

APPLICATION MANUAL

White LED Driver IC for Camera Lights TK11892F

CONTENTS

1 . DESCRIPTION	2
2 . FEATURES	2
3 . APPLICATIONS	2
4 . TYPICAL APPLICATION INFOMATION	2
5 . PIN CONFIGURATION	3
6 . BLOCK DIAGRAM	3
7 . ABSOLUTE MAXIMUM RATINGS	4
8 . ELECTRICAL CHARACTERISTICS	5
9 . TEST CIRCUIT	7
10 . TYPICAL CHARACTERISTICS	9
11 . PIN DESCRIPTION	13
12 . CIRCUIT DESCRIPTION	14
13 . APPLICATION INFOMATION	17
14 . PACKAGE DESCRIPTION	20
15 . NOTES	21
16 . OFFICES	21



White LED Driver IC for Camera Lights TK11892F

1. DESCRIPTION

TK11892F is a step-up DC-DC converter designed for camera lights for mobile phones and portable equipment, using constant frequency PWM architecture, with the following built in: a very high current switching transistor (1.0A peak), a very high speed oscillator (2.0MHz), a switch over current detector, a low voltage reference, two error amplifiers, a PWM comparator, open-circuit protection and ON/OFF control.

TK11892F can drive up to four LEDs in series at 100mA with a small coil because of the high (2.0MHz) oscillation frequency. Two logic inputs control four modes of operation: Shutdown mode (1.0µA max), Indicator mode for a small amount of light used before the actual flash or to inform about an incoming call, Torch mode for the movie lighting, Flash mode for camera flash lighting. This IC has an operating supply voltage range of 2.65V~8.0V and the adjustable output voltage can be set as high as 18.5V. The white LEDs are connected in series and driven at a constant current, resulting in uniform brightness and high efficiency. The reference voltage is a very low 22mV or 117mV, 248mV, achieving high efficiency operation with a constant current output. The built-in zener diode can be used for open-circuit protection in case the output load is disconnected, such as the string of LEDs opened. The

internal Open-circuit voltage circuit reduces the external component count.

TK11892F can also be used in as a step-up DC-DC converter.

TK11892F is available in the SON3024-8 surface mount package.

2. FEATURES

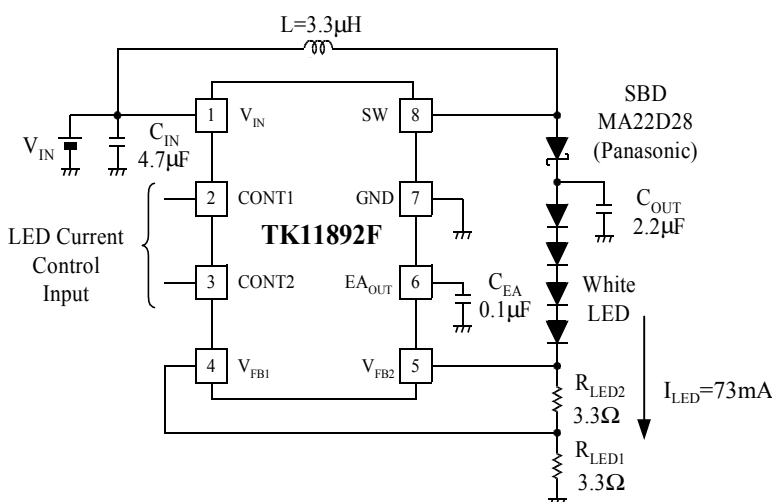
- Built-in Three Modes LED Dimming and Shutdown Mode
- Wide Operating Voltage Range (2.65V to 8.0V)
- 2.0MHz High Speed Operation
- Internal Switching Transistor (MAX 1.0A)
- Maximum Duty Cycle 90%
- Very Small Inductor Available
- Very Small Package, SON3024-8

3. APPLICATIONS

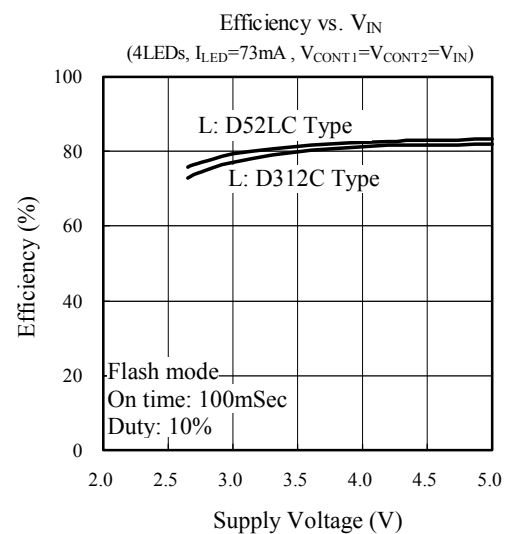
- Camera Lights for Mobile Phone and Portable Equipment
- LED Backlighting and Frontlighting
- Step-up DC-DC Converters

4. TYPICAL APPLICATION INFOMATION

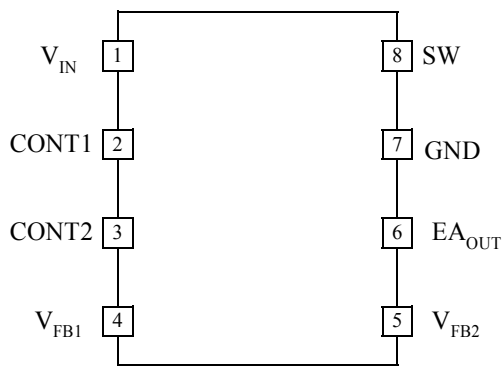
APPLICATION CIRCUIT (2LEDs in Series)



L: D312C Type TOKO Part Number: 1001BS-3R3M
D52LC Type TOKO Part Number: A914BYW-3R5M

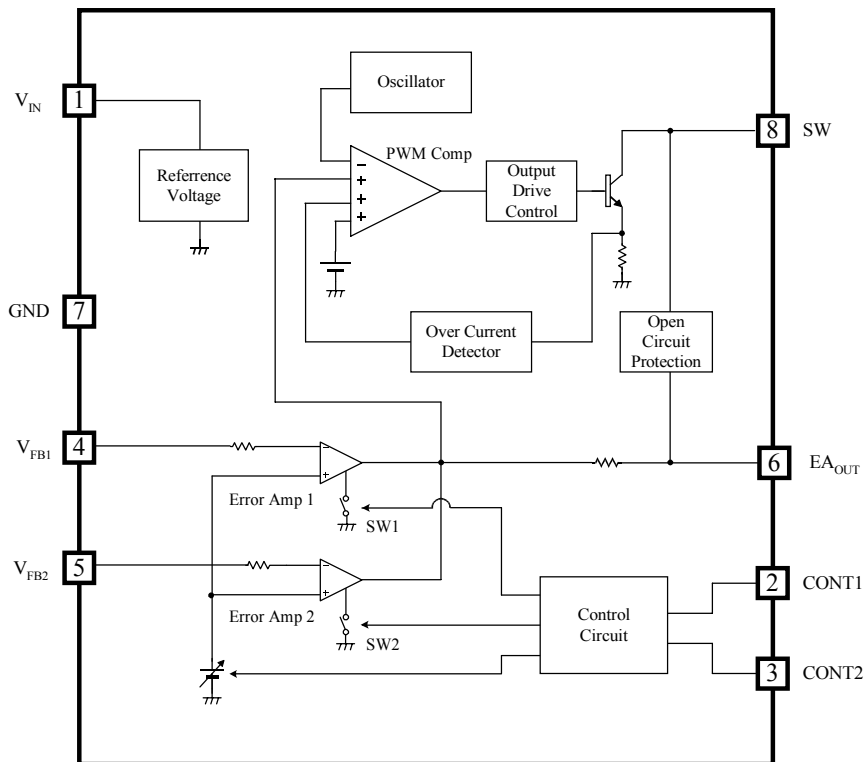


5. PIN CONFIGURATION



Pin No.	Symbol	Function
1	V_{IN}	Power Supply Voltage Input
2	CONT1	CONT1 Input
3	CONT2	CONT2 Input
4	V_{FB1}	Feedback Voltage 1
5	V_{FB2}	Feedback Voltage 2
6	EA_{OUT}	Error Amplifier Output
7	GND	Ground
8	SW	Switch (Connect inductor and diode here)

6. BLOCK DIAGRAM



7. ABSOLUTE MAXIMUM RATINGS

T_A=25°C

Parameter	Symbol	Rating	Units	Conditions
Absolute Maximum Ratings				
Supply Voltage	V _{IN}	-0.3 ~ 15	V	
Switch Voltage	V _{SW MAX}	25.0	V	
CONT1, CONT2 Pin Voltage	V _{CONT}	-0.3 ~ 20	V	
V _{FB1} , V _{FB2} Pin Voltage	V _{FB}	-0.3 ~ V _{IN}	V	
EA _{OUT} Pin Voltage	V _{EAOUT}	-0.3 ~ 1.2	V	
Switch Peak Current	I _{SW PEAK MAX}	2.1	A	
Power Dissipation	P _D	600	mW	*
Storage Temperature Range	T _{STG}	-55 ~ +150	°C	
Operating Conditions				
Operating Temperature Range	T _{OP}	-30 ~ 85	°C	
Operating Voltage Range	V _{OP}	2.65 ~ 8.0	V	

* P_D must be decreased at the rate of 4.8mW/°C for operation above 25°C on TK11892's evaluation board.

8. ELECTRICAL CHARACTERISTICS

$V_{IN}=3V, T_A=25^{\circ}C$ (unless otherwise noted.)

Parameter	Symbol	Value			Units	Conditions
		MIN	TYP	MAX		
Oscillator Section						
Frequency	f	1.35	2.0	2.45	MHz	
Error Amplifier 1 Section (V_{FB1} Pin, EA_{OUT} Pin)						
Threshold Voltage	V_{EA1}	231	248	265	mV	$V_{CONT1}=V_{CONT2}=3.0V$
Input Bias Current	I_{EAIN}	-1.0	-0.2	1.0	μA	$V_{CONT1}=V_{CONT2}=3.0V$
Output High Voltage	$V_{EAOUT,HIGH}$	0.76	0.85	-	V	$V_{FB1}=0V$
Output Low Voltage	$V_{EAOUT,LOW}$	-	0.05	0.2	V	$V_{CONT1}=V_{CONT2}=3.0V$ $V_{FB1}=1.0V$
Output Source Current	$I_{EAOUT,SOURCE}$	-	-36	-21	μA	$V_{CONT1}=V_{CONT2}=3.0V$ $V_{EAOUT}=0.45V$
Output Sink Current	$I_{EAOUT,SINK}$	21	36	-	μA	$V_{CONT1}=V_{CONT2}=3.0V$ $V_{EAOUT}=0.45V$
Voltage Gain	A_V	-	40	-	dB	
Gain Band Width	GBW	-	2	-	MHz	$A_V=0dB$
Error Amplifier 2 Section (V_{FB2} Pin, EA_{OUT} Pin)						
Threshold Voltage 1	V_{EA1}	11	22	33	mV	$V_{CONT1}=0V, V_{CONT2}=3.0V$
Threshold Voltage 2	V_{EA2}	107	117	127	mV	$V_{CONT1}=3.0V, V_{CONT2}=0V$
Input Bias Current	I_{EAIN}	-1.0	-0.2	1.0	μA	$V_{CONT1}=3.0V, V_{CONT2}=0V$
Output High Voltage	$V_{EAOUT,HIGH}$	0.76	0.85	-	V	$V_{FB1}=0V$
Output Low Voltage	$V_{EAOUT,LOW}$	-	0.05	0.2	V	$V_{CONT1}=3.0V, V_{CONT2}=0V$ $V_{FB1}=1.0V$
Output Source Current	$I_{EAOUT,SOURCE}$	-	-36	-21	μA	$V_{CONT1}=3.0V, V_{CONT2}=0V$ $V_{EAOUT}=0.45V$
Output Sink Current	$I_{EAOUT,SINK}$	21	36	-	μA	$V_{CONT1}=3.0V, V_{CONT2}=0V$ $V_{EAOUT}=0.45V$
Voltage Gain	A_V	-	40	-	dB	
Gain Band Width	GBW	-	2	-	MHz	$A_V=0dB$
Dead Time Control Section						
Maximum Duty Cycle 1	D_{MAX1}	87	92	-	%	$V_{CONT1}=V_{CONT2}=3.0V$ $V_{FB1}=0V$
Maximum Duty Cycle 2	D_{MAX2}	84	88	-	%	$V_{CONT1}=3.0V, V_{CONT2}=0V$ $V_{FB2}=0V$
CONT 1 Section (CONT1 Pin)						
Input Voltage +	$V_{CONT1,HIGH}$	1.2	-	19	V	On mode
Input Voltage -	$V_{CONT1,LOW}$	0	-	0.3	V	Off mode
Input Bias Current	$I_{CONT1,IN}$	-	38	50	μA	$V_{CONT1}=3V$
CONT 2 Section (CONT2 Pin)						
Input Voltage +	$V_{CONT2,HIGH}$	1.2	-	19	V	On mode
Input Voltage -	$V_{CONT2,LOW}$	0	-	0.3	V	Off mode
Input Bias Current	$I_{CONT2,IN}$	-	38	50	μA	$V_{CONT1}=3V$
Output Switch Section (SW Pin)						
Switch Current Limit	$I_{SW,LIMIT}$	1.0	1.5	2.0	A	
Switch Saturation Voltage 1	$V_{SW,SAT1}$	-	0.12	0.3	V	$I_{SW}=200mA$ $V_{CONT1}=3.0V, V_{CONT2}=0V$
Switch Saturation Voltage 2	$V_{SW,SAT2}$	-	0.20	0.4	V	$I_{SW}=500mA$ $V_{CONT1}=V_{CONT2}=3.0V$
Switch Leakage Current	$I_{SW,OFF}$	-	0.2	2.0	μA	$V_{FB}=1V, V_{SW}=16.5V$

V_{IN}=3V, T_A=25°C (unless otherwise noted.)

Parameter	Symbol	Value			Units	Conditions
		MIN	TYP	MAX		
Open-Circuit Protection Section						
Open-Circuit Voltage	V _{OVP}	18.5	22.0	24.5	V	*NOTE 1
V_{IN} Section (V_{IN} Pin)						
Low Voltage Stop	V _{IN,LOW}	2.20	2.45	2.65	V	
Quiescent Supply Current 1	I _{IN,ON1}	3.0	5.2	7.0	mA	V _{FB1} =1V V _{CONT1} =V _{CONT2} =3.0V
Quiescent Supply Current 2	I _{IN,ON2}	2.8	4.9	6.8	mA	V _{FB2} =1V V _{CONT1} =3.0V, V _{CONT2} =0V
Shutdown Supply Current	I _{IN,OFF}	-	0.01	1.0	μA	V _{CONT1} =V _{CONT2} =0V
Output Current (Output Voltage is 16.5V when 4LEDs are connected in series.) *NOTE 2						
Output Current 1	I _{OUT1}	-	-	70	mA	V _{IN} =2.7V, T _A =+85°C V _{CONT1} =V _{CONT2} =3.0V Pulse width ≤ 100mSec, Duty ≤ 1/10)
Output Current 2	I _{OUT2}	-	-	90	mA	V _{IN} =3.0V, T _A =+85°C V _{CONT1} =V _{CONT2} =3.0V Pulse width ≤ 100mSec, Duty ≤ 1/10)

GENERAL NOTE: The parameters with min. or max. values will be guaranteed at T_A=T_J=25 with test during manufacturing or SQC (Statistical Quality Control) methods. The operation between -30~85 is guaranteed by design.

*NOTE 1: Open-Circuit Voltage is a measurement value by "9-2. Test Circuit".

*NOTE 2: Output Current of maximum value is guaranteed by design.
It depends on external parts and applied condition.
The measurement circuit is shown in "9-3 Test Circuit".

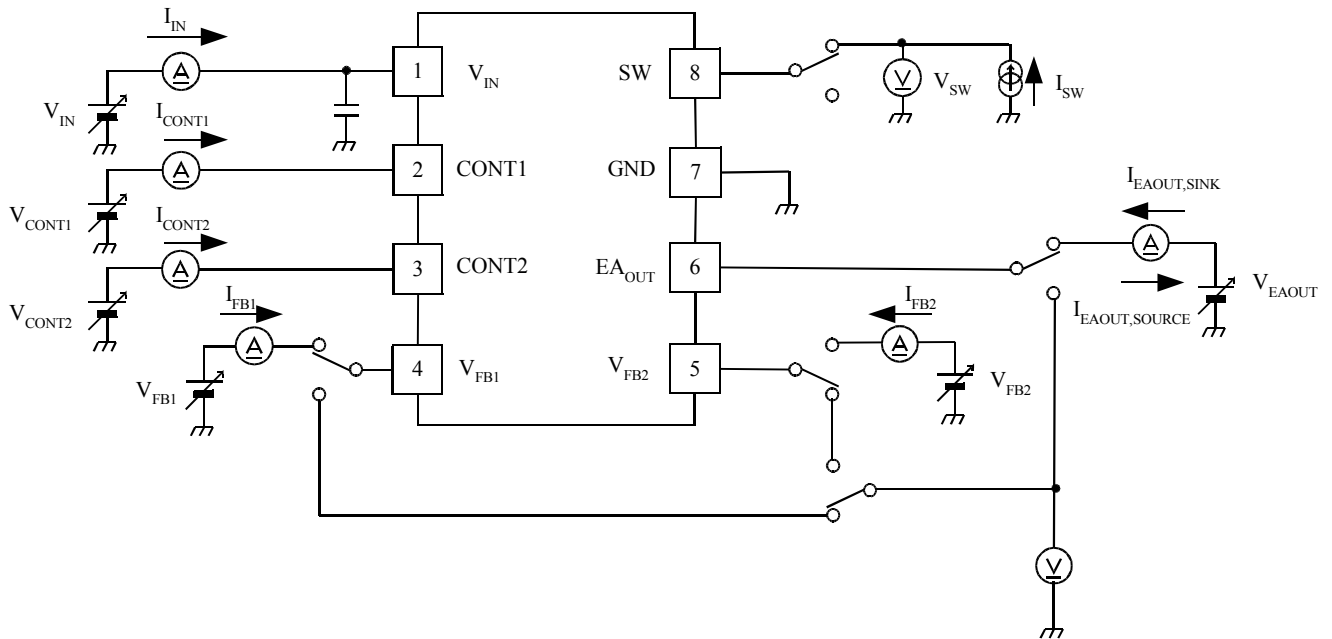
Control Input and LED Current Setting

Mode	CONT1	CONT2	ERROR AMP1	ERROR AMP2	V _{FB} Voltage	LED Current
Shutdown	0	0	OFF	OFF	-	-
Indicator	0	1	OFF	ON	V _{FB2} =22mV ± 11mV	$I_{LED1} = \frac{22mV}{R_{LED1} + R_{LED2}}$ (*I _{LED1} ≈ 0.2 · I _{LED2})
Torch	1	0	OFF	ON	V _{FB2} =117mV ± 10mV	$I_{LED2} = \frac{117mV}{R_{LED1} + R_{LED2}}$
Flash	1	1	ON	OFF	V _{FB1} =248mV ± 17mV	$I_{LED3} = \frac{248mV}{R_{LED1}}$

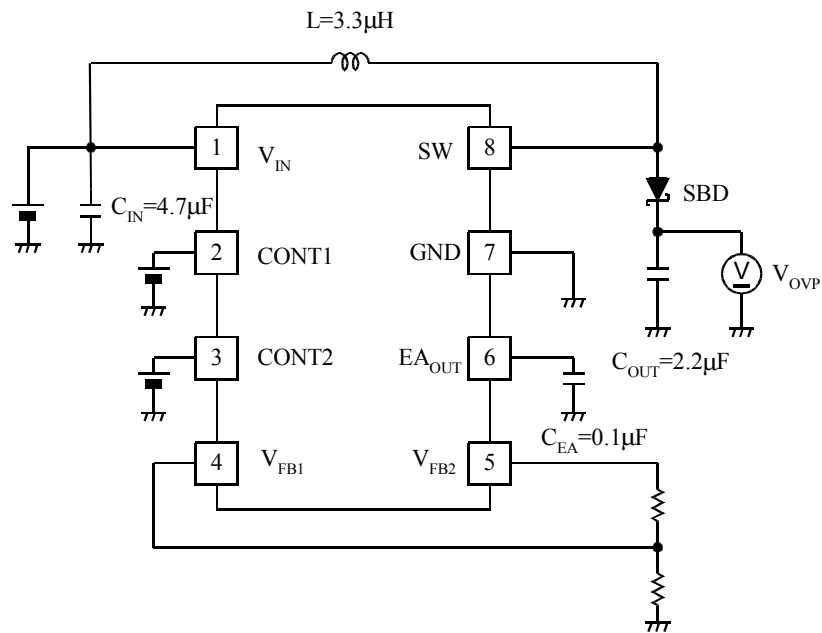
* 0: Low (V_{CONT} ≤ 0.3V), 1: High (V_{CONT} ≥ 1.2V)

9. TEST CIRCUIT

9-1. Test Circuit



9-2. Test Circuit for Open-Circuit Voltage

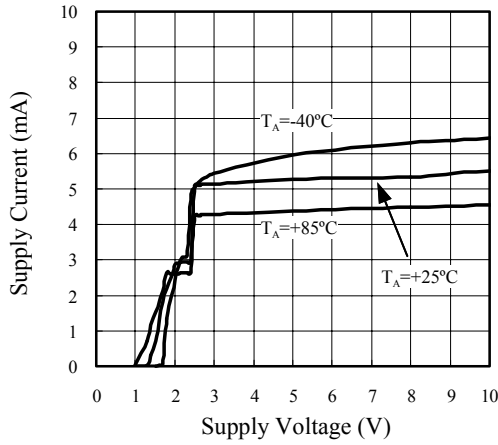


L: 3.3µH (TOKO D312C Type)
 SBD: MA22D28 (Panasonic)

10. TYPICAL CHARACTERISTICS

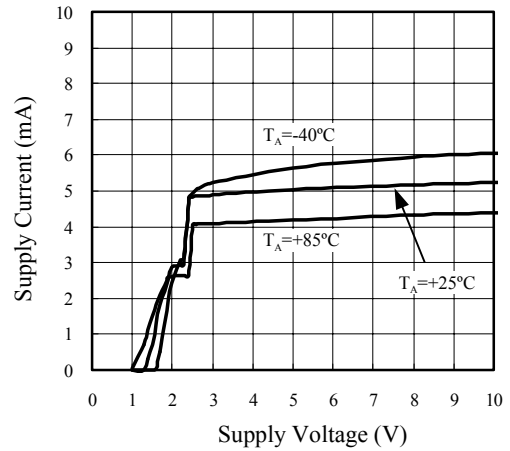
■ Quiescent Supply Current1 vs. Supply Voltage

$$V_{IN}=V_{CONT1}=V_{CONT2}, V_{FB1}=1.0V$$



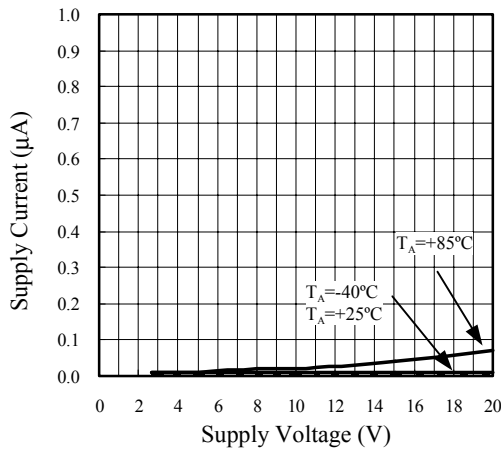
■ Quiescent Supply Current2 vs. Supply Voltage

$$V_{IN}=V_{CONT1}, V_{CONT2}=0V, V_{FB2}=1.0V$$



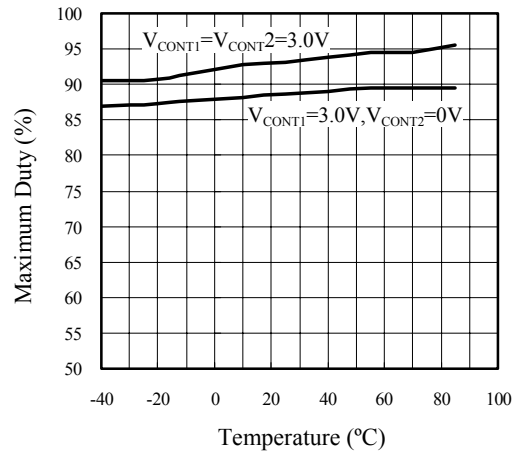
■ Shutdown Supply Current vs. Supply Voltage

$$V_{CONT1}=V_{CONT2}=0V$$



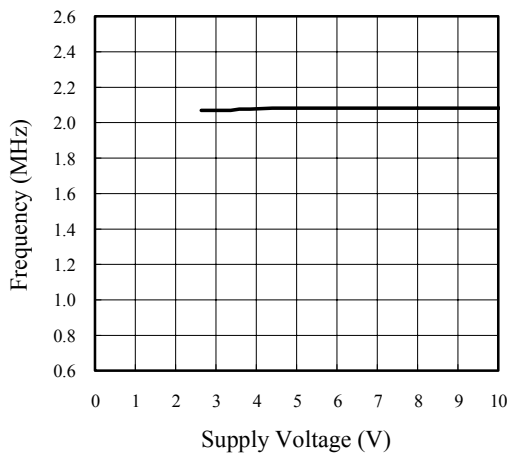
■ Maximum Duty vs. Temperature

$$V_{IN}=3.0V, V_{FB1}=V_{FB2}=0V, I_{SW}=10mA$$



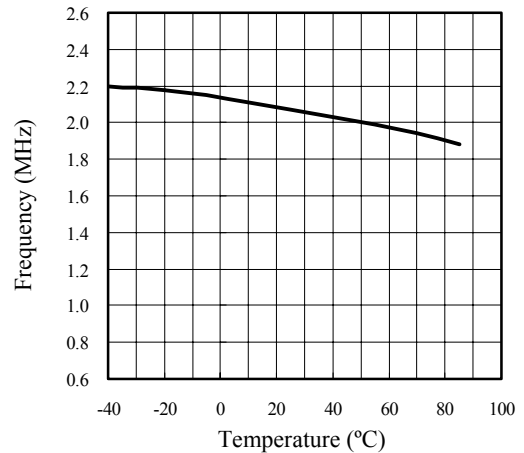
■ Frequency vs. Supply Voltage

$$T_A=+25^\circ C$$

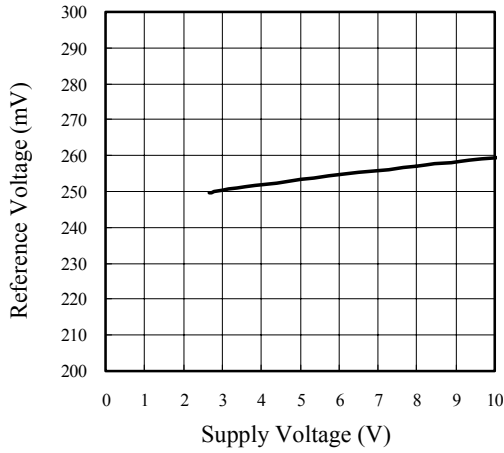


■ Frequency vs. Temperature

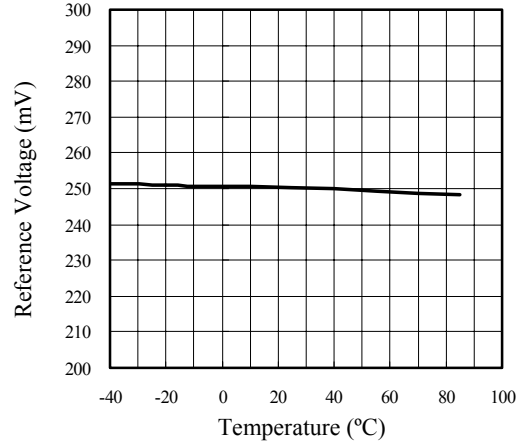
$$V_{IN}=3.0V$$



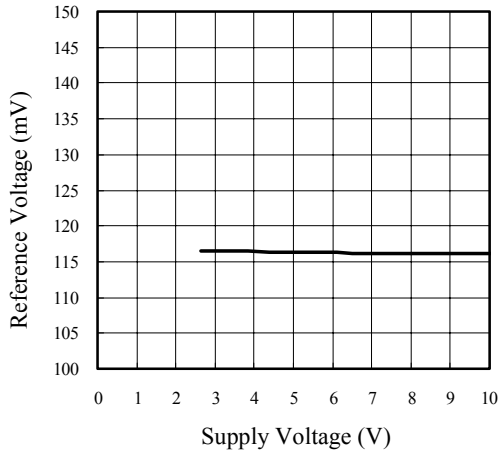
■ Reference Voltage vs. Supply Voltage (Flash mode)
 $V_{IN}=V_{CONT1}=V_{CONT2}, T_A=+25^{\circ}C$



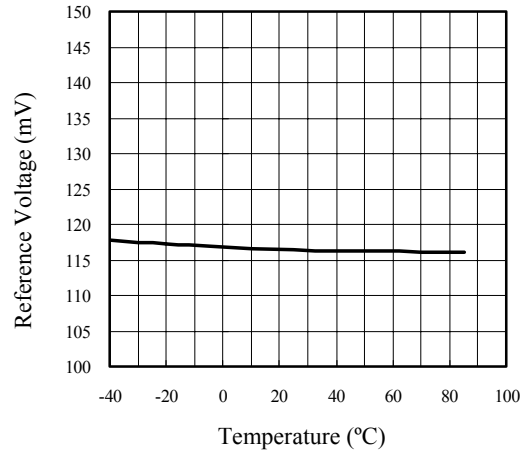
■ Reference Voltage vs. Temperature (Flash mode)
 $V_{IN}=V_{CONT1}=V_{CONT2}=3.0V$



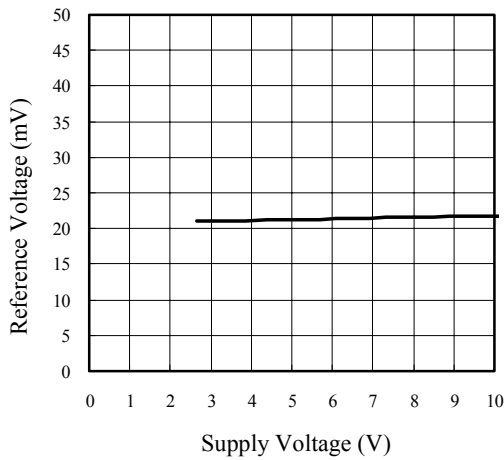
■ Reference Voltage vs. Supply Voltage (Torch mode)
 $V_{IN}=V_{CONT1}, V_{CONT2}=0V, T_A=+25^{\circ}C$



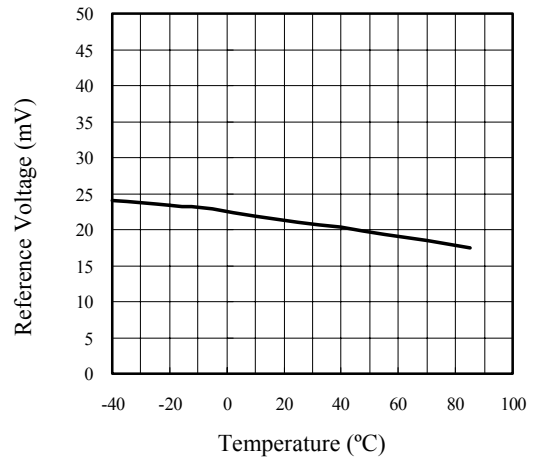
■ Reference Voltage vs. Temperature (Torch mode)
 $V_{IN}=V_{CONT1}=3.0V, V_{CONT2}=0V$



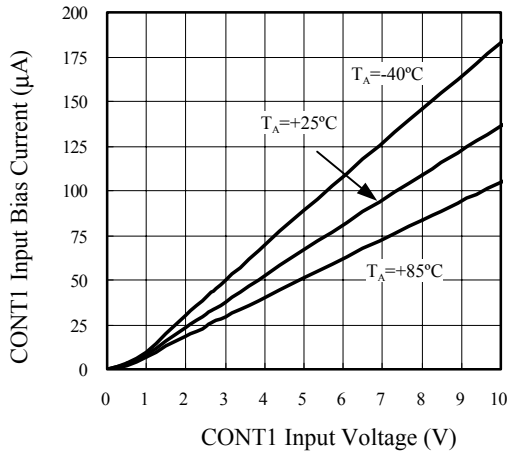
■ Reference Voltage vs. Supply Voltage (Indicator mode)
 $V_{IN}=V_{CONT2}, V_{CONT1}=0V, T_A=+25^{\circ}C$



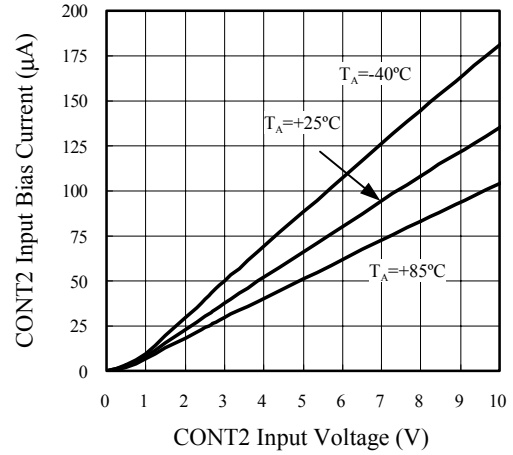
■ Reference Voltage vs. Temperature (Indicator mode)
 $V_{IN}=V_{CONT2}=3.0V, V_{CONT1}=0V$



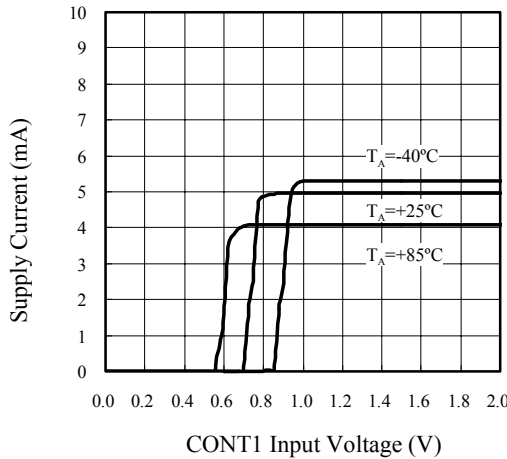
■ CONT1 Input Bias Current vs. CONT1 Input Voltage
 $V_{IN}=3.0V$



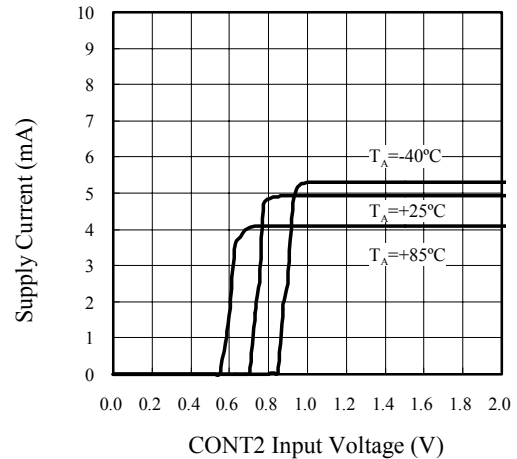
■ CONT2 Input Bias Current vs. CONT2 Input Voltage
 $V_{IN}=3.0V$



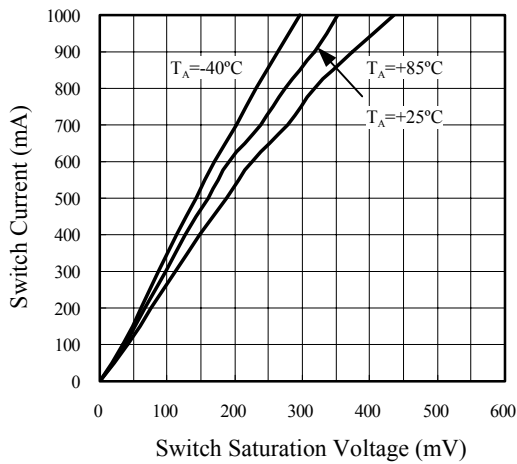
■ Supply Current vs. CONT1 Input Voltage
 $V_{CONT2}=0V, V_{FB2}=0V$



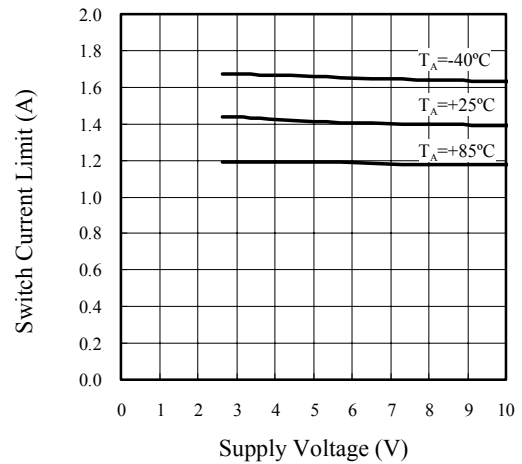
■ Supply Current vs. CONT2 Input Voltage
 $V_{CONT1}=0V, V_{FB2}=0V$



■ Switch Current vs. Switch Saturation Voltage
 $V_{IN}=V_{CONT1}=V_{CONT2}=3.0V$

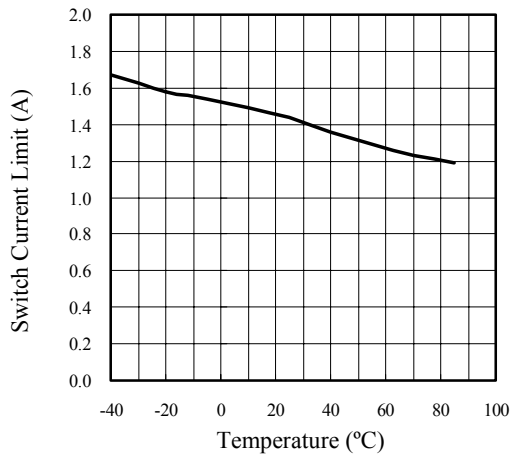


■ Switch Current Limit vs. Supply Voltage
 $V_{CONT1}=V_{CONT2}=V_{IN}$



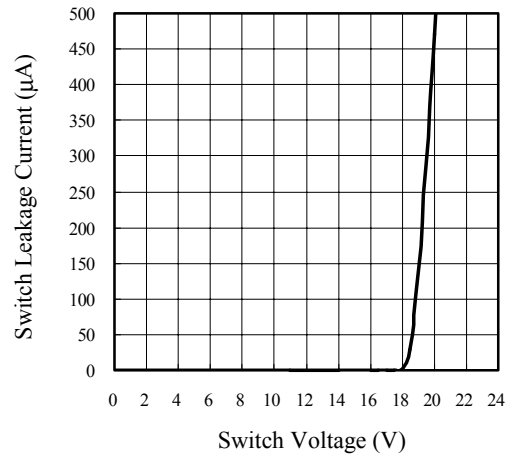
■ Switch Current Limit vs. Temperature

$$V_{IN} = V_{CONT1} = V_{CONT2} = 3.0V$$



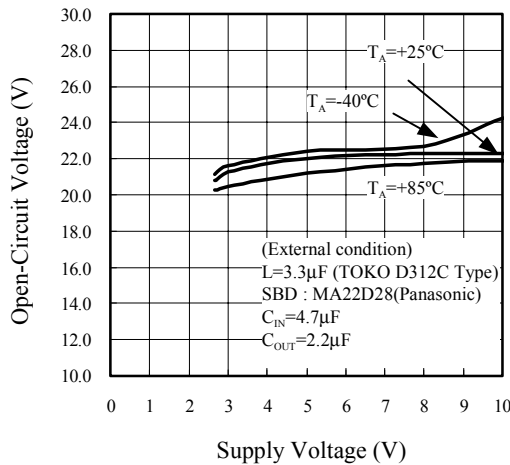
■ Switch Leakage Current vs. Switch Voltage

$$V_{IN} = V_{CONT1} = V_{CONT2} = 3.0V, V_{FBI} = 1.0V$$



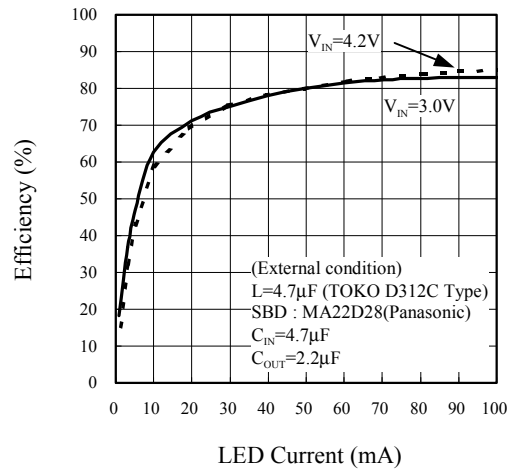
■ Open-Circuit Voltage vs. Supply Voltage

$$V_{IN} = 3.0V$$



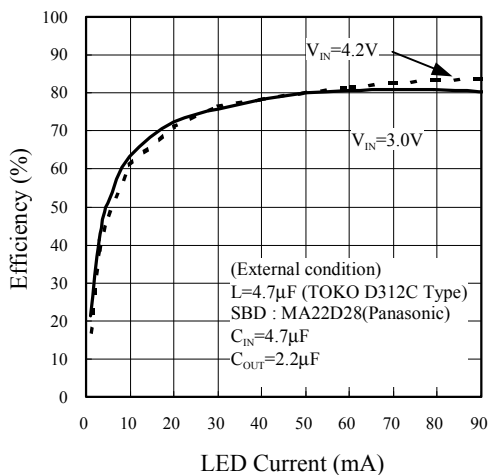
■ Efficiency vs. LED Current

2LEDs in Series, $V_{CONT1} = V_{CONT2} = 3.0V, T_A = +25^\circ C$



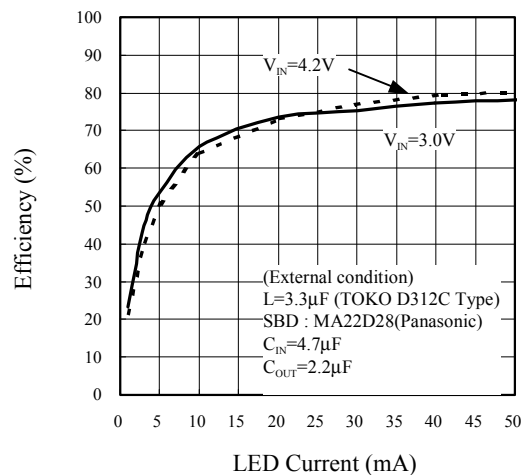
■ Efficiency vs. LED Current

3LEDs in Series, $V_{CONT1} = V_{CONT2} = 3.0V, T_A = +25^\circ C$



■ Efficiency vs. LED Current

4LEDs in Series, $V_{CONT1} = V_{CONT2} = 3.0V, T_A = +25^\circ C$



11. PIN DESCRIPTION

No.	Symbol	Internal Equivalent Circuit	Description
1	V_{IN}	—	Power supply voltage input: When the supply voltage falls below 2.45V ($V_{IN,LOW}$), TK11892F stops switching to avoid malfunction.
2	CONT1		This pin is the chip-enable input and LED Current Control signal input with a built-in 200kΩ pull-down resistor. Set the either CONT1 or CONT2 pin higher than 1.2V to enable the device. Set the both CONT1 and CONT2 below 0.3V to disable the device. The CONT1, CONT2 pin can be pulled up to 20V, regardless of the supply voltage and output voltage.
3	CONT2		
4	V_{FB1}		<p>Error amplifier inverting input 1: The error amplifier detects the output voltage of the DC-DC converter and outputs the PWM control signal. When CONT1 and CONT2 is High, Error Amp.1 is operated and the threshold voltage is 248mV (typ).</p>
5	V_{FB2}		<p>Error amplifier inverting input 2: If one of the control pins is pulled high, Error amp.2 is operated. When CONT1 is high and CONT2 is low, the threshold voltage is 117mV (typ). When CONT1 is low and CONT2 is high, the threshold voltage is 22mV (typ).</p>
6	EA_{OUT}		<p>Error amplifier output: Compensation pin. A capacitor combination connected to this pin provides compensation for the control loop.</p>
7	GND	—	Ground
8	SW		<p>This pin is the collector of the internal 18.5V NPN power switch. The switch transistor has a maximum 1A peak current capability. This pin will also work as open-circuit protection. The Open-Circuit Voltage is approximately 22.0V.</p>

12. CIRCUIT DESCRIPTION

12.1 PWM Comparator

The voltage comparator has one inverting and three non-inverting inputs. The comparator is a voltage-pulse width converter that controls the ON time of the output pulse depending on the input voltage. The output level is high when the sawtooth wave is lower than the error amplifier output voltage, current sense comparator output voltage, and idle period setting voltage.

Maximum duty cycle, which is the maximum ON time of the output pulse, is decided by an idle period setting of the output pulse, is decided by an idle period setting voltage. The maximum duty cycle is set to 90% including circuit delay and Turn-off delay of Switching Transistor.

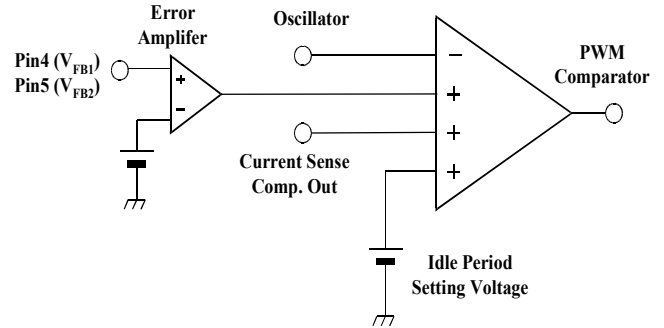


Fig. 1: Internal equivalent circuit of PWM Comparator

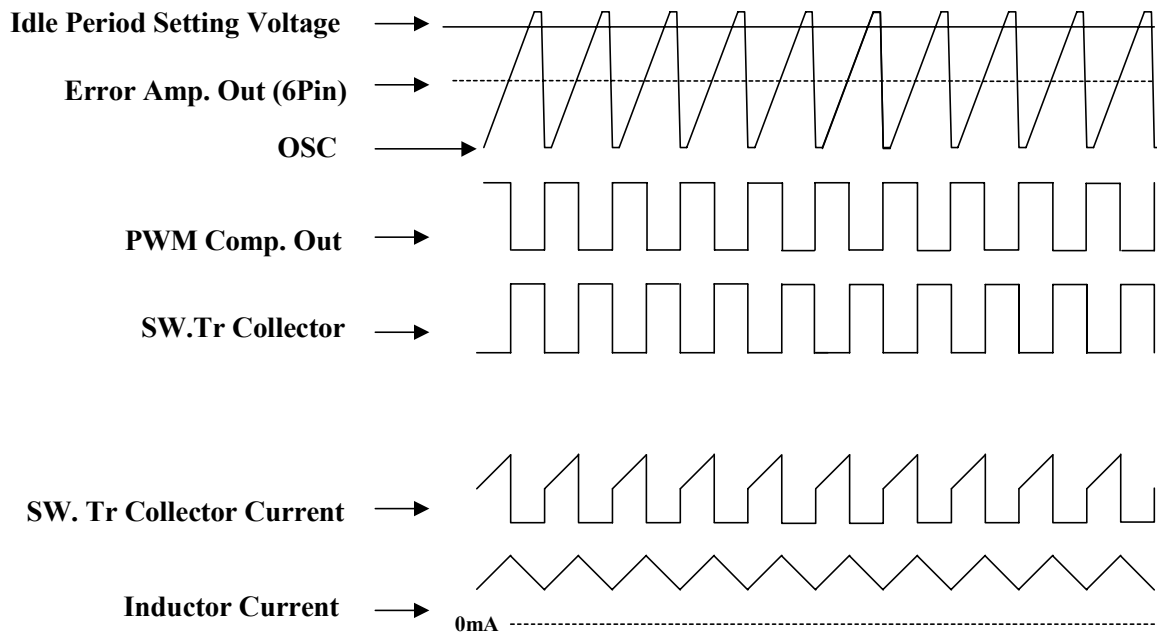


Fig. 2: Timing Diagram of PWM Comparator

12.2 Error Amplifier

TK11892F has two Error Amplifiers that can be selected by control signal at Pin 2 and Pin 3. (See 12.3 Control) The error amplifier detects the output voltage of the DC-DC converter and outputs the PWM control signal. The voltage gain is fixed, and connecting a phase compensation capacitor to the EA_{OUT} pin (pin 7) provides stable phase compensation for the system. Reference Voltage divided from the Band gap voltage is supplied to the inverting input of the error amplifier.

This architecture allows the series-connected white LEDs to be driven with a constant current. The LED current (I_{LED}) is set by an external resistor (R_{LED1} , R_{LED2}) connected between the V_{FB1} , V_{FB2} pin and GND (see Fig.3). The current of each LED is

$$I_{LED} = \frac{V_{EA}}{R_{LED1}} \text{ or } I_{LED} = \frac{V_{EA}}{R_{LED1} + R_{LED2}} \quad (1)$$

Where V_{EA} : Error amplifier threshold voltage
Current setting is shown in Table 1, 2.

Output voltage V_{OUT} is given by

$$V_{OUT} = n \cdot V_F + V_{EA} \quad (2)$$

or

$$V_{OUT} = n \cdot V_F + (V_{EA} + I_{LED} \cdot R_{LED2}) \quad (3)$$

Where V_F : LED forward voltage drop
 n : Number of LEDs connected in series

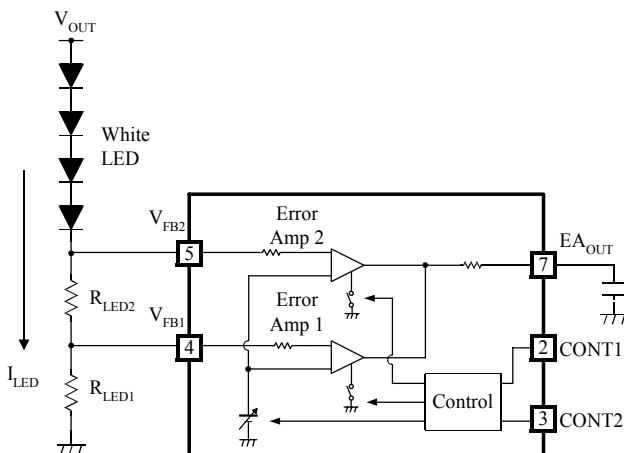


Fig 3: Setting constant current through LED

12.3. Control (CONT1, CONT2)

The control pins CONT1 and CONT2 are used to enable or disable the device. TK11892F is enabled if one of the control pins is pulled higher than 1.2V. Setting both CONT1 and CONT2 to 0.3V or less will disable the IC; that is, shutdown mode. During shutdown, the supply current drops to 1µA or less.

CONT1 and CONT2 can also be used to dimming. The control signal selects error amplifier 1 or 2. The threshold voltage V_{EA} of the error amplifier is set respectively and LED current can be switched with a control signal. See Table 1. Moreover, the LED current of each mode can be set by R_{LED1} or R_{LED2} .

Table 1: Control Input

CONT1	CONT2	MODE	Error Amplifier	V_{EA} (typ)
0	0	shutdown	-	-
0	1	Indicator	2	20mV
1	0	Torch	2	117mV
1	1	Flash	1	248mV

Table 2: LED current Setting

MODE	LED Current Setting
Indicator	$I_{LED1} = \frac{22mV}{R_{LED1} + R_{LED2}}$ (* $I_{LED1} \approx 0.2 \cdot I_{LED2}$)
Torch	$I_{LED2} = \frac{117mV}{R_{LED1} + R_{LED2}}$
Flash	$I_{LED3} = \frac{248mV}{R_{LED1}}$

CONT1 and CONT2 can also be used for PWM dimming. The PWM signal can either be applied to CONT1 or CONT2, or both inputs can be tied together and the PWM signal can be applied to both pins. The average current of the LED changes due to the On/Off cycle of the IC, which follows the duty cycle of the PWM signal.

12.4 Operating supply voltage range

When the supply voltage falls below 2.45V ($V_{IN,LOW}$), TK11892F stops switching to avoid malfunction. The recommended operating voltage range of this IC is 2.65V~8.0V. However, the maximum rating for the supply voltage is as high as 15V.

12.5 Open-Circuit Protection

TK11892F has internal open-circuit protection. When the main feedback loop is opened, IC will operate at maximum duty cycle because the V_{FB} pin falls to ground level, and the Output voltage will climb out of feedback control. Because TK11892 has the OVP function built into the SW Pin, output voltage is clamped at nearly 22V. (When $L=4.7\mu H$ is used.) The clamped level of V_{OUT} is enough to drive 4 white LEDs connected in series.

12.6 Maximum Output Current

The maximum output current of TK11892F is shown in Fig.4 when 4 White LEDs are connected in series and are driven in the Flash mode. (Flash time: 100msec, Duty: 10%) This is the minimum value of the worst case in the following conditions.

Conditions

- Ambient Temperature range: $-30^{\circ}C \sim +85^{\circ}C$
- Output: 4 LEDs in series ($V_{OUT}=16.5V$)
- Flash time ($V_{CONT1,2}=1.2V$): 100mSec
- Duty: 10%
- Inductance: D312C Type (TOKO)
- $L=3.3\mu H \pm 20\%$
- Operating frequency range: 1.35MHz~2.45MHz

Maximum output current is measured by TK11892F's evaluation board.

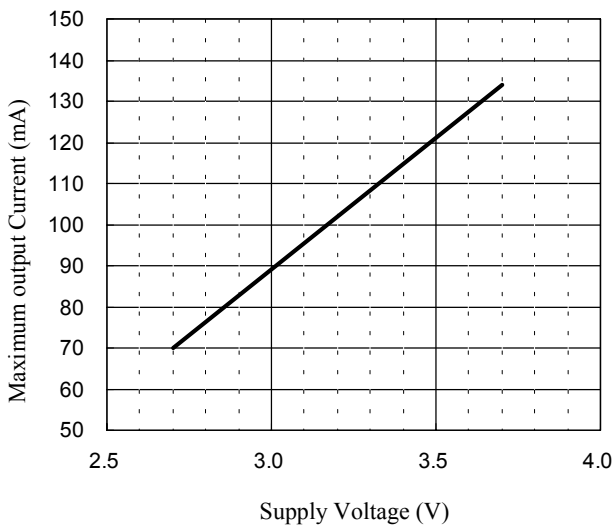


Fig. 4: Maximum output current of 4LEDs in series

Table 3: Summary of maximum output current

$$V_{CONT1}=V_{CONT2}=1.2V$$

Number of White LED	Maximum current		Condition
	Continuous mode	Flash mode 100msec duty 10%	
2	100mA		L: D312C Type (TOKO) SBD: MA22D28L (Panasonic) $V_{IN}=3.0V \sim$ $T_A = -30 \sim +85^{\circ}C$
3	90mA	100mA	
4	50mA	90mA	

* This value is reference only.

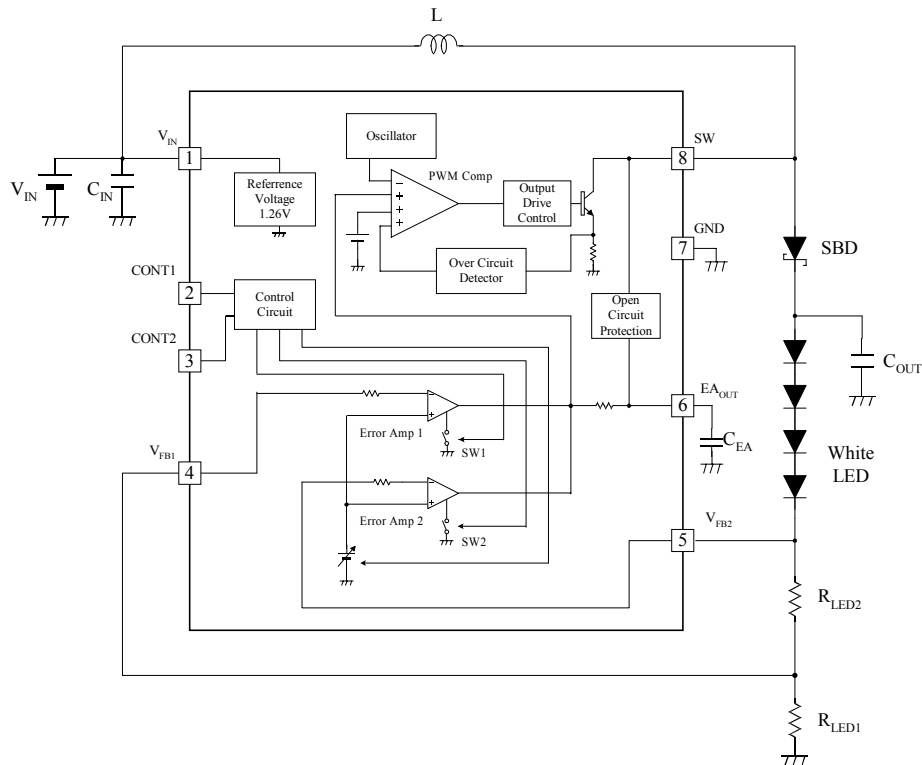
The maximum current changes based on the external components used (for example Inductor type), the ambient temperature range, the PCB layout. Please set the LED current after enough evaluation with your PCB, external component, and operating conditions.

13. APPLICATION INFORMATION

13-1 Example application condition

- White LED Flash driving current: 73mA(100mSec)
 - Torch driving current: 17mA
 - Indicator driving current: 3mA
- LED Current is adjusted by R_{LED1}
- LED Current is adjusted by R_{LED1} and R_{LED2}
- LED Current is adjusted by R_{LED1} and R_{LED2}
- Input Voltage range : $V_{IN}=2.7V\sim 4.2V$

13-2. Recommended application circuit



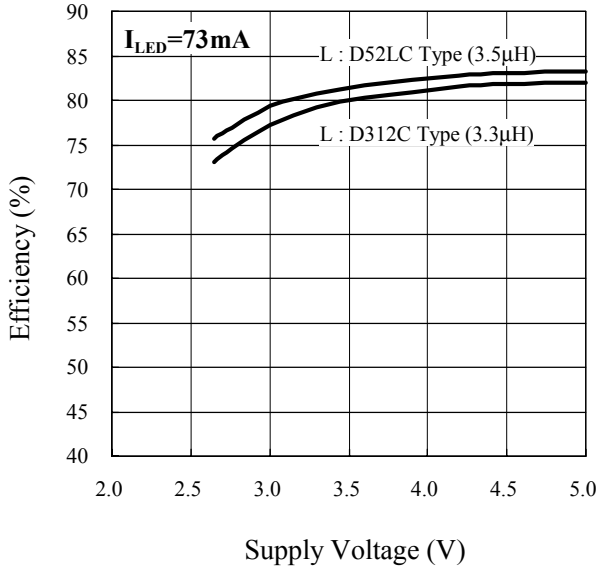
13-3. Recommended components

- L: 3.3 μ H (TOKO D312C Type, Part number: 1001BS-3R3M)
- L: 3.5 μ H (TOKO D52LC Type, Part number: A914BYW-3R5M)
- SBD: MA22D28L (Panasonic 1.5A, 30V)
- C_{IN} : 4.7 μ F/6V (KYOCERA CM105X5R475M06AB)
- C_{OUT} : 2.0 μ F 1 μ F/25V \times 2 parallel (KYOCERA CT21X5R105K25AB095)
- C_{EA} : 0.1 μ F, 6V (KYOCERA CM105B104K25A)
- R_{LED1} : 3.3 Ω , R_{LED2} : 3.3 Ω

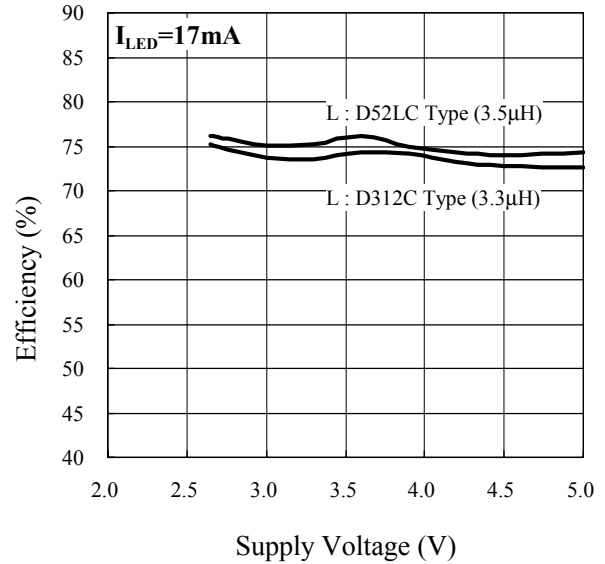
13-4. Efficiency in recommended circuit (4 LEDs in Series)

$$\text{Efficiency} = \frac{V_{\text{OUT}} \cdot I_{\text{LED}}}{V_{\text{IN}} \cdot I_{\text{IN}}} \times 100$$

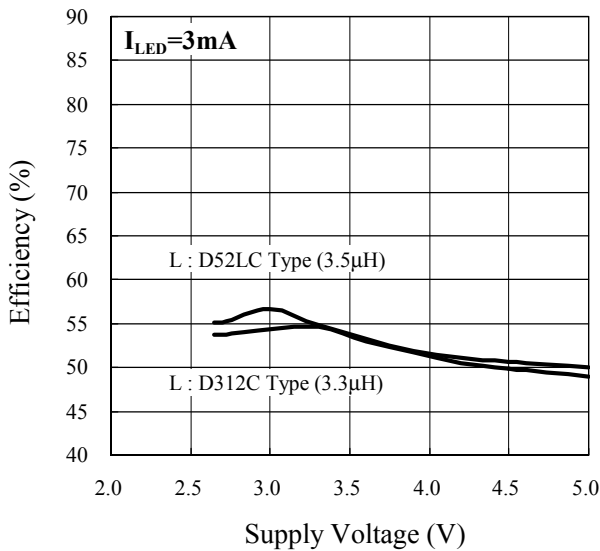
■ Efficiency vs. Supply Voltage
Flash mode: $V_{\text{CON1}}=V_{\text{CONT2}}=V_{\text{IN}}$



■ Efficiency vs. Supply Voltage
Torch mode: $V_{\text{CON1}}=V_{\text{IN}}, V_{\text{CONT2}}=0V$



■ Efficiency vs. Supply Voltage
Indicator mode: $V_{\text{CON2}}=V_{\text{IN}}, V_{\text{CONT1}}=0V$



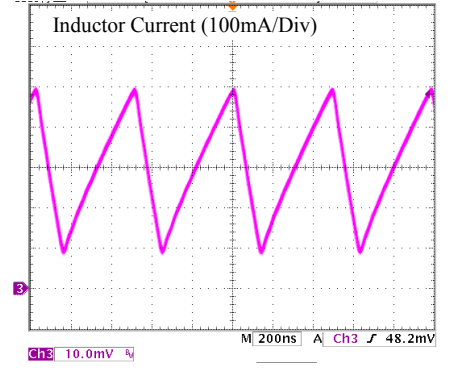
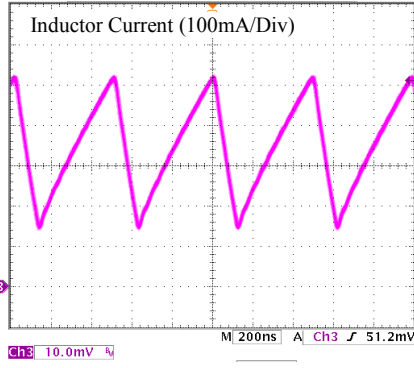
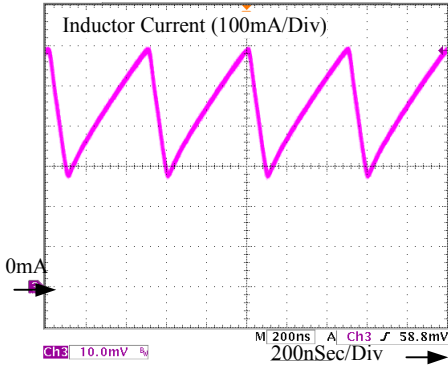
13-5. Inductor Current Waveform

13-5-1. Flash mode (4LEDs $I_{LED}=73mA$)

$V_{IN}=3.0V$ ($I_{LPK}=580mA$)

$V_{IN}=3.7V$ ($I_{LPK}=520mA$)

$V_{IN}=4.2V$ ($I_{LPK}=480mA$)

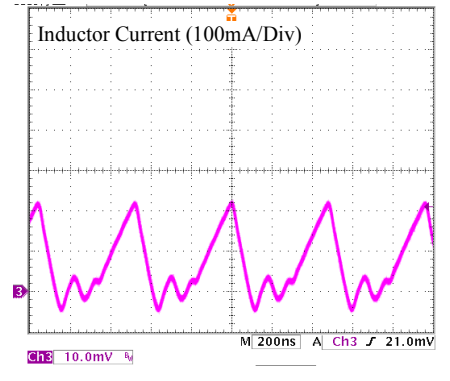
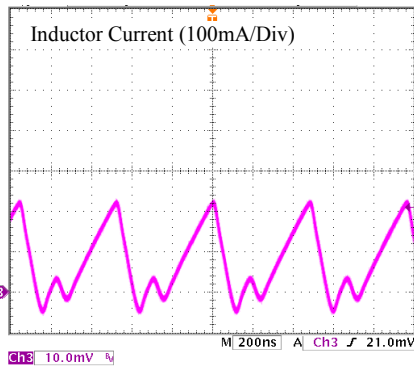
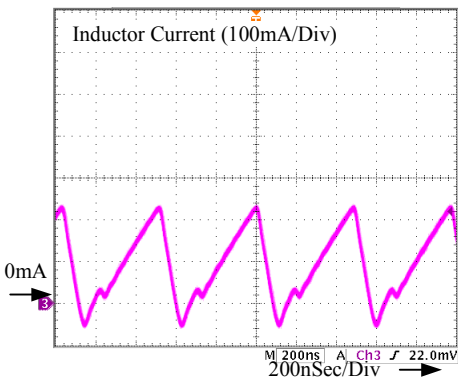


13-5-2. Torch mode (4LEDs $I_{LED}=17mA$)

$V_{IN}=3.0V$ ($I_{LPK}=220mA$)

$V_{IN}=3.7V$ ($I_{LPK}=215mA$)

$V_{IN}=4.2V$ ($I_{LPK}=210mA$)

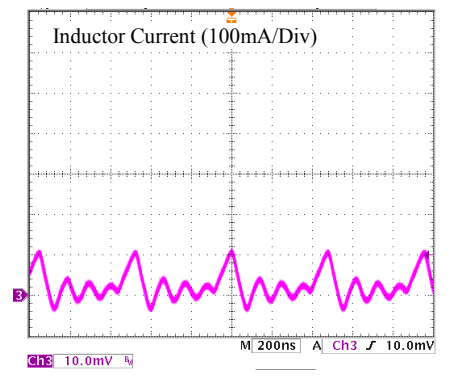
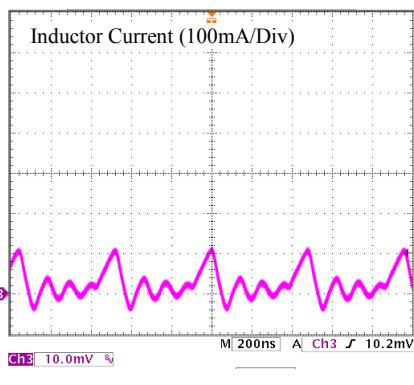
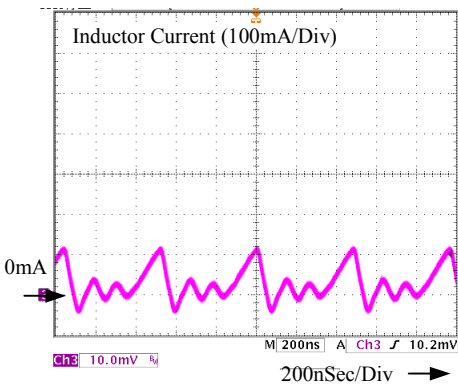


13-5-3. Indicator mode (4LEDs $I_{LED}=3mA$)

$V_{IN}=3.0V$ ($I_{LPK}=106mA$)

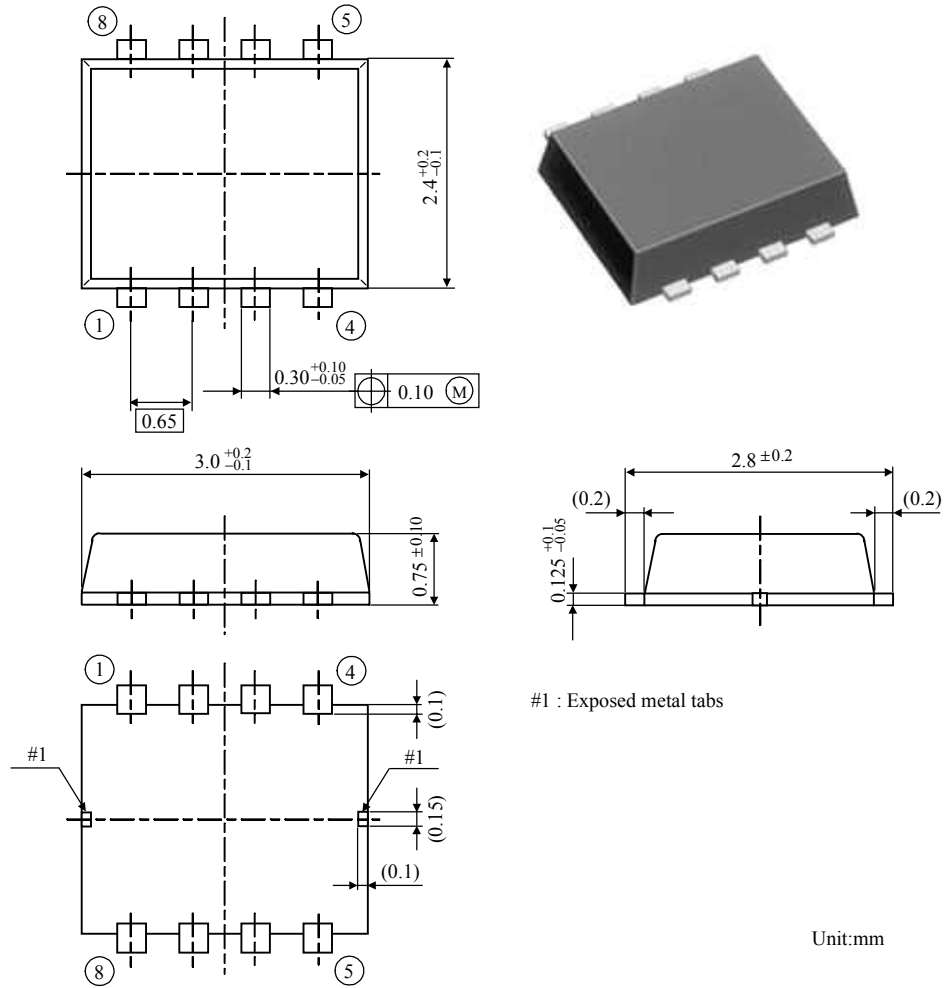
$V_{IN}=3.7V$ ($I_{LPK}=104mA$)

$V_{IN}=4.2V$ ($I_{LPK}=100mA$)



14. PACKAGE DESCRIPTION

Package: SON3024-8



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■ None of the ozone depleting substances(ODS) under the Montreal Protocol are used in our manufacturing process.

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If you need more information on this product and other TOKO products, please contact us.

■ TOKO Inc. Headquarters
 1-17, Higashi-yukigaya 2-chome, Ohta-ku, Tokyo,
 145-8585, Japan
 TEL: +81.3.3727.1161
 FAX: +81.3.3727.1176 or +81.3.3727.1169
 Web site: <http://www.toko.co.jp/>

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