LED Driver Series for LCD Backlight

Simple Structure Constant Current Backlight Driver for LCD panels (Non-step type)

BD9206EFV

No.09040EAT03

●Description

BD9206EFV is an IC with a built-in 6ch high-accuracy (absolute accuracy:±4%) constant-current driver.
Capable of lighting a maximum of 36 white LEDs with 6 rows×6 lines.
Due to the wide input voltage range (8V~30V), it can be widely used from a backlights of Note PC and PDA etc. to LED light sources of Scanner and PPC etc.
Moreover, it restrain the generation of heat at the time of large current drive because of adoption of high-heat-radiation package(HTSSOP-B20).

●Features

1) A wide input voltage range（8V～30V）
2) Capable of driving a maximum of 36 white LEDs of 6 series×6 parallel
3) Value of constant current is set by the VSET terminal
4) Due to the STBY terminal, the consumption current at the time of standby is low
5) PWM dimming is possible due to the clock input to the EN terminal
6) Built-in 5V regulator
7) High-heat-radiation package of HTSSOP-B20 6.4×6.5×0.85mm

●Applications

For use in LED light source of PPC and Scanner etc., LED lighting fixture, and LCD backlight lights of monitor and note PC etc.

●Absolute maximum ratings（Ta＝25℃）

Item	Symbol	Rating	Unit
Power Supply Voltage	Vcc	36	V
LED output voltage	VLED	28	V
Power Dissipation	Pd	3.2 *1	W
Operational Temperature Range	Topr	−40～+85	℃
Storage Temperature Range	Tstg	−55～+150	℃
LED Maximum Current	ILED	30 *2	mA

∗1 Reduce with 25.6mW at 1℃ if Ta= 25℃ or above at the time of mounting a base-plate of glass epoxy in 4 layer of 70mm×70mm×1.6mm.
∗2 It is value per LED driver 1ch.
Please set inside the range which does not exceed the allowable loss value of the package.

●Recommended Operational condition（Ta=25℃）

Item	Symbol	Rating	Unit
Power Supply Voltage	Vcc	8～30	V
EN terminal clock input possible range	VENCLK	100～10000	Hz
VSET input possible range	VSET	0.6～3	V
Applied voltage range for LED terminal	VLED	0.6～28	V

●Electrical Characteristics（Unless specified, Ta=25℃,Vcc=24V）

Item	Symbol	Ratings			Unit	Conditions
		Min.	Typ.	Max.		
【Whole】						
Circuit electric current when OFF	IOFF	-	17	28	μA	STBY=L, EN=L, TEST=L
Circuit electric current when stand by	IST	-	1.8	3.6	mA	STBY=H, EN=L, TEST=L
Circuit electric current when operating	ICC	-	2.5	5.0	mA	STBY=H, EN=H, TEST=L
【LED Driver 1~6】						
Output current	ILED	19.2	20.0	20.8	mA	VSET=2.0V, VLED=1V
Leak electric current when OFF	ILEDLK	-	0.0	5.0	μA	VLED=26V
Influx electric current to VSET terminal	IINVSET	-	-0.05	-0.10	μA	VSET=2V
【VREG】						
Output voltage	VREG	4.7	5.0	5.3	V	Io=1mA
Output current	IOMAX	10	30	-	mA	Vo=VREG×0.9
【UVLO】						
Detection voltage	VUVREG	2.4	2.9	3.4	V	VREG fall down
Hysteresis voltage	VUHYVREG	0.05	0.1	0.2	V	VREG rise up
【STBY, EN, TEST】						
Input Low level	VIL	-0.3	-	0.8	V	
Input high level	VIH	2.0	-	Vcc	V	
Input current	RPD	33	47	66	μA	Vin=3V

It is not the radiation-proof design for this product.

●Block diagram

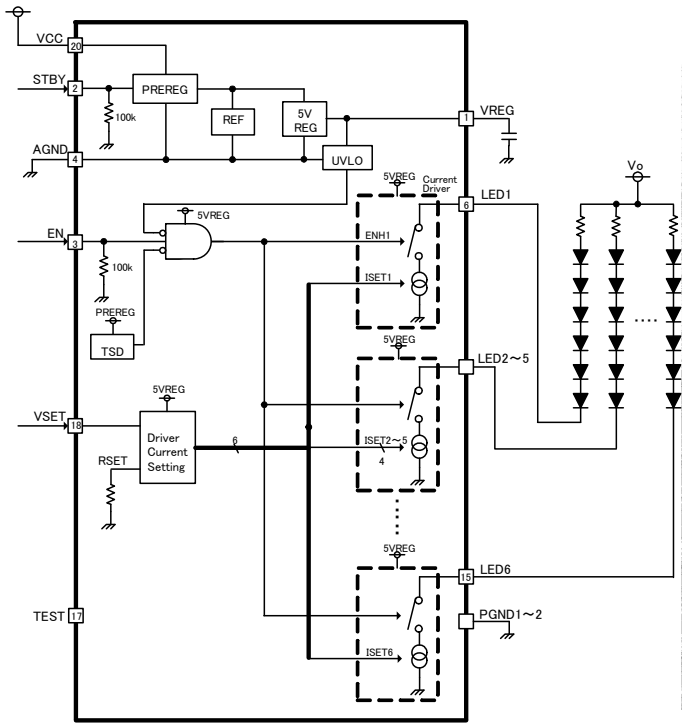
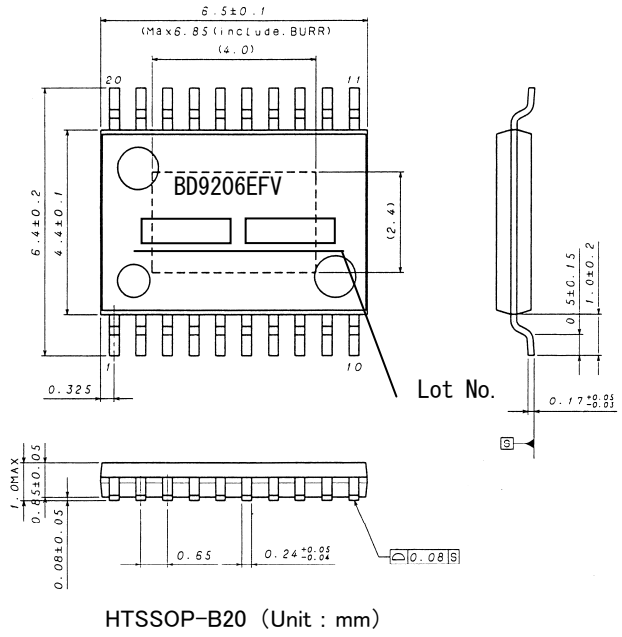


Fig..1

●Package outline drawing



HTSSOP-B20 (Unit : mm)

Fig..2

●Terminal placement diagram

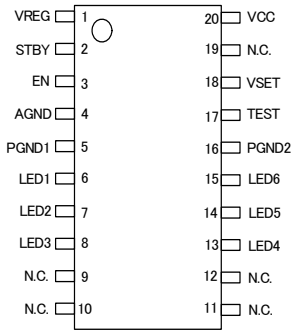


Fig..3

●Terminal explanation

Terminal number	Terminal name	Function	Terminal number	Terminal name	Function
1	VREG	Power supply for internal circuit	11	N.C.	(Not yet connected terminal)
2	STBY	Stand by terminal (Low:OFF,High:stand by, operation)	12	N.C.	(Not yet connected terminal)
3	EN	LED1～16 Enable terminal(Active:High)	13	LED4	Output terminal 4 for LED driver
4	AGND	GND for internal standard section	14	LED5	Output terminal 5 for LED driver
5	PGND1	POWER GND for LED driver	15	LED6	Output terminal 6 for LED driver
6	LED1	Output terminal 1 for LED driver	16	PGND2	Power GNDPOWER GND for LED driver
7	LED2	Output terminal 2 for LED driver	17	TEST	Terminal for test mode shift (Use at usual time : Low)
8	LED3	Output terminal 3 for LED driver	18	VSET	Standard voltage terminal for fixed electric current setting
9	N. C.	(Not yet connected terminal)	19	N.C.	(Not yet connected terminal)
10	N. C.	(Not yet connected terminal)	20	VCC	Terminal of power supply

●Reference data(Unless specified,VCC=24V, Ta=25℃)

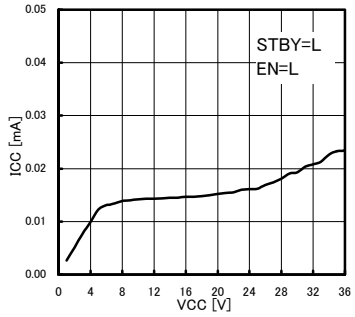


Fig..4−1 Circuit electric current (at the time of OFF mode)

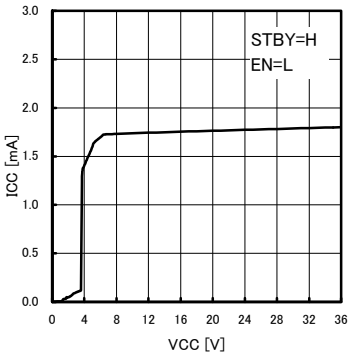


Fig..4−2 Circuit electric current (at the time of stand by mode)

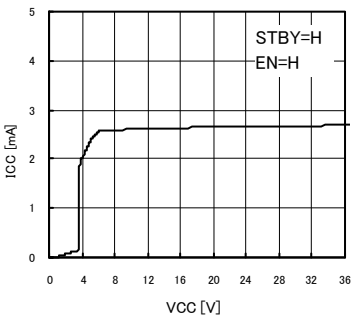


Fig..4−3 Circuit electric current (at the time of operating mode)

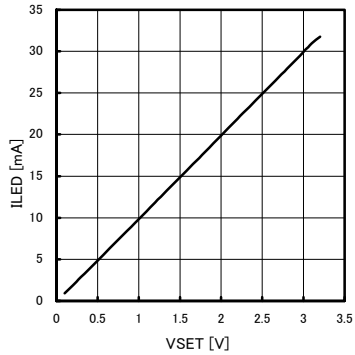


Fig..4−4 VSET Constant electric current Characteristics

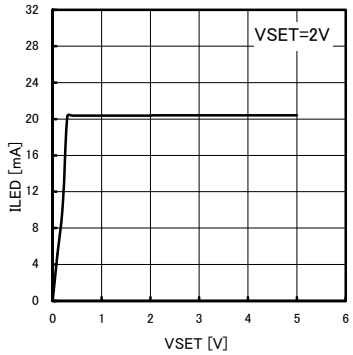


Fig..4−5 VLED Dependency of ILED

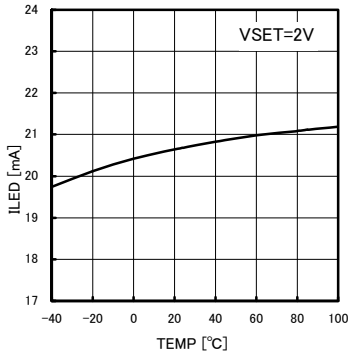


Fig..4−6 Constant electric current temperature characteristic

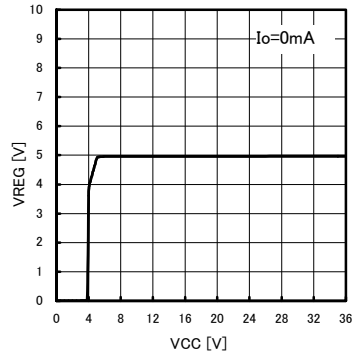


Fig..4−7 VREG_VCC characteristic

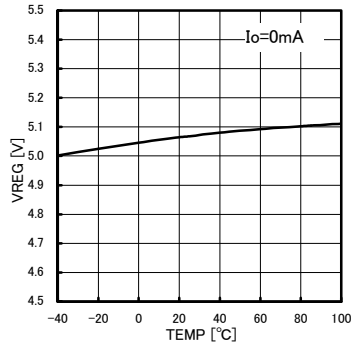


Fig..4−8 VREG temperature characteristic

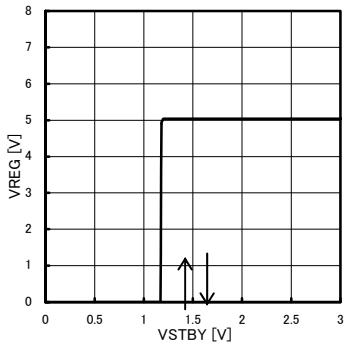


Fig..4−9 STBY Threshold voltage

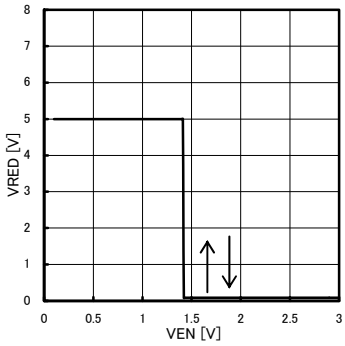


Fig..4−10 EN Threshold voltage

● Block functional descriptions

■PREREG, REF, 5VREG

PREREG is an circuit of constant voltage supplied to REF and 5VREG in which the voltage applied to VCC terminal is made to be constant.

REF is a temperature-compensated reference voltage resource and used as reference voltage of TSD (Thermal Shutdown Circuit).

5VREG is a 5V constant-voltage source and used as a power supply of constant-current driver.

The 5V constant voltage is output to VREG terminal. Moreover, it is recommended to attach a 1μF ceramic capacitor using for phase correction, to VREG terminal.

■UVLO（Under Voltage Lock Out）

The LED driver is turned OFF when the VREG voltage is less than 2.9V(typ). The operation of lighting up is reset when VREG becomes more than 3.0V(typ).

■ TSD（Thermal Shutdown Circuit）

TSD circuit protects the IC from thermo runaway or thermal damage.

TSD circuit detects the chip temperature and turns the circuit off if the chip temperature reaches 175℃. The hysteresis of 20℃ is set for TSD detection and release so as to prevent malfunction caused by temperature fluctuations.

■Current Driver（Constant-current driver）, Driver Current Setting

Current Driver(Constant-current driver) is an circuit that generates a constant current for lighting of LED.

Constant-current circuit of BD9206EFV consists of the constant current setting part and the constant current driver part. The constant-current driver part operates in such a manner that the voltage of Point a is equal to the voltage of point b because the part serves as a buffer, the input of which is the voltage VX that is set by the constant current setting part.

Therefore, the current ILED that flows into the VLED terminal is as follows:

ILED = Vb/RSET = Va/RSET = VX/RSET = VSET*A/RSET = VSET*B

（A and B are numerical constants）

For BD9206EFV, the numerical constants inside the IC are set in such a way that the following formula is brought into existence:

ILED(mA) = VSET ＊10 (VSET=0.6～3.0V)

If VSET is fixed, then the Vb is fixed, therefore the current ILED always flows independent of the fixed voltage of VLED. However, the constant current operation is stopped if the voltage of VLED terminal is less than 0.6V, so please ensure VLED>0.6V.

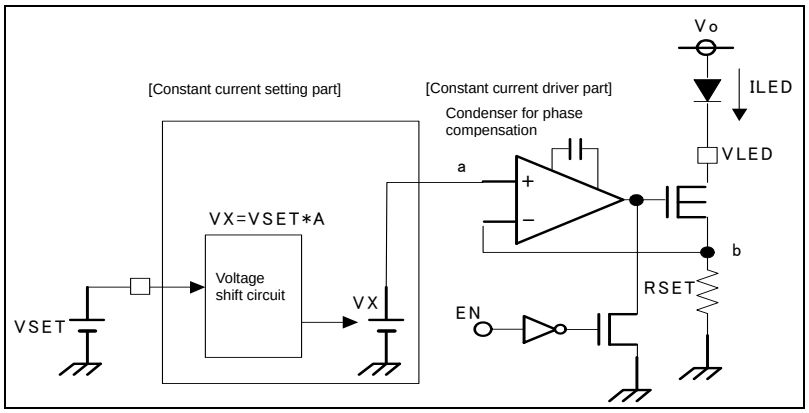


Fig..5

● Rise time and Fall time of LED Driver's constant current

In the state of STBY=H, the rise time of constant current at the time of EN=L→H and the fall time at the time of EN=H→L are as shown in the following table.
As shown in Fig.5, the constant current driver is formed in such a way that the NMOS of the driver output is made to be operated or stopped by the EN signal.
Therefore, the rise time for the second time or later is shorter than the one for the first time because the electrical charge of the capacitor for phase compensation is reopened from the charged state.

	First time	Second time or later	Remarks
Rise time	2.9μs ± 7%	2.6μs ± 7%	The time interval between the moment of EN=L→H and the moment at which the I_{LED} reaches 90% of the set value
Fall time	0.7μs ± 11%	0.7μs ± 11%	The time interval between the moment of EN=H→L and the moment at which the I_{LED} reaches 10% of the set value

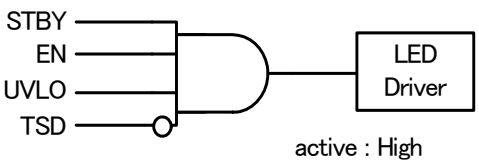
On the condition that VCC=Vo=24V, VF(LED)=3.2V 5-stage connection, RL=15Ω

■STBY, EN

At the time of STBY=L, it becomes the OFF mode, then only a portion of the circuit inside the IC is operating, so the circuit current is restricted to 17μA (typ).
At the time of STBY=H, it becomes the Standby mode, then 5VREG is started and UVLO is released before the LED driver gets into the state of Ready.
After that, if EN=L→H, then the current flows into the LED driver and the LED is lighted up.
Note: If STBY and EN are simultaneously made to be L→H, then the rising edge of the LED driver gets late because the starting time of 5VREG is necessary.
If it is used after PWM dimming, then please let STBY=H beforehand and input the CLK to EN before using.

●Operation logic of LED driver

STBY \ EN	L	H
L	Stop	Stop
H	Stop	Operation



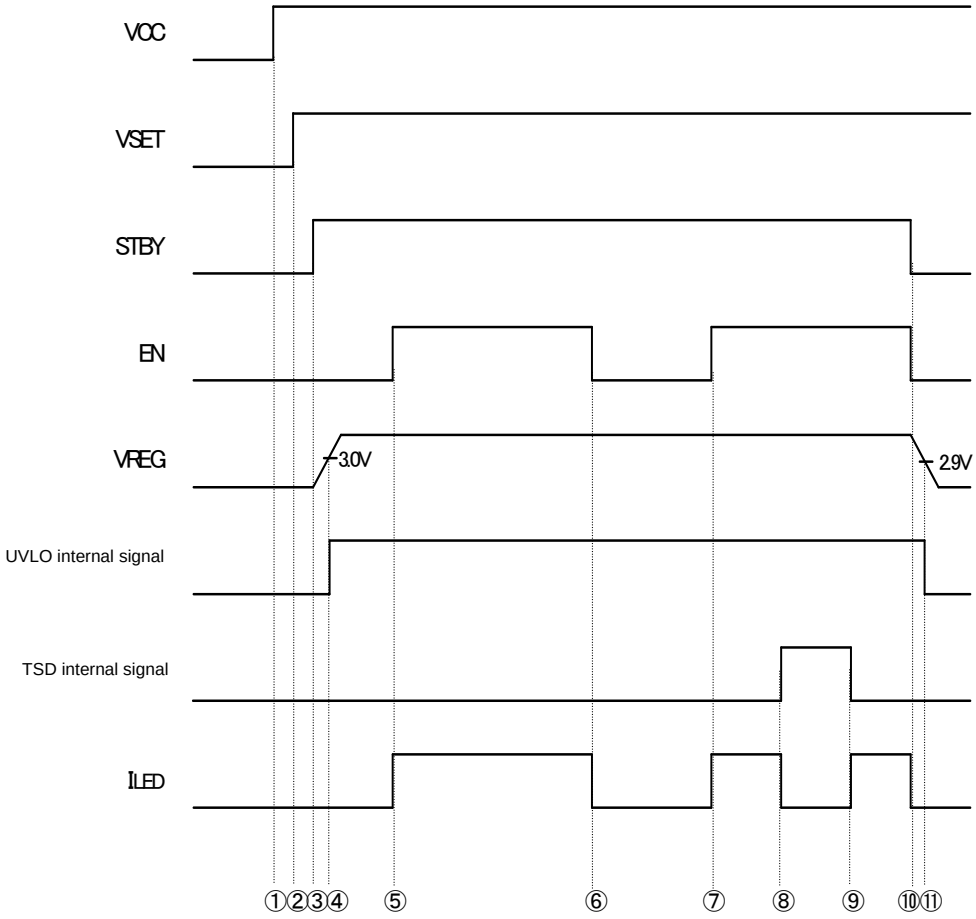
●Logic of LED driver protection circuit

Function	Stop	Operation
UVLO	VREG < 2.9V(typ)	VREG > 3.0V(typ)
TSD	Ta > 175℃	Ta < 155℃

■TEST terminal

TEST terminal is only used in ROHM's testing process before delivery, so please use the IC with the terminal fixed at Low in normal times.

●Timing chart



① VCC input.
② VSET Setting
③ It moves to OFF mode due to STBY = L -> H. 5VREG (VREG) start. Rising time ms.
④ It becomes UVLO = H depending upon VREG >3.0V, it moves to stand-by mode. As for LED driver, it is ready state.
⑤ LED Lighting with EN = L -> H .
⑥ LED lighting out with EN = H → L
⑦ it is same with ⑤
⑧ Detecting TSD with Ta > 175℃, LED lighting out
⑨ Deleting TSD with Ta < 155℃, LED lighting
⑩LED lighting out with STBY,EN=H→L
⑪Detecting UVLO=L with VREG<2.9V

Fig..7

※Please be careful about a current flowing to the VCC side via the diode for electrostatic breakdown protection if a voltage is applied to STBY terminal or EN terminal earlier than to VCC terminal.

●Recommendation of Circuit figure

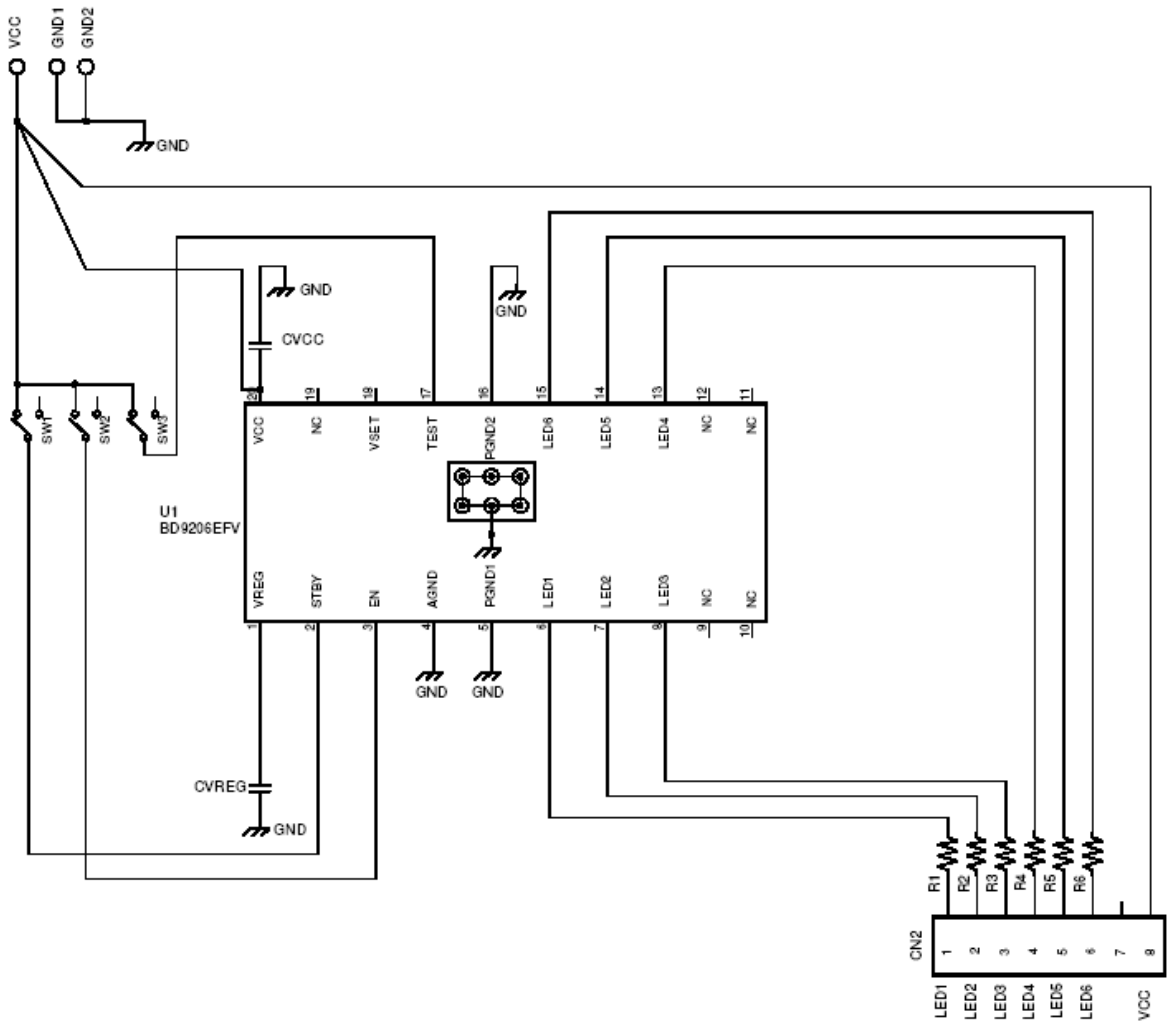


Fig..8

When you use VCC=24V ILED=20mA

Variety	Symbol	Usage	Type	Maker	Value	Unit
Resistance	R1～R6	For reducing IC thermal loss	MCR03Series15R0	ROHM	15Ω	
capacitor	CVCC	For input by-pass capacitor	GMR55DB31H106	murata	10uF	
	CVREG	For VREG phase compensation	GMR188R71A105	murata	1uF	

●The points of manufacturing substrate

For this IC, at the time of LED lighting, the temperature of the package increases due to heat generation of the constant current driver.

Therefore, please bring the radiating fin on the back side of the package down to the GND with wide substrate pattern in order to promote heat radiation.

In addition, the heat radiation can be further promoted by putting a thermal VIA in.

The heat radiation can be promoted similarly by connecting the unconnected terminals, TEST terminals and unused terminals of LED1~6 to GND.

●The calculation of electric power consumption for IC and the deciding method of external resistance value

Electric power consumption of IC is decided with formula below.

P(N)=ICC∗VCC+[(Vo−RL∗ILED)−(Vf+⊿Vf+⊿VfT)∗M]∗N∗ILED ・・・・①

ICC	:	IC Consumed electric current
VCC	:	Input voltage
Vf	:	LED Vf voltage (normal temperature typ)
⊿Vf	:	LED Vf Variation
⊿VfT	:	LED Vf Temperature variation
M	:	Stage number around LED 1 line
N	:	LED line number
ILED		LED Constant current value
Vo		Voltage OF LED anode side
RL		external resistance (external loss)

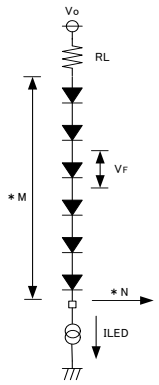


Fig..9

Please insert the heat-radiation resistor RL in order to decrease the heat radiation at the IC.

If the value of RL is made to be larger, then the heat radiation of the IC is decreased, but if the terminal voltage VLED of the LED driver is less than 0.6V, then the constant current operation becomes impossible, therefore please set the RL in such a way that the following expression is met:

VLED=Vo-(Vf+⊿Vf+⊿VfT)*M-RL*ILED>0.6V

Please set the ILED and RL in such a way that the relational expressions ① & ② are met.

Moreover, the permissible loss of the package is as shown in the following graph.

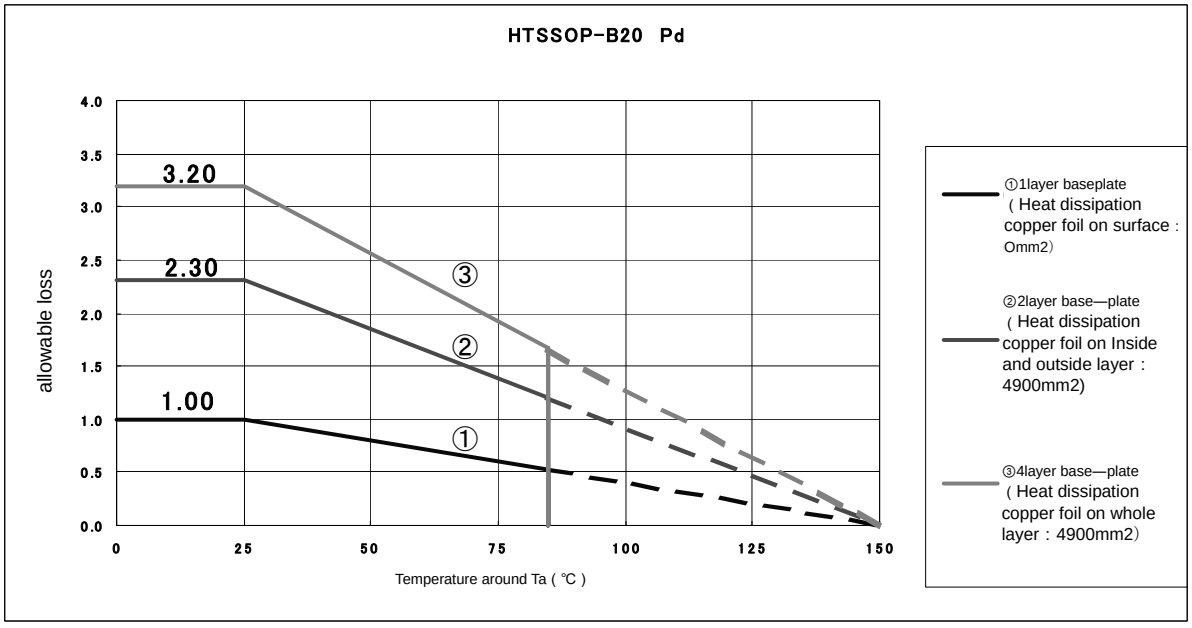
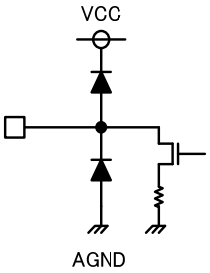
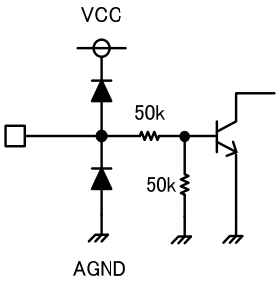
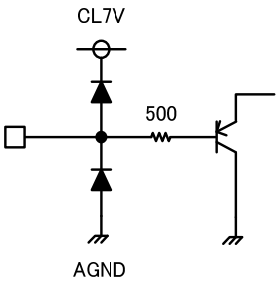
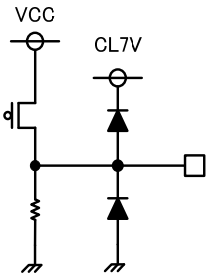
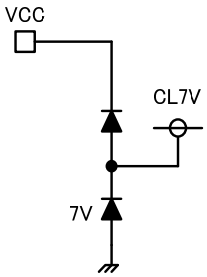
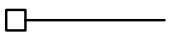


Fig..10

●**Input/output equivalent circuit**

6:LED1, 7:LED2, 8:LED3, 13:LED4, 14:LED5, 15:LED6	2:STBY 3:EN, 17:TEST
	
18:VSET	1:VREG
	
CL7V	9, 10, 11, 12, 19:N.C.
	 N.C. pin is not connected

※The voltage clamp element of 7V is connected to CL7V.

●Notes for use

1.) The absolute maximum ratings

We pay sufficient attention for quality control to this product but If the absolute maximum ratings are exceeded, such as with applied voltage or operational temperature range, a degradation or a destruction may occur. The short or open modes cannot be specified. so if special modes which exceed the absolute maximum ratings are assumed, physical safety precautions such as fuses should be in place.

2.) Reverse connection of power supply connector

The reverse connection of power connector may cause damage to IC. Please take countermeasures such as inserting a diode between the power supply and IC's external power supply pin for protection against the damage caused by the reverse connection.

3.) Power supply line

The return of the regenerated current is caused by the back electromotive force of the external coil, so please take the measures such as inserting a capacitor between power supply and GND as a route of regenerated current, and determine the capacitance value after thoroughly ensuring that there is no problems in the Characteristics of electrolyte capacitor, such as no loss of capacitance at low temperature. Heat design should take into account of power dissipation (Pd) under actual usage conditions, with wide enough margins

4.) GND Potential

The potential of the GND terminal should be the minimum potential under all operating conditions.

5.) Heat Design

Heat design should take into account of power dissipation under actual usage conditions, with wide enough margins.

6.) Short-circuiting between Terminals and Incorrect Mounting

When mounting to the PWB, pay special attention to the direction and proper placement of the IC. If the IC is attached incorrectly, it may be destroyed. Furthermore, there is also a possibility of breakdown, when the foreign body enters during outputting and between power supply and GND.

7.) The operation in the strong magnetic fields

Please be careful that there is a possibility of malfunction which is happening when you use it in a strong electromagnetic field.

8.) ASO

Please do the setting in such a way that the output Tr does not exceed the absolute maximum rating and ASO in case of using this IC. For CMOS IC and the IC with more than one power supply, a rush current may flow instantaneously at the time of power on, so please be careful about power supply coupling capacitance, power supply, GND pattern wiring width and length.

9.) Thermal shutdown circuit (TSD circuit)

This IC incorporates a built-in thermal shutdown circuit (TSD circuit). The TSD circuit is that has designed only to shut the IC off to prevent the thermal runaway operation , not for IC protection or guarantee as purpose. Therefore, please do not continue to use the IC after operating this circuit and also do not use the IC designating operation as prerequisite.

10.) Inspection of the Set Substrate

If a condenser is connected to a pin with low impedance when inspecting the set substrate, stress may be placed on the IC, so please be sure to discharge after each process. Moreover, please be sure to turn off the power supply before connecting & inspecting or before detaching when it is connected to jig at inspection process.

11.) About IC terminal input

This IC is a monolithic IC, and there are a P+ isolation and the P substrate for separation of element between each element. There is a P-N junction formed between this P-layer and each element's N-layer, forming every parasitic element, as shown in Fig.15, when resistance and transistor are connected with terminal

- In the case of GND> (terminal A) with resistance or GND>(terminal B) with transistor(NPN), the P-N junction operates as a parasitic diode.
- In addition, when GND> (terminal B) with the transistor (NPN), the parasitic NPN transistor operates due to the aforementioned parasitic diode and the N layer of the other element approached

  With the IC's configuration, the production of parasitic elements is inevitable. The operation of parasitic elements causes interferences between circuits, leading to malfunction and even destruction. Therefore, uses which cause the parasitic elements to operate, such as applying voltage to the input terminal which is lower than the GND (P-substrate), should be avoided.

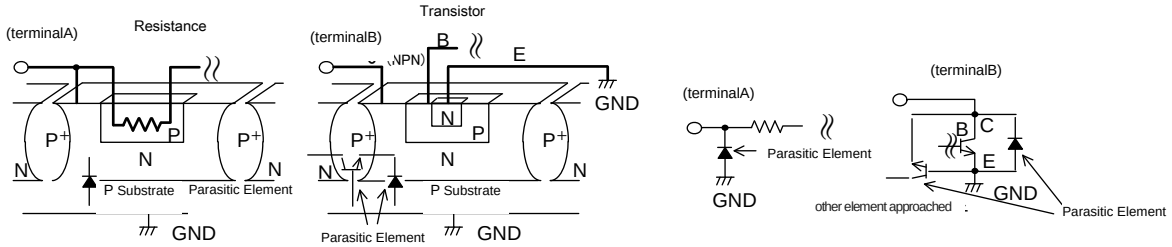


Fig.11 Simple Structure of bipolar IC (Sample)

●**Ordering part number**

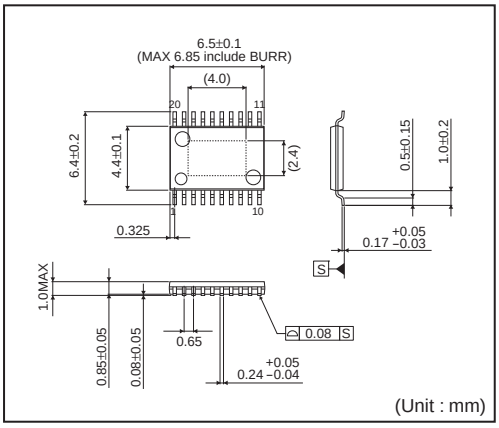
B	D	9	2	0	6	E	F	V	-	E	2

Part No. 92 06

Package
EFV: HTSSOP-B20

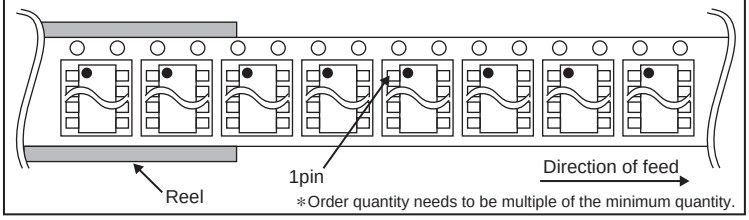
Packaging and forming specification
E2: Embossed tape and reel

HTSSOP-B20



<Tape and Reel information>

Tape	Embossed carrier tape (with dry pack)
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

Notes

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