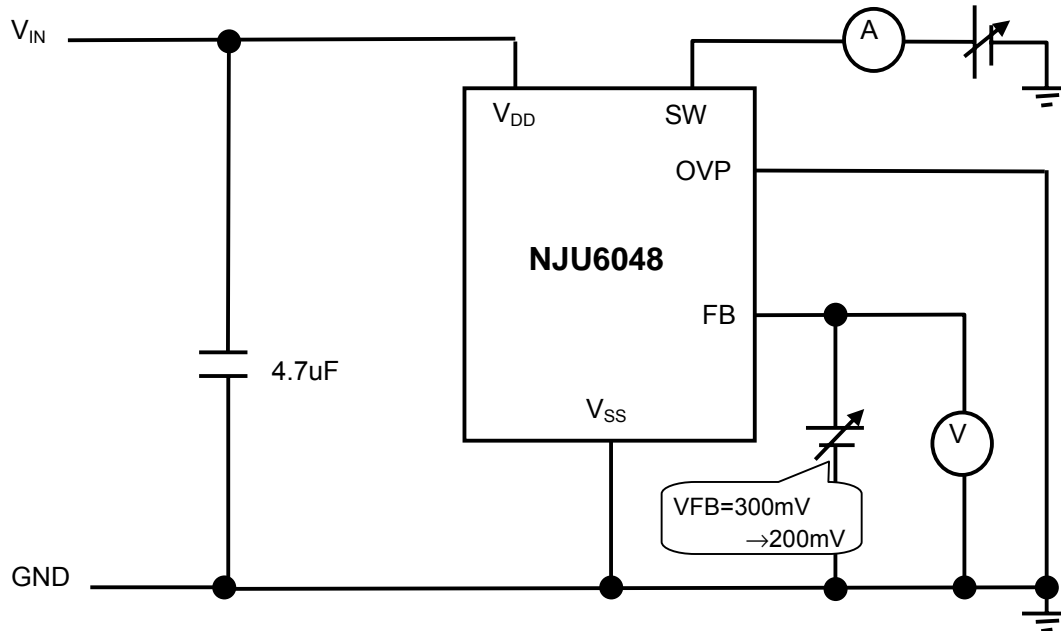


# NJU6048

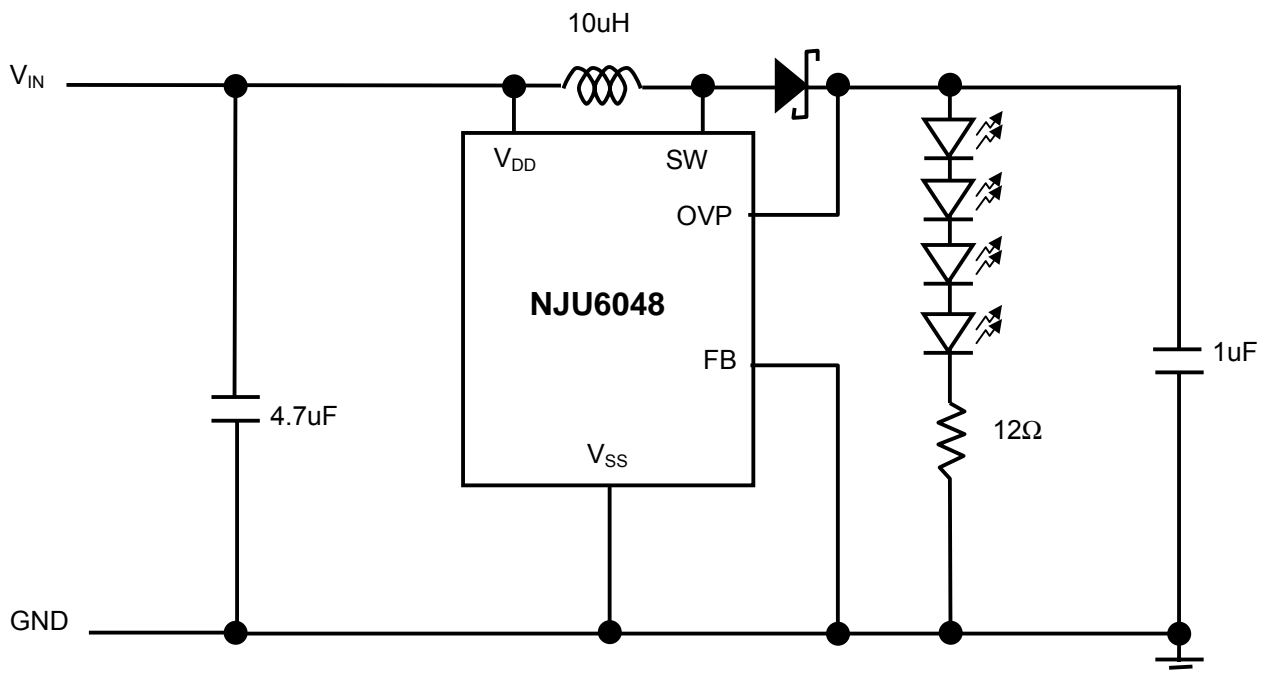
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## FB Comparator Trip point

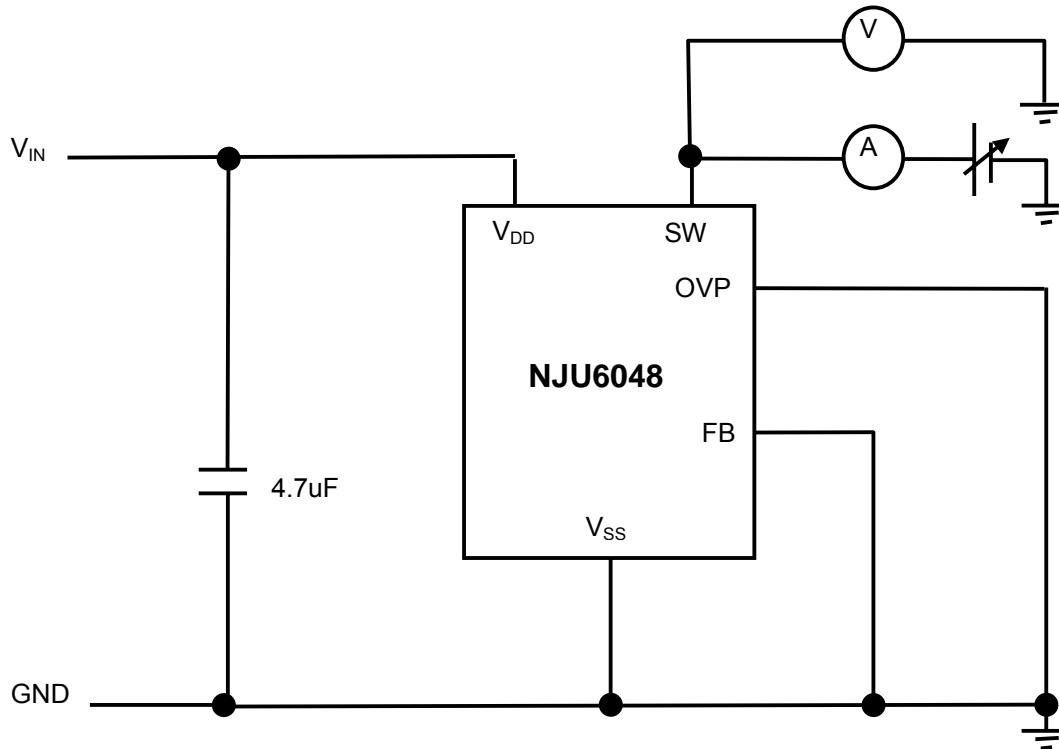
In stepping down  $V_{FB}$  from 300mV,  $V_{FBP}$  is the threshold voltage to begin switching operation.



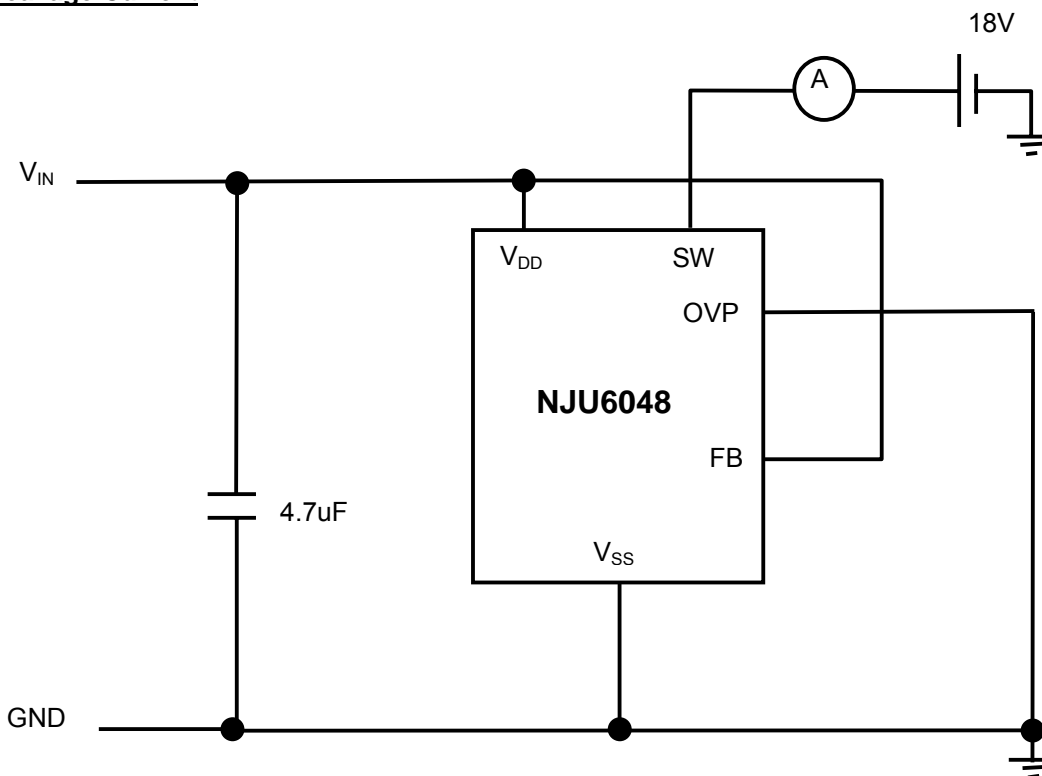
## Switch Off Time



## Switch Current Limit / Switch $R_{DS(ON)}$



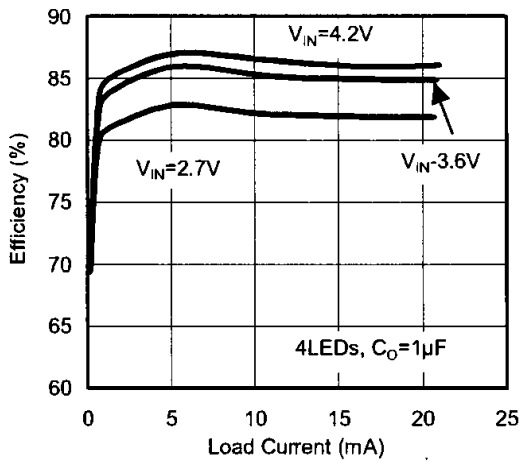
## Switch Leakage Current



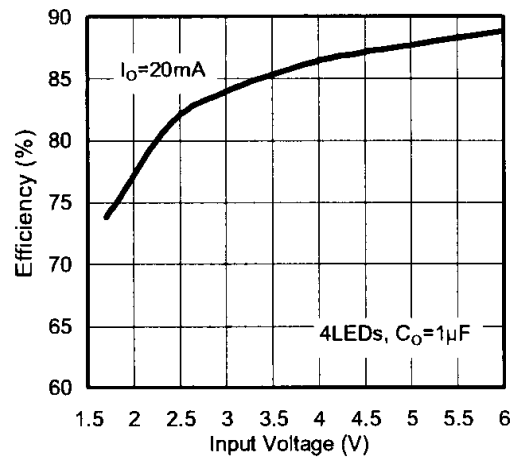
## ■ TYPICAL PERFORMANCE

( $V_{DD}=3.6V$ ,  $V_{SS}=0V$ ,  $L=10\mu H$ ,  $T_a=25^\circ C$ )

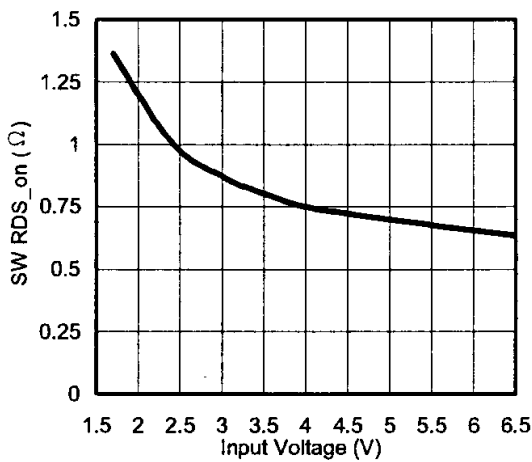
Efficiency vs. Output Current



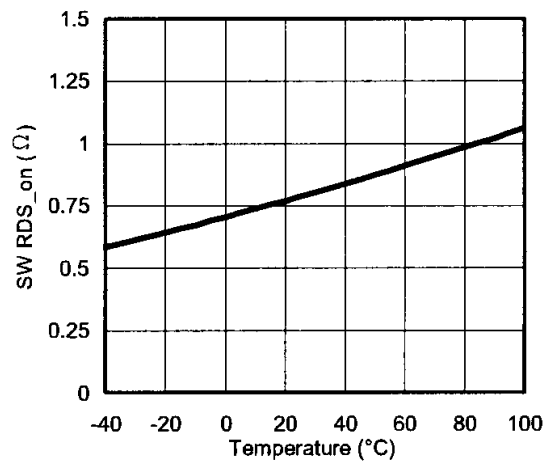
Efficiency vs. Input Voltage



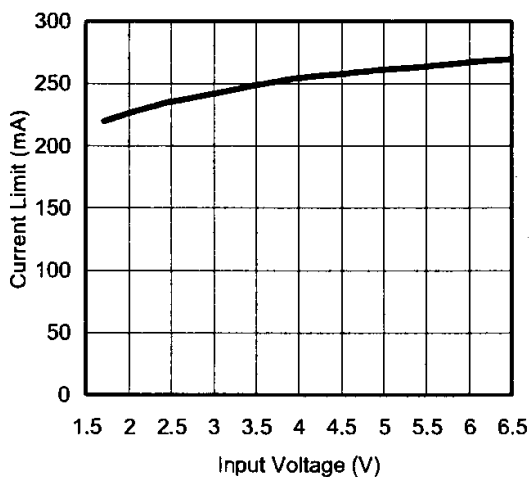
SW RDS\_on vs. Input Voltage



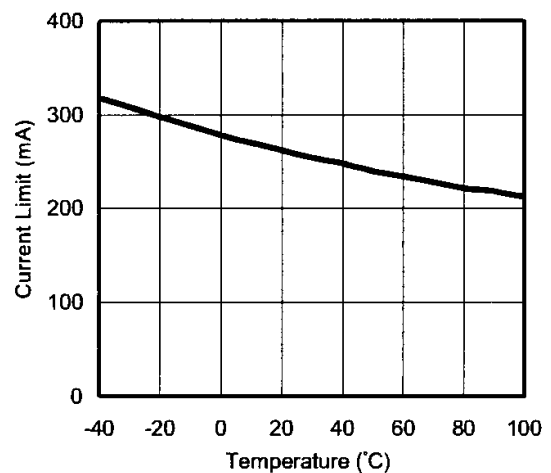
SW RDS\_on vs. Temperature



Current Limit vs. Input Voltage



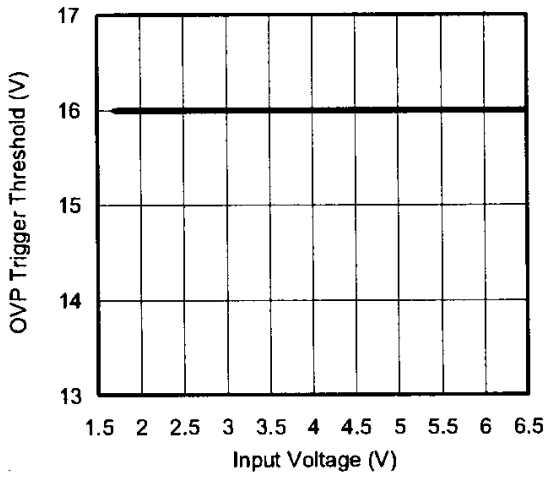
Current Limit vs. Temperature



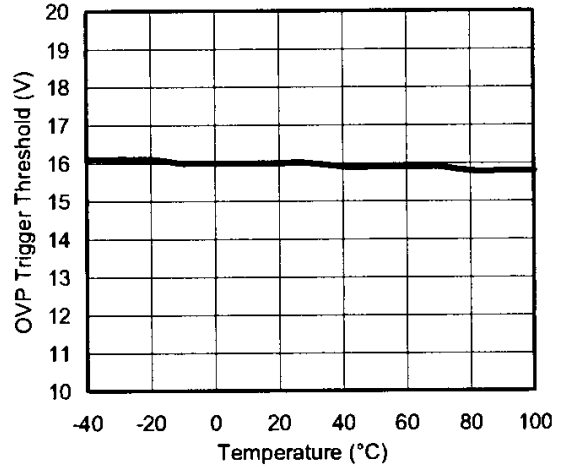


( $V_{DD}=3.6V$ ,  $V_{SS}=0V$ ,  $L=10\mu H$ ,  $T_a=25^\circ C$ )

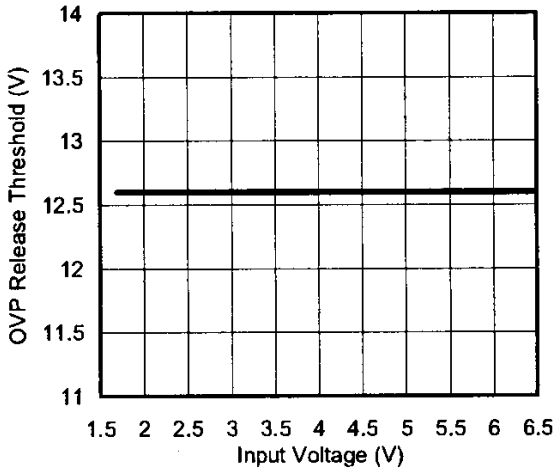
**OVP Trigger Threshold vs. Input Voltage**



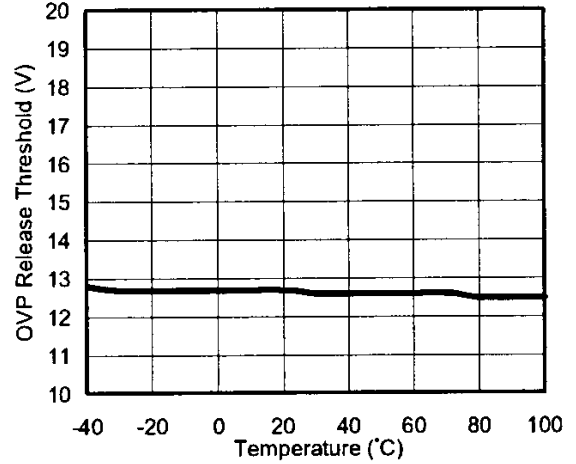
**OVP Trigger Threshold vs. Temperature**



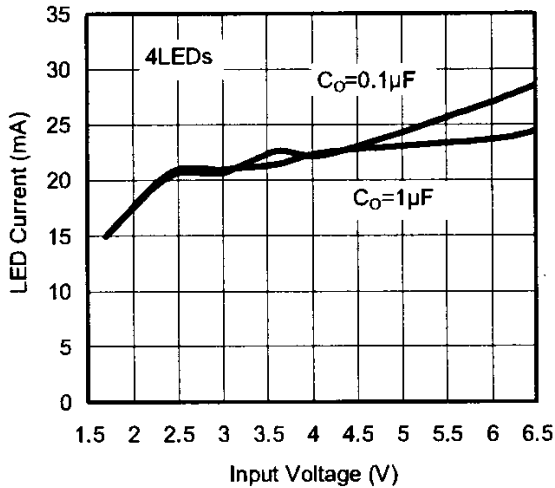
**OVP Release Threshold vs. Input Voltage**



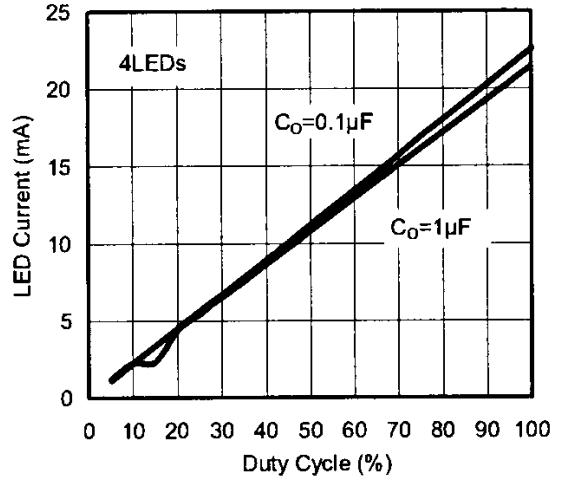
**OVP Release Threshold vs. Temperature**



**LED Current vs. Input Voltage**

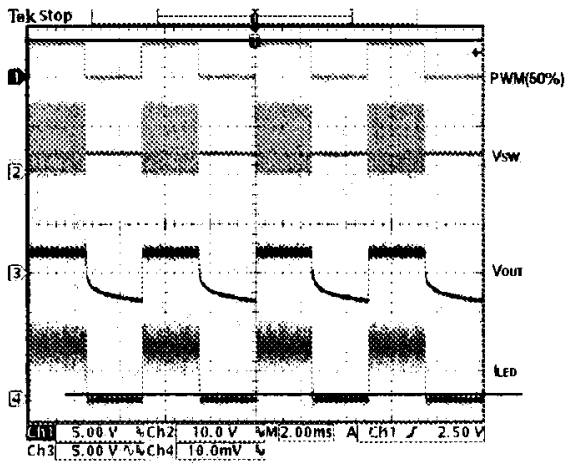


**LED Current vs. Duty Cycle**

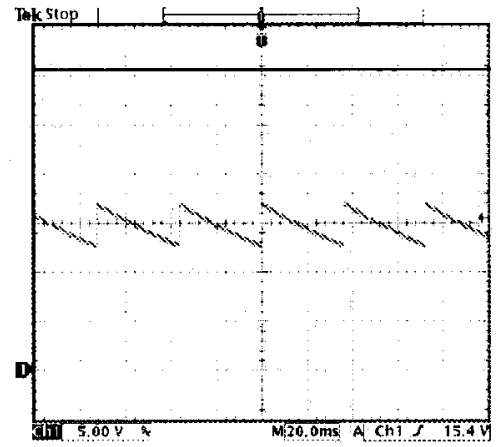


( $V_{DD}=3.6V$ ,  $V_{SS}=0V$ ,  $L=10\mu H$ ,  $T_a=25^\circ C$ )

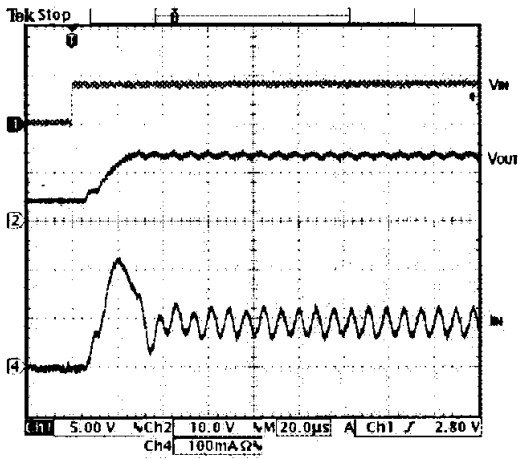
### PWM Dimming



### OVP Waveform

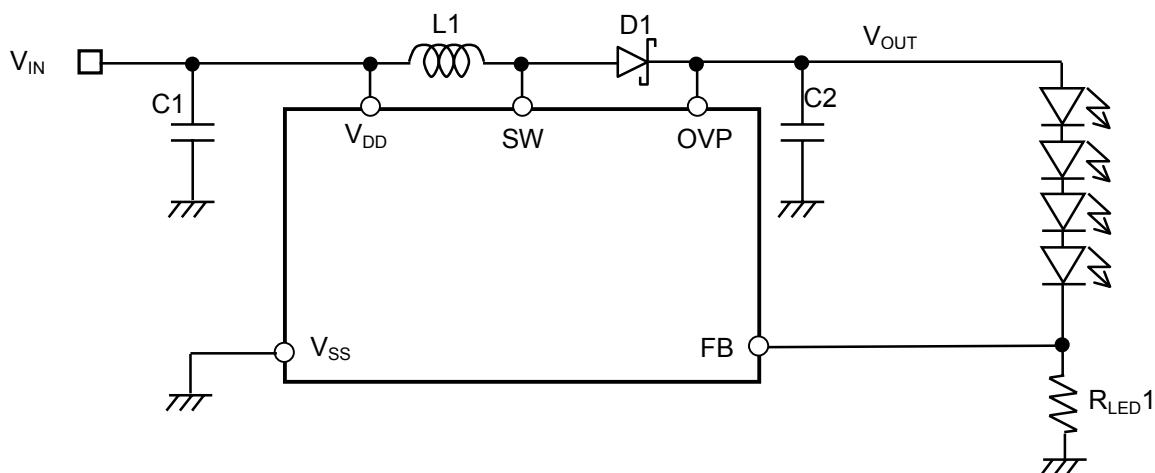


### Inrush Current Waveform



## ■ TYPICAL APPLICATION CIRCUITS

(1) 4 white LEDs



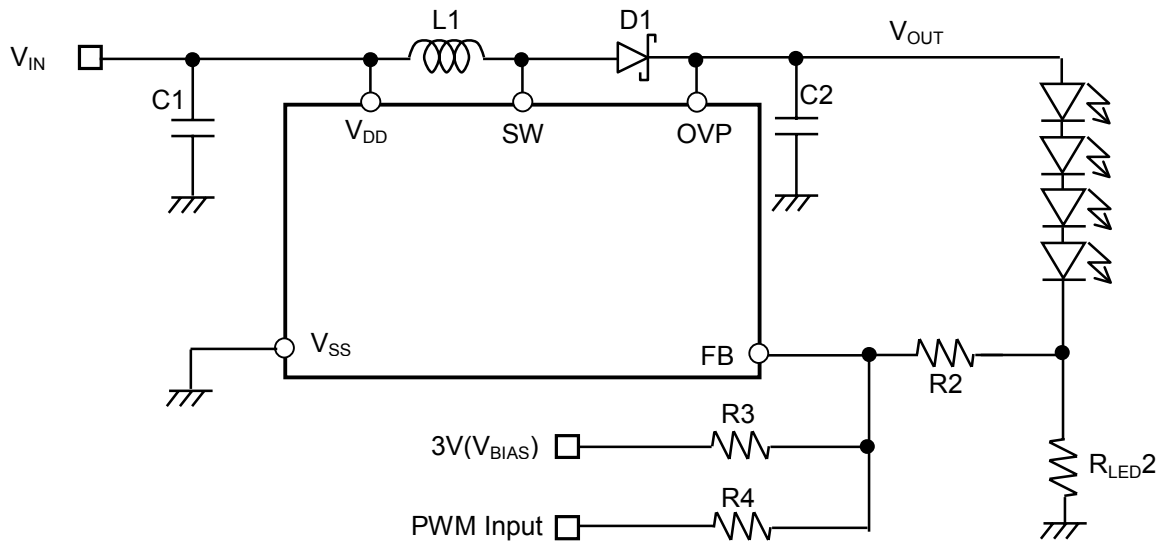
### Referential List of External Components

Component	Supplier / Parts Number	Qty	Value
IC1	LED Driver IC	1	-
L1	Inductor	1	10uH
D1	Schottky Diode	1	-
C1	Ceramic Capacitor	1	4.7uF/10V
C2	Ceramic Capacitor	1	1uF/25V
R <sub>LED1</sub>	Chip Resistor	1	12Ω
LED1 to 4	White LED	4	-

# NJU6048

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(2) 4 white LEDs & Dimming control by external PWM signal



## Referential List of External Components

Component	Supplier / Parts Number	Qty	Value
IC1	LED Driver IC NJRC / NJU6048	1	-
L1	Inductor Murata / LQH32CN100K23	1	10uH
D1	Schottky Diode On Semiconductor / MBR0530	1	-
C1	Ceramic Capacitor Murata / GRM21BF11A475Z	1	4.7uF/10V
C2	Ceramic Capacitor Taiyo Yuden / TMK325BJ105MD	1	1uF/25V
RLED2	Chip Resistor Standard	1	5.1Ω
R2	Chip Resistor Standard	1	15KΩ
R3	Chip Resistor Standard	1	300KΩ
R4	Chip Resistor Standard	1	430KΩ
LED1 to 4	White LED Nichia / NSCW215T	4	-

**MEMO****[CAUTION]**

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