TOSHIBA BiCD Digital Integrated Circuit Silicon Monolithic

TB62757FUG

Step Up Type DC/DC Converter for White LED

The TB62757FUG is a high efficient Step-Up Type DC/DC Converter specially designed for constant current driving of White LED.

This IC can drive 2-6 white LEDs connected series using a Li-ion battery.

This IC contains N-ch MOS-FET Transistor for Coil-Switching, and LED Current (I_F) is set with an external resistor.

This IC is especially for driving back light white LEDs in LCD of PDA, Cellular Phone, or Handy Terminal Equipment.

This device is Pb-free product.

SSOP6-P-0.95B
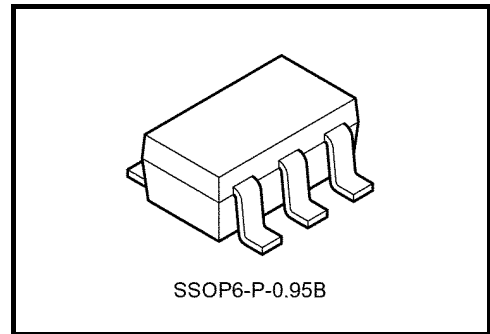
Weight: 0.016 g (Typ.)

Features

- Can drive 2-6 white LEDs connected series
- Output Over Voltage Shutdown Function :
    Switching Operation is shut downed when OVD terminal Voltage is over 22 V (typ.).
- Variable LED Current I_F is set with a external resistor :
    20 mA (Typ.) @RSENS = 16 Ω
- Output Power : Available for 400mW LED loading
- High Efficiency : 87% @Maximum (Using recommended external parts: Typ. 4LEDs)
- IC Package : SSOP6-P-0.95 (SOT23-6)
- Switching Frequency : 1.1 MHz (Typ.)

Block Diagram
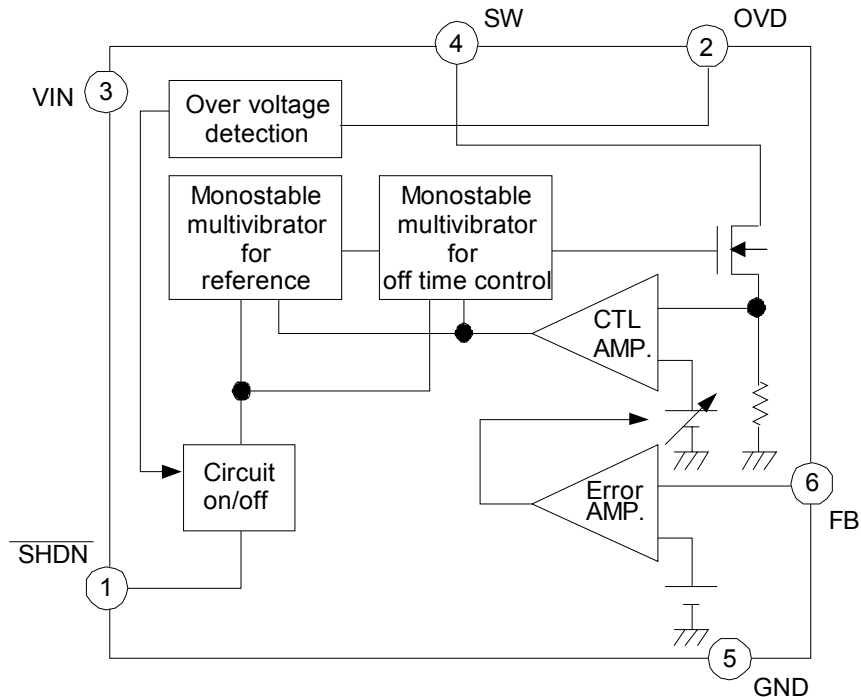
Pin Assignment (Top view)
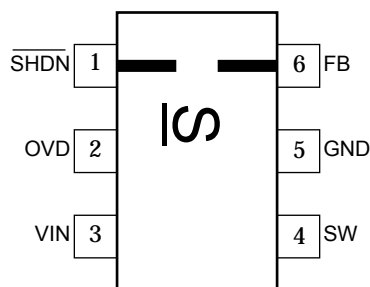
Note1: This IC could be destroyed in some case if amounted in 180° inverse direction.
Please be careful about IC direction in mounting.

Note2: The control pin must be set to a certain logic level, as unstable output could result if the pin is
left open.

Pin Function

Pin No.	Symbol	Function Description
1	$\overline{\text{SHDN}}$	Voltage-Input Terminal for IC-Enable / Setting LED-I_F. $\overline{\text{SHDN}}$=H Operation Mode $\overline{\text{SHDN}}$=L Shutdown Mode (IC shutdown) I_F adjustment with PWM input signal is available.
2	OVD	Over Voltage Detection Terminal. IC Switching Operation is disabled with detection over voltage. If the voltage returns to detection level or less, Operation is enabled again.
3	VIN	Supply Voltage Input Terminal. (2.8V to 5.5V)
4	SW	Switch Terminal for DC/DC Converter. Nch MOSFET Built-In.
5	GND	Ground Terminal.
6	FB	LED I_F Setting Resister Connecting Terminal.

I/O Equivalent Pin Circuits
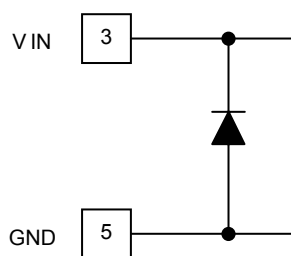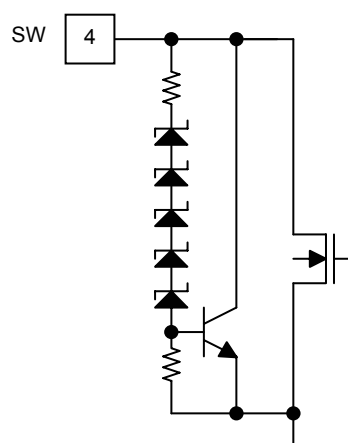
1. $\overline{\text{SHDN}}$ Terminal
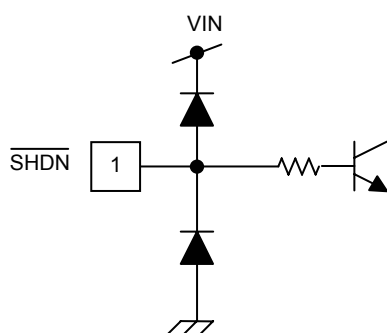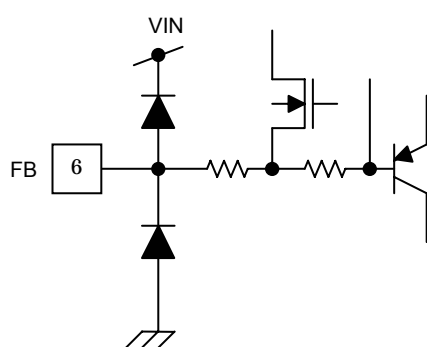
2. OVD Terminal
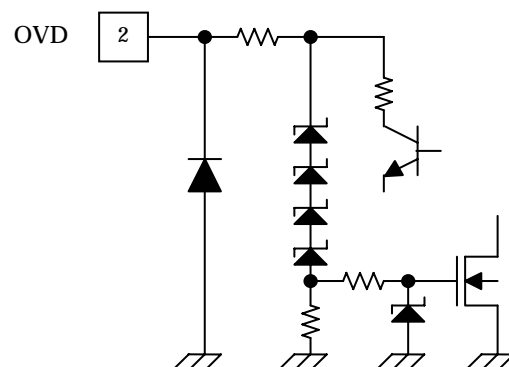
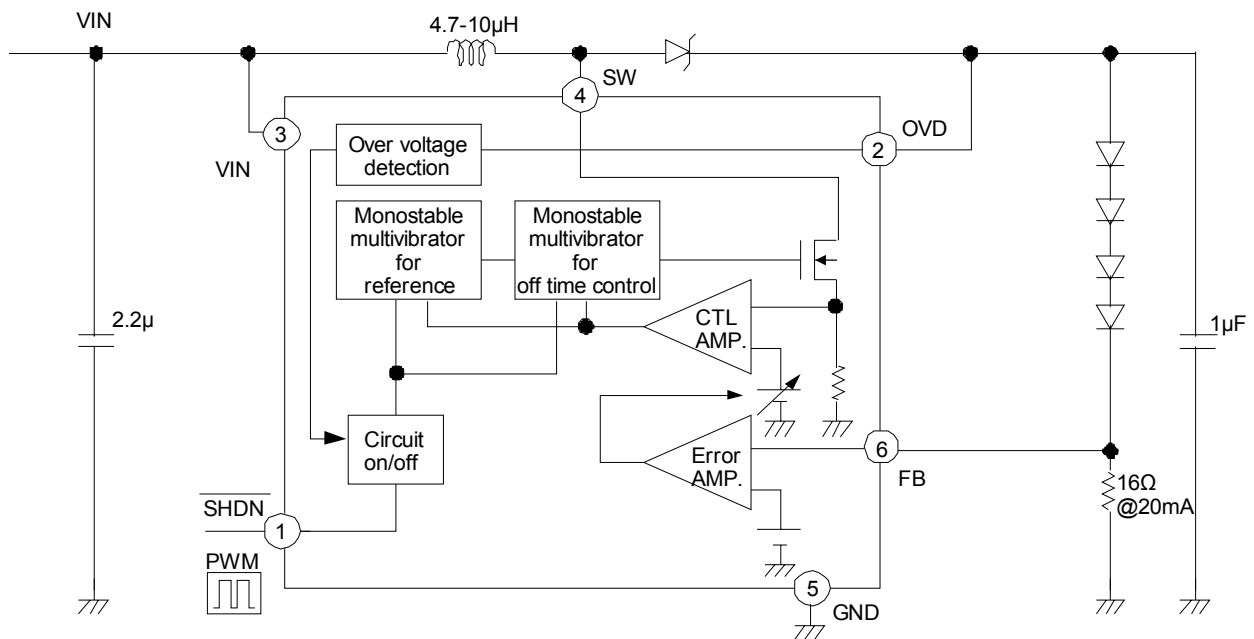3. VIN terminal to GND terminal

4. SW Terminal

5. FB Terminal

Application Note

Protection in LED opened condition

The operation with OVD terminal is available for the protection in case LED Circuit opened.

Please see the example of application circuit.

If load of LED is detached, Nch MOS switching operation is disabled with detection of boost circuit voltage.

Setting of External Capacitor

In case not using PWM signal to $\overline{\text{SHDN}}$ terminal for brightness control, recommended values are
C_1 = Over 2.2 (μF), C_2 = Over 1.0 (μF)
In case with PWM signal to $\overline{\text{SHDN}}$ terminal for brightness control, recommended values are
C_1 = Over 4.7 (μF), C_2 = Under 0.1 (μF).
The recommended capacitor values depend on the Brightness Control Method.
<Please refer the next page or later>
The capacitor value must be considered for gain enough accuracy of brightness with reduction of noise from Input current changing.

Setting of External Inductor Size

Please select the inductor size with referring this table corresponding to each number of LEDs.

Recommendation

LEDs	Indictor Size	Note
2	4.7 μH	
3		
4	6.8 μH	LED current I_F = 20 mA
5	8.1 μH	
6	10 μH	

LED Current IF Setting

The resistance between the FB pin and GND, RSENS (Ω) is the resistance for the setting the output current.
Depending on the resistance value, it is possible to set the average output current Io (mA).
The average output current Io (mA) can be approximated with the following equation:

$$I_F = (325 \text{ [mV]}/\text{RSENS [}\Omega\text{]})$$

The current value error is $\pm$ 5%.

Current Dimming Control

Recommended Brightness Control Circuits are 4 types.

1) Input PWM signal to $\overline{\text{SHDN}}$ terminal

I_F can be adjusted with PWM signal by inputting it to $\overline{\text{SHDN}}$ terminal.

Notice

Minimum ON-time of PWM signal input

Set the minimum ON-time or OFF-time 33μs or more in inputting the PWM signal.
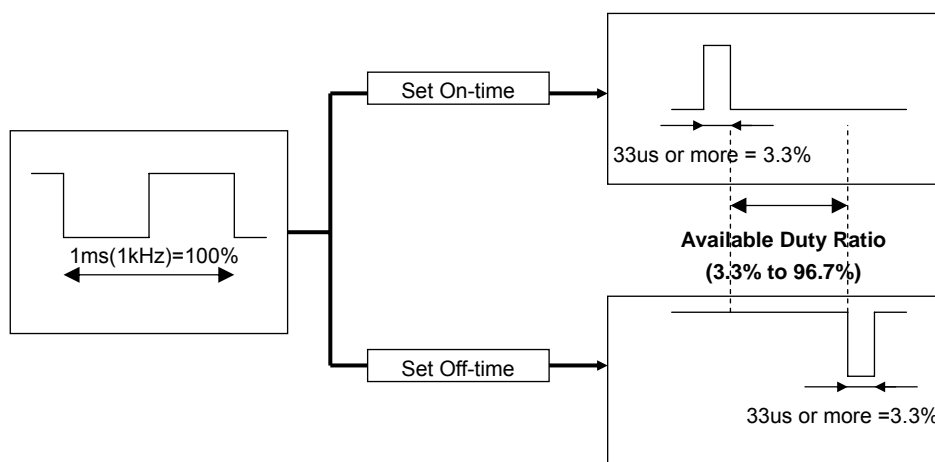
Set the Duty ratio satisfying the condition above.

Ex) In case PWM Frequency is 1kHz,

1kHz is 1ms (PWM Width = 100%) and it takes 10μs per 1%.

To set the pulse width 33us or more, necessary ON-or-OFF-time is calculated below.

33μs ÷ 10μs = 3.3%   (Under the condition that 10μs equals 1%.)

Finally, the Duty Ratio can be set in range of 3.3% to 96.7%.

PWM signal frequency

The recommended PWM signal frequency is from 100Hz to 10kHz. There is a possibility to arise the audible frequency in mounting to the board because it is within the auditory area.

Constant number of external capacitor

To reduce the fluctuation of input current and increase the accuracy of brightness, the values that $C_1 = 4.7$ (μF) or more , $C_2 = 0.1$ (μF) or less are recommended.

When the PWM signal is off, the time to drain C_2 of charge depends on the constant number. And so, the actual value is little different from the theoretical value.

PWM input signal

Set the amplitude of PWM signal within the range of $\overline{\text{SHDN}}$ terminal specification.

Rush current in inputting

In case dimming by inputting the PWM signal to the $\overline{\text{SHDN}}$ terminal, this IC turns on and off repeatedly. And the rush current, which provides the charge to C_2, arises in turning on. Take care in selecting the condenser.
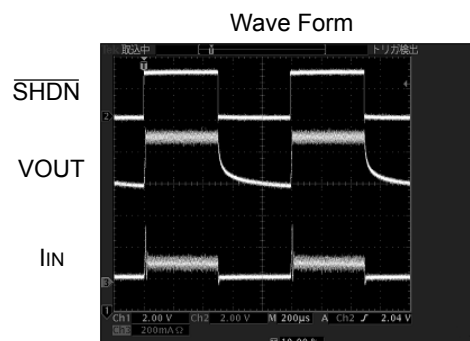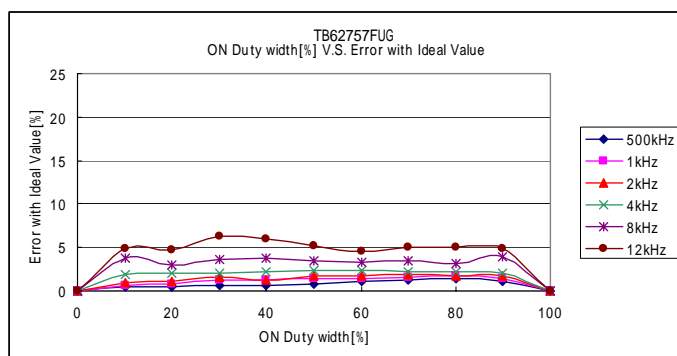
Current value in Control with PWM : Ideal Equation

$$I_F[mA] = \frac{325[mV] \times ON \; Duty \; [\%]}{RSENS \; [\Omega]}$$

<Reference Data>
Condition: V$_{IN}$=3.6V, L=6.8µH, 4LEDs, RSENS=16mΩ@Io=20mA

(1) C1=4.7µF, C2=0.1µF

Wave Form

(2) C1=4.7µF, C2=0.47µF

Wave Form

(3) C1=4.7µF, C2=1.0µF

Wave Form

(4) C1=2.2µF, C2=1.0µF

Wave Form

2005-11-7
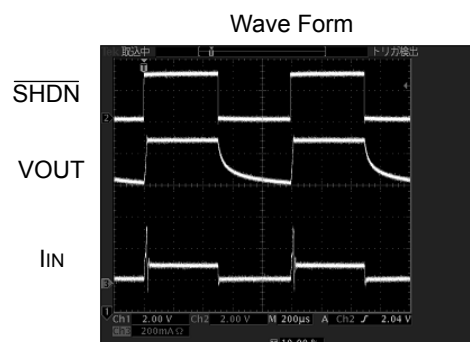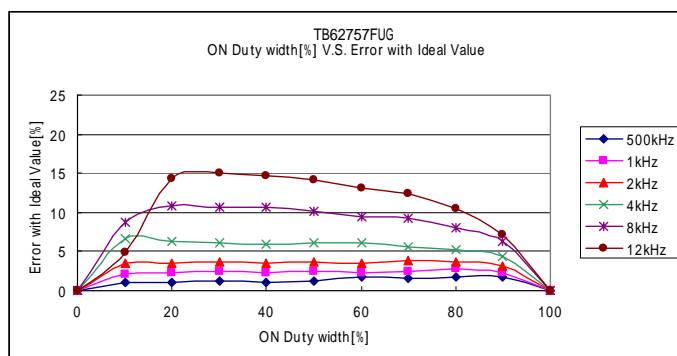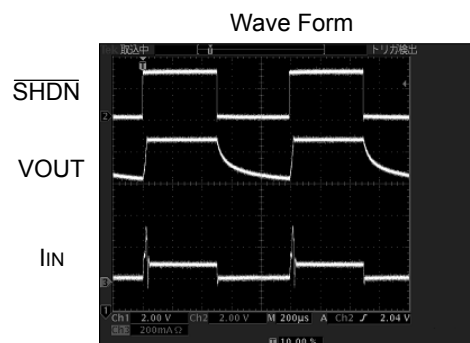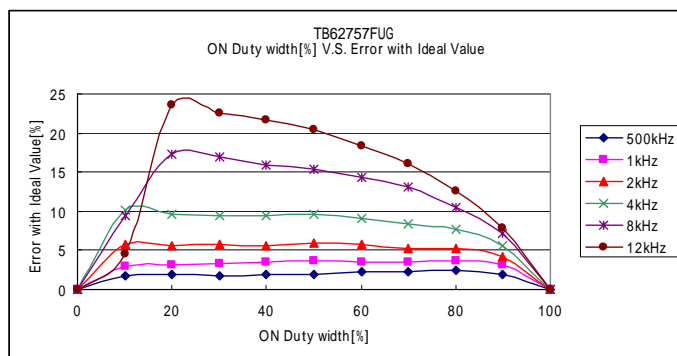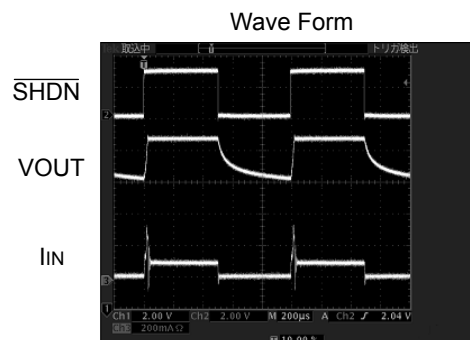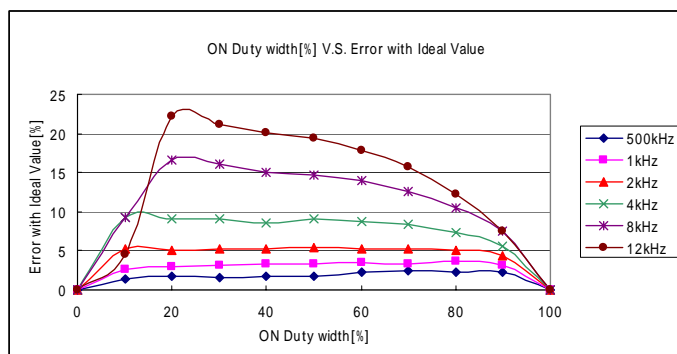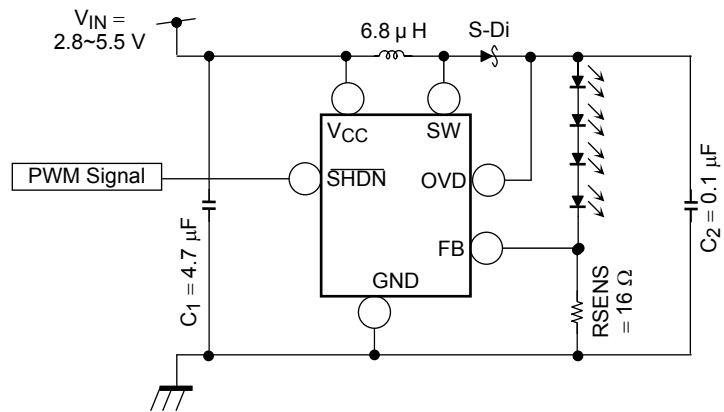
2) Input analog voltage to FB terminal

      IF can be adjusted with Analog voltage input to FB terminal.

      This method is without repeating IC ON/OFF, and no need to consider holding rash current.

    << Notice >>

      LED current value goes over 100% of the current set with RSENS,

      if the input analog voltage is between 0V to 325mV(TYP.).

      for ref.) Analog voltage = 0 to 2.2V

            About external parts value, please see recommended circuit.

Supply Voltage[V]	Ratio with Setting Current
No Connect(OFF)	100%
0	116.0%
0.2	106.5%
0.4	95.4%
0.6	84.5%
0.8	73.6%
1	59.9%
1.2	48.4%
1.4	37.4%
1.6	26.6%
1.8	15.9%
2	5.8%
2.2	0.0%

Analog Voltage Input to FB Terminal
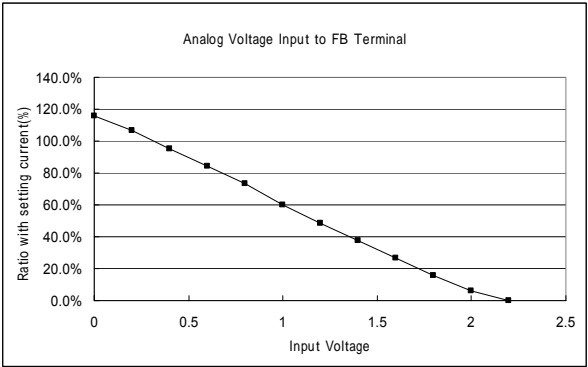
Recommended application

3) Input PWM signal with filtering to FB terminal

IF can be adjusted with filtering PWM signal using RC filter indicated in recommended circuit, because the PWM signal can be regard as analog voltage after filtering.

This method is without repeating IC ON/OFF, and no need to consider holding rash current.
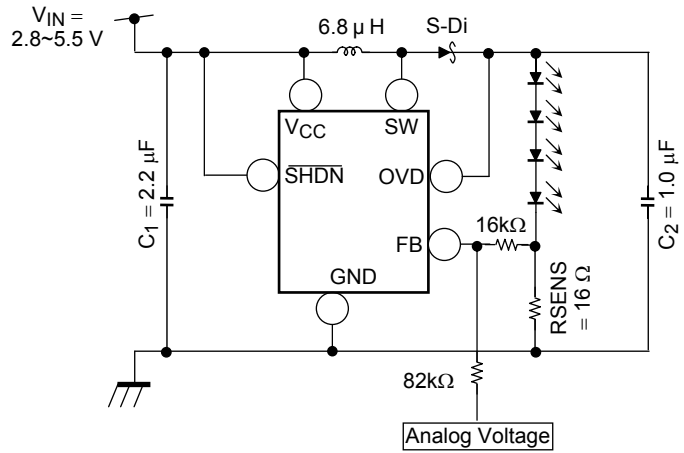
<< Notice >>

LED current value goes over 100% of the current set with RSENS, if the input voltage after filtering is between 0V to 325mV(TYP.).

for ref.) Voltage during PWM Signal-ON = 2V

About external parts value, please see recommended circuit.

Supply Voltage[V]	Ratio with Setting Current
No Connect(OFF)	100%
0	116.1%
10%	105.3%
20%	95.1%
30%	84.8%
40%	74.6%
50%	64.0%
60%	53.8%
70%	43.7%
80%	34.0%
90%	24.2%
100%	13.3%

TB62757FUG
Input PWM signal filtered with R,C to the FB terminal
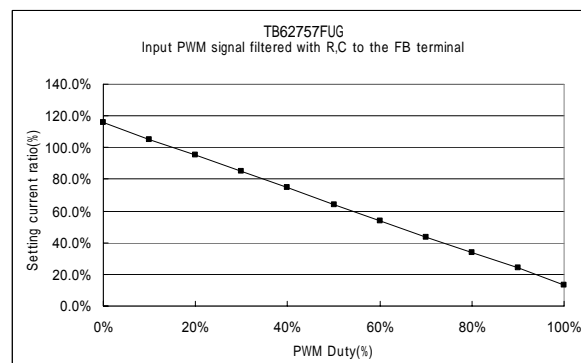
Recommended application
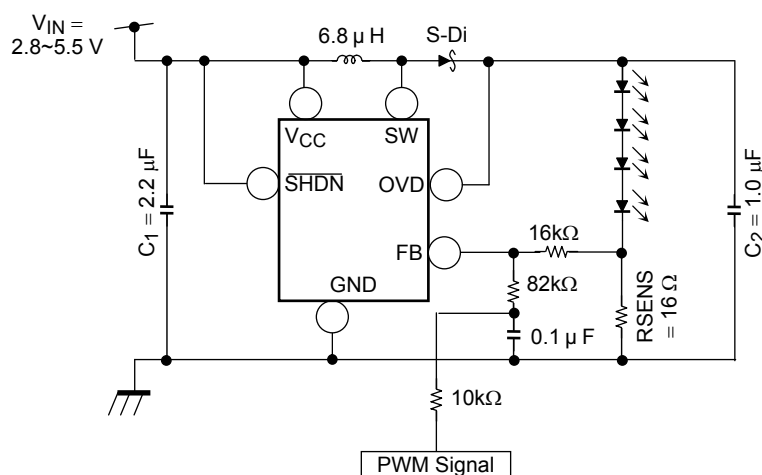
4) Input Logic signal

      IF can be adjusted with Logic signal input as indicated in recommended circuit.
      The Resistor connected the ON-State Nch MOS Drain and RSENS determines IF.

Average of Setting Current Io(mA) is next, approximately.
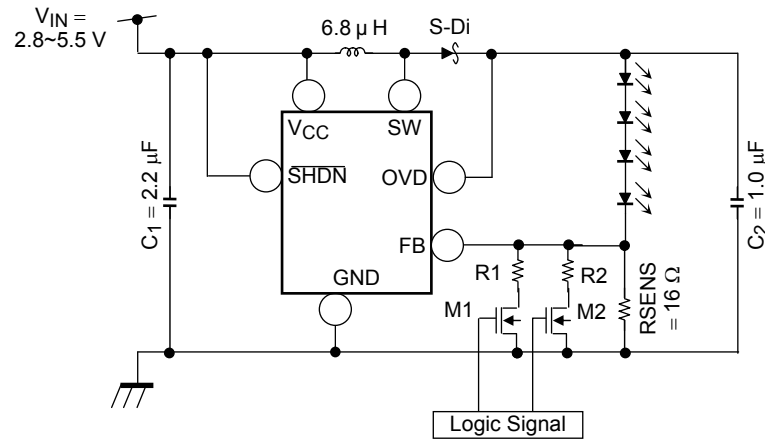
$$I_F = (325[mV] / \text{Sum of Resistor Value}[\Omega])$$

Recommended application

M1	M2	LED Current
OFF	OFF	$\dfrac{325[mV]}{\text{RSENS }[\Omega]}$
ON	OFF	$325 \quad mV \quad \times \quad \dfrac{\text{RSENS }[\Omega] \times R1\,[\Omega]}{\text{RSENS }[\Omega] + R1\,[\Omega]}$
OFF	ON	$325 \quad mV \quad \times \quad \dfrac{\text{RSENS }[\Omega] \times R2\,[\Omega]}{\text{RSENS }[\Omega] + R2\,[\Omega]}$
ON	ON	$325 \quad mV \quad \times \quad \dfrac{\text{RSENS }[\Omega] \times R1\,[\Omega] \times R2\,[\Omega]}{\text{RSENS }[\Omega] \times R1\,[\Omega] + \text{RSENS }[\Omega] \times R2\,[\Omega] + R1\,[\Omega] \times R2\,[\Omega]}$

Absolute Maximum Ratings (Ta = 25℃ if without notice)

Characteristics	Symbol	Ratings	Unit
Power Supply Voltage	V_{IN}	−0.3 to +6.0	V
Input Voltage	$V_{\overline{SHDN}}$	−0.3 to +V_{IN} + 0.3(Note3)	V
Switching Terminal Voltage	V_o (SW)	-0.3 to 24	V
Switching Terminal Current	I_o (SW)	380	mA
Power Dissipation	P_D	0.41 (Device)	W
		0.47 (on PCB) (Note4)	
Thermal Resistance	$R_{th\,(j-a)}$	300 (Device)	°C/W
		260 (on PCB)	
Operation Temperature Range	T_{opr}	−40 to +85	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C
Maximum Junction Temperature	T_j	150	°C

Note 3: However, do not exceed 6V.

Note 4: Power Dissipation must be calculated with subtraction of 3.8 mW/°C from Maximum Rating with every 1°C if T_{opr} is upper 25°C. (on PCB)

Recommended Operating Condition (Ta = -40°C to 85°C if without notice)

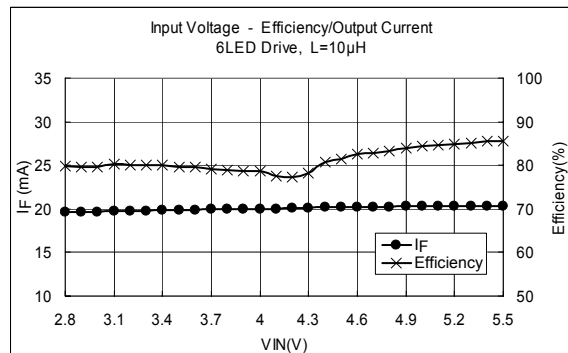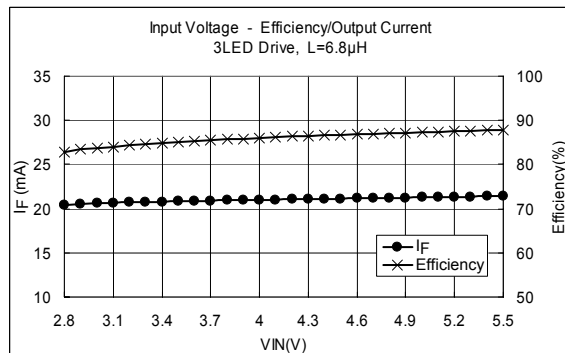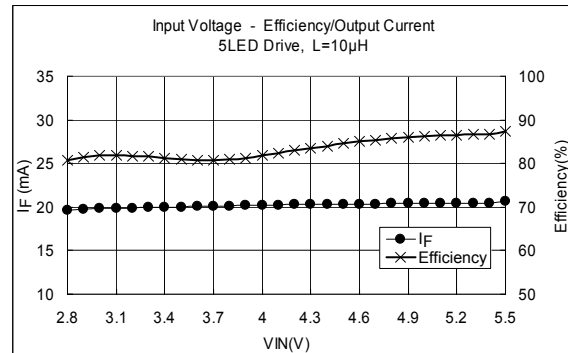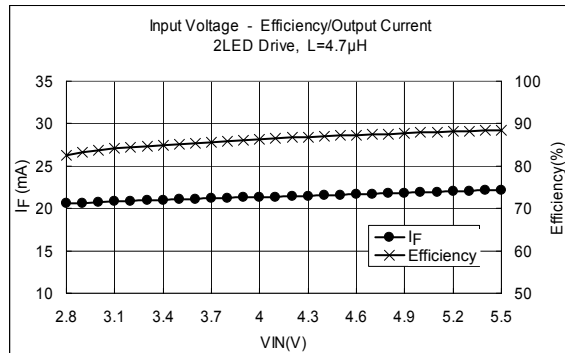| Characteristics	Symbol	Test Condition	Min	Typ	Max	Unit
Power Supply Voltage	V_{IN}		2.8	-	5.5	V
SHDN terminal input Pulse Width	tpw	ON duty width, OFF duty width	33	-	-	µs
LED Current (Average Value)	I_{o1}	V_{IN} = 3.6 V, R_{SENS}=16Ω 4LEDs, T_a = 25°C	-	20	-	mA

Electrical Characteristics (Ta = 25°C V$_{IN}$ = 2.8 to 5.5V, if without notice)

Characteristics	Symbol	Test Condition	Min	Typ	Max	Unit
Input Voltage Range	V$_{IN}$		2.8	-	5.5	V
Operating Consumption Current	I$_{IN}$ (On)	V$_{IN}$=3.6V, R$_{SENS}$=16Ω	-	0.9	1.5	mA
Quiescent Consumption Current	I$_{IN}$ (Off)	V$_{IN}$=3.6V,V$_{\overline{SHDN}}$=0V	-	0.5	1.0	µA
$\overline{SHDN}$ terminal 'H' level input voltage	V$_{\overline{SHDN}H}$	-	1.3	-	V$_{IN}$	V
$\overline{SHDN}$ terminal 'L' level input voltage	V$_{\overline{SHDN}L}$	-	0	-	0.4	V
$\overline{SHDN}$ Terminal Current	I$_{\overline{SHDN}}$	VI$_{IN}$=3.6V,V$_{\overline{SHDN}}$=3.6V	-10	0	10	µA
Integrated MOS-Tr Switching Frequency	f$_{OSC}$	V$_{IN}$=3.6V,V$_{\overline{SHDN}}$=3.6V	0.77	1.1	1.43	MHz
SW Terminal Protection Voltage	V$_o$ (SW)	-	-	25	-	V
Switching Terminal Current	I$_{oZ}$ (SW)	-	-	400	-	mA
Switching Terminal Leakage Current	I$_{oz}$ (SW)	-	-	0.5	1	µA
FB Terminal Feedback Voltage (VFB)	V$_{FB}$	V$_{IN}$=3.6V, R$_{SENS}$=16Ω, L=6.8µH	308	325	342	mV
FB Terminal Line Regulation	ΔV$_{FB}$	V$_{IN}$=3.6V center V$_{IN}$=3.0 to 5.0V	-5	-	5	%
OVD Terminal Voltage	V$_{OVD}$	-	19	22	23.5	V
OVD Terminal Leakage Current	I$_{OVDZ}$	V$_{OVD}$=16V	-	0.5	1	µA

1. Application Circuit Example and Measurement Data (reference data)
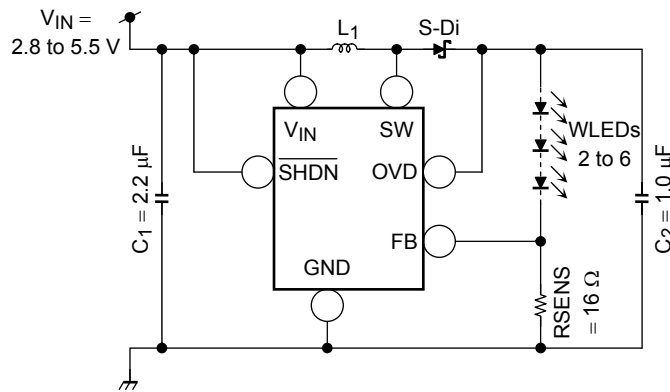
● Evaluation conditions (Ta = 25°C)
- L_1 : CXLD120 series (NEO MAX CO.,Ltd.) (Size: 2.5 mm × 3.0 mm × 1.2 mm)
- C_1 : C2012JB1E225K (TDK Corp.)
- C_2 : C2012JB1E105K (TDK Corp.)
- S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
- WLEDs: NSCW215T (NICHIA Corp.)
- RSENS: RK73B1ETBK (KOA Corp.)

Input Voltage - Efficiency/Output Current
2LED Drive, L=4.7μH

Input Voltage - Efficiency/Output Current
5LED Drive, L=10μH

Input Voltage - Efficiency/Output Current
3LED Drive, L=6.8μH

Input Voltage - Efficiency/Output Current
6LED Drive, L=10μH

Input Voltage - Efficiency/Output Current
4LED Drive, L=6.8μH

\<Measurement Data\>
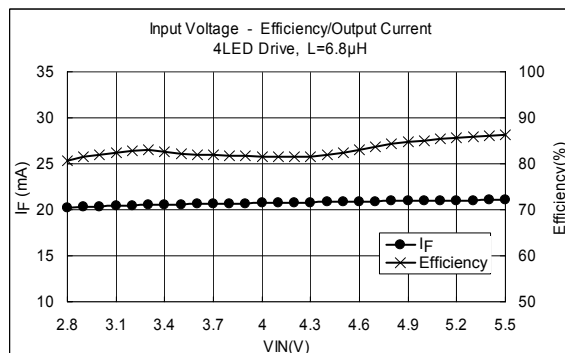
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

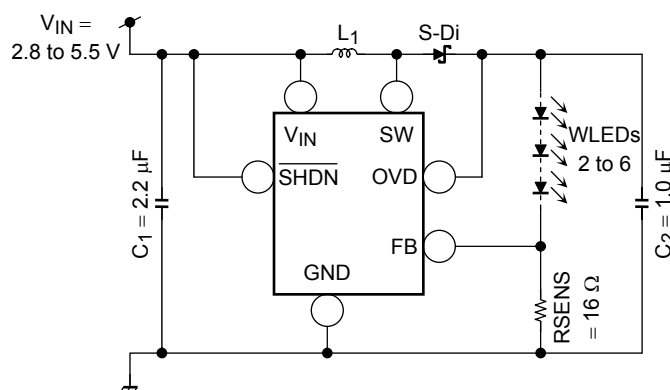|	Efficiency (%)	Average Efficiency (%)
2 LEDs	82.60 to 88.46	86.29
3 LEDs	82.69 to 87.78	85.95
4 LEDs	80.73 to 86.22	83.05
5 LEDs	80.73 to 87.28	83.45
6 LEDs	79.78 to 85.55	81.15

Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

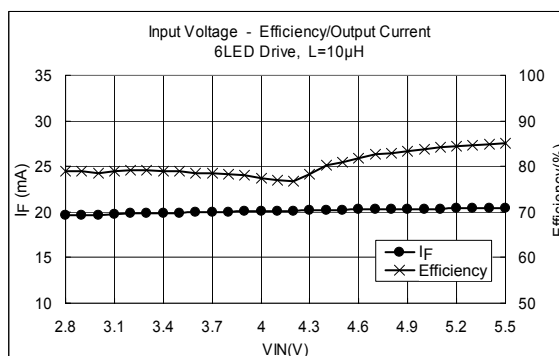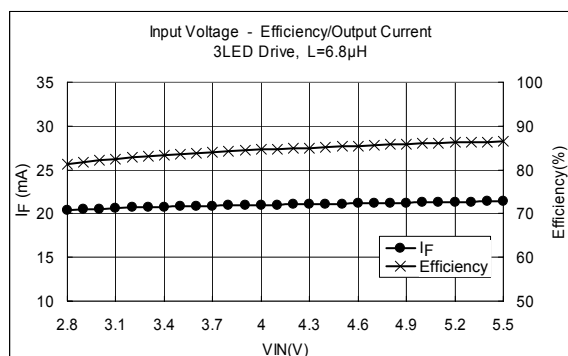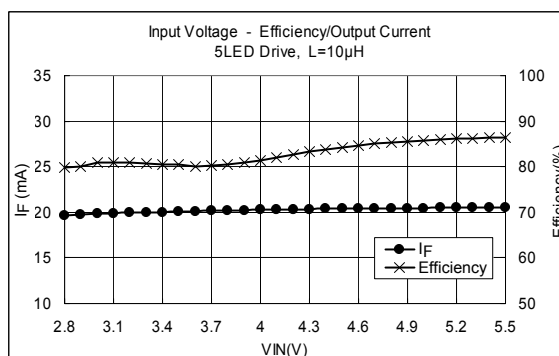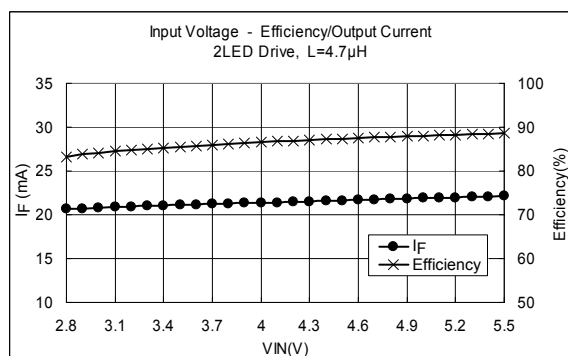|	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.13	−3.50	1.77
3 LEDs	20.60	−1.95	1.38
4 LEDs	20.87	−1.75	1.11
5 LEDs	20.06	−1.81	1.15
6 LEDs	19.90	−1.95	1.28

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

2. Application Circuit Example and Measurement Data (reference data)

V_{IN} = 2.8 to 5.5 V

L_1 S-Di

V_{IN} SW
$\overline{SHDN}$ OVD
FB
GND

C_1 = 2.2 µF
C_2 = 1.0 µF
WLEDs 2 to 6
RSENS = 16 Ω

● Evaluation conditions (Ta = 25°C)
L_1 : 1001AS series (TOKO, INC)
        (Size: 3.6 mm × 3.6 mm × 1.2 mm)
C_1 : C2012JB1E225K (TDK Corp.)
C_2 : C2012JB1E105K (TDK Corp.)
S-Di   : CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs : NSCW215T (NICHIA Corp.)
RSENS: RK73B1ETBK (KOA Corp.)

Input Voltage - Efficiency/Output Current
2LED Drive, L=4.7µH

Input Voltage - Efficiency/Output Current
5LED Drive, L=10µH

Input Voltage - Efficiency/Output Current
3LED Drive, L=6.8µH

Input Voltage - Efficiency/Output Current
6LED Drive, L=10µH

Input Voltage - Efficiency/Output Current
4LED Drive, L=6.8µH

\<Measurement Data\>
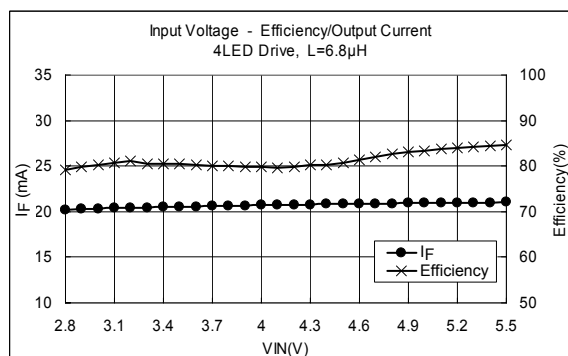
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

|	Efficiency (%)	Average Efficiency (%)
2 LEDs	83.10 to 88.60	86.55
3 LEDs	81.32 to 86.47	84.54
4 LEDs	79.15 to 84.63	81.30
5 LEDs	79.72 to 86.39	82.87
6 LEDs	78.91 to 85.10	80.47

Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

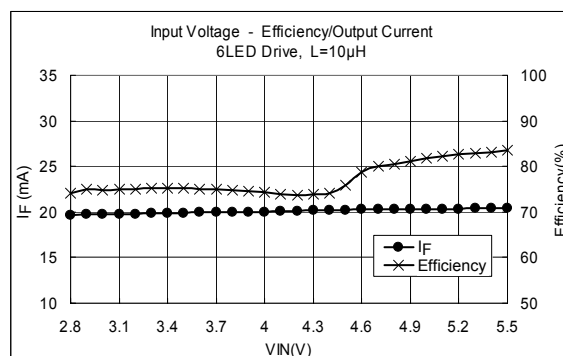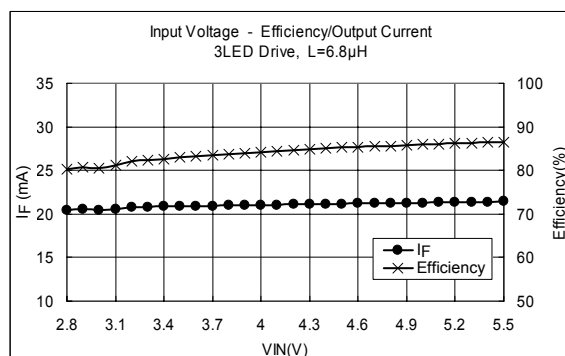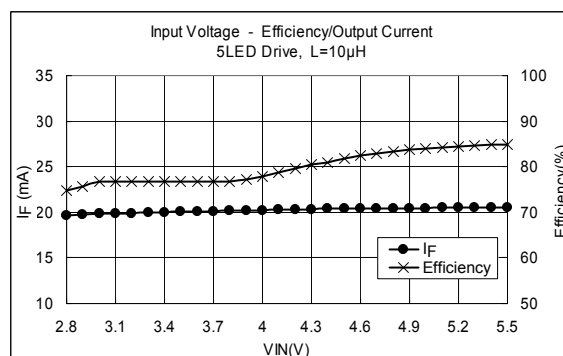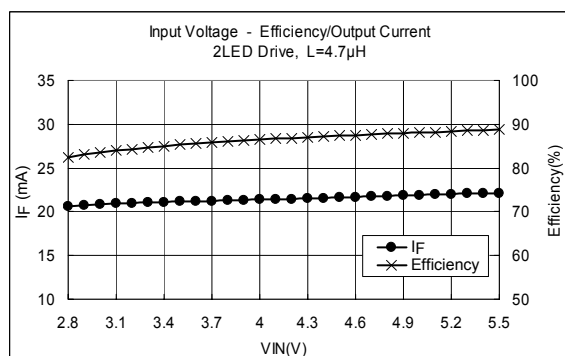|	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.17	−3.32	1.73
3 LEDs	20.85	−1.95	1.38
4 LEDs	20.56	−1.79	1.15
5 LEDs	20.10	−1.82	1.22
6 LEDs	19.95	−1.94	1.26

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

3. Application Circuit Example and Measurement Data (reference data)
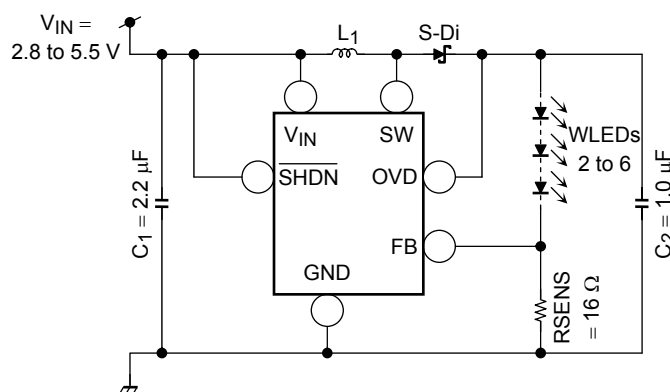
● Evaluation conditions (Ta = 25°C)
L_1 : LQH2M series
(Murata Manufacturing Co.,Ltd.)
(Size: 2.0 mm × 1.6 mm × 0.95 mm)
C_1 : C2012JB1E105K (TDK Corp.)
C_2 : C2012JB1E105K (TDK Corp.)
S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs: NSCW215T (NICHIA Corp.)
RSENS: RK73B1ETBK (KOA Corp.)

Input Voltage - Efficiency/Output Current
2LED Drive, L=4.7µH

Input Voltage - Efficiency/Output Current
5LED Drive, L=10µH

Input Voltage - Efficiency/Output Current
3LED Drive, L=6.8µH

Input Voltage - Efficiency/Output Current
6LED Drive, L=10µH

Input Voltage - Efficiency/Output Current
4LED Drive, L=6.8µH

<Measurement Data>
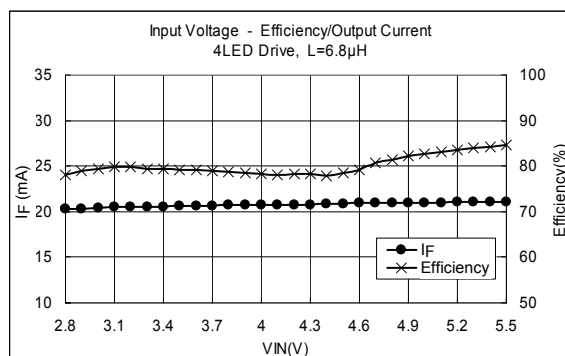
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

|	Efficiency (%)	Average Efficiency (%)
2 LEDs	82.37 to 88.70	86.38
3 LEDs	80.19 to 86.55	84.12
4 LEDs	78.11 to 84.54	80.16
5 LEDs	74.79 to 84.94	79.94
6 LEDs	74.14 to 83.47	77.17

Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

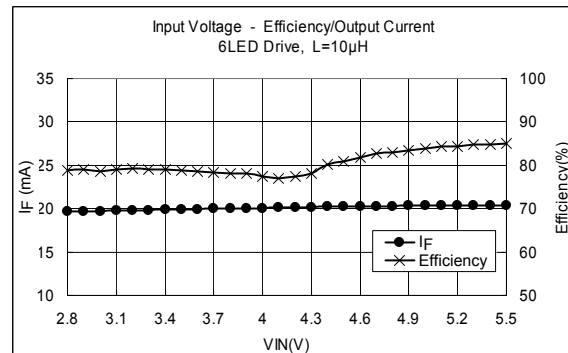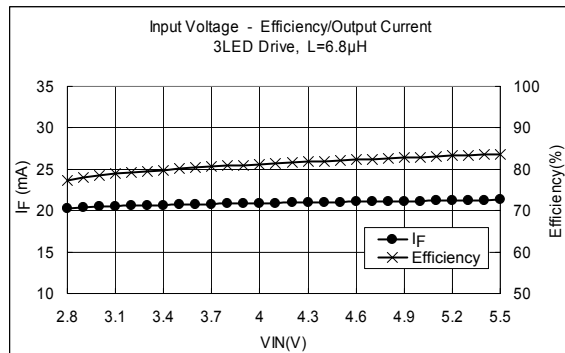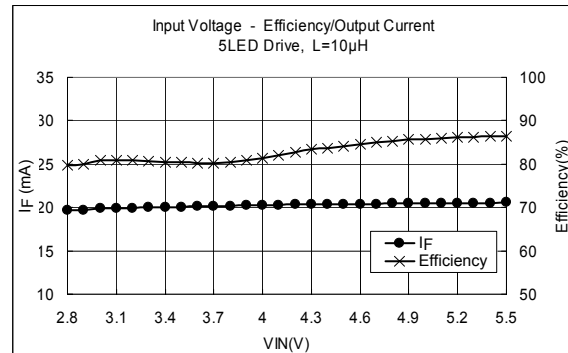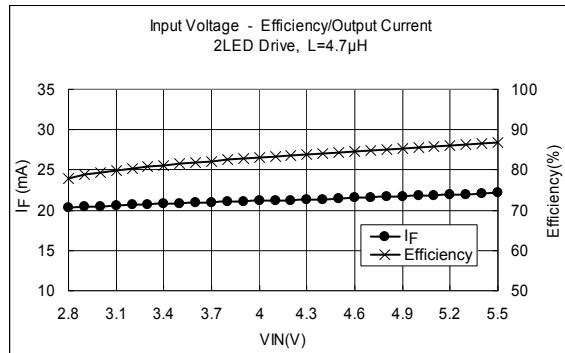|	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.19	−3.26	1.69
3 LEDs	20.90	−1.87	2.17
4 LEDs	20.63	−1.78	1.01
5 LEDs	20.09	−1.88	1.25
6 LEDs	19.93	−1.99	1.07

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

4. Application Circuit Example and Measurement Data (reference data)
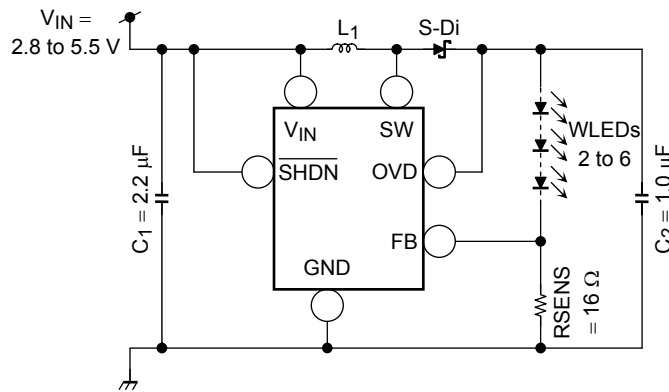
Evaluation conditions (Ta = 25°C)
- L_1 : VLF3010A series (TDK Corp.)
  (Size: 3.0 mm × 3.0 mm × 1.0 mm)
- C_1 : C2012JB1E225K (TDK Corp.)
- C_2 : C2012JB1E105K (TDK Corp.)
- S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
- WLEDs : NSCW215T (NICHIA Corp.)
- RSENS : RK73B1ETBK (KOA Corp.)

Input Voltage - Efficiency/Output Current
2LED Drive, L=4.7µH

Input Voltage - Efficiency/Output Current
5LED Drive, L=10µH

Input Voltage - Efficiency/Output Current
3LED Drive, L=6.8µH

Input Voltage - Efficiency/Output Current
6LED Drive, L=10µH

Input Voltage - Efficiency/Output Current
4LED Drive, L=6.8µH

<Measurement Data>
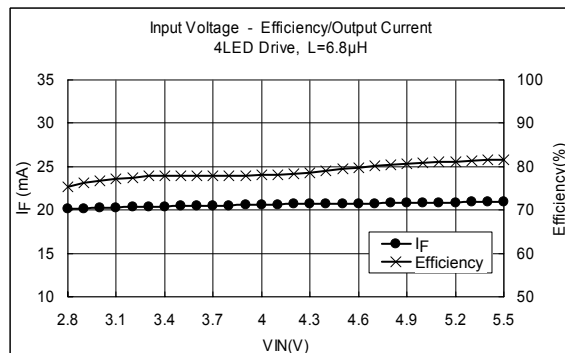
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

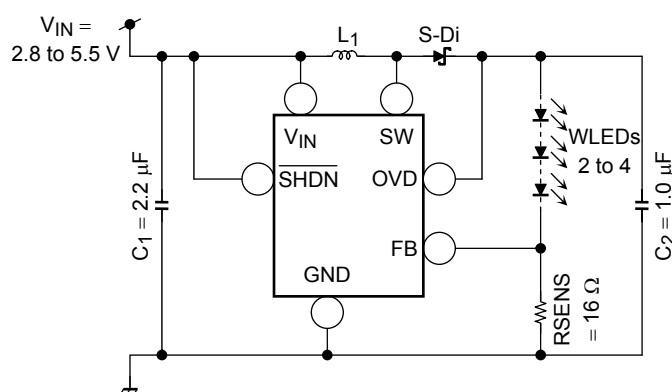|	Efficiency (%)	Average Efficiency (%)
2 LEDs	79.85 to 86.97	84.02
3 LEDs	80.19 to 85.32	83.39
4 LEDs	78.77 to 83.60	80.69
5 LEDs	79.72 to 86.39	82.87
6 LEDs	78.91 to 85.10	80.49

Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

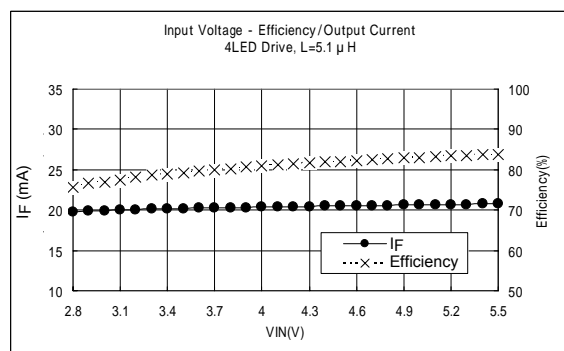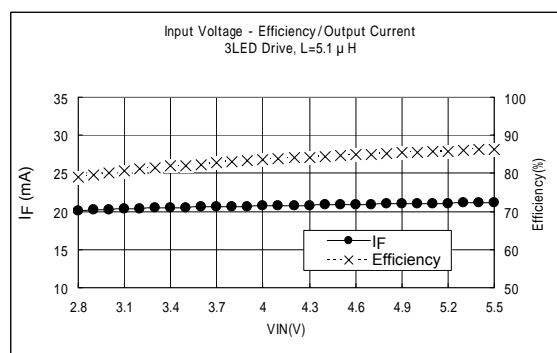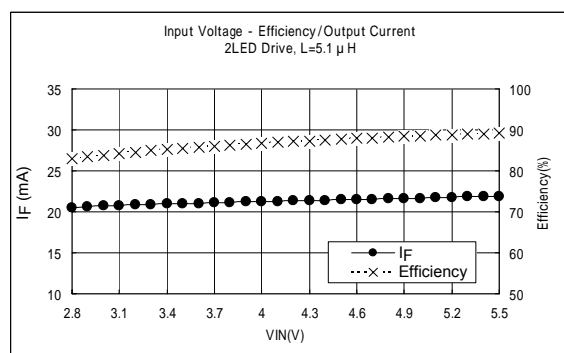|	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.19	−3.08	1.67
3 LEDs	20.89	−1.86	1.33
4 LEDs	20.64	−1.68	1.11
5 LEDs	20.10	−1.82	1.22
6 LEDs	19.95	−1.94	1.26

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

TOSHIBA

5. Application Circuit Example and Measurement Data (reference data)

Application circuit diagram:

$V_{IN} = $ 2.8 to 5.5 V

$C_1 = 2.2 \ \mu F$

SHDN, V_{IN}, SW, OVD, FB, GND

L_1, S-Di

WLEDs 2 to 4

$C_2 = 1.0 \ \mu F$

RSENS = 16 Ω

- Evaluation conditions (Ta = 25°C)
  - L_1 : 32R51 (KOA Corp.)
    (Size: 3.2 mm × 2.5 mm × 0.6 mm)
  - C_1 : C2012JB1E225K (TDK Corp.)
  - C_2 : C2012JB1E105K (TDK Corp.)
  - S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
  - WLEDs: NSCW215T (NICHIA Corp.)
  - RSENS: RK73B1ETBK (KOA Corp.)

Input Voltage - Efficiency/Output Current
2LED Drive, L=5.1µ H

Input Voltage - Efficiency/Output Current
3LED Drive, L=5.1µ H

Input Voltage - Efficiency/Output Current
4LED Drive, L=5.1µ H

<Measurement Data>

Efficiency in the range of V_{IN} = 2.8 to 5.5 V

	Efficiency (%)	Average Efficiency (%)
2 LEDs	83.08 to 89.23	86.73
3 LEDs	79.02 to 86.30	83.52
4 LEDs	75.75 to 83.83	80.78

Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.06	−2.46	4.02
3 LEDs	20.57	−2.39	2.94
4 LEDs	20.22	−2.28	2.65

Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

Package Dimensions
SSOP6-P-0.95B

Unit: mm
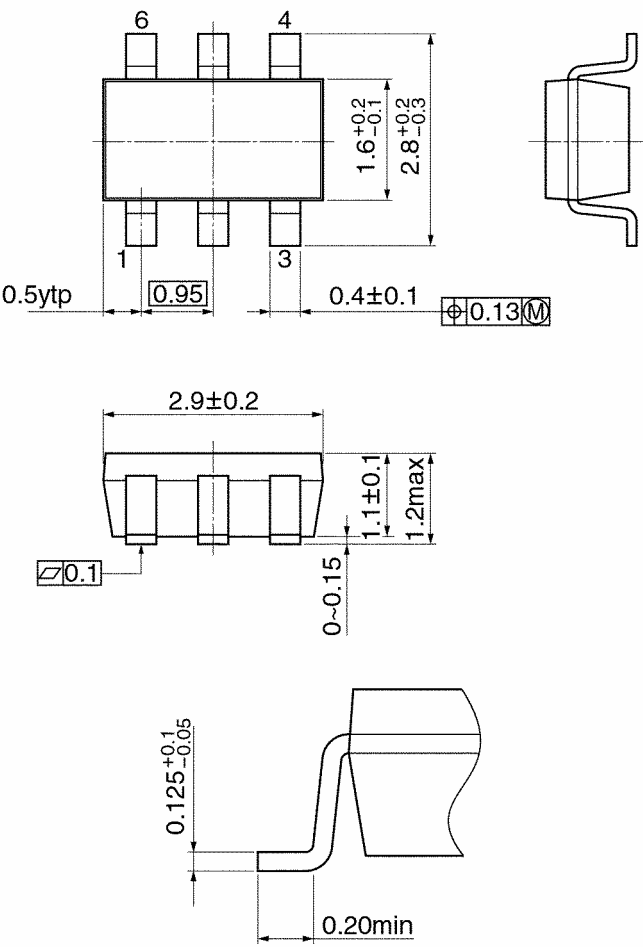
Weight : 0.016 g (Typcal)

Notes on Contents

Block Diagrams

Some functional blocks, circuits, or constants may be omitted or simplified in the block diagram for explanatory purposes.

Equivalent Circuitry

Some parts of the equivalent circuitry may have been omitted or simplified for explanatory purposes.

Maximum Ratings

The absolute maximum ratings of a semiconductor device are a set of specified parameter values that must not be exceeded during operation, even for an instant.

If any of these ratings are exceeded during operation, the electrical characteristics of the device may be irreparably altered and the reliability and lifetime of the device can no longer be guaranteed.

Moreover, any exceeding of the ratings during operation may cause breakdown, damage and/or degradation in other equipment. Applications using the device should be designed so that no maximum rating will ever be exceeded under any operating conditions.

Before using, creating and/or producing designs, refer to and comply with the precautions and conditions set forth in this document.

Application Examples

The application examples provided in this data sheet are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

In providing these application examples, Toshiba does not grant the use of any industrial property rights.

Handling of the IC

Ensure that the product is installed correctly to prevent breakdown, damage and/or degradation in the product or equipment.

Short circuiting between output and line to ground faults may result in damage to the IC. Please exercise precaution in designing the output line, power line and GND line so as to prevent such damage.

Be careful to insert the IC correctly. Inserting the IC the wrong way (e.g., wrong direction) may result in damage to the IC.

Please exercise precaution in handling external components as shorting and opening such components may cause an overcurrent, which in turn may result in power overcurrent and/or in damage to the IC.

Overcurrent and Thermal Protection

Toshiba does not guarantee that these protection functions will prevent damage to the product. These functions are only intended as a temporary means of preventing output short circuiting and other abnormal conditions.

If the guaranteed operating ranges of this product are exceeded, these protection functions may not function as intended and this product might be damaged due to output short circuiting.

The overcurrent protection function is intended to protect this product from temporary short circuiting only. Short circuiting that last for a long time may cause excessive stress and damage to this product.

About solderability, following conditions were confirmed

• Solderability

(1) Use of Sn-63Pb solder Bath
· solder bath temperature = 230°C
· dipping time = 5 seconds
· the number of times = once
· use of R-type flux

(2) Use of Sn-3.0Ag-0.5Cu solder Bath
· solder bath temperature = 245°C
· dipping time = 5 seconds
· the number of times = once
· use of R-type flux

RESTRICTIONS ON PRODUCT USE

030619EBA