



BYD Microelectronics Co., Ltd.

BF1005 Series

ON/OFF Dimming LED Driver IC

General Description

The BF1005 series is a high performance LED driver with on/off dimming function. It contains hysteretic start-up, output short/open protection, constant output current control circuit and etc. It operates in primary-side feedback while removing the need of secondary feedback circuitry. It can meet the requirement to drive LED up to 30W.

The BF1005 series has an on/off dimming function. Take BF1005 for example, the output current will be 100% when the first time power on corresponding to the first stage, 55% when the second time power on corresponding to the second stage, 25% when the third time power on corresponding to the third stage and 10% when the fourth time power on corresponding to the fourth stage. The cycle will restart to stage-one again when the fifth time power on. And this cycle will go on if the power off time is no more than 2 seconds.

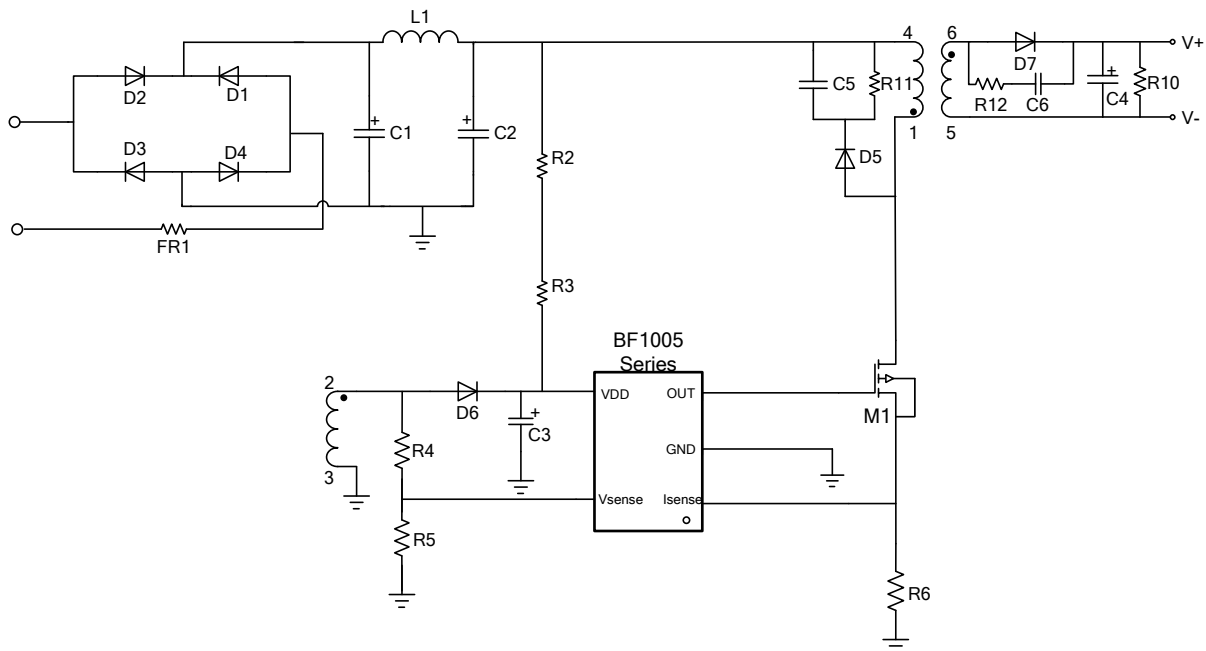
Features

- ON/OFF Dimming Function with Ordinary Switch
- Typical $\pm 5\%$ Output Current Accuracy
- No Opto-coupler and TL431 Required
- Built-in Short Circuit Protection, VDD Over Voltage Protection
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)
- SOT23-5 Package

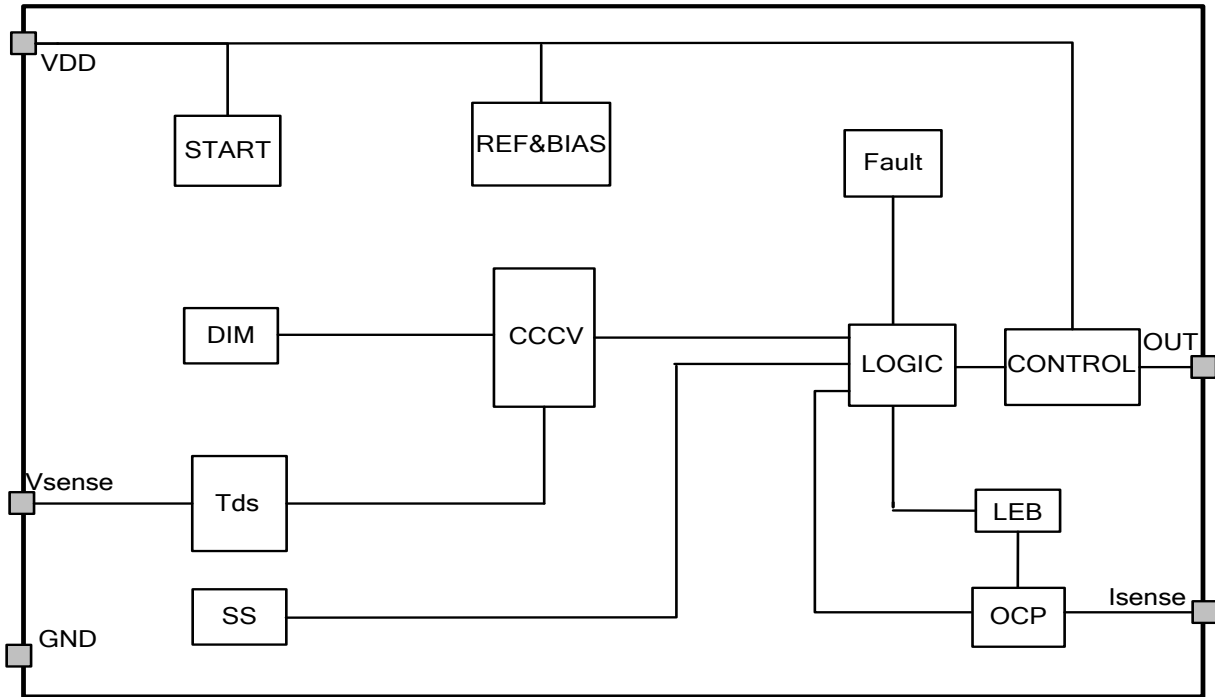
Application

- LED lampion
- LED bulb (E14、E27 etc)
- LED bedlamp

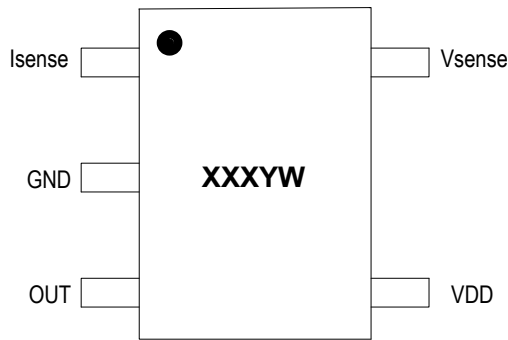
Typical Application



Block Diagram



Package Type and Marking Information



XXX= Internal Code (LX5&5A3&5A2&5B3&5B2),
 Y=manufacturing Year Code,
 W=Manufacturing Week Code



Note:

Product Name	Mark	Function Description
BF1005	LX5YW	4-stages dimming; output current :100%,55%,25%,10%
BF1005-A3	5A3YW	3-stages dimming; output current:100%,40%,8%
BF1005-A2	5A2YW	2-stages dimming; output current from 100% to 8%
BF1005-B3	5B3YW	3-stages dimming; output current: 8%,40%,100%
BF1005-B2	5B2YW	2-stages dimming; output current from 8% to 100%

Pin Description

Pin number	Pin name	Pin description
1	Isense	Current sense input.
2	GND	Ground.
3	OUT	Gate drive output for the external power MOS switch.
4	VDD	Power supply.
5	Vsense	Voltage sense input from the auxiliary winding.

Electrical Characteristic

(TA = 25°C, if not otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Supply Voltage						
Start-up Current	I _{dd}	VDD=14V	6	17	25	μA
Operation Current	I _{oc}			1		mA
Turn-on Threshold Voltage	V _{ON}		14.5	16.5	18.5	V
Turn-off Threshold Voltage	V _{OFF}	BF1005	9.5	11	12.5	V
		A2/A3/B2/B3	9.0	10.2	11.4	V
CC/CV Mode Change Voltage	V _{CCCV}		19.5	20.5	21.5	V
Oscillator						
The MAX Duty Cycle	T _{ds} /T _{MAX}		40	41	42	%
Current Sensing						
Leading Edge Blanking	T _{LEB}		300	400	500	ns



Maximum Current Sense Detection Voltage	Vocp_max		1.18	1.20	1.22	V
Gate Driver Output						
Output Delay Time	T _d			150		ns
Output Rising Time	T _r	VDD=18V,CL=1nF		200		ns
Output falling Time	T _f	VDD=18V,CL=1nF		50		ns

Absolute Maximum Ratings

Item	Symbol	Value	Unit
VDD pin input voltage	VDD	40	V
SENSE pin input voltage	V _{SENSE} I _{SENSE}	7	V
Power Dissipation	P _D	400	mW
Operating Junction Temperature	T _J	-40 to +125	°C
Storage Temperature Range	T _{STJ}	-55 to +150	°C

Attention: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Operation Description

The BF1005 series has an on/off dimming function without extra components and control signal input. It uses PFM with a constant factor between the demagnetization time and the operate cycle time to regulate the output current. Particular inductance compensation mode without more external components can achieve a high tight output current regulation.

● Start-up Current and Constant Frequency Start

The BF1005 series is designed to have a low start-up current so that VDD can be charged up above the UVLO threshold and starts up quickly. After start-up, BF1005 series will operate in a constant frequency (Typ.25KHz) until the output voltage up to a certain value, so that the output can set up quickly.

● CC/CV Operation Mode

The switching frequency of BF1005 series is controlled according to the load condition and the operation mode. When operating in DCM, the maximum output power is given by:

$$P_{out} = 0.5 * L_p * F_{sw} * I_p * I_p \quad (1)$$

(L_p: the inductance of primary winding; I_p: the peak current of primary winding)

Refer to the equation 1, the change of the primary winding inductance results in the change of the maximum output power and the constant output current in CC mode. To compensate the change from variations or primary winding inductance, the switching frequency is controlled by an internal loop, the relation is given by:

$$F_{sw} = 1 / (2 * T_{ds}) \quad (2)$$

(T_{ds}: The demagnetization time of secondary winding)

Since T_{ds} is proportional to the inductance, as a result, the F_{sw} is constant, thus the maximum output power and constant current in CC mode will not change as primary winding inductance changes. The output current can be calculated by the following expressions:

$$I_{out} = 0.5 * \frac{T_{ds}}{T} * \frac{N_p}{N_s} * I_p \quad (3)$$

(N_p: Primary winding turns of the transformer; N_s: Secondary winding turns of the transformer.)

As the voltage of the VDD pin approaches to V_{ccv} from the CC operation mode, the power supply smoothly switches to operate in CV portion. During CV operation, the IC adjusts the MOS switching frequency to provide a constant output voltage. The output voltage can be calculated by the following expressions:

$$V_{out} = [(20.5 + VD6) * \frac{N_s}{N_a}] - VD7 \quad (4)$$

(N_s: Secondary winding turns of the transformer; N_a: Auxiliary winding turns of the transformer.)

● Switching dimming operation

The BF1005 series gives a very convenient switching dimming function for user without extra components and control signal input. The users could turn on and off the input power to control the light intensity. Take BF1005 for example, when the first time power on, the output current is 100% (stage_1), once the power is off, and if the power is on again in 2 seconds, the logic output will change to the second stage and the output current will be 55%, the output current of third stage is 25% and the fourth is 10%. So if you want to choose the third stage or the fourth stage, you should re-power on during the holding time (2 seconds). Then the cycle will go on and on. The process is shown as figure1.

If the power off time is more than 3 seconds, the circuit will be reset, and then the stage will go to the first stage.

The 3-stages are 100%, 40% and 8%. The 2-stages are 100% and 8%. And the output current of 2 and 3 stages can be from high to low or opposite by choosing different products of BF1005 series.

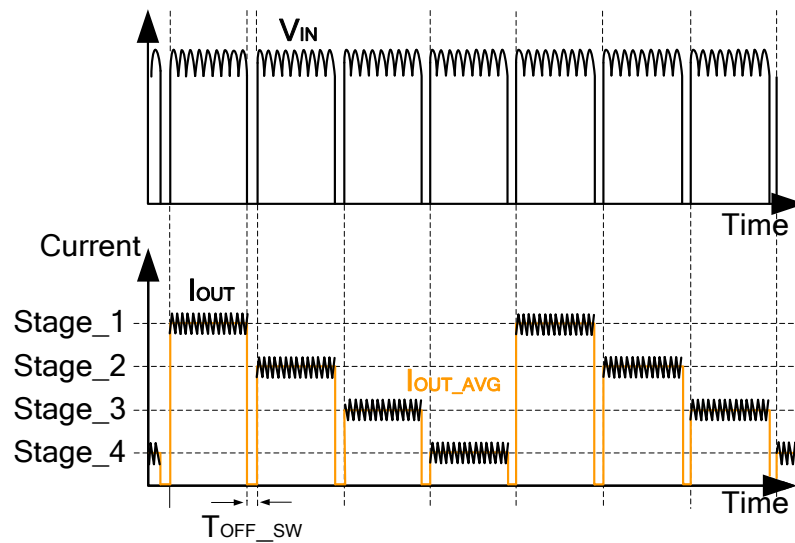


Figure1

- **Cycle-by-Cycle Current limit**

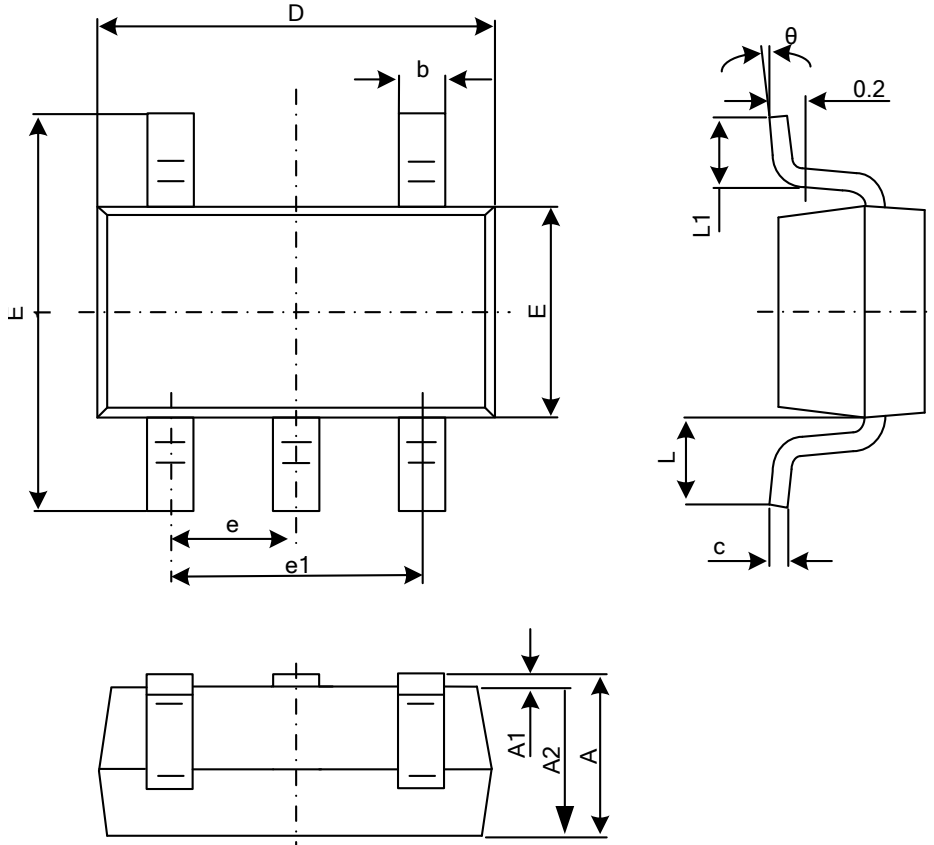
The current limit circuit senses the primary current from the voltage on the sensing resistor cycle by cycle. When the voltage exceeds the internal threshold, the power MOS will turn off immediately.

- **Voltage Protection Function**

The BF1005 series includes such a function that protect against output over-voltage and under-voltage, which could be monitored by VDD pin. If the voltage at VDD pin exceeds the over-voltage threshold, the external power MOS will be turned off immediately and the controller will restart. Once VDD drops below the UVLO threshold, the controller will reset itself and go into a new start cycle. The controller will continue the start cycle until the error condition is removed.

Package Outline

SOT23-5



Symbol	Dimensions In Millimetres		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



RESTRICTIONS ON PRODUCT USE

- The information contained herein is subject to change without notice.
- BYD Microelectronics Co., Ltd. (short for BME) exerts the greatest possible effort to ensure high quality and reliability. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing BME products, to comply with the standards of safety in making a safe design for the entire system, including redundancy, fire-prevention measures, and malfunction prevention, to prevent any accidents, fires, or community damage that may ensue. In developing your designs, please ensure that BME products are used within specified operating ranges as set forth in the most recent BME products specifications.
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