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℃）

Parameter	Symbol	Rating	Unit
Supply voltage（VCC-GND）	Vcc	36	V
STBY-GND Voltage	V_{STBY}	36	V
OUT-GND Voltage	V_{OUT}	36	V
INV-GND Voltage	V_{INV}	5	V
Maximum switching output current.	Iout	1.5(*1)	A
Allowable loss	Pd	800(*2)	mW
Operating temperature range	Topr	-20 ~ +85	℃
Storage temperature range	Tstg	-55 ~ +150	℃

(*1)Regardless of the listed rating, do not exceeded Pd, ASO or Tjmax=150℃.
(*2) Without heat sink, reducing by the 16 mW every 1℃ rise in temperature. (above 25℃)

●**Operating range (Ta=-40～+85℃)**

Parameter	Symbol	Limit			Unit	Conditions
		Min.	Typ.	Max.		
Supply voltage	VCC	8.0	-	35.0	V	
Output voltage	Vo	2.5	-	0.8×(VCC-Io×Ron)	V	

●**Electrical characteristics** （Unless otherwise specified, Ta=25℃,VCC=24V,STBY=3V）

Parameter		Symbol	Limit			Unit	Conditions
			Min.	Typ.	Max.		
Output MOS ON resistance		Ron	-	1.0	1.5	Ω	
Oscillating frequency		fosc	810	900	990	kHz	
Overcurrent detection current		Iocp	1.6	-	-	A	
INV terminal threshold voltage		VINV	0.194	0.200	0.206	V	
INV terminal bypass current		IINV	-	1	2	µA	VINV=0.2V
STBY terminal control voltage	ON	VSTBYON	2.0	-	36	V	
	OFF	VSTBYOFF	-0.3	-	0.3	V	
STBY terminal inflow current		Istby	5	15	30	µA	STBY=3V
Circuit current		Icc	-	5	12	mA	
Standby current		Ist	-	0	5	µA	STBY＝0V
Soft start time		Tss	-	-	10	ms	STBY＝0→3V

Without radiation-proof design.

●Block diagram
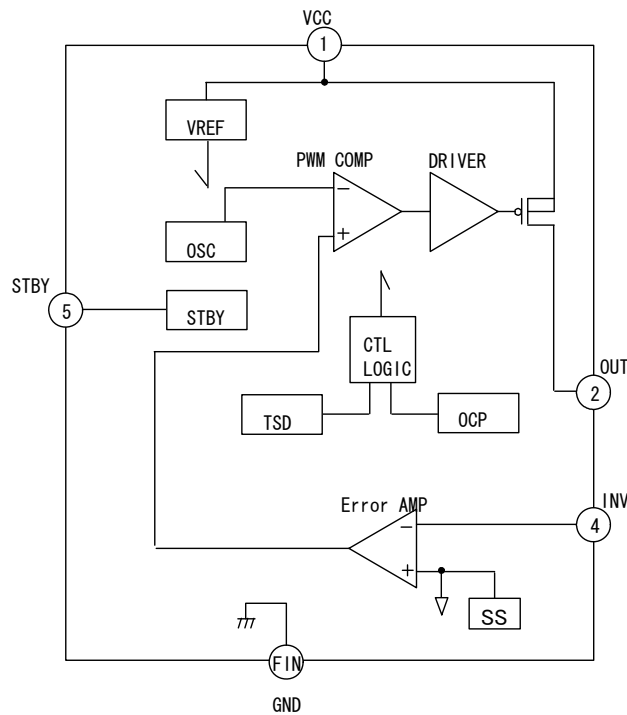
●Outline drawing of package
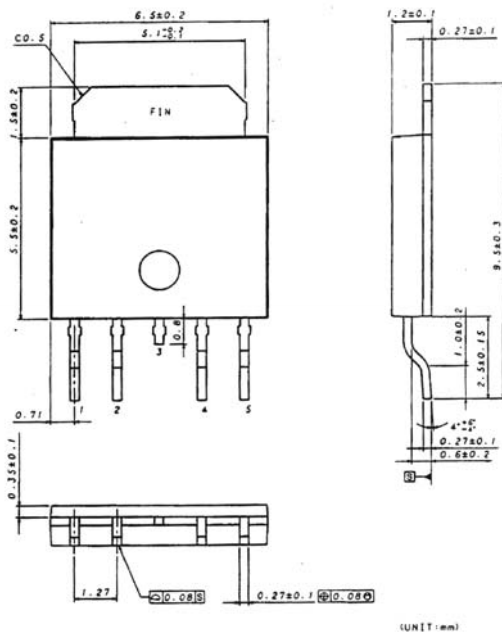
TO252S-5 （Unit：mm）

●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

※Used normally in open-circuit condition

●**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℃. For TSD detection and release, the hysteresis of 15℃ 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_{OUT}(MAX) + $\triangle$IL or more. Iout(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.

$$\triangle IL = \frac{(VCC-VOUT)}{L1} \times \frac{VOUT}{VCC} \times \frac{1}{fosc}$$

L1: Coil value, VCC: Input voltage, VOUT: Output voltage, $\triangle$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($\triangle$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=Iout(MAX)×Vf×(1-VOUT/VCC)

Iout (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$\leqq$$\triangle$VL/$\triangle$IL

$\triangle$VL : Permissible ripple voltage, $\triangle$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 =$\triangle$IL/2$\sqrt{}$3

IRMS: Permissible ripple current effective value of output capacity, $\triangle$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.

$$IRMS = IOUT \times \sqrt{(1-VOUT / VCC) \times VOUT / VCC}$$

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.

$ILED[A] = VINV[V]/R1[\Omega]$

$= 0.2V/R1[\Omega]$
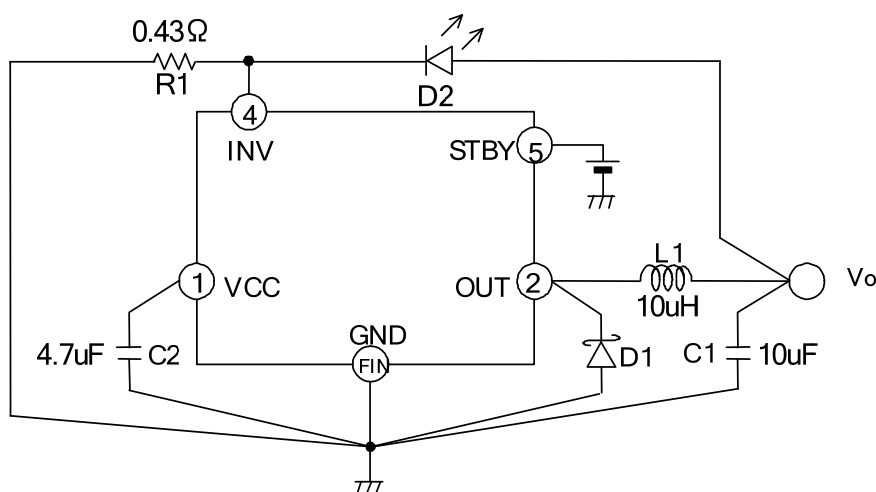
Moreover, DCDC Output voltage will be the value below.

$VO[V] = VF (LED\ Forward\ voltage) + VINV[V]$

$= VF + 0.2V(typ)$

● 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 parts example>
Coil	L1＝10μH	:C6-K3LA（mitsumi）
Diode	D1	:RB050LA-30（ROHM）
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
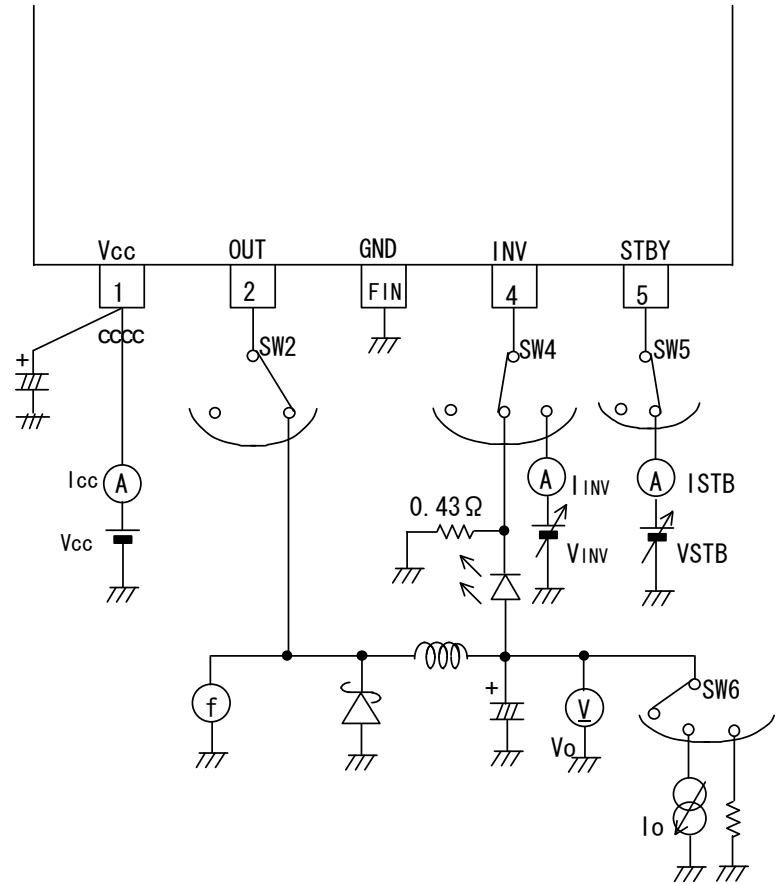
● Heat transfer characteristic

①IC unit
②2 layers substrate(area of substrate back copper foil:15 mm×15mm)
③2 layers substrate(area of substrate back copper foil:70 mm×70mm)
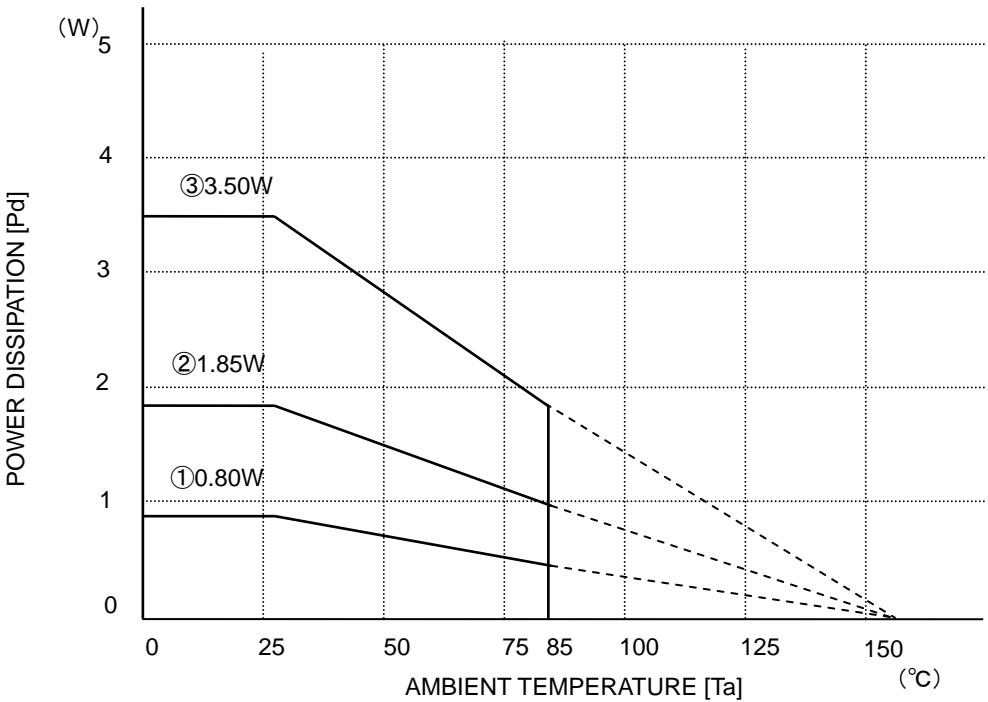
● I/O terminal equivalent circuit diagram

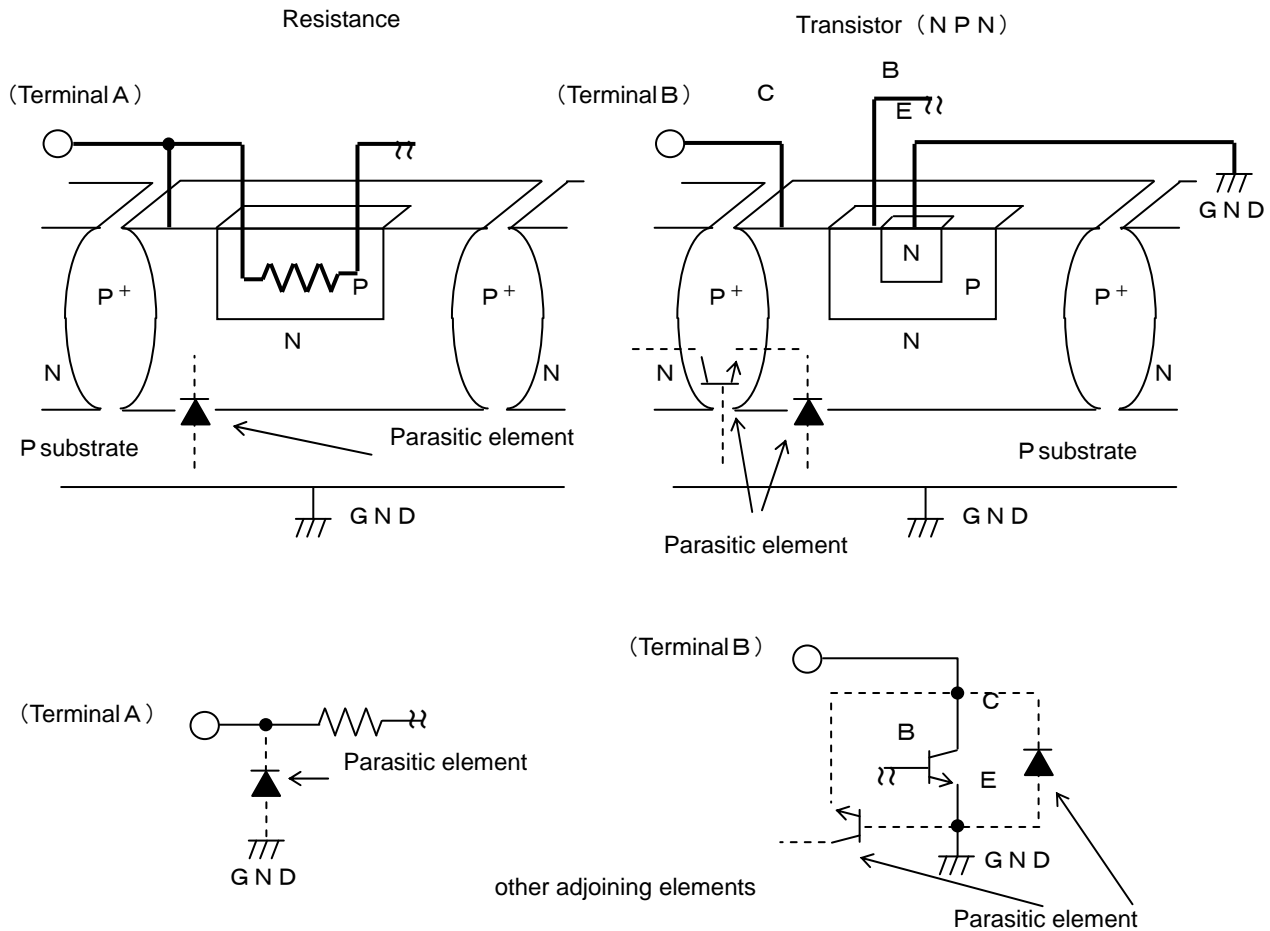| 1Pin,FIN (VCC, GND)	2pin (OUT)	4pin (INV)	5pin (STBY)

●**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.

10. 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.
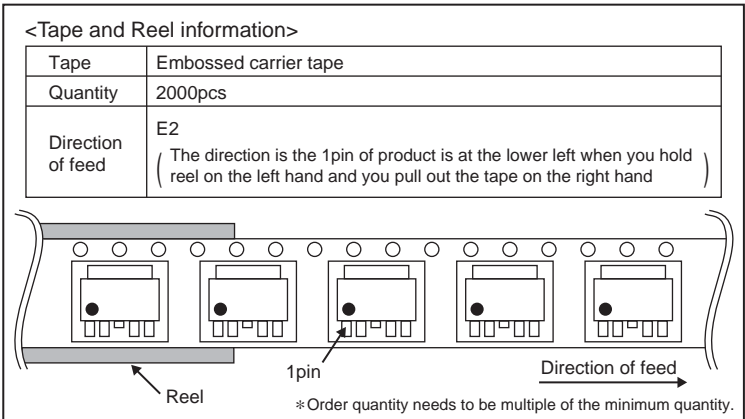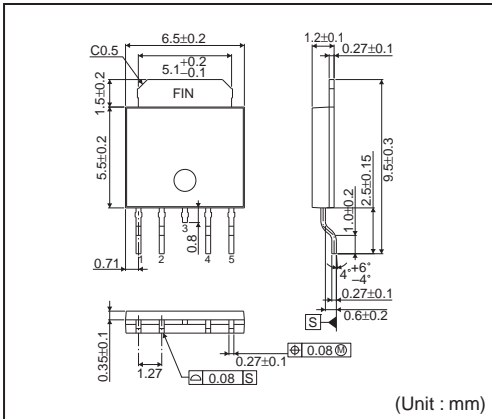
Resistance

Transistor（N P N）

（Terminal A）

（Terminal B）

Simple structure example of bipolar IC

●**Ordering part number**

B	D		9	2	0	7		F	P	S	-	E	2

Part No.   Part No.   Package   Packaging and forming specification

FPS: TO252S-5   E2: Embossed tape and reel

TO252S-5

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the lower left when you hold reel on the left hand and you pull out the tape on the right hand)

1pin   Direction of feed

Reel   ＊Order quantity needs to be multiple of the minimum quantity.

(Unit : mm)

Notes

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