

## Technical Note

# ROHM Electronic components

## LED Driver series for lighting Step-down type with 1.5A output

## BD9207FPS

No.09093EAT01

#### Description

BD9207FPS is a LED driver with built-in step-down switching regulator and incorporates the built-in switching MOS EFT of Pch.

Feedback voltage is as low as 0.2V and can suppress the loss on the sense resistance of LED.

It is operated by PWM method with an oscillating frequency of 900 KHz and can use smaller coil than a switching regulator of low-frequency operation.

#### Features

- 1) Maximum switching current of 1.5A
- 2) Built-in Pch switching MOS FET for high efficiency
- 3) Low loss because feedback voltage is as low as 0.2V
- 4) High oscillating frequency of 900KHz (Fixed)
- 5) Built-in soft start function
- 6) Built-in overcurrent protection circuit (OCP)
- 7) Built-in thermal shutdown circuit (TSD)
- 8) ON/OFF of output is possible by STBY terminal.
- 9) Compact surface-mount TO252S-5 package

#### Applications

- · For use in the light sources of PPC
- Printer etc. and the LCD backlights of LED lighting apparatus & monitor
- Note PC etc.

#### ●Absolute maximum ratings(Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply voltage(VCC-GND)	Vcc	36	V
STBY-GND Voltage	V <sub>STBY</sub>	36	V
OUT-GND Voltage	Vout	36	V
INV-GND Voltage	V <sub>INV</sub>	5	V
Maximum switching output current.	lout	1.5(*1)	А
Allowable loss	Pd	800(*2)	mW
Operating temperature range	Topr	-20 ~ +85	°C
Storage temperature range	Tstg	-55 ~ +150	S

(\*1)Regardless of the listed rating, do not exceeded Pd, ASO or Tjmax=150°C.

(\*2) Without heat sink, reducing by the 16 mW every 1°C rise in temperature. (above 25°C)

#### ●Operating range (Ta=-40~+85°C)

Descent		Limit			1.1	O an d'iti an a
Parameter	Symbol	Min.	Тур.	Max.	Unit	Conditions
Supply voltage	VCC	8.0	-	35.0	V	
Output voltage	Vo	2.5	-	0.8× (VCC-lo×Ron)	V	

#### ●Electrical characteristics (Unless otherwise specified, Ta=25°C, VCC=24V, STBY=3V)

Parameter		Symbol Limit			Unit	Conditions
		Min.	Тур.	Max.	Unit	Conditions
nce	Ron	-	1.0	1.5	Ω	
	fosc	810	900	990	kHz	
rrent	Іоср	1.6	-	-	А	
	VINV	0.194	0.200	0.206	V	
ent	IINV	-	1	2	μA	VINV=0.2V
ON	VSTBYON	2.0	-	36	V	
OFF	VSTBYOFF	-0.3	-	0.3	V	
rent	Istby	5	15	30	μA	STBY=3V
	Icc	-	5	12	mA	
	lst	-	0	5	μA	STBY=0V
	Tss	-	-	10	ms	STBY=0→3V
	rrent ON OFF rrent	SymbolnceRonfoscirrentlocpvinvvinvrentIINvONVSTBYONOFFVSTBYOFFrrentlstbylcclstIstTss	Symbol Min.   nce Ron -   fosc 810   irrent locp 1.6   VINV 0.194   rent IINV -   ON VSTBYON 2.0   OFF VSTBYOFF -0.3   irrent Istby 5   Ist - -   Tss - -	SymbolLimitMin.Typ.InceRon-1.0fosc810900Irrentlocp1.6-VINV0.1940.200rentIINV-1ONVSTBYON2.0-OFFVSTBYOFF-0.3-Istby515Ist-0Tss-0	$\begin{tabular}{ c c c c } \hline & & & & & & & & & & & & & & & & & & $	$\begin{tabular}{ c c c c } \hline & & & & & & & & & & & & & & & & & & $

Without radiation-proof design.

#### Block diagram



#### Outline drawing of package



TO252S-5 (Unit : mm)

#### Explanation of terminal

Pin No.	Pin Name	Function
1	VCC	Supply voltage terminal
2	OUT	Drain terminal of built-in PMOS FET
3%	OUT	Drain terminal of built-in PMOS FET
FIN	GND	Ground terminal
4	INV	Output voltage feedback terminal
5	STBY	ON/OFF control terminal

XUsed normally in open-circuit condition

### BD9207FPS

#### •Functional explanation of block

VREF

The constant voltage to be temperature-compensated is created from the voltage inputted from VCC terminal.

• OSC

Triangular wave with an oscillating frequency of 900 KHz is created, as an input of PWM comparator, by built-in resistor and capacitor.

Error AMP

It detects, at INC terminal, the voltage of sense resistance terminal created by LEC current, and compares it to the reference voltage, and amplifies and outputs the differential voltage. (The reference voltage is 0.2V±3%)

PWM COMP

PWM COMP converts the output voltage of error amplifier into the pulse-width modulation waveform and outputs it to DRIVER.

DRIVER

Push-pull FET driver takes in the PWM waveform and directly drives the Pch MOS FET that is built-in in the IC.

STBY

The ON/OFF control of output is performed by STBY terminal. The output becomes ON if STBY voltage is High level.

Thermal shutdown circuit (TSD)

TSD circuit protects the IC from runaway thermal operation or heat damage.

TSD circuit detects the temperature of chip, and the circuit becomes off if the temperature reaches 175°C. For TSD detection and release, the hysteresis of 15°C is set, so the malfunction caused by temperature variation is prevented.

Over Current Protection (OCP)

Out is turned off if the voltage difference between VCC – OUT, caused by the current flowing in the Pch MOS EFT built-in in OCP circuit, is detected and reaches the reference value of OCP. The OCP is not of latch type but of self-return type.

Soft start circuit (SS)

Soft start time is set by the built-in capacitor connected to SS circuit. The capacitor is charged when STBY terminal becomes High level and the IC is started. The soft start time is set at 4ms or so.

#### Selection and setting of application parts

#### Coil L1

The application efficiency will decrease by the larger serial resistance element of coil. Moreover, because OCP operates by 1.6A(min) or more, so please notice the heat generated by overload output or short.

Please set current ratings of coil with I<sub>OUT</sub>(MAX) + ∠IL or more. lout(MAX): maximum load current

If current flows more than ratings current, then coil generates heat, magnetic saturation, and causes oscillation or low efficiency.

Please select the peak current with enough margins not to exceed current rating of coil.

	(VCC-VOUT)		VOUT		1
⊿IL <sub>.</sub> =	L1	_× .	VCC	- ×	fosc

L1: Coil value, VCC: Input voltage, VOUT: Output voltage,  $\angle$ IL: Ripple current, fosc: Oscillation frequency When value the efficiency, we recommend C10-H5R(mitsumi). Efficiency will be improved about 1~2%.

#### Schottky diode D1

Please select Schottky diode with lowest forward voltage VF.

(We can suppress the dissipation of forward voltage descent, and raise the efficiency. )

Diode selection is based on maximum forward current rating, reverse voltage rating and permissible power dissipation of diode.

•The maximum current ratings are assumed more than the value of maximum load current+ coil ripple current( $\Delta I_L$ ).

•Reverse voltage rating is set to be VIN or more.

·Please choose the smallest one of reverse current IR.

Especially, IR grows at high temperature, and causes thermo runaway.

• Select the diode which permissible power dissipation within ratings.

Diode power dissipation Pdi is shown below.

Pdi=lout(MAX)×Vf×(1-VOUT/VCC)

lout ( MAX ) : Load current. Vf: Forward voltage, VOUT: Output voltage, VCC: Input voltage

#### Output capacitor C1

Select the output capacitor with ESR met the following formula.

ESR≦⊿VL/⊿IL

∠VL : Permissible ripple voltage, ∠IL : Ripple current

Moreover, permissible ripple current effective value of output capacity is calculated by the next formula, and use this value to select the capacitor with enough margins.

IRMS =⊿IL/2√3

IRMS: Permissible ripple current effective value of output capacity,  $\angle$ IL : Ripple current

Ceramic capacitor must use the one more than B characteristic.

Besides above mentioned, IC might not be normally operated according to the different setting condition of ambient temperature and output voltage.

Moreover, even aluminum electrolytic capacitor can be used, please confirm its operation enough before using it.

Input capacitor C2

Input capacitor built in Pch MOS FET ON is the current supply of coil by FET.

So, please close to IC as near as possible to connect it. Enough margins is taken on setting input capacitor in capacitor withstand voltage and permissible ripple current value. According to the ripple current effective value of input capacitor shown below, select the capacitor with enough permissible ripple current value.

IRMS=IOUT×√(1-VOUT / VCC)×VOUT / VCC

IRMS : Permissible ripple current value of input capacitor

IOUT : Load current. VOUT: Output voltage, VCC: Input voltage

Resistance R1

LED Current value is set below according to sense resistance R1.  $ILED[A] = VINV[V]/R1[\Omega]$   $= 0.2V/R1[\Omega]$ Moreover, DCDC Output voltage will be the value below. VO[V] = VF(LED Forward voltage) + VINV[V] = VF+0.2V(typ)

Recommended circuit example and notes of substrate layout



- To prevent noise and low efficiency, please set up the capacitor and Schottky diode between VCC GND as near as possible to IC.
- Please connect the resistance and output LC filter capacitor between INV GND with same GND for the stability of output voltage.

<recommended< th=""><th>l parts example&gt;</th><th></th><th></th></recommended<>	l parts example>		
Coil	$L1 = 10 \mu H$	:C6-K3LA(mitsumi)	
Diode	D1	:RB050LA-30(ROHM	(N
Capacitor	C1=10µF(25V)	: Ceramic capacitor	GRM31CB31E106KA75L(murata)
	C2=4.7µF(50V)	: Ceramic capacitor	GRM32EB31H475KA87L(murata)
Resistance	R1=0.43Ω	:MCR10EZPFR430	(ROHM)

• Measurement circuit diagram



#### • Heat transfer characteristic





#### • I/O terminal equivalent circuit diagram

1Pin,FIN (VCC, GND)	2pin (OUT)	4pin (INV)	5pin (STBY)
			STBY

#### Notes for use

1. We have paid enough attention to quality control of this product, but it may be destroyed when the absolute maximum rating of impressed voltage and operating temperature range is exceeded. Because we can't specify that is short-mode or open-mode etc while it is destroyed, so please discuss to give physical safety action with postulating the special mode exceeded absolute maximum rating.

#### 2. About application circuit

Application circuit is recommended, but please fully confirm temperature characteristic etc when using it. Moreover, please acknowledge that our company can't confirm enough about patent.

#### 3. About the range of operation power-supply voltage

Circuit function operation at the range of operation ambient temperature is guaranteed when it is in the range of operation power-supply voltage. About characteristic value, the specification value of electric characteristic can't be guaranteed, but the characteristic value doesn't change rapidly in these ranges.

4. About ground connection

The ground connection shown in application circuit example should equip enough fat GND(FIN) to every ground connection with shortest pattern drawing, and the pattern shouldn't interfere the electric characteristic.

#### 5. About input power-supply

The input power-supply shown in application circuit example should equip input pin VCC(1pin) with short enough pattern drawing, and the pattern shouldn't interfere the electric characteristic.

- 6. Please think about permissible power dissipation (Pd) in an actual using status, and do the heat design with enough margins.
- 7. Please pay enough attention to the direction and displacement of IC when you install it on PCB. If you install it by mistake, IC might be destroyed, Moreover, when short-circuit happen by foreign substance entered between outputs, or output and power supply GND, it will be destroyed.
- 8. Please note that there is a possibility of malfunction if you use it in strong electromagnetic field.
- 9. Please set STBY terminal voltage to 0.3V or less when putting it on standby status, to 2.0V or more when putting it on operation status.

Please do not fix STBY terminal voltage from 0.3V to 2.0V. It may cause malfunction or breakdown.

- This IC is a monolithic IC, and there are P + isolation and P substrate for element separation between each element. P-N joint is formed with this P layer and N each element's layer, and various parasitic elements are composed.
  - For instance, as shown in the figure below, when resistance and transistor are connected with terminal:
    - P-N joint operates as a parasitic diode when GND > (terminal A) in resistance, GND >(terminal B) in transistor (NPN).
    - Moreover, when GND > (terminal B) in transistor (NPN), the parasitic NPN transistor operates with N layer of other elements adjoining with above-mentioned parasitic diode.

According to potential relation, parasitic element in IC structure can be consequent. The operating of parasitic element maybe interfere the circuit operation, and become the cause of malfunction and destruction. Therefore, please pay enough attention not to use it by impressing lower voltage than GND (P substrate) on I/O terminal etc to operate parasitic element.





#### Ordering part number



#### TO252S-5



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(Note1) Medical Equipment (	Classification of the Specific Applications
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JAPAN	USA	EU	CHINA
CLASSⅢ		CLASS II b	
CLASSⅣ	CLASSI	CLASSⅢ	CLASSII

- 2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
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  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [h] Use of the Products in places subject to dew condensation
- 4. The Products are not subject to radiation-proof design.
- 5. Please verify and confirm characteristics of the final or mounted products in using the Products.
- 6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- 7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
- 8. Confirm that operation temperature is within the specified range described in the product specification.
- 9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

#### Precaution for Mounting / Circuit board design

- 1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- 2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

#### Precautions Regarding Application Examples and External Circuits

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This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of lonizer, friction prevention and temperature / humidity control).

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- 3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
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