

## White LED Step-Up Converter

The KAB3403T/DN is a monolithic step-up DC/DC converter specifically designed to drive white LEDs with a constant current from Li-ion cell. Relative large 320mV feedback voltage & its high accuracy help you setting LED current with an external resistor.

KAB3403T/DN is available in an extremely low profile & small TS-6 package.

A 10μH inductor is sufficient for most applications.

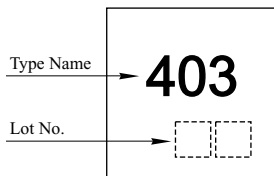
### FEATURES

- Inherently Matched LED Current.
- High Efficiency : 87% (max.)
- Built in an open circuit protection for the LEDs fail.
- Drives Up to Five LEDs
- Built in an N-channel MOSFET Switch.
- Fast 1.1MHz(typ.) Switching Frequency.
- Wide Dimming control range : 12%~100%.
- Automatic Soft-Start
- Built in OVD (Over voltage protection.)
- Extremely low height & small Packaging.

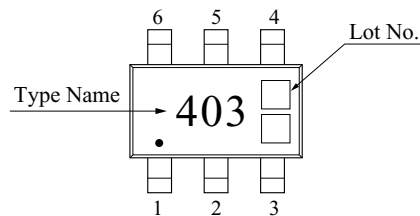
### APPLICATIONS

- Cellular Phones
- Smart Phones
- PDAs
- Digital Cameras
- MP3 Players, Color Displays

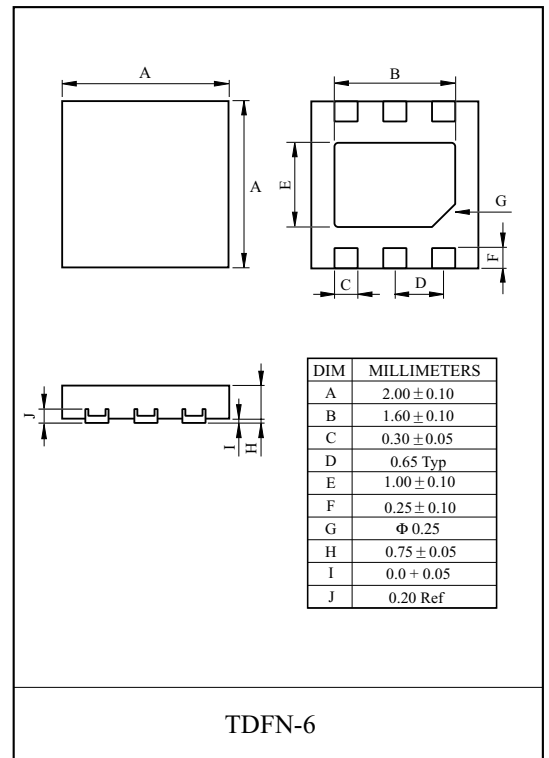
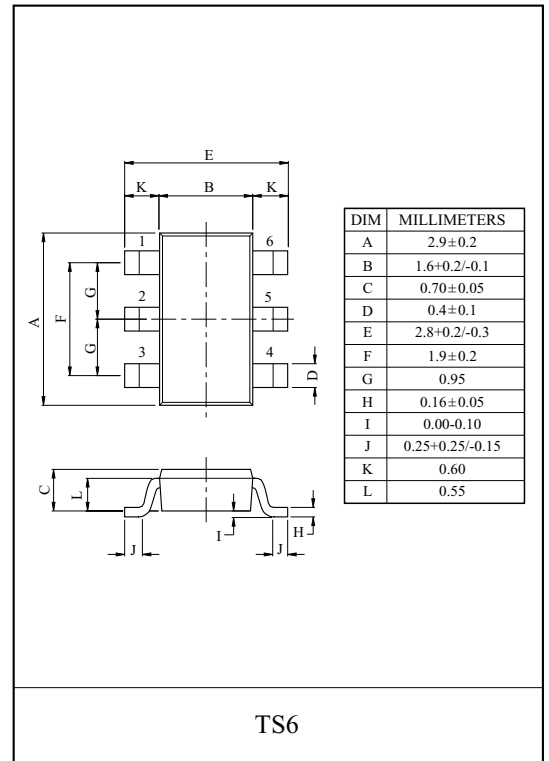
### Marking



**KAB3403DN**

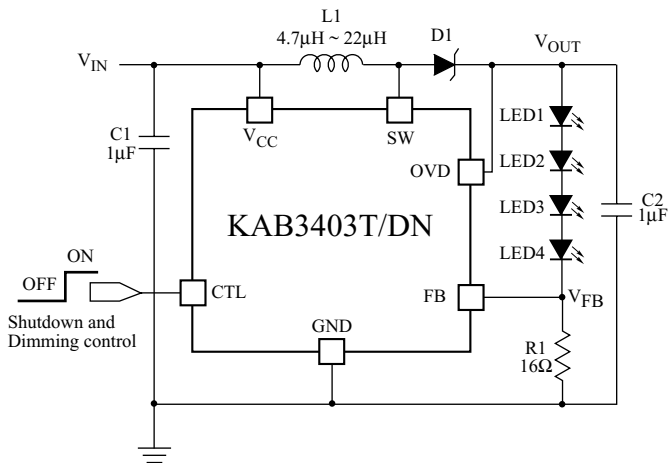


**KAB3403T**

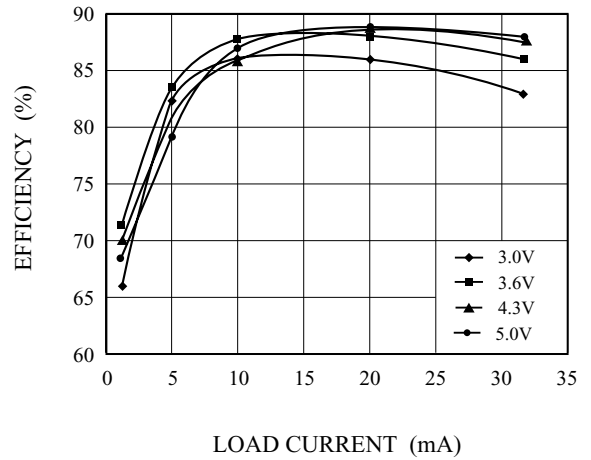


# KAB3403T/DN

## TYPICAL APPLICATION



## CONVERSION EFFICIENCY



## BLOCK DIAGRAM

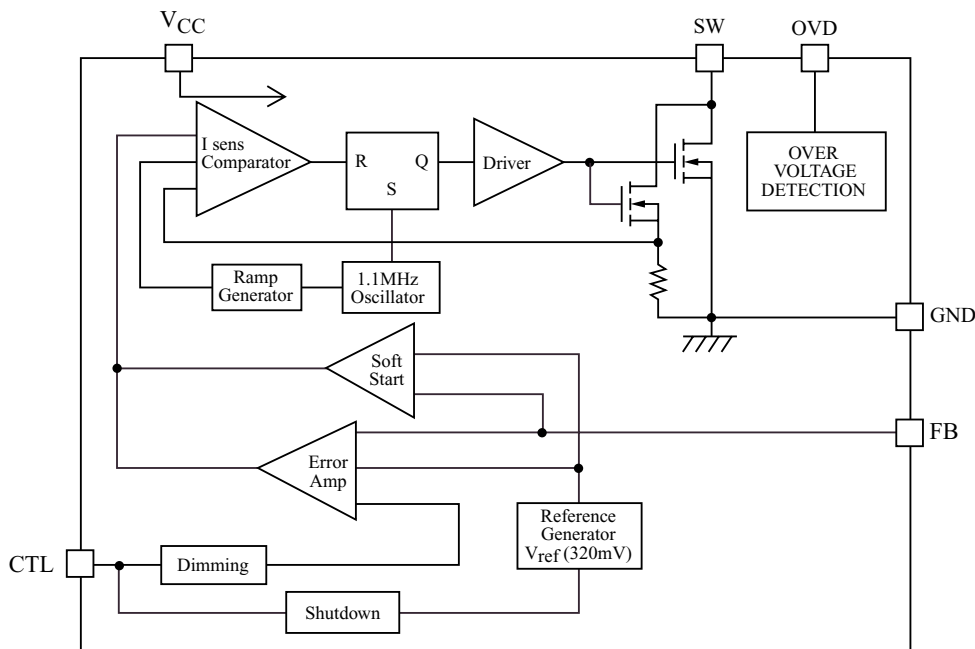


figure 2. KAB3403T/DN Block Diagram

## PIN FUNCTIONS

NO.		SYMBOL	FUNCTION AND CONNECTION.
KAB3403T	KAB3403DN		
6	1	V <sub>CC</sub>	Input supply pin. Must be locally bypassed.
5	2	GND	Ground pin. Connect directly to local ground plane,
4	3	FB	Feedback pin. Reference voltage is 320mV. Connect cathode of lowest LED and resistor here.
3	4	SW	Switch pin. Connect inductor/diode here. Minimize trace area at this pin to reduce EMI.
2	5	OVD	Over output voltage detect pin. Connect cathode of schottky diode and anode of highest LED.
1	6	CTL	Control pin : Shutdown or dimming control. Connect external enable or dimming circuits. Shutdown mode (IF = 0) : V <sub>CTL</sub> < 1.0V Dimming control mode : (IF = 12% ~ 100%, depend on V <sub>CTL</sub> )

# KAB3403T/DN

## MAXIMUM RATINGS (Ta=25 °C)

CHARACTERISTICS	SYMBOL	RATING	UNIT
Input Voltage	V <sub>CC</sub>	-0.3 ~ 6.0	V
Switching pin Voltage	V <sub>SW</sub>	-0.3 ~ 22	V
OVD pin Voltage	V <sub>OVD</sub>	-0.3 ~ 22	V
Operating temperature range	T <sub>opr</sub>	-40 ~ 85	°C
Storage temperature range	T <sub>stg</sub>	-55 ~ 150	
Maximum Junction temperature	T <sub>j</sub>	150	

## RECOMMENDED OPERATING CONDITIONS (T<sub>opr</sub>=-40~85 °C)

CHARACTERISTICS	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage	V <sub>CC</sub>	-	2.7	-	5.5	V
CTL pin voltage for full LED current	V <sub>CTL H</sub>	V <sub>CC</sub> =3.0V	2.7	-	-	V
CTL pin voltage to shutdown chip	V <sub>CTL L</sub>		-	-	0.5	V
LED Current	I <sub>F</sub>	V <sub>CC</sub> =3.6V, R <sub>SENSE</sub> =16 Ω, T <sub>opr</sub> =25 °C, Five LED	-	20	-	mA
CTL Response Delay (When Power ON.)	T <sub>pd CTL</sub>	-	2	-	-	μs

## ELECTRICAL CHARACTERISTIC

(T<sub>opr</sub>=-40~85 °C, V<sub>CC</sub>=2.7~5.5V, R<sub>SENSE</sub>=16 Ω, unless otherwise noted.)

CHARACTERISTICS	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage	V <sub>CC</sub>	-	2.7	-	5.5	V
Supply Current	I <sub>CC</sub>	V <sub>CC</sub> = 3.6V, V <sub>CTL</sub> =3.6V	-	0.9	1.5	mA
		V <sub>CTL</sub> = 0V	-	0.5	1	μA
Feedback Voltage	V <sub>FB</sub>	V <sub>CC</sub> =V <sub>CTL</sub> =3.0V, T <sub>opr</sub> = 25 °C, L =4.7μH	304	320	336	mV
CTL Pin Bias Current	I <sub>CTL</sub>	V <sub>CC</sub> = 3.0V, V <sub>CTL</sub> = 3.0V	-	5	10	μA
Switching Frequency	f <sub>OSC</sub>	V <sub>CTL</sub> = 3.0V	0.77	1.1	1.43	MHz
Switching Pin Current	I <sub>O(SW)</sub>	-	-	400	-	mA
Switch Leak Current	I <sub>OZ(SW)</sub>	-	-	0.5	1	μA
OVD Pin Voltage	V <sub>OVD</sub>	-	19	21	23	V
OVD Pin Leak Current	I <sub>OZ(OVD)</sub>	V <sub>OVD</sub> = 18V	-	0.5	1	μA
Switching Pin OVP	V <sub>O(SW)</sub>	-	25	-	-	V
CTL pin voltage for Full LED Current	V <sub>CTL H</sub>	V <sub>CC</sub> = 3.0V	2.7	-	-	V
CTL pin voltage to shutdown Chip	V <sub>CTL L</sub>		-	-	0.5	V
Feedback Bias Current	I <sub>FB</sub>	-	-	0.5	1	μA
Maximum Duty Cycle	D <sub>max</sub>	-	85	90	-	%

# KAB3403T/DN

## ■ Inductor Section

A 10uH inductor is sufficient for most application. The efficiency comparison of different value inductors help you design your application circuits.

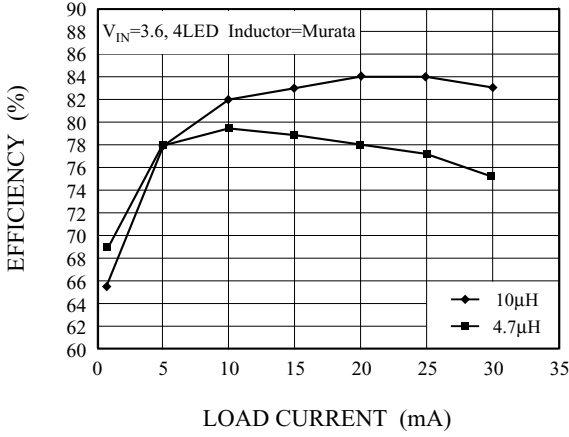


Figure3. Efficiency Comparison of different value inductors

## ■ Inductor Section

A 1uF input capacitor and output capacitor above 1uF are sufficient for most KAB3403T/DN application.

## ■ Diode Selection

For Diode Selection, both forward voltage drop and diode capacitance need to be considered. Schottky diodes with higher current ratings usually have lower forward voltage and larger diode capacitance, which can cause significant switching losses. A schottky diode rated at 100mA to 200mA is sufficient for most KAB3403T/DN applications.

Part No.	Reverse Voltage (V)	Forward Current (mA)	Voltage Drop (V)	Package
KDR730E	30	200 mA	0.6V (max) at 200 mA	
KDR720E	30	200 mA	0.5V(max) at 200 mA	
KDR412	20	500 mA	0.5V(max) at 500 mA	

Table1. Recommended Schottky Diode

## ■ LED Current Control

The LED current is controlled by the feedback resistor (RSENSE in Figure 1). The feedback reference is 320mV. The LED current is  $320\text{mV}/R_{\text{SENSE}}$ . The tolerance of LED Current is depends on tolerance of RSENSE and feedback reference.

## ■ Open-Circuits Protection

In the case of output open circuit, when LEDs are disconnected from the circuit or the LEDs fail, the feedback voltage will be zero.

The KAB3403T/DN will then switch at a high duty cycle resulting in a high output voltage. But Internal Over Voltage Protection Circuits prevent output voltage ascending over OVD pin voltage(19V ~ 23V see Fig 4). This circuits is valid when driving up to 4 LEDs in series. But, when driving more than 4 LEDs in series, Normal output voltage could be over OVD pin voltage. In this case, zener diode can be used to check connect of OVD pin to LED anode.(see Fig 5) [Recommended Zener diode : KDZ3.0V]

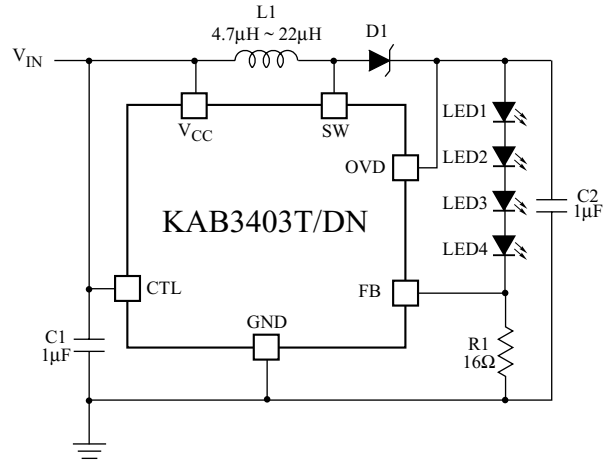


Figure4. 4LEDs driver with Open-circuit protection.

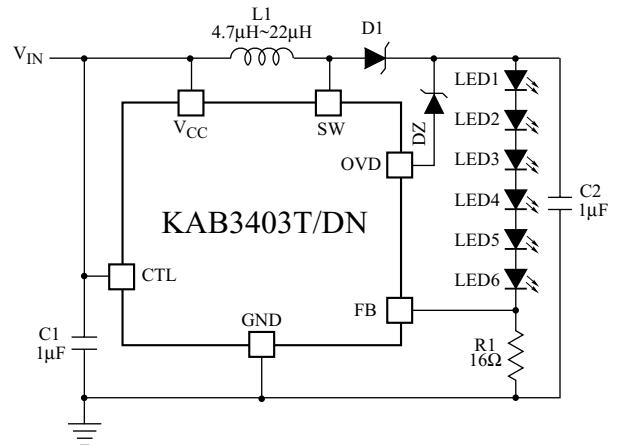


Figure5. 6LEDs driver with Open-circuit protection.

## ■ Dimming Control

There are 4 different type of dimming control circuits;

### 1. Using a DC Voltage to CTL pin

Description	$V_{\text{CTL}}$			UNIT
	0V~0.5V	1V~2.5V	$V_{\text{CTL}} > 2.5\text{V}$	
Rate Of the LED Current	0	25 ~ 100	100	%
Example : $R_{\text{SENSE}} = 16 \Omega$	0	5 ~ 20	20	mA

Table 2 CTL pin Voltage vs  $I_{\text{LED}}$

# KAB3403T/DN

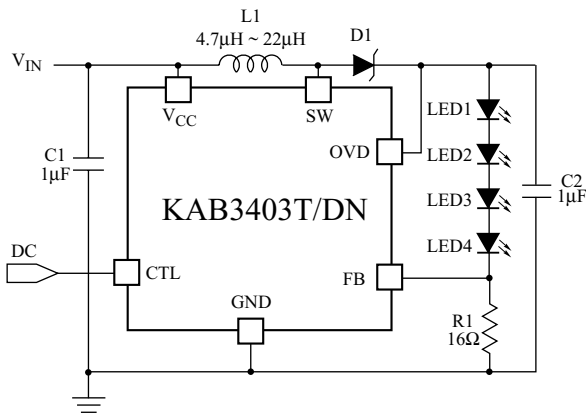


Figure6. Using a DC Signal to CTL pin.

## 2. Using a filtered PWM Signal to CTL pin.

The filtered PWM signal can be considered as an adjustable DC voltage. It can be used to replace the variable DC Voltage source in dimming control. The circuit is shown in Figure 7

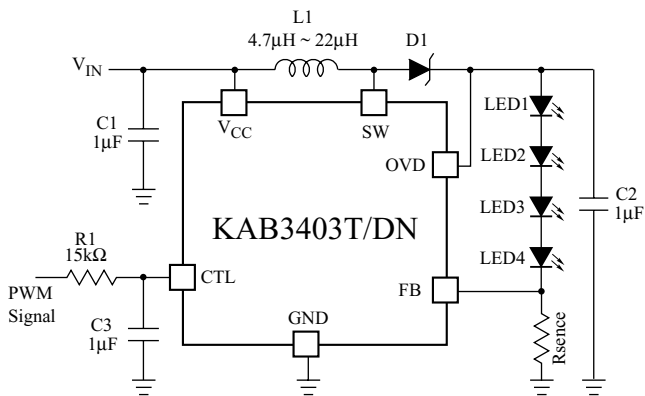
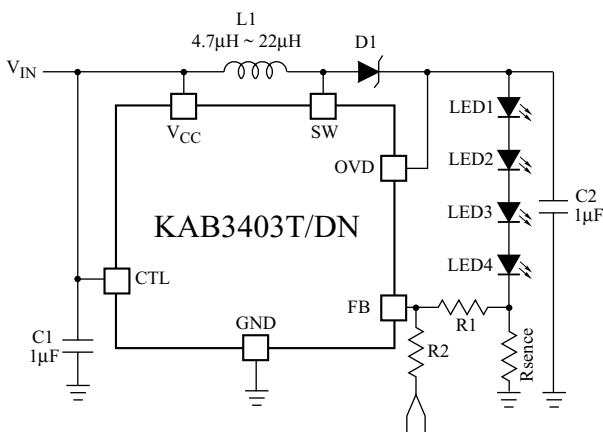


Figure7. Using a filtered PWM Signal to CTL pin.

## 3. Using a DC Voltage to FB pin.

The dimming control using a DC control voltage to FB pin of the KAB3403T/DN is shown in Figure. The LED current can be varied applying a DC voltage to the FB pin. The voltage can come from a filtered PWM signal. It can be used to replace the variable DC voltage source in dimming control.



## 4. Using a Logic Signal to FB pin.

For application that need to adjust the LED current in discrete steps. A logic signal can be used as shown in Figure 9.

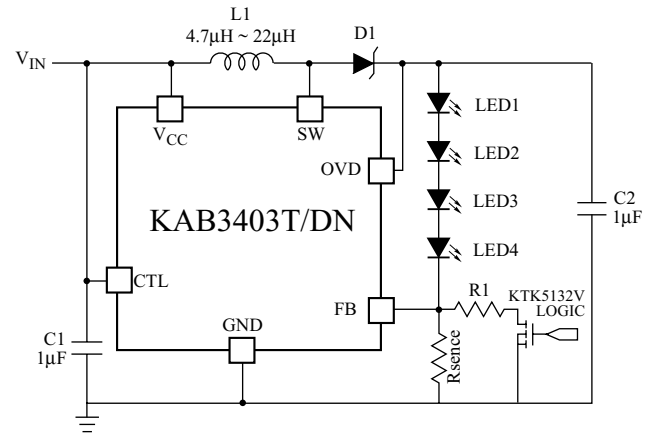
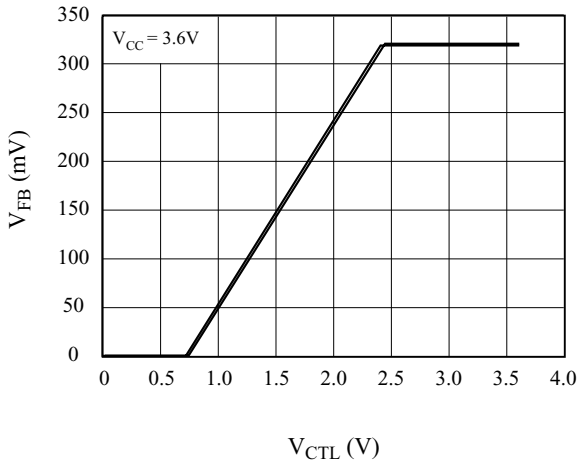


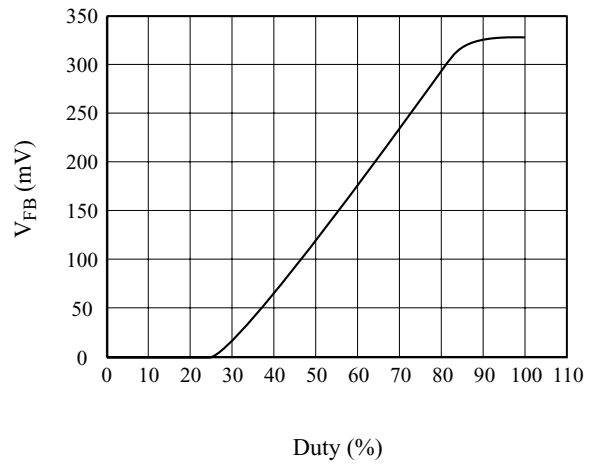
Figure9. Using a Logic Signal to FB pin.

# KAB3403T/DN

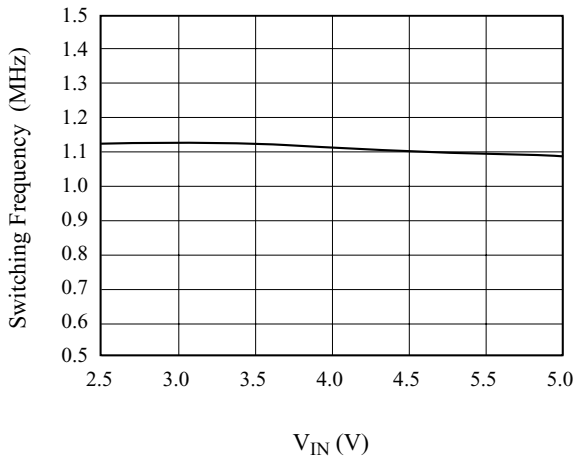
$V_{FB}$  vs  $V_{CTL}$



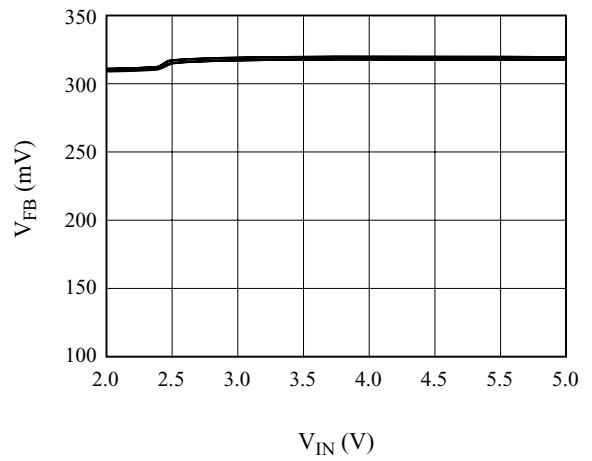
$V_{FB}$  vs Duty



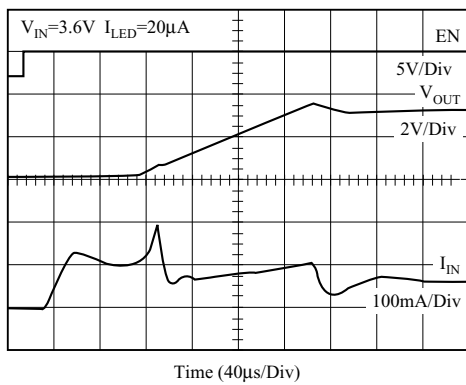
Switching Frequency vs  $V_{IN}$



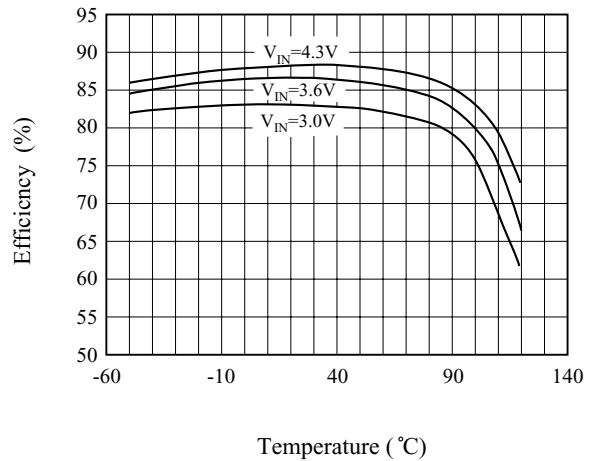
$V_{FB}$  vs  $V_{IN}$



Inrush Current

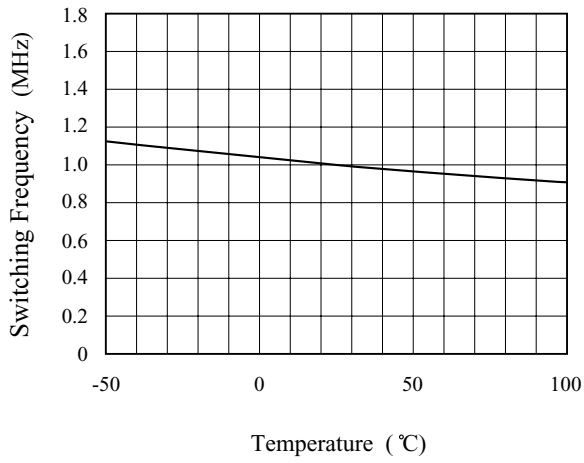


Efficiency vs Temperature

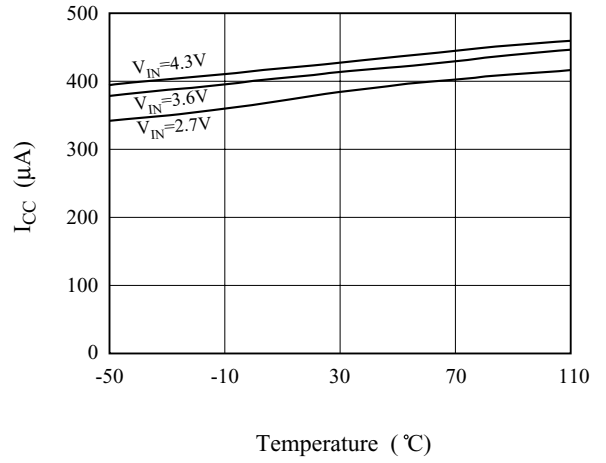


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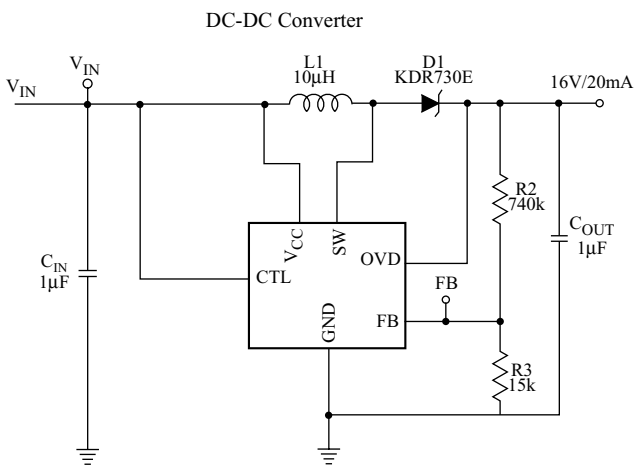
Switching Frequency vs Temperature



Quiescent Current vs Temperature



## APPLICATION CIRCUIT



EFFICIENCY

