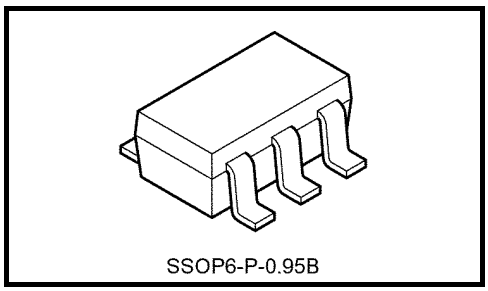
TOSHIBA BiCD Digital Integrated Circuit Silicon Monolithic

TB62736FUG

Step-up Type DC/DC Converter for White LEDs

The TB62736FUG is a high efficiency step-up type DC/DC converter that is designed especially for use as a constant current driver of white LEDs.
It is possible to drive 2 - 6 white LEDs connected in series using a lithium-ion battery. (Typ. 4 White LEDs)
This IC incorporates an N-ch-MOS transistor required for switching of an external inductor.
The forward current of the LEDs can be controlled by an external resistor. An analog voltage input and a pulse input system (PWM) can be used as a brightness control function.
The switching frequency is fixed at around 1.1 MHz.
This IC is best suited for use as a driver of white LED back lighting in color LCDs in PDAs, cellular phones and handy terminal devices.
This device is Pb-free product.

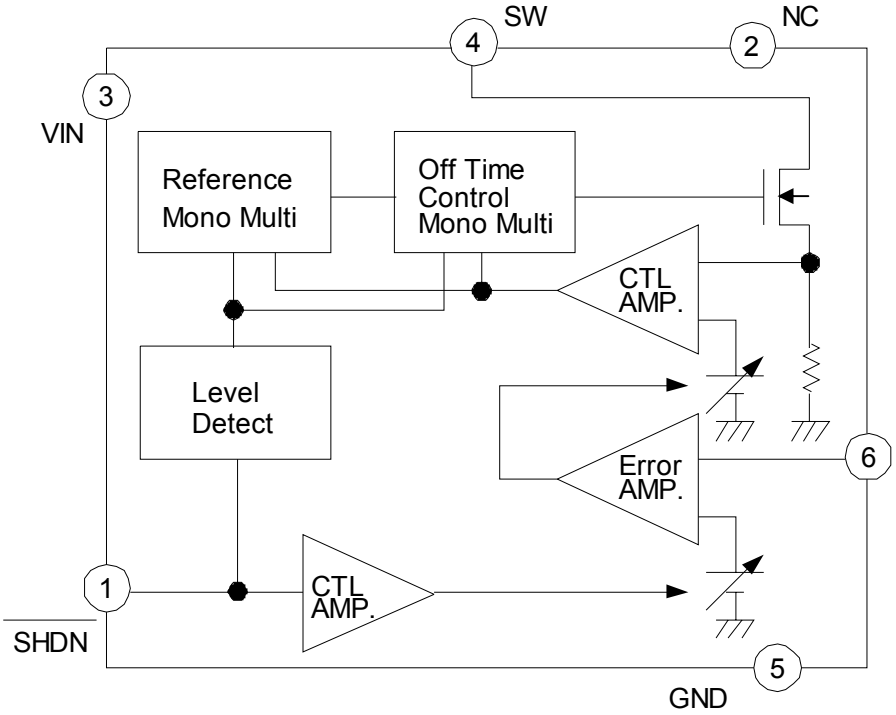


Weight: 0.016 g (typ.)

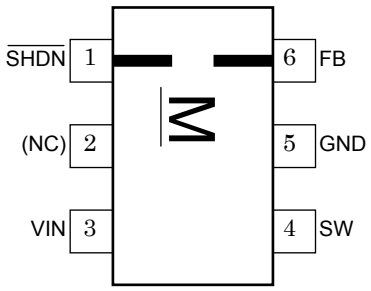
Features

- Brightness control function with changing drive current:
  LED current I_F = 25% to 100% (analog input)
- LED current values controlled by external resistance
  : 20mA (typ.) @ RSENS=16Ω
- Output power : 400 mW
- High efficiency : maximum 87% (when used with components as recommended herein)
- Switching Frequency : 1.1MHz(Typ.)
- Package : SSOP6-P-0.95 (SOT23-6)

Block Diagram



Pin Assignment (top view)



Note 1: The IC may break if mounted 180 degrees in reverse. Ensure the device is correctly orientated before assembley.

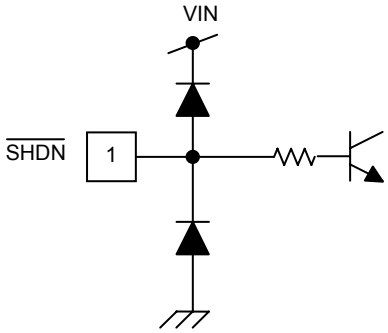
Pin Functions

No.	Symbol	Function
1	$\overline{SHDN}$	Input pin for IC ON/OFF control and variable LED I_F. 0 to 0.5V : Shutdown Mode (IC shutdown) 1.0V to 2.5V : I_F = 25 to 100% Variable (Linear Control) Over 2.5V : I_F = 100% PWM signal input for IF control (see p.5) This pin must be set to a certain logic level, as unstable output could result if the pin is left open.
2	NC	No Connection or Connected to GND
3	VIN	Supply voltage pin. Supply voltage range : 2.8V to 5.5V
4	SW	DC/DC converter switching pin – switch incorporates N-ch MOSFET
5	GND	Ground pin
6	FB	LED IF setting resistor connecting terminal.

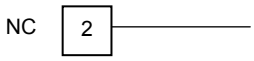
Note2: The NC terminal is not connected to the internal circuit.

I/O Equivalent Pin Circuits

1. $\overline{\text{SHDN}}$ pin

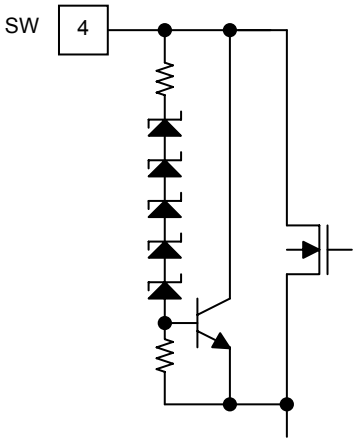


2. NC pin

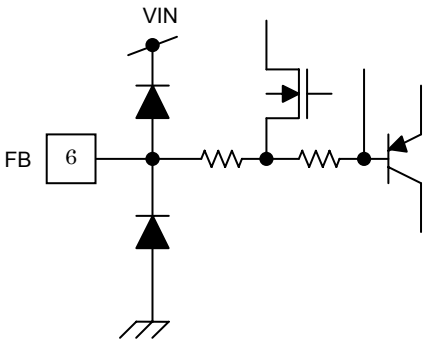


The NC pin is not connected to any internal circuit.

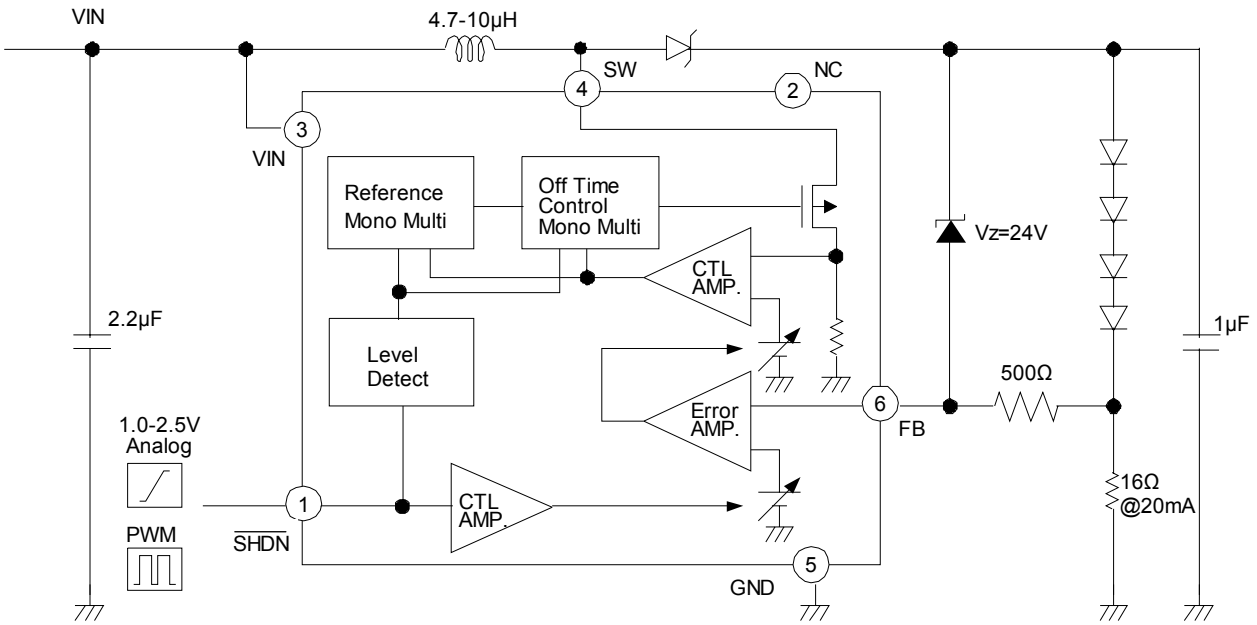
3. SW pin



4. FB pin



Application Circuit Example



Protection at the time of LED opening

The zener diode in the application circuit example is necessary for the provision of over-voltage protection for when the LED becomes open. As the IC does not incorporate a voltage protection circuit, it is strongly advised that a zener diode be connected.

The zener diode should satisfy the following conditions:

i) Less than maximum output voltage of 24V
ii) Greater than the total series LED V_F
iii) Less than the maximum output capacitance C_2.

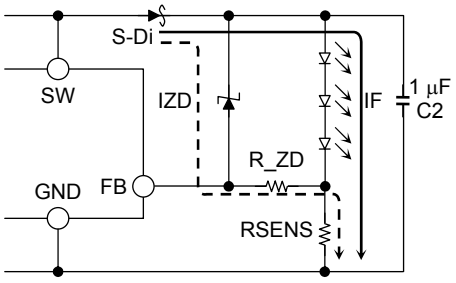
Moreover, by connecting a protection circuit such as R_ZD in the figure below, it is possible to control the output current when the LED becomes open, and to use a zener diode of lower tolerance.

An example of IZD control by R_ZD connection. (RSENS = 16 Ω)

R_DZ (Ω)	IZD (mA)
500	0.6
100	2.8

In order to avoid adverse effects on driver characteristics,

Toshiba recommends a resistance of 500 ohms or less.



Protection circuit application

Output-side Capacitor Setting

It is recommended that the value of C2 be equal to, or greater than 1.0 (μF).

External Inductor Size Setting

For each number of LEDs, the selected inductance should be greater than the value indicated in the table below.

Number of LEDs	Inductance (Unit: μH)	Note
2	4.7	I_F = 20 mA
3	6.8	
4		
5	10	
6		

Control of I_F

The resistance RSENS is connected between the FB pin and the GND pin.
The average current is controlled by the RSENS value, and calculated using the following equation:

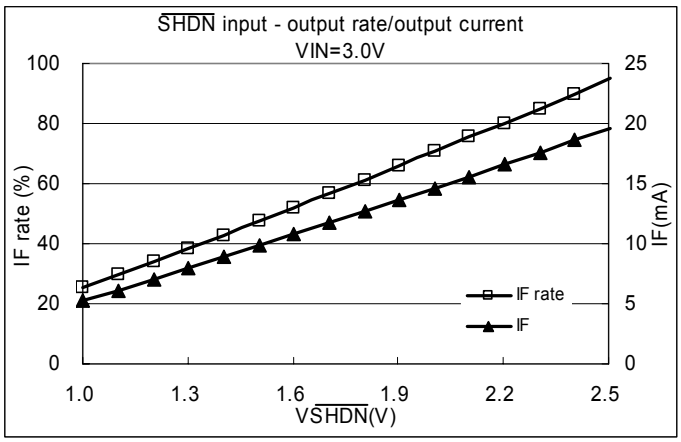
$$I_F\ (mA) = [\ 325mV / RSENS(\Omega)\ ]$$

Margin of error is ±5%.

Current control using SHDN pin

This IC can carry out variable of the IF current by external resistance Variable range : 25 to 100%

$\overline{SHDN}$ Voltage	$V\overline{SHDN}$=0V~0.5V	$V\overline{SHDN}$=1V~2.5V	$V\overline{SHDN}$>2.5V	Note
Io Valuable Rate	0	25 - 100	100	UNIT : %



Dimming using PWM signal input

A dimming function can also by applied using a PWM signal.
[Notes]

- When using a PWM signal, the minimum pulse width of the PWM should be greater than 33μs.
- Duty ratio of PWM function should be set at 10% - 90%.
- The recommended PWM frequency should be 100Hz - 10kHz.

<<Output current is calculated using the following equation>>

$$IF(mA) = \frac{325[mV] \times ON\ Duty\ [\%]}{RSENS\ [\Omega]}$$

Absolute Maximum Ratings (T_a = 25°C, unless otherwise specified)

Characteristics	Symbol	Ratings	Unit
Power supply voltage	V_{IN}	−0.3 to 6.0	V
Input voltage	V_{SHDN}	−0.3 to V_{IN} + 0.3(Note3)	V
Switching pin voltage	$V_{O\ (SW)}$	−0.3 to 24	V
Power Dissipation	P_D	0.41 (IC only)	W
		0.47 (IC mounted on PCB)(Note4)	
Thermal resistance	$R_{th\ (j\text{-}a)\ 1}$	300 (IC only)	°C/W
	$R_{th\ (j\text{-}a)\ 2}$	260 (IC mounted on PCB)	
Operating temperature range	T_{opr}	−40 to 85	°C
Storage temperature	T_{stg}	−55 to 150	°C
Maximum junction temperature	T_j	150	°C

Note3: However, do not exceed 6V.

Note4: Power dissipation is reduced by 3.8mW/°C from the maximum rating for every 1°C exceeding the ambient temperature of 25°C (when the IC is mounted on a PCB).

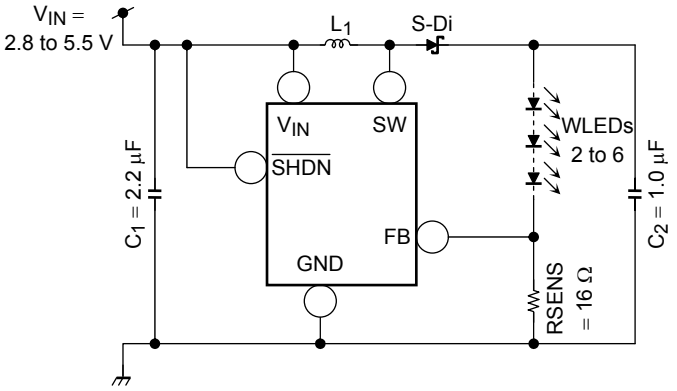
Recommended Operating Condition (T_a = –40 to 85°C, unless otherwise specified)

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V_{IN}	—	2.8	—	5.5	V
$\overline{SHDN}$ pin input pulse width	tpw	ON/OFF duty width	33	—	—	μs
$\overline{SHDN}$ pin H level input voltage	$V_{\overline{SHDN}\ (H)}$	—	2.7	—	V_{IN}	V
$\overline{SHDN}$ pin L level input voltage	$V_{\overline{SHDN}\ (L)}$	—	0	—	0.5	V
LED current (Average value)	I_{O1}	V_{IN} = 3.6 V, R_{SENS} = 16 Ω 4LEDs, T_a = 25°C	—	20	—	mA

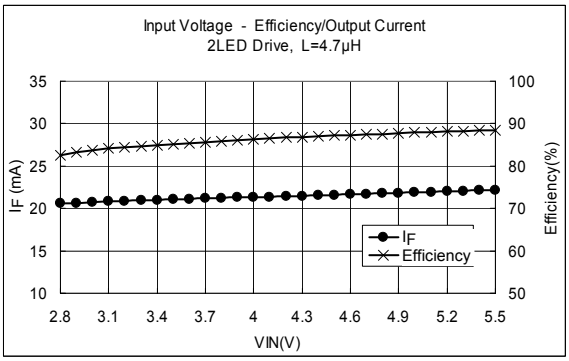
Electrical Characteristics (T_a = 25°C V_{IN} = 2.8~5.5 V, unless otherwise specified)

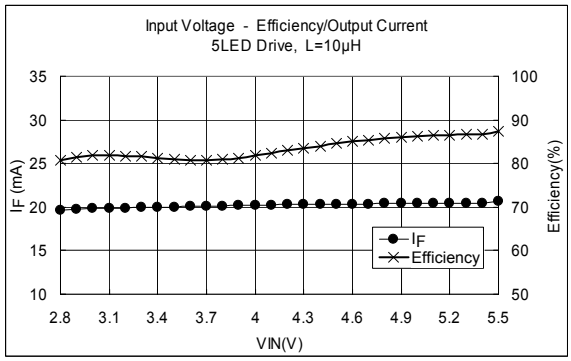
Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Operating consumption current	$I_{IN\ (ON)}$	V_{IN} = 6.0 V, RSENS = 16 Ω	—	0.9	1.5	mA
Standby consumption current	$I_{IN\ (OFF)}$	V_{IN} = 3.6 V, $V_{\overline{SHDN}}$ = 0 V	—	0.5	1.0	μA
$\overline{SHDN}$ pin H level input voltage	$V_{\overline{SHDN}\ (H)}$	—	2.7	—	V_{IN}	V
$\overline{SHDN}$ pin L level input voltage	$V_{\overline{SHDN}\ (L)}$	—	0	—	0.5	V
$\overline{SHDN}$ pin current	$I_{\overline{SHDN}}$	V_{IN} = 3.6 V, $V_{\overline{SHDN}}$ = 3.6 V or 0V	−10	0	10	μA
Integrated MOS-FET switching frequency	f_{OSC}	V_{IN} = 3.6 V, $V_{\overline{SHDN}}$ = 3.6 V	0.77	1.1	1.43	MHz
Switching pin protection voltage	$V_{O\ (SW)}$	—	—	25	—	V
Switching pin current	$I_{O\ (SW)}$	—	—	400	—	mA
Switching pin leakage current	$I_{OZ\ (SW)}$	—	—	0.5	1	μA
FB pin feedback voltage	V_{FB}	V_{IN} = 3.6 V, R_{SENS} = 16 Ω L = 4.7μH	308	325	342	mV
FB pin line regulation	ΔV_{FB}	V_{IN} = 3.6 V center V_{IN} = 3.0V to 5.0V	−5	—	5	%

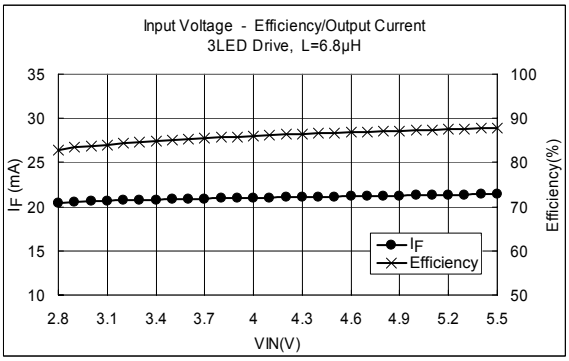
1. Application Circuit Example and Measurement Data (reference data)

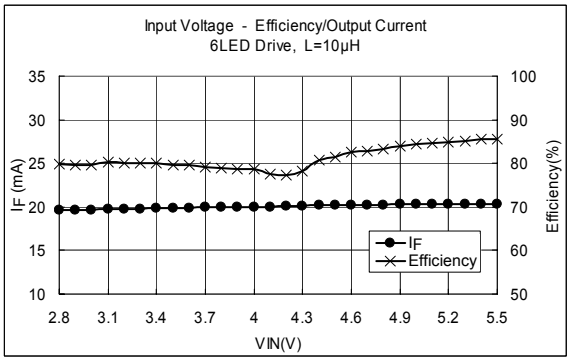


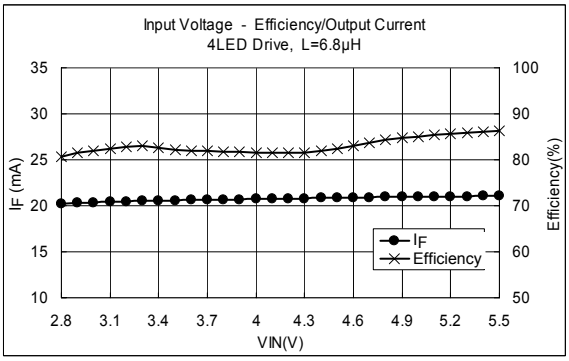
- Evaluation conditions (Ta = 25°C)
  - L_1 : CXLD120 series (NEO MAX CO.,Ltd.) (Size: 2.5 mm × 3.0 mm × 1.2 mm)
  - C_1 : C2012JB1E225K (TDK Corp.)
  - C_2 : C2012JB1E105K (TDK Corp.)
  - S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
  - WLEDs: NSCW215T (NICHIA Corp.)
  - RSENS: RK73B1ETBK (KOA Corp.)











<Measurement Data>

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

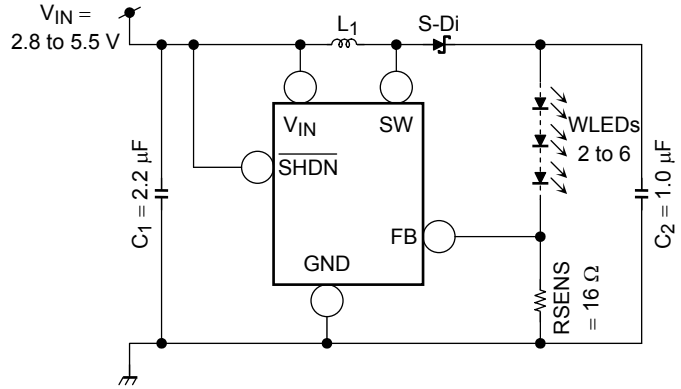
	Efficiency (%)	Average Efficiency (%)
2 LEDs	82.60 to 88.46	86.29
3 LEDs	82.69 to 87.78	85.95
4 LEDs	80.73 to 86.22	83.05
5 LEDs	80.73 to 87.28	83.45
6 LEDs	79.78 to 85.55	81.15

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

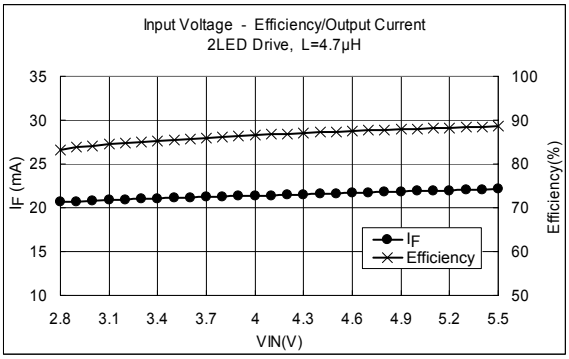
	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.13	−3.50	1.77
3 LEDs	20.60	−1.95	1.38
4 LEDs	20.87	−1.75	1.11
5 LEDs	20.06	−1.81	1.15
6 LEDs	19.90	−1.95	1.28

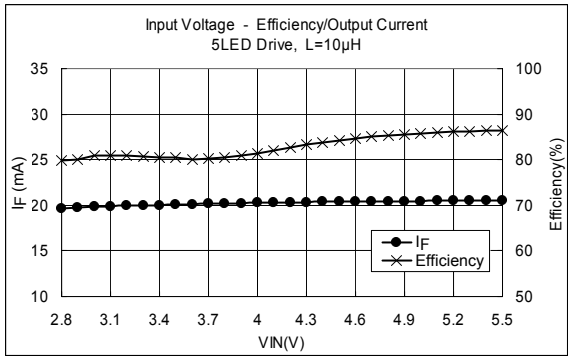
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

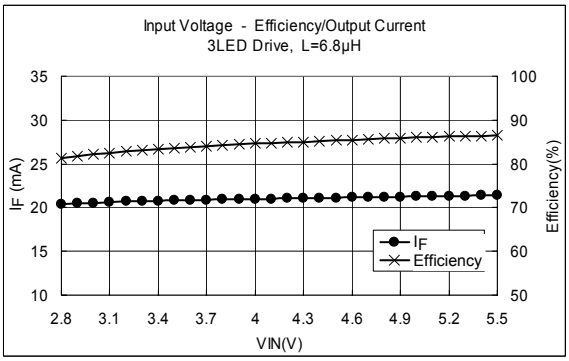
2. Application Circuit Example and Measurement Data (reference data)

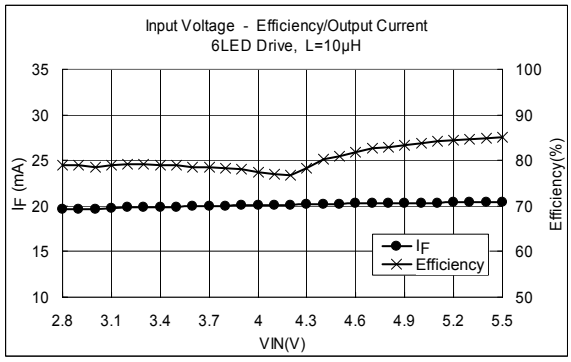


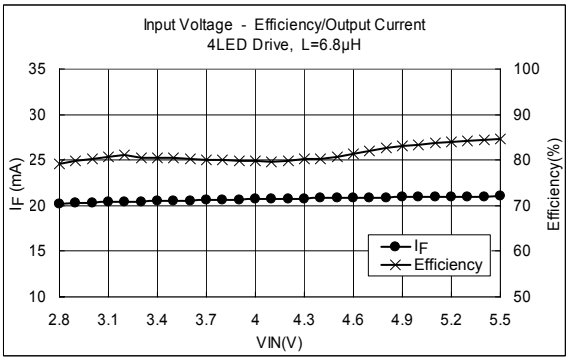
- Evaluation conditions (Ta = 25°C)
  - L_1 : 1001AS series (TOKO, INC)
    (Size: 3.6 mm × 3.6 mm × 1.2 mm)
  - C_1 : C2012JB1E225K (TDK Corp.)
  - C_2 : C2012JB1E105K (TDK Corp.)
  - S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
  - WLEDs: NSCW215T (NICHIA Corp.)
  - RSENS: RK73B1ETBK (KOA Corp.)











<Measurement Data>

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

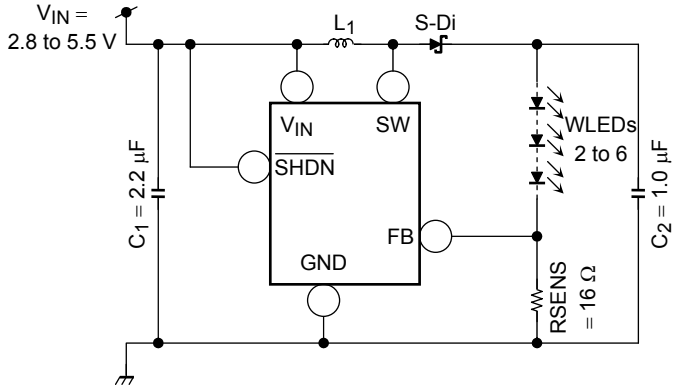
	Efficiency (%)	Average Efficiency (%)
2 LEDs	83.10 to 88.60	86.55
3 LEDs	81.32 to 86.47	84.54
4 LEDs	79.15 to 84.63	81.30
5 LEDs	79.72 to 86.39	82.87
6 LEDs	78.91 to 85.10	80.47

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

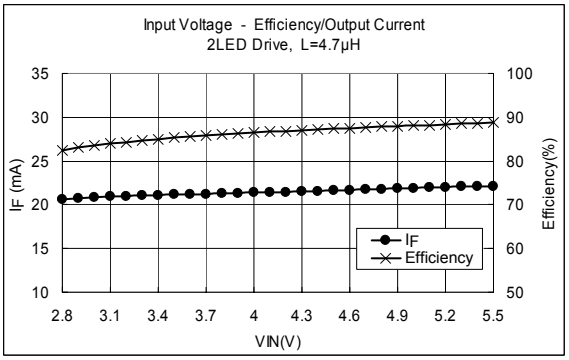
	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.17	−3.32	1.73
3 LEDs	20.85	−1.95	1.38
4 LEDs	20.56	−1.79	1.15
5 LEDs	20.10	−1.82	1.22
6 LEDs	19.95	−1.94	1.26

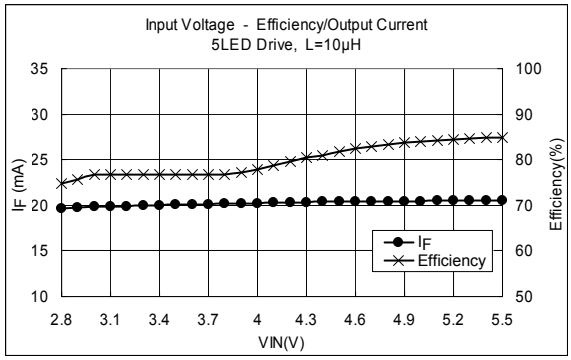
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

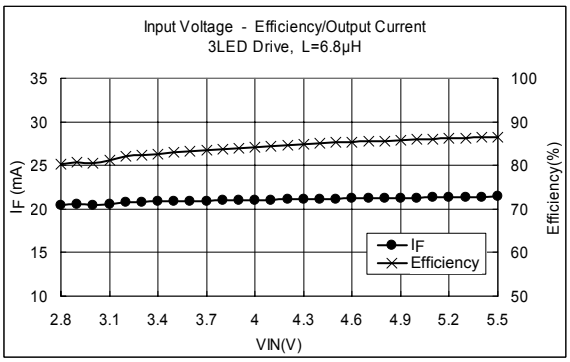
3. Application Circuit Example and Measurement Data (reference data)

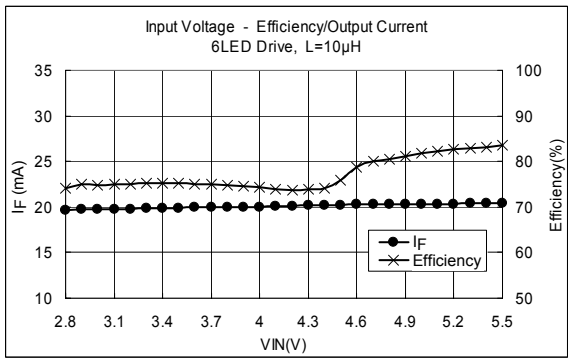


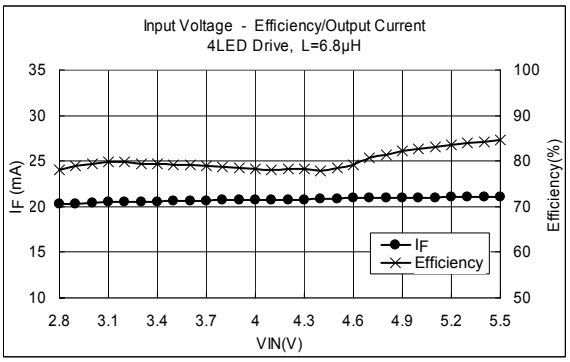
- Evaluation conditions (Ta = 25°C)
  - L_1 : LQH2M series
    (Murata Manufacturing Co.,Ltd.)
    (Size: 2.0 mm × 1.6 mm × 0.95 mm)
  - C_1 : C2012JB1E105K (TDK Corp.)
  - C_2 : C2012JB1E105K (TDK Corp.)
  - S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
  - WLEDs: NSCW215T (NICHIA Corp.)
  - RSENS: RK73B1ETBK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











<Measurement Data>

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

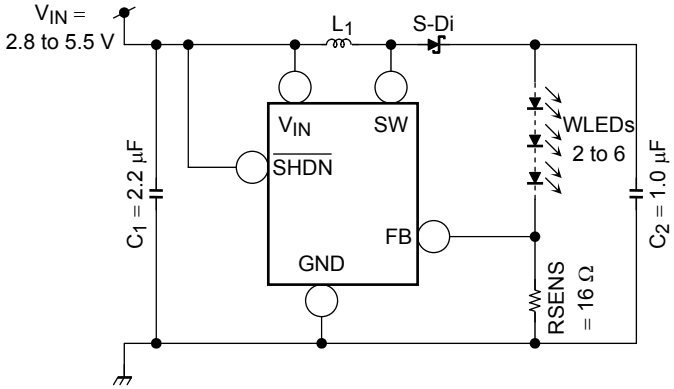
	Efficiency (%)	Average Efficiency (%)
2 LEDs	82.37 to 88.70	86.38
3 LEDs	80.19 to 86.55	84.12
4 LEDs	78.11 to 84.54	80.16
5 LEDs	74.79 to 84.94	79.94
6 LEDs	74.14 to 83.47	77.17

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

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.)
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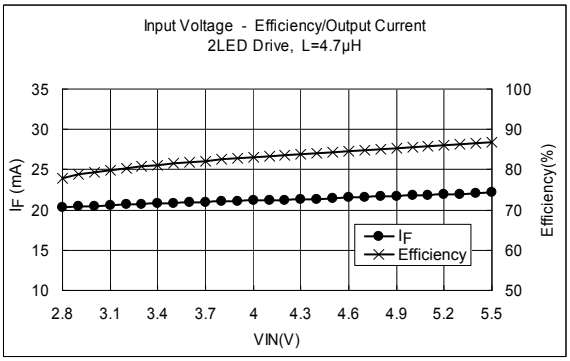
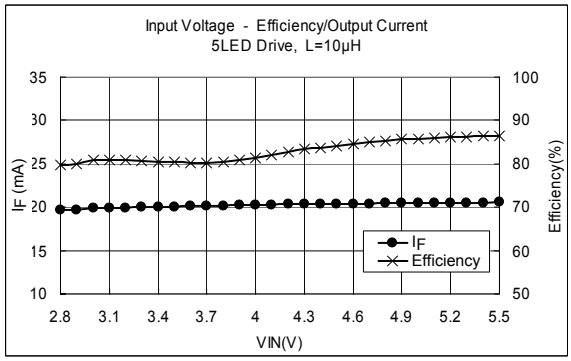
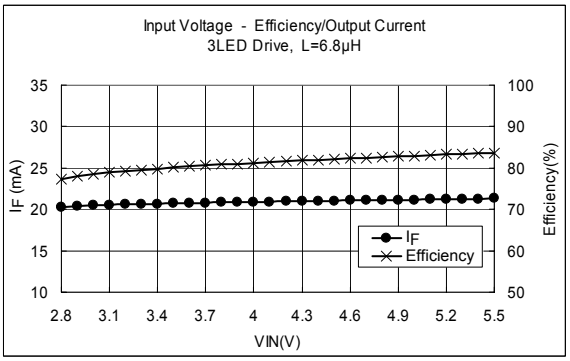
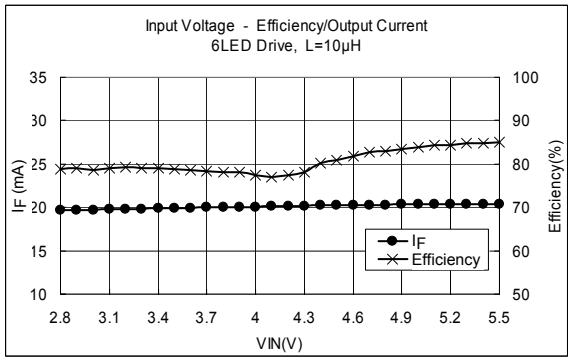
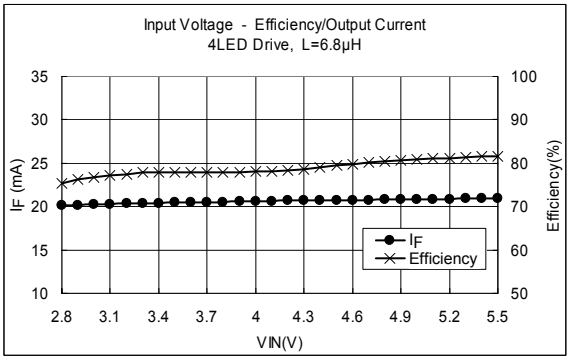










<Measurement Data>

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

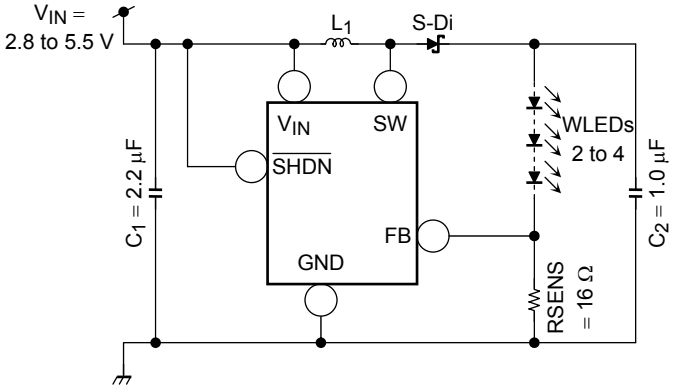
	Efficiency (%)	Average Efficiency (%)
2 LEDs	79.85 to 86.97	84.02
3 LEDs	80.19 to 85.32	83.39
4 LEDs	78.77 to 83.60	80.69
5 LEDs	79.72 to 86.39	82.87
6 LEDs	78.91 to 85.10	80.49

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

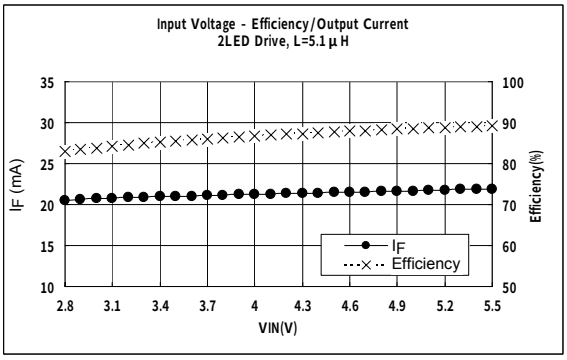
	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.19	−3.08	1.67
3 LEDs	20.89	−1.86	1.33
4 LEDs	20.64	−1.68	1.11
5 LEDs	20.10	−1.82	1.22
6 LEDs	19.95	−1.94	1.26

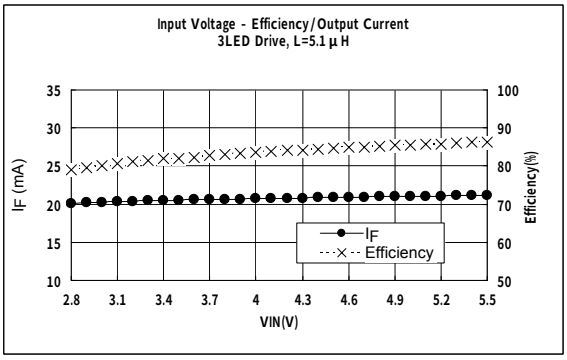
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

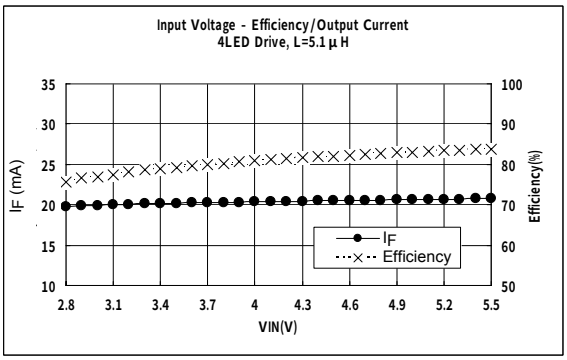
5. Application Circuit Example and Measurement Data (reference data)



- 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.)







<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

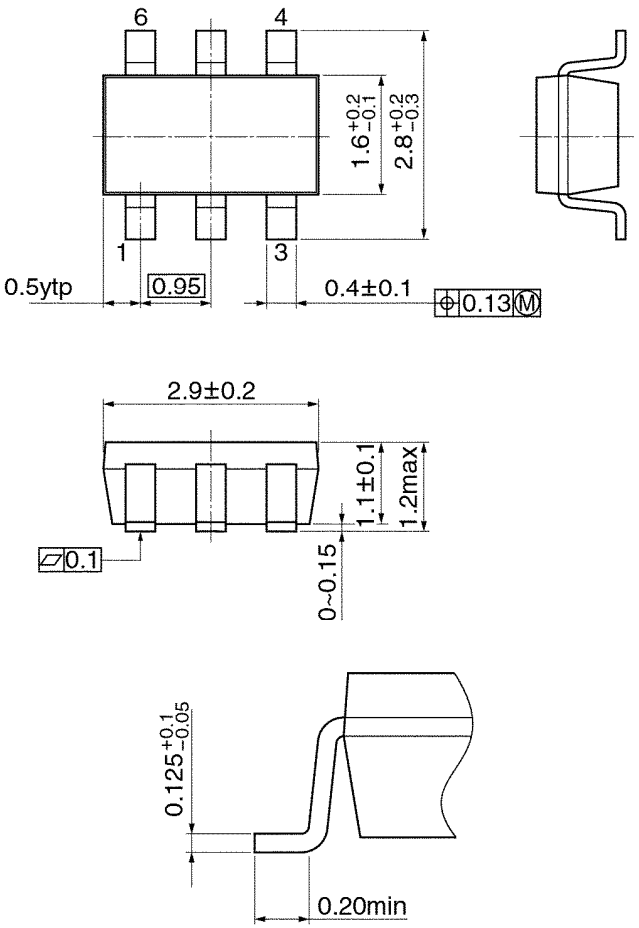
Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	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 (typ.)

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-37Pb 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

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030619EBA

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- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of TOSHIBA or others.
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