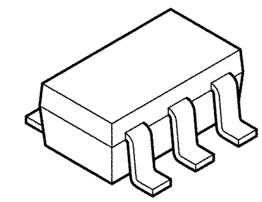
TOSHIBA BiCD Digital Integrated Circuit Silicon Monolithic

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.



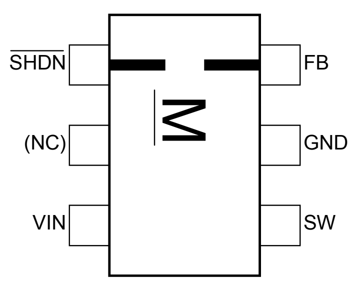
SSOP6-P-0.95B

Weight: 0.016 g (typ.)

Features

- Brightness control function : LED forward current 25~100%
- Maximum output voltage : over 24V
- LED current values controlled by external resistance
  : 20mA (typ.) @ RSENS=16Ω
- Output power : 400 mW
- Package : SSOP6-P-0.95 (SOT23-6)
- High efficiency : maximum 87% (when used with components as recommended herein)
- Thermal Shutdown Function incorporated : 150 degree (typ.)

Pin Assignment (top view)



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

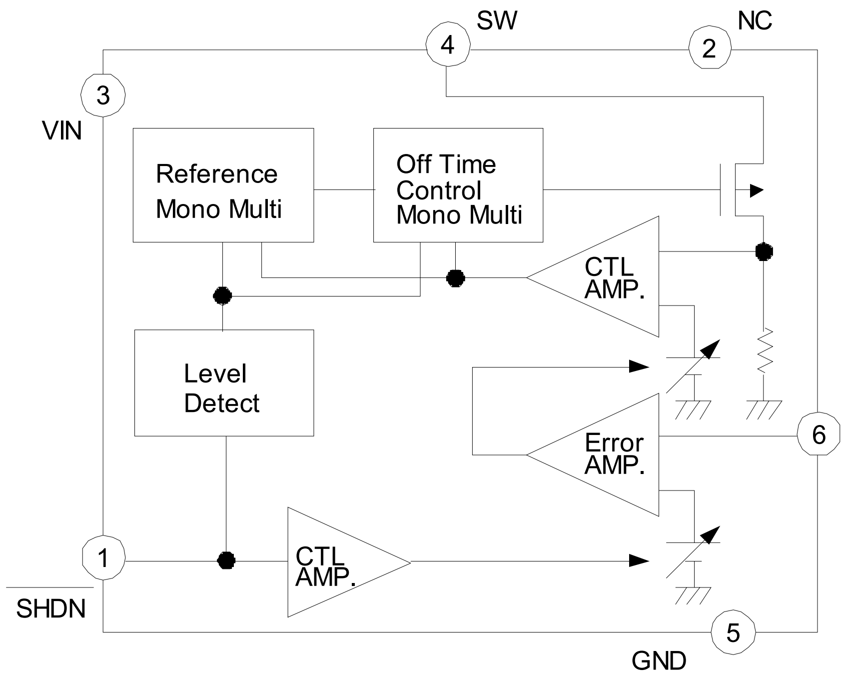
Note 2: The control pin must be set to a certain logic level, as unstable output could result if the pin is left open..

Note 3: Regarding soldering, the following conditions were confirmed

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

Block Diagram



Pin Functions

No.	Symbol	Function
1	$\overline{\text{SHDN}}$	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)
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	Connected to the cathode of LED

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

Absolute Maximum Ratings (T_{opr} = 25°C, unless otherwise specified)

Characteristics	Symbol	Ratings	Unit
Power supply voltage	V_{IN}	−0.3 to 6.0	V
Input voltage	V_{in}	−0.3 to V_{CC} + 0.3	V
Switching pin voltage	$V_{O\ (SW)}$	−0.3 to 24	V
Switching pin current	$I_{O\ (SW)}$	380	mA
Power Dissipation	P_D	0.41 (IC only)	W
		0.47 (IC mounted on PCB) (Note)	
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}	−40 to 150	°C
Maximum junction temperature	T_j	125	°C

Note: 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).

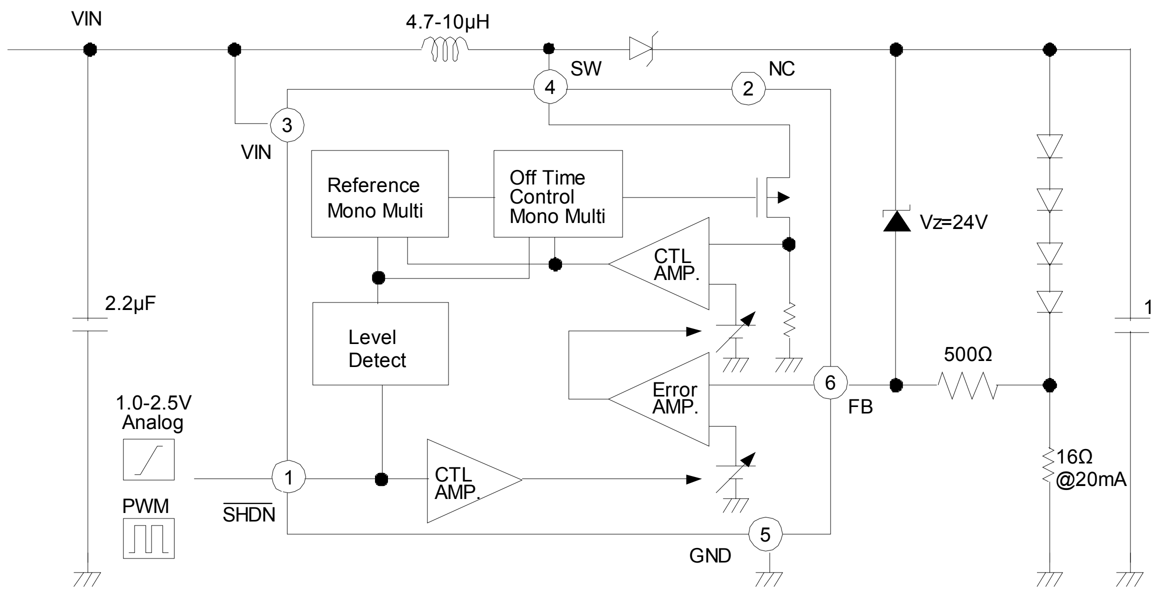
Recommended Operating Condition (T_{opr} = −40 to 85°C, unless otherwise specified)

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

Electrical Characteristics (T_{opr} = −40~85°C V_{CC} = 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 current	$I_{\overline{SHDN}}$	V_{IN} = 3.6 V, $V_{\overline{SHDN}}$ = 3.6 V	−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, RSENS = 16 Ω T_{opr} = 25°C, 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	%

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.

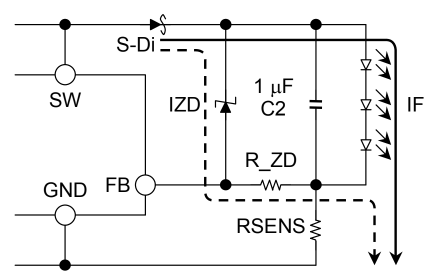
Moreover, by connecting a protection circuit such as R_ZD in the figure below, it is possible to control the output current when the LED becomes open, and to use a zener diode of lower tolerance.

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

R_DZ (Ω)	IZD (mA)
500	0.6
100	1.0

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:

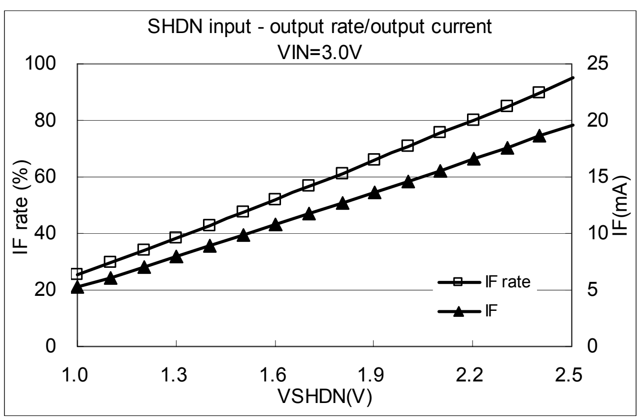
$$I_F \text{ (mA)} = [\ 325\text{mV} / \text{RSENS}(\Omega)\ ]$$

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 : 30 to 100%

SHDN Voltage	VSHDN=0V~0.5V	VSHDN=1V~2.5V	VSHDN>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]

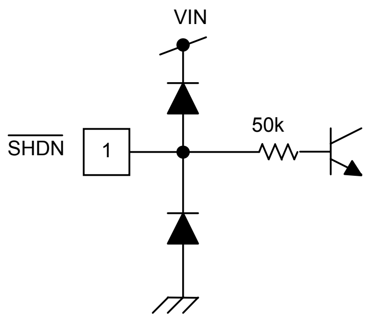
- When using a PWM signal, the minimum pulse width of the PWM should be greater than 33μs.
- Duty ratio of PWM function should be set at 10% - 90%.
- The recommended PWM frequency should be 100Hz - 10kHz.

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

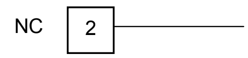
$$\text{IF(mA)} = \frac{325[\text{mV}] \times \text{ON Duty } [\%]}{\text{RSENS } [\Omega]}$$

I/O Equivalent Pin Circuits

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

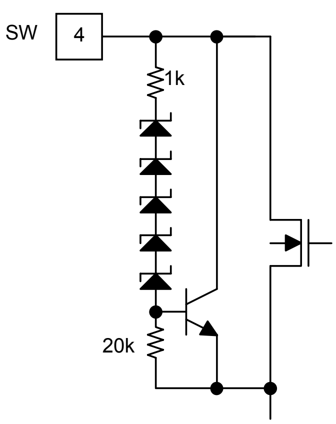


2. NC pin

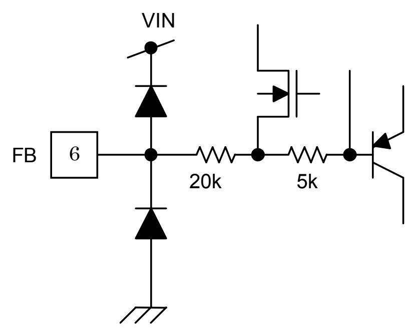


The NC pin is not connected to any internal circuit.

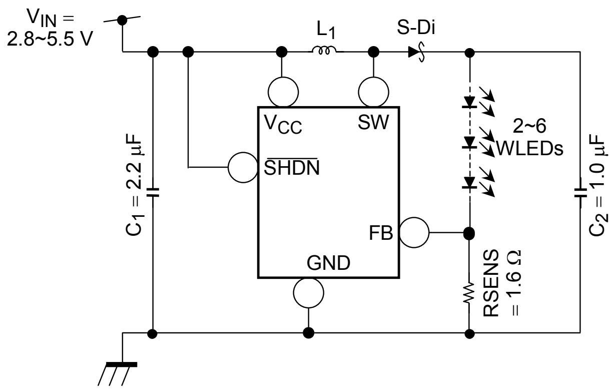
3. SW pin



4. FB pin

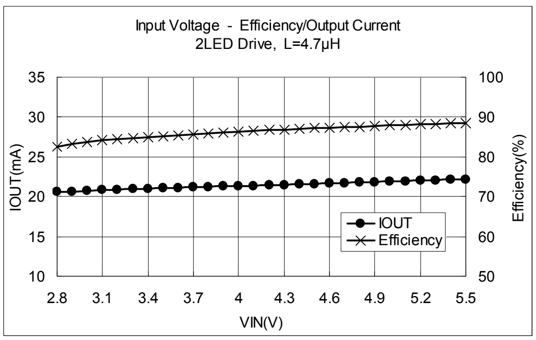


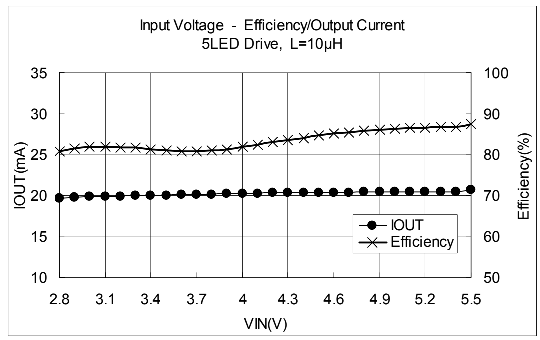
1. Application Circuit Example and Measurement Data (Reference data)

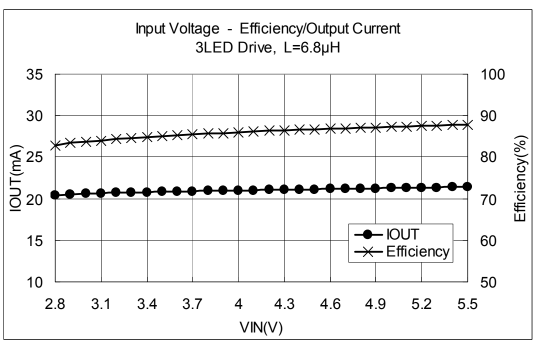


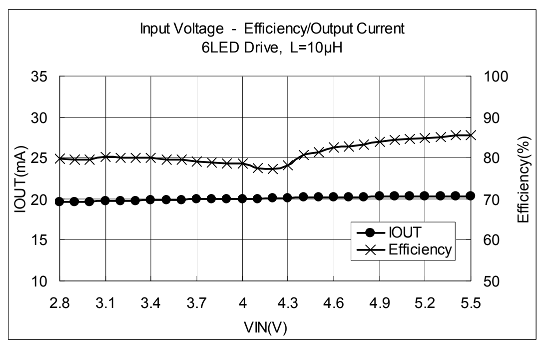
• Evaluation conditions

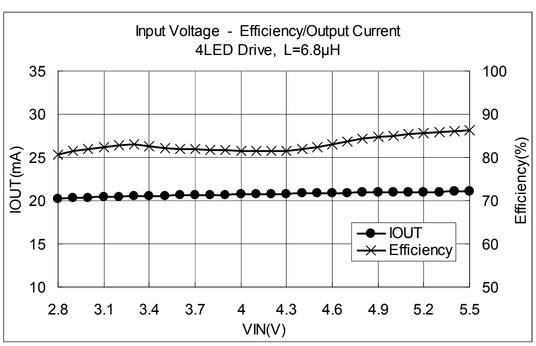
L	: CXLD120 series (NEO MAX CO.,Ltd.) (Size 2.5 × 3.0 × 1.2 mm)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
LED	: NSCW215T (NICHIA Corp.)
C1	: C2012JB1E105K (TDK Corp.)
C2	: C2012JB1E105K (TDK Corp.)











<Measurement Data>

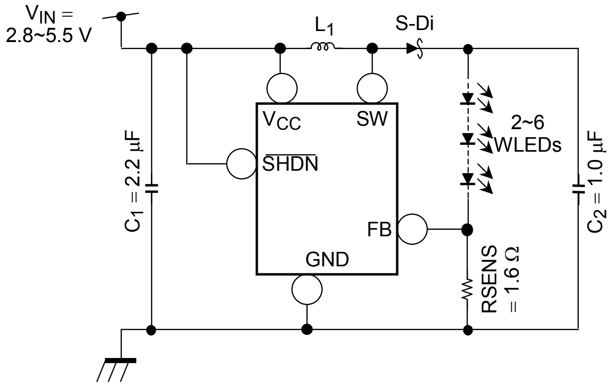
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

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

Output current in the range of V_{IN} = 3.0 to 5.0 V

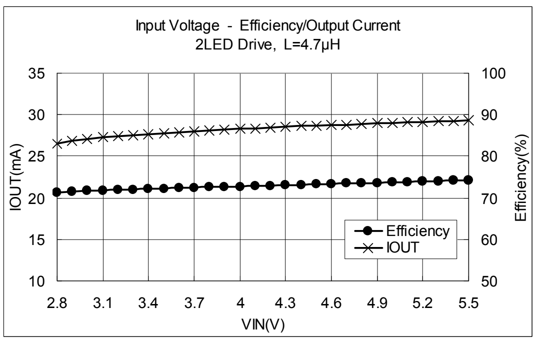
	Output Current (mA) V_{IN} = 3.6 V center	Tolerance (%)	
		MIN	MAX
2 LED	21.13	−3.50	1.77
3 LED	20.60	−1.95	1.38
4 LED	20.87	−1.75	1.11
5 LED	20.06	−1.81	1.15
6 LED	19.90	−1.95	1.28

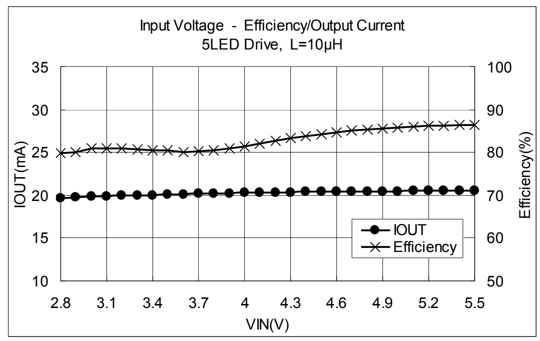
2. Application Circuit Example and Measurement Data (Reference data)

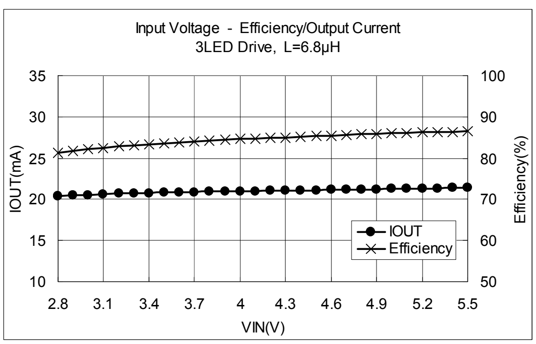


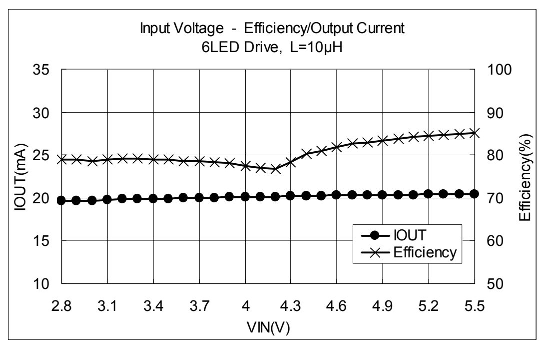
• Evaluation conditions

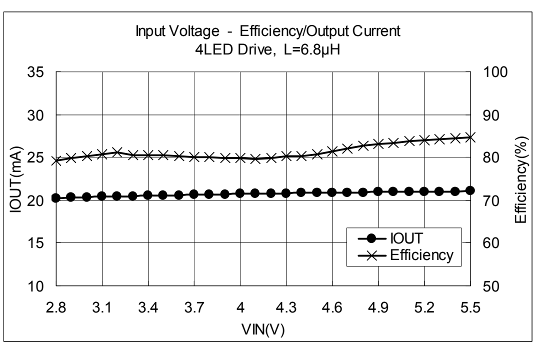
L	: 1001AS series (TOKO, INC) (Size 3.6 × 3.6 × 1.2 mm)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
LED	: NSCW215T (NICHIA Corp.)
C1	: C2012JB1E105K (TDK Corp.)
C2	: C2012JB1E105K (TDK Corp.)











<Measurement Data>

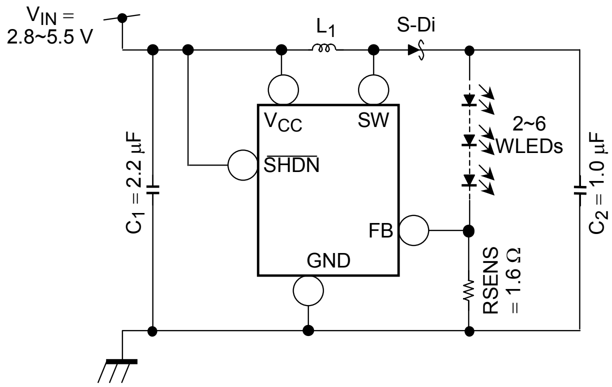
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

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

Output current in the range of V_{IN} = 3.0 to 5.0 V

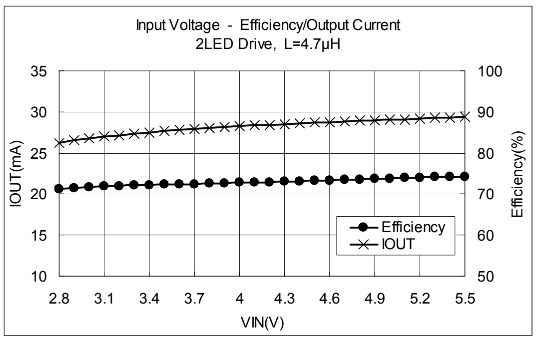
	Output Current (mA) V_{IN} = 3.6 V center	Tolerance (%)	
		MIN	MAX
2 LED	21.17	−3.32	1.73
3 LED	20.85	−1.95	1.38
4 LED	20.56	−1.79	1.15
5 LED	20.10	−1.82	1.22
6 LED	19.95	−1.94	1.26

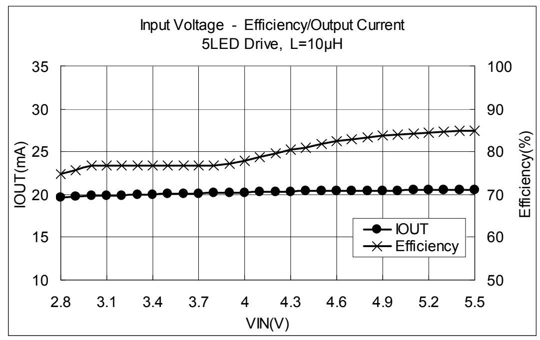
3. Application Circuit Example and Measurement Data (Reference data)

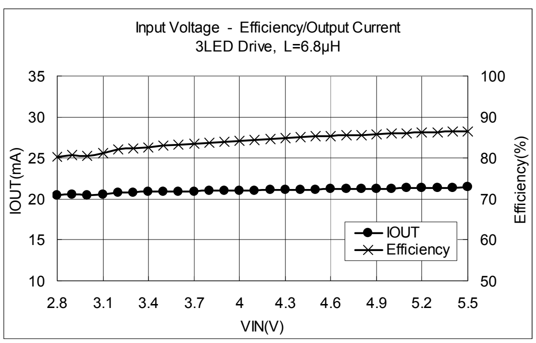


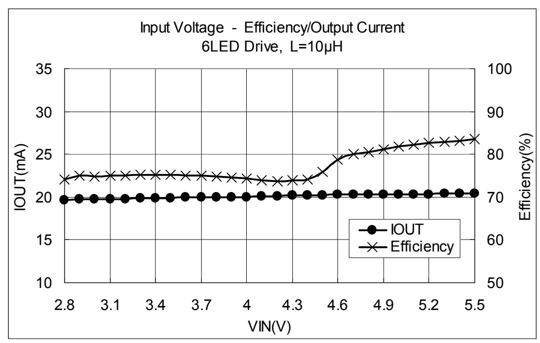
• Evaluation conditions

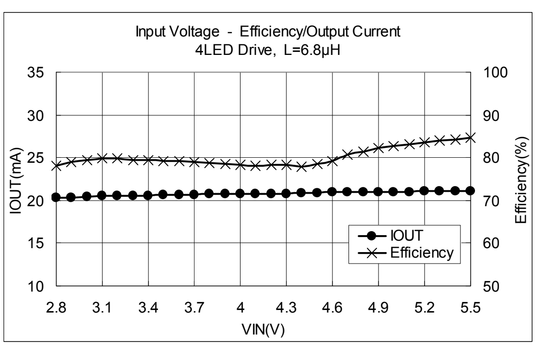
L	: LQH2M series (Murata Manufacturing Co.,Ltd.) (Size 2.0 × 1.6 × 0.95 mm)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
LED	: NSCW215T (NICHIA Corp.)
C1	: C2012JB1E105K (TDK Corp.)
C2	: C2012JB1E105K (TDK Corp.)











<Measurement Data>

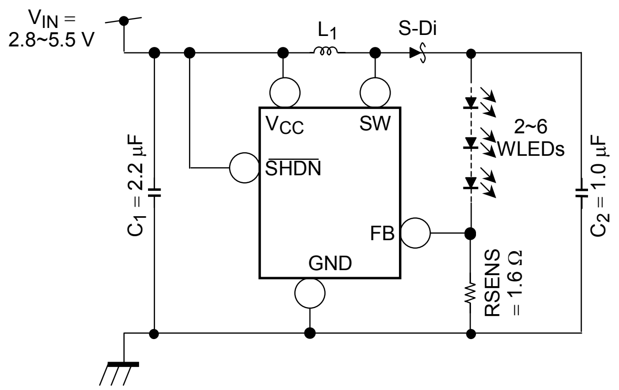
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

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

Output current in the range of V_{IN} = 3.0 to 5.0 V

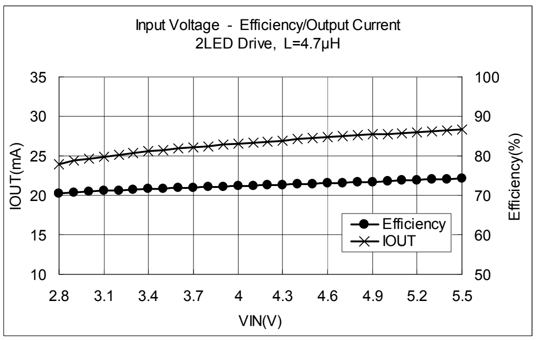
	Output Current (mA) V_{IN} = 3.6 V center	Tolerance (%)	
		MIN	MAX
2 LED	21.19	−3.26	1.69
3 LED	20.90	−1.87	2.17
4 LED	20.63	−1.78	1.01
5 LED	20.09	−1.88	1.25
6 LED	19.93	−1.99	1.07

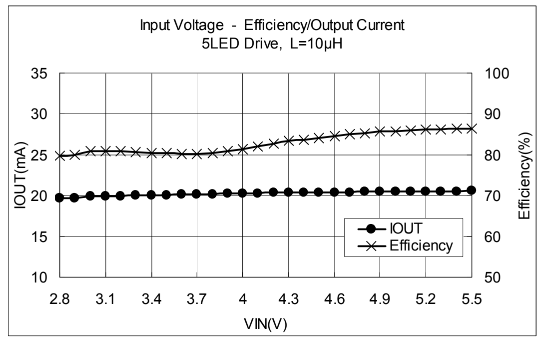
4. Application Circuit Example and Measurement Data (Reference data)

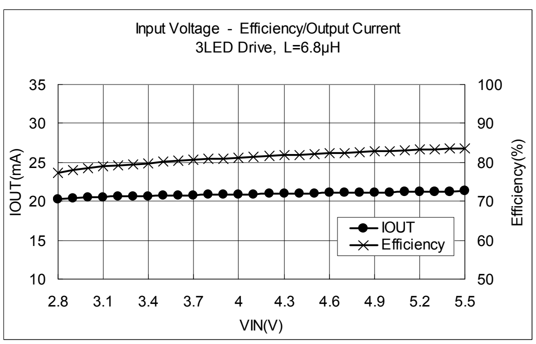


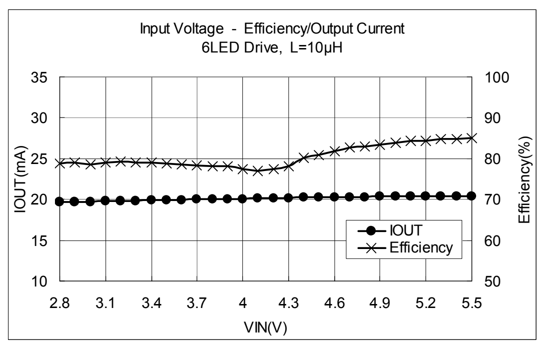
• Evaluation conditions

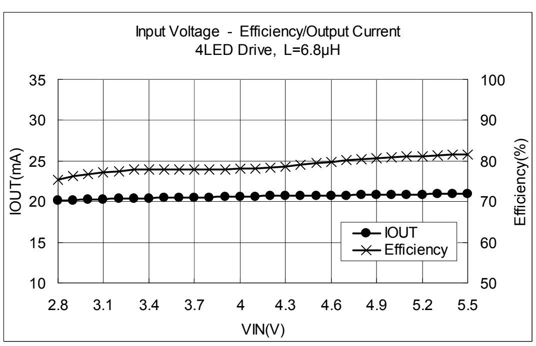
L	: VLF3010A series (TDK Corp.) (Size 3.0 × 3.0 × 1.0 mm)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
LED	: NSCW215T (NICHIA Corp.)
C1	: C2012JB1E105K (TDK Corp.)
C2	: C2012JB1E105K (TDK Corp.)











<Measurement Data>

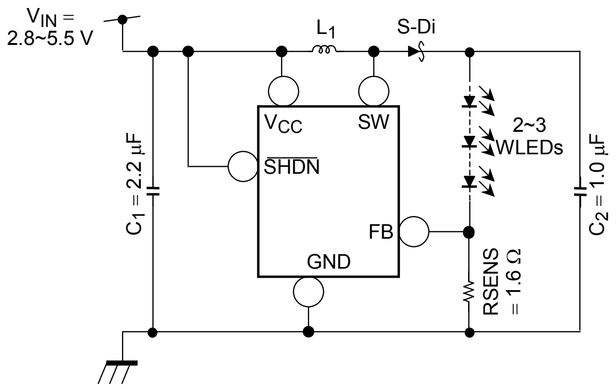
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

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

Output current in the range of V_{IN} = 3.0 to 5.0 V

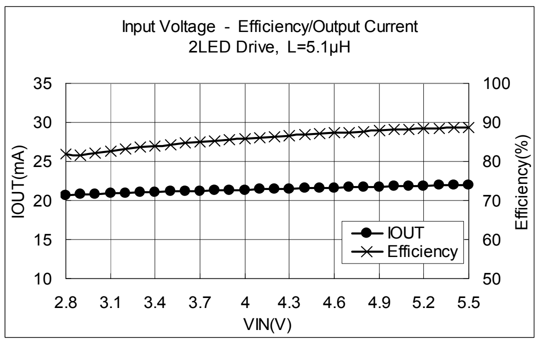
	Output Current (mA) V_{IN} = 3.6 V center	Tolerance (%)	
		MIN	MAX
2 LED	21.19	−3.08	1.67
3 LED	20.89	−1.86	1.33
4 LED	20.64	−1.68	1.11
5 LED	20.10	−1.82	1.22
6 LED	19.95	−1.94	1.26

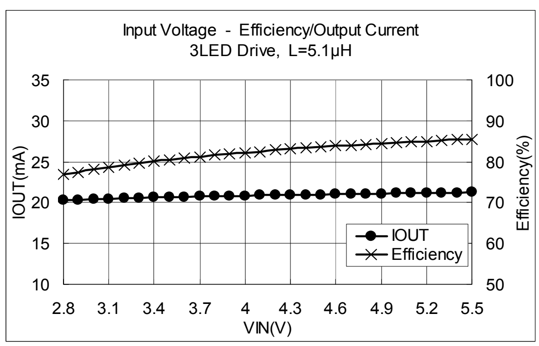
5. Application Circuit Example and Measurement Data (Reference data)



• Evaluation conditions

L	: 32R51 (KOA Corp.)
	(Size 3.2 × 2.5 × 0.6 mm)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
LED	: NSCW215T (NICHIA Corp.)
C1	: C2012JB1E105K (TDK Corp.)
C2	: C2012JB1E105K (TDK Corp.)





<Measurement Data>

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

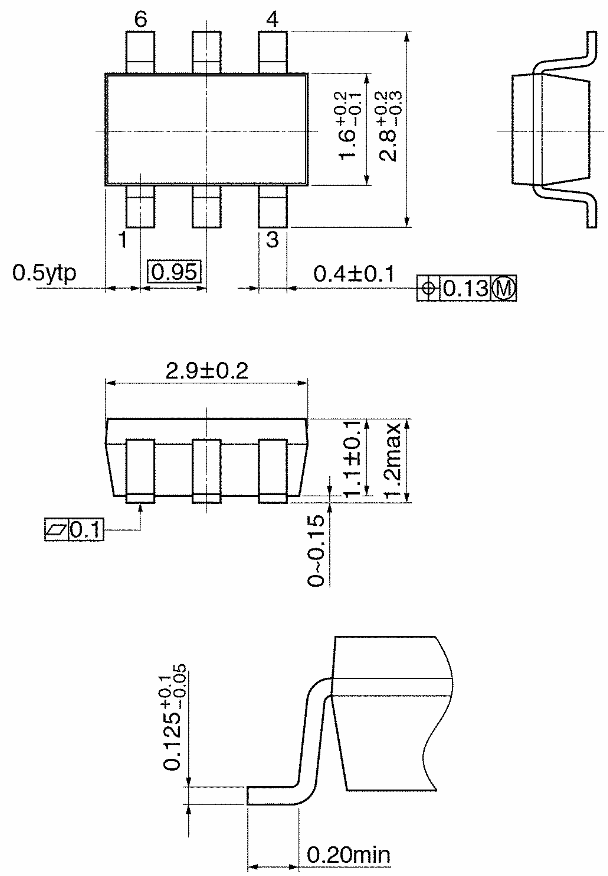
	Efficiency (%)	Average Efficiency (%)
2 LED	81.78～88.79	85.84
3 LED	76.84～85.48	82.17

Output current in the range of V_{IN} = 3.0 to 5.0 V

	Output Current (mA) V_{IN} = 3.6 V center	Tolerance (%)	
		MIN	MAX
2 LED	21.19	−2.99	1.64
3 LED	20.71	−1.98	1.44

Package Dimensions

SSOP6-P-0.95B Unit: mm



Weight: 0.016 g (typ.)

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030619EBA

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