XC9133 Series

查询XC9133供应商

Step-Up DC/DC Converter-LED Backlight Driver

GENERAL DESCRIPTION

The XC9133 series is a fixed frequency, constant current step-up DC/DC converter which is optimized for LED backlight applications in mobile phones, PDAs and digital cameras. Output voltage of up to 17.5V is possible so that four white LEDs can be driven in series. Since the LED current is set by only one external resistor, all white LEDs placed in series can be turned on at the same time. The new DC/DC Converter is also able to drive a network of two parallel banks of three LEDs. LED dimming is controlled by adjusting the duty cycle of a PWM signal (10kHz Max.) applied to the CE pin.

Efficiency is high with a 0.2V low feedback reference voltage ensuring the R_{LED} losses are minimal. In addition, an internal MOSFET with a low R_{DSON} of 2.4 is used. A low profile and small board area solution can be achieved using a chip inductor and a small ceramic output capacitor C_L=0.22μF as a result of the high 1MHz switching frequency.

If white LEDs are opened or damaged, the detector built in the Lx pin causes the IC to stop oscillating, preventing excessive increase of the output voltage.

APPLICATIONS

For White LED drivers

Mobile phones

PDAs

Digital cameras

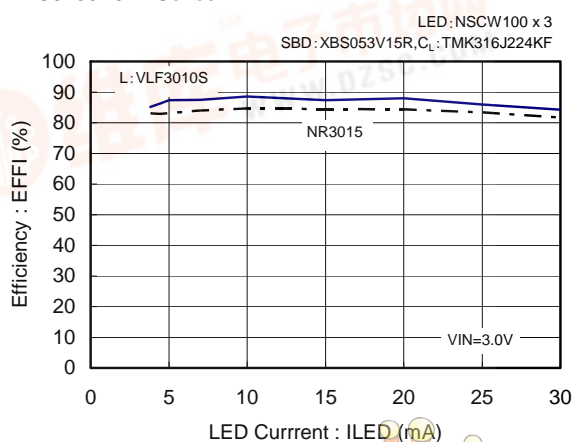## FEATURES

Input Voltage Range	: 2.5V ~ 6.0V
Output Voltage Range	: Up to 17.5V externally set-up
	Reference voltage 0.2V ±5%
Oscillation Frequency	: 1.0MHz± 20%
ON Resistance	: 2.4
High Efficiency	: 85%
	3 white LEDs in series
	V_{IN}=3.6V, I_{LED}=20mA
Control	: PWM control
Stand-by Current	: I_{STB}=1.0μA (MAX.)
Output Capacitor	: 0.22μF, ceramic
Lx Limit Current	: 360mA TYP.
Lx Overvoltage Limit	: 19V (TYP.)
Packages	: SOT-25
	USP-6C (under development)

TYPICAL APPLICATION CIRCUIT
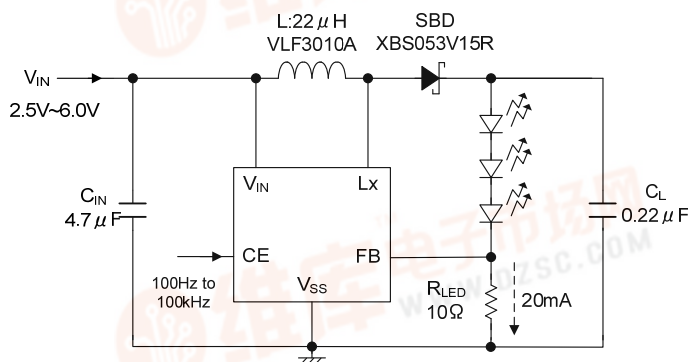
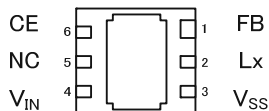

TYPICAL PERFORMANCE CHARACTERISTICS

XC9133B02A Series

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PIN CONFIGURATION

V$_{IN}$ CE

```
 5        4
┌─────────────┐
│             │
└─────────────┘
 1    2    3
```

Lx   V$_{SS}$ FB

SOT-25 (TOP VIEW)

CE   6   1   FB

NC   5   2   Lx

V$_{IN}$ 4   3   V$_{SS}$
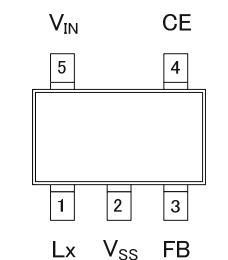
USP-6C (BOTTOM VIEW)
under development

*The dissipation pad should be left open.
 If the circuit needs to be connected to other
 pin, it should be connected to the Vss pin.

PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTION
SOT-25	USP-6C (under development)		
1	2	Lx	Switch
2	3	V$_{SS}$	Ground
3	1	FB	Voltage Feedback
4	6	CE	Chip Enable
5	4	V$_{IN}$	Power Input
-	5	NC	No Connection

CE PIN FUNCTION

CE PIN	OPERATIONAL STATE
H	Operation
L	Shut-down

PRODUCT CLASSIFICATION

Ordering Information

XC9133 _____ - $^{(*1)}$

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
	Lx Overvoltage Limit	B	Available
	FB Voltage	02	0.2V
	Oscillation Frequency	A	1MHz
-	Packages Taping Type $^{(*2)}$	MR	SOT-25
		MR-G	SOT-25 (Halogen & Antimony free)
		ER	USP-6C (under development)

$^{(*1)}$ The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

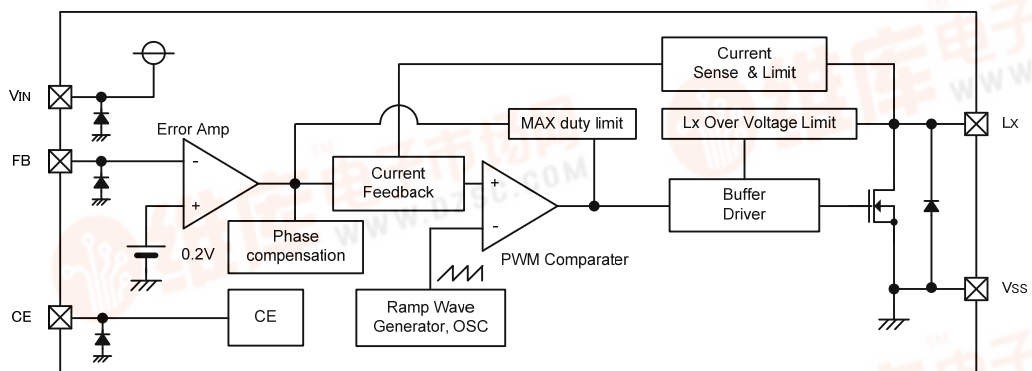$^{(*2)}$ The device orientation is fixed in its embossed tape pocket.
   For reverse orientation, please contact your local Torex sales office or representative.
   (Standard orientation: R-   , Reverse orientation: L-   )

BLOCK DIAGRAMS

XC9133B02A

ABSOLUTE MAXIMUM RATINGS

Ta = 25

PARAMETER		SYMBOL	RATINGS	UNITS
V_{IN} Pin Voltage		V_{IN}	$V_{SS} - 0.3 \sim 7.0$	V
Lx Pin Voltage		V_{Lx}	$V_{SS} - 0.3 \sim 22.0$	V
FB Pin Voltage		V_{FB}	$V_{SS} - 0.3 \sim 7.0$	V
CE Pin Voltage		V_{CE}	$V_{SS} - 0.3 \sim 7.0$	V
Lx Pin Current		I_{Lx}	1000	mA
Power Dissipation	SOT-25	Pd	250	mW
	USP-6C (under development)		100	
Operating Temperature Range		Topr	- 40 ~ + 85	
Storage Temperature Range		Tstg	- 55 ~ +125	

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ELECTRICAL CHARACTERISTICS

XC9133B02AMR

Ta = 25

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT.	CIRCUIT
FB Voltage	V_{FB}		0.19	0.20	0.21	V	
Output Voltage Range	V_{OUTSET}		V_{IN}	-	17.5	V	
Input Voltage Range	V_{IN}		2.5	-	6.0	V	
Supply Current 1	I_{DD1}		-	420	720	μA	
Supply Current 2	I_{DD2}	$V_{IN}=V_{Lx}$, FB=0.4V	-	60	140	μA	
Stand-by Current	I_{STB}	CE=0V, V_{Lx}=5.0V	-	0	1.0	μA	
Oscillation Frequency	f_{OSC}		0.8	1.0	1.2	MHz	
Maximum Duty Cycle	MAXDTY		86	92	98	%	
Efficiency [*1]	EFFI	When connected to ext. components, V_{IN}=3.6V, R_{LED}=20	-	85	-	%	
Current Limit	I_{LIM}	When connected to ext. components, V_{IN}=3.6V	260	360	460	mA	
Lx Overvoltage Limit	V_{LxOVL}	Voltage which Lx pin voltage holding "High" level V_{IN} 2.5V	18.0	19.0	22.0	V	
Lx ON Resistance	R_{SWON}	V_{IN}=3.6V, V_{Lx}=0.4V [*3]	-	2.4			
Lx Leakage Current	I_{LxL}	Same as I_{STB}	-	0.0	1.0	μA	
CE High Voltage	V_{CEH}	CE applied voltage when Lx starts oscillation	0.65	-	6.0	V	
CE Low Voltage	V_{CEL}	CE applied voltage which Lx pin voltage holding "High" level	V_{SS}	-	0.2	V	
CE High Current	I_{CEH}	Same as I_{DD2}	-0.1	-	0.1	μA	
CE Low Current	I_{CEL}	Same as I_{STB}	-0.1	-	0.1	μA	
FB High Current	I_{FBH}	Same as I_{DD2}	-0.1	-	0.1	μA	
FB Low Current	I_{FBL}	Same as I_{STB}	-0.1	-	0.1	μA	

NOTE: *Test circuit   : Unless otherwise stated, V_{IN}=3.0V, V_{CE}=3.0V, R_{LED}=10
           *Test circuit   : Unless otherwise stated, V_{IN}=3.0V, V_{CE}=3.0V, V_{FB}=0.0V, V_{PULL}=5.0V, R_{PULL}=100
           *Test circuit   : Unless otherwise stated, V_{IN}=3.0V, V_{CE}=3.0V, V_{FB}=0.0V
           *Test circuit   : Unless otherwise stated, V_{CE}=3.0V, V_{PULL}=5.0V

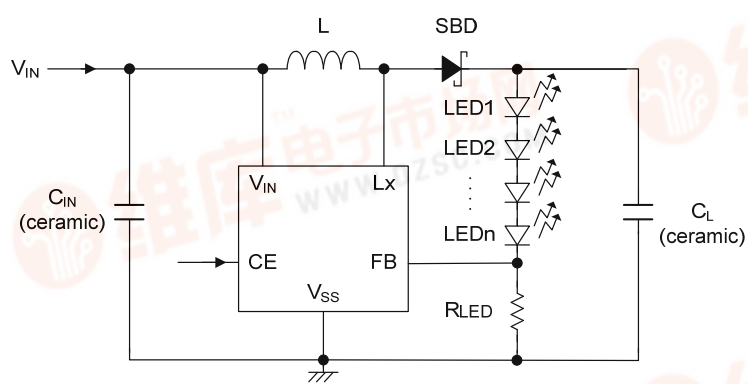*1: The duty cycle is forcibly reduced when maximum duty cycle periods are repeated.

*2: LED NSPW310BS x 3, EFFI = {[(output voltage) x (output current)] / [(input voltage) x (input current)]} x 100

*3: V_{PULL} is adjusted to make V_{LX} 0.4V when the driver transistor is turned on.

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TYPICAL APPLICATION CIRCUITS

XC9133B02A

EXTERNAL COMPONENTS

SYMBOL	VALUE	PART NUMBER	MANUFACTURER
L	22μ H	VLF3010A-220MR	TDK
SBD [*1]	-	XBS053V15R [*2]	TOREX
		MA2Z720	PANASONIC
C_{IN}	4.7μ F	JMK107BJ475MA-B	TAIYO YUDEN
C_L [*3]	0.22μ F	TMK107BJ224KA-B	TAIYO YUDEN

NOTE:

*1: Please use a Schottky barrier diode (SBD) with a low junction capacitance.

*2: For using the XBS053V15R with four white LEDs in series, please be noted with a direct reverse voltage (V_R=20V) and a repetitive peak reverse voltage (V_{RM}=30V).

*3: Use ceramic capacitors processing a low temperature coefficient.

OPERATIONAL EXPLANATION

The series consists of a reference voltage source, ramp wave circuit, error amplifier, PWM comparator, phase compensation circuit, Lx overvoltage limit circuit, N-channel MOS driver transistor, current limiter circuit and others. Phase compensation is performed on the resulting error amplifier output, to input a signal to the PWM comparator to determine the turn-on time during switching. The PWM comparator compares, in terms of voltage level, the signal from the error amplifier with the ramp wave from the ramp wave circuit, and delivers the resulting output to the N-channel MOS driver transistor to cause the Lx pin to output a switching duty cycle. This process is continuously performed to ensure stable output voltage. The current feedback circuit detects the N-channel MOS driver transistor's current for each switching operation, and modulates the error amplifier output signal. This enables a stable feedback loop even when a low ESR capacitor, such as a ceramic capacitor, is used, ensuring stable output voltage.

<Reference Voltage Source>
The reference voltage source provides the reference voltage to ensure stable output voltage of the IC.

<Ramp Wave Circuit>
The ramp wave circuit determines switching frequency. The 1MHz (TYP.) of frequency is fixed internally.
Clock pulses generated in this circuit are used to produce ramp waveforms needed for PWM operation.
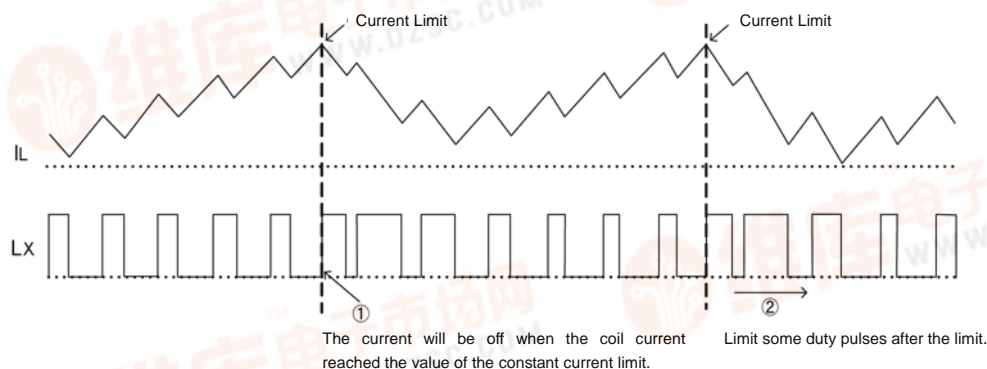
<Error Amplifier>
The error amplifier is designed to monitor output voltage. The amplifier compares the reference voltage with the FB pin voltage. When a feed-back voltage becomes lower than the reference voltage, an output voltage of the error amplifier is increased. Gain and frequency characteristics of the error amplifier output are fixed internally as an optimize signal.

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OPERATIONAL EXPLANATIONS (Continued)

<Current Limit>
The current limit circuit of the XC9133 series monitors the current flowing through the N-channel MOS driver transistor connected to the Lx pin, and features a combination of the constant-current type current limit mode and the duty cycle limit of the next pulse.

① When the driver current is greater than a specific levels, the constant-current type current limit function operates to turn off the pulses from the Lx pin at any given timing.

② The IC controls the next pulse to be smaller than the first pulse.

The current will be off when the coil current reached the value of the constant current limit.

Limit some duty pulses after the limit.

<Lx Overvoltage Limit Circuit>
XC9133 series' Lx overvoltage limit circuit monitors the Lx pin voltage. When the Lx pin voltage exceeds than 19V (TYP.), the IC performs the function of latching the OFF state of the driver transistor, and goes into operation suspension mode. In suspension mode, operations can be resumed by restoring power to the V_{IN} pin. The suspension mode does not mean a complete shutdown, but a state in which pulse output is suspended; therefore, the internal circuitry remains in operation.

<Maximum Duty Cycle Limit>
The XC9133 series' maximum duty cycle limit circuit monitors the duty cycle. When the maximum duty cycle is repeated for a certain time, the IC controls the error amplifier output so that the duty cycle of the next pulse becomes smaller than that of the first pulse.

<CE Pin Function>
The operation of the XC9133 series will enter into the shut down mode when a low level signal is input to the CE pin. During the shut down mode, the supply current is 0μA (TYP.), with high impedance at the Lx pin. The IC starts its operation with a high level signal to the CE pin. The input to the CE/MODE pin is a CMOS input and the sink current is 0 μA (TYP.). 100μs after disable, the IC goes into suspension mode and supply current is minimal. After this, the IC will be in stand-by mode and the supply current will be 0μA (TYP.).

NOTES ON USE

<Lx (Pin 1): Switch Pin>
Please connect the anode of a Schottky barrier diode and an inductor to the Lx pin.

<FB (Pin 3): Voltage Feedback Pin>
The reference voltage is 200mV (TYP.). A resistor (R_{LED}) should be connected to the FB pin for setting the cathode of LEDs and a constant current value. The resistance value can be calculated by the following equation.

$R_{LED}=0.2 / I_{LED}$
I_{LED}=Setting constant current value

Typical example:

I_{LED}	R_{LED}	I_{LED}	R_{LED}
5mA	40	13.3mA	15
10mA	20	20mA	10

<CE (Pin 4): Chip Enable Pin>
An ENABLED state is reached when the CE voltage exceeds 0.65V and a DISABLED state when the CE Voltage falls below 0.2V.

<V_{IN} (Pin 5): Power Supply Pin>
Please connect an inductor and an input by-pass capacitor (C_{IN}) to the V_{IN} pin.
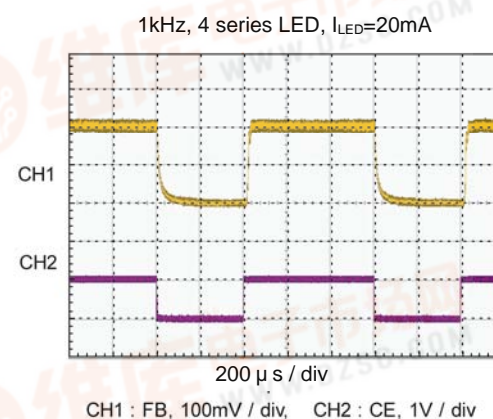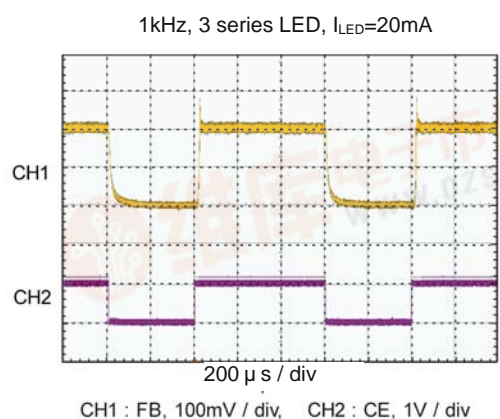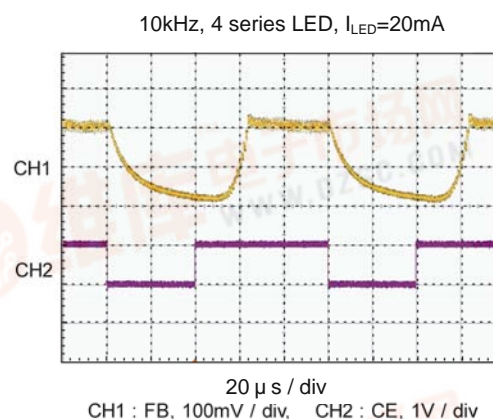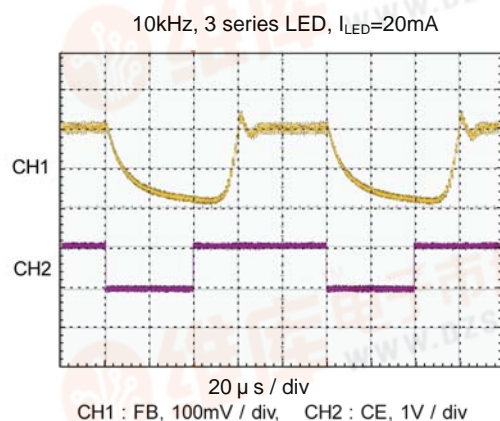
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APPLICATION INFORMATION

<Dimming Control>

1. Applying PWM signal to the CE pin

The XC9133 repeats on/off operations by a PWM signal applied to the CE pin. The magnitude of LED current, I_{LED}, when the diode is on, is determined by R_{LED}. The magnitude is zero when the diode is off. The average of LED current is proportional to the positive duty ratio of the PWM signal.

The frequency of the PWM signal can be controlled to the optimum value between 100Hz and 10kHz. With regard to the amplitude of the PWM signal, the high level should be higher than the "H" voltage of CE, V_{CEH}, and the low level, lower than the "L" voltage of CE, V_{CEL}.

10kHz, 3 series LED, I_{LED}=20mA

CH1
CH2

20µ s / div
CH1 : FB, 100mV / div,   CH2 : CE, 1V / div

10kHz, 4 series LED, I_{LED}=20mA

CH1
CH2

20µ s / div
CH1 : FB, 100mV / div,   CH2 : CE, 1V / div

1kHz, 3 series LED, I_{LED}=20mA

CH1
CH2

200µ s / div
CH1 : FB, 100mV / div,   CH2 : CE, 1V / div

1kHz, 4 series LED, I_{LED}=20mA

CH1
CH2

200µ s / div
CH1 : FB, 100mV / div,   CH2 : CE, 1V / div

2. Step-Wise Regulation of LED Current

In some applications, it may be necessary to incorporate step-wise regulation of LED current, I_{LED}. Step-wise regulation of LED illumination is achieved by connecting a switch element SW1 in parallel with R_{LED} and in series with R_{LED1} and turning SW1 on and off, as shown below. Choose a resistance of R_{LED} so that the minimum necessary current is gained when switch element SW1 is off. The resistance of R_{LED1} should be such that a desired increase of current passed through the LED is gained when the switch element is on.

Ex.) Current I_{LED} = 5mA and 15mA
   $R_{LED} = 200mV / 5mA = 40\ \Omega$
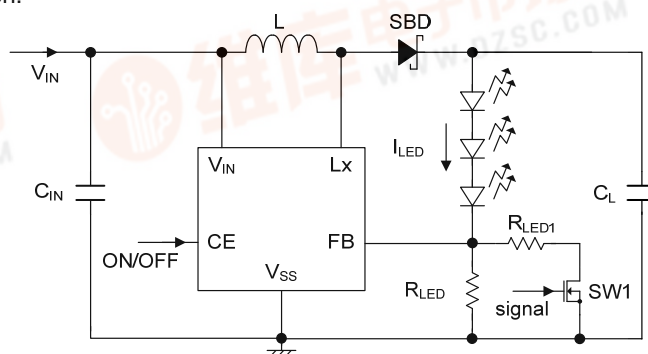 $R_{LED1} = 200mV / (15mA - 5mA) = 20\ \Omega$

Figure   Circuit using Step-wise Regulation of LED Current

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APPLICATION INFORMATION (Continued)

<Dimming Control (Continued)>

3. Using DC Voltage

If in an application it is necessary to control the LED current by a variable DC voltage, illumination control of LED is achieved by connecting R1 and R2 and applying a direct-current voltage to R2, as shown below.

When R1>>R_{LED}, I_{LED} which flows into LEDs can be calculated by the following equation;

I_{LED} = (V_{REF} - R1 / R2 (V_{DC} - V_{REF})) / R_{LED}

V_{REF} = 0.2V (TYP.)

Ex.1) When R1 = 10k Ω, R2 = 100k Ω, R_{LED} = 10 Ω,
In the range of 0.2V to 2.2V DC, I_{LED}
(LED current) varies between 20mA to 0mA.
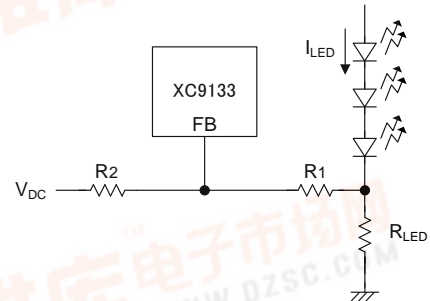
Figure   Circuit using DC voltage

Ex.2) When R1 = 10k Ω, R2 = 100k Ω, R3 = 10k Ω,
C1 = 0.1μF, R_{LED} = 10Ω, the average LED current will be 10mA by inputting a PWM signal of CE 'H' level: 2.2V, CE 'L' level: 0V, duty cycle: 50%, oscillation frequency: 100Hz.   As well as the way of dimming control by applying the PWM signal to the CE pin, the average LED current increases proportionally with the positive duty cycle of the PWM signal.
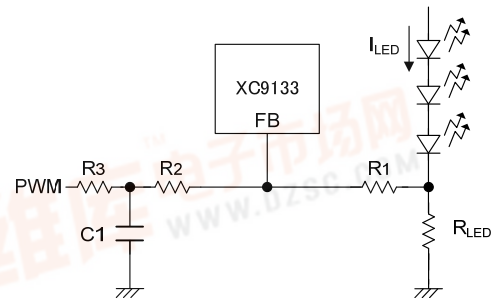
Figure   Circuit inputting a PWM signal to the FB pin

<Prevent Emission Caused by White LEDs Leakage>

When the input voltage (V_{IN}) is high, minimum illumination may occur even if the CE pin is in the disable state.   If this happens, please connect a transistor to between the LED and the FB pin.   By driving the CE signal in-phase and cutting the pass to current, the minimum illumination can be prevented.
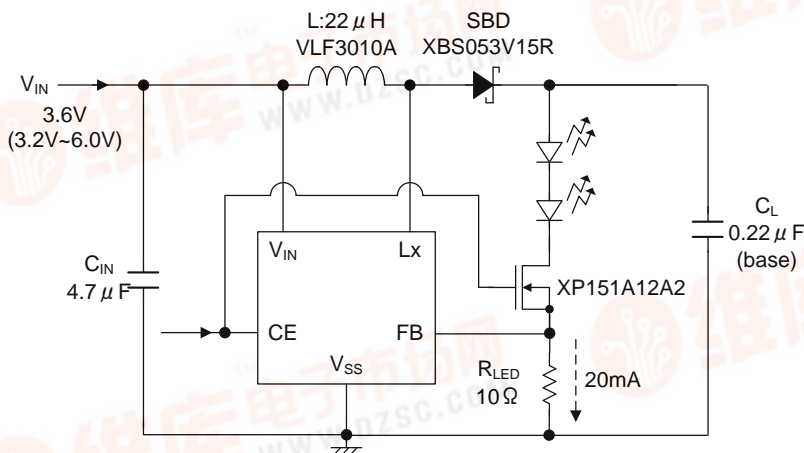
Figure   Circuit Prevent Emission Caused by White LEDs Leakage

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APPLICATION INFORMATION (Continued)

<Illumination of Six in Total White LEDs>

It is possible to illuminate three-series two parallel white LEDs, six in total, using an input voltage V_{IN} 3.2V.
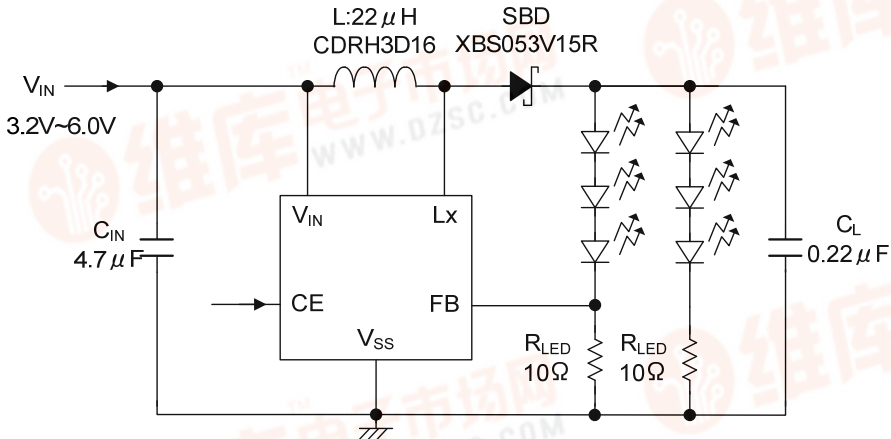

Figure   Circuit Illumination of Six in Total White LEDs

<Use as Flash>

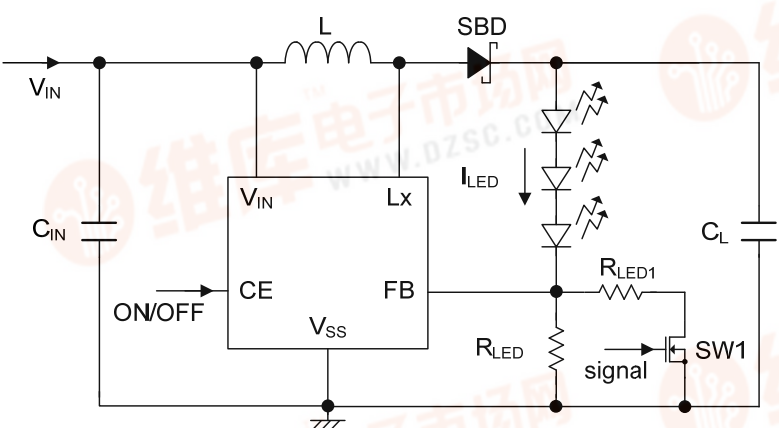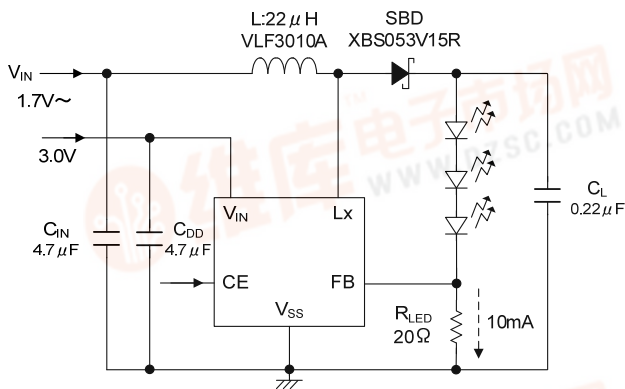An LED current 65mA (MAX.) can be supplied to two white LEDs.

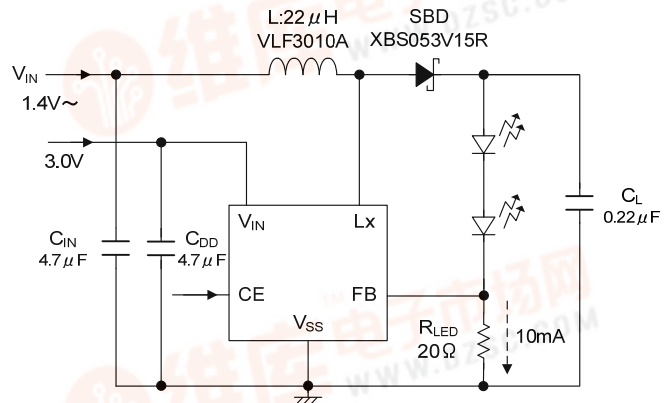Figure   Circuit using a Flash

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APPLICATION INFORMATION (Continued)

<Separate Supply Source of the Step-up Circuit (V$_{IN}$) from V$_{IN}$ Pin>
Supply source of the step-up circuit can be used separately from V$_{IN}$ pin.

Circuit example of separating supply source of
the step-up circuit from V$_{IN}$ pin (3 LEDs)

Circuit example of separating supply source of
the step-up circuit from V$_{IN}$ pin (2 LEDs)

Note: Please input 2.5V~6V to the V$_{IN}$ pin when you use.

<LED Open-circuit Protection>
If white LEDs are opened or damaged, the FB pin is pulled down, so that the operating duty ratio reaches the maximum. Accordingly, the output voltage continues to increase, possibly causing the Lx pin voltage to exceed the absolute maximum rating of 22V.
If white LEDs are opened or damaged, the detector built in the Lx pin causes the IC to stop oscillating, preventing excessive increase of the output voltage. However, the detector may detect an overvoltage if the Lx pin voltage exceeds 18V, which is the overvoltage limit, even when no LEDs are open. Therefore, care must be taken if four LEDs each having a forward voltage of 4.45V or more are connected in series.

<Startup Inrush Current>
The XC9133 series has no soft-start circuit built-in in order to minimize delay at startup. The inrush current can reach up to the current limit I$_{LIM}$.
In some cases, overshoot can occur.

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APPLICATION INFORMATION (Continued)

<Instruction on Pattern Layout>

1. In order to stabilize V_{IN}'s voltage level, we recommend that an input by-pass capacitor (C_{IN}) be connected as close as possible to the V_{IN} & V_{SS} pins.
2. Please mount each external component as close to the IC as possible.
3. Wire external components as close to the IC as possible and use thick, short connecting traces to reduce the circuit impedance.
4. Make sure that the PCB GND traces are as thick as possible, as variations in ground potential caused by high ground currents at the time of switching may result in instability of the IC.
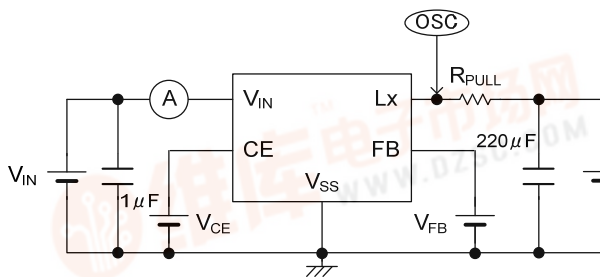
XC9133B Series Pattern Layout (SOT-25)
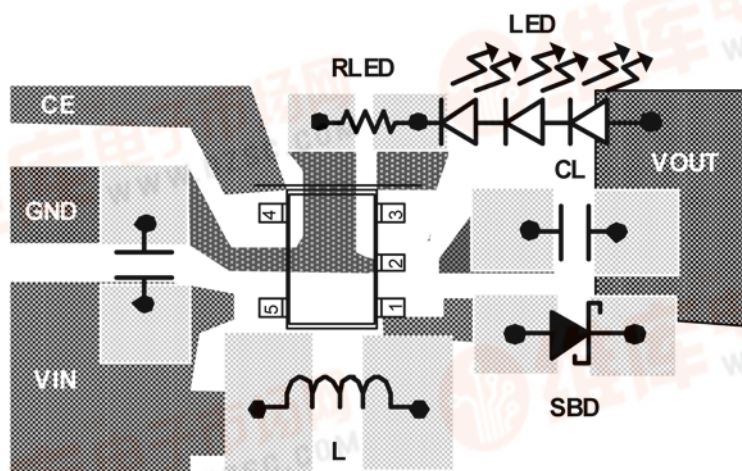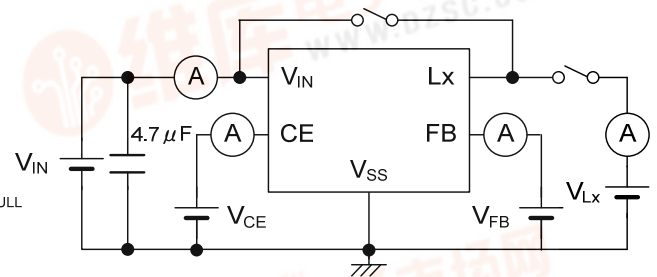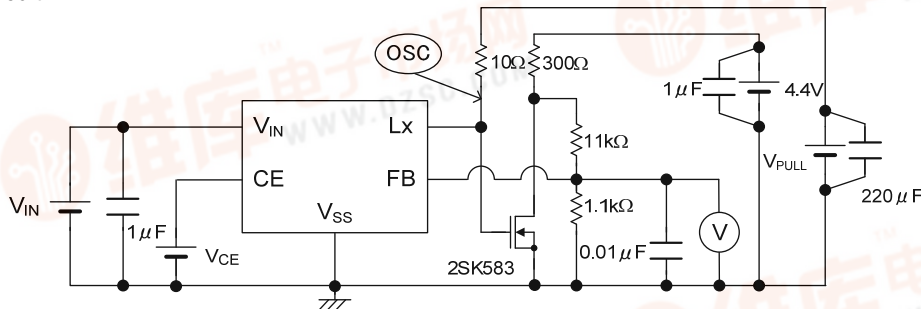
TEST CIRCUITS

Circuit   (XC9133B02A Series)
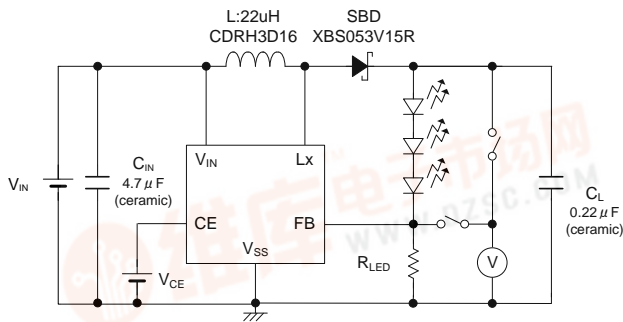
Circuit

Circuit

Circuit

1. The measurement method of L_X ON Resistance R_{SWON}

Using the circuit   , Lx ON resistance can be measured by adjusting V_{PULL} voltage to set Lx voltage V_{LX} 0.4V when the driver transistor is ON.

The oscilloscope is used for measuring the Lx voltage when the driver transistor is ON.

$$R_{SWON} = 0.4 / ((V_{PULL} - 0.4) / 10)$$

2. The measurement method of current limit I_{LIM}

Using the circuit   , current limit I_{LIM} can be calculated by the equation including V_{PULL} voltage when FB voltage is decreased while V_{PULL} voltage is adjusted and Lx voltage V_{LX} when the driver transistor is ON.

The oscilloscope is used for measuring the Lx voltage when the driver transistor is ON.
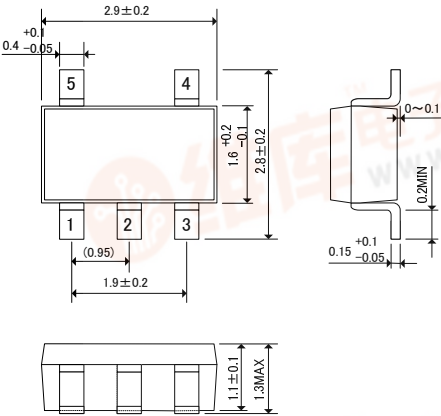
$$I_{LIM} = (V_{PULL} - V_{LX}) / R_{PULL}$$
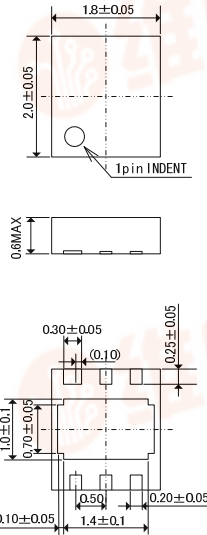$$R_{PULL} \quad 10\Omega$$

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PACKAGING INFORMATION
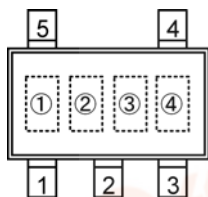
SOT-25

USP-6C (under development)

(unit : mm)

(unit : mm)

* Pin no. 1 is wider than other pins.

MARKING RULE

SOT-25

SOT-25
(TOP VIEW)

Represents product series

MARK	PRODUCT SERIES
F	XC9133B02AD x

Represents Lx overvoltage limit

MARK	Lx OVERVOLTAGE LIMIT	PRODUCT SERIES
B	Available	XC9133B02AM x

Represents oscillation frequency

MARK	OSCILLATION FREQUENCY	PRODUCT SERIES
A	1MHz	XC9133B02AM x

Represents production lot number
0 to 9 and A to Z, or inverted characters 0 to 9 and A to Z repeated.
(G, I, J, O, Q, W excepted)

USP-6C (under development)
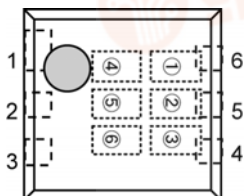
USP-6C
(TOP VIEW)

Represents product series

MARK	PRODUCT SERIES
K	XC9133B02AD x

Represents Lx overvoltage limit

MARK	Lx OVERVOLTAGE LIMIT	PRODUCT SERIES
B	Available	XC9133B02AD x

Represents FB voltage

MARK		FB VOLTAGE (V)	PRODUCT SERIES
0	2	0.2	XC9133B02AD x

Represents oscillation frequency

MARK	OSCILLATION FREQUENCY	PRODUCT SERIES
A	1MHz	XC9133 B02AD x

Represents production lot number
0 to 9 and A to Z repeated (G, I, J, O, Q, W excepted)
* No character inversion used.

查询XC9133供应商

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