

## Power Management ICs for Automotive Body Control

# LED Drivers for Automotive Light



BD8372HFP-M, BD8372EFJ-M

No.11039EAT13

### ●Description

BD8372HFP-M and BD8372EFJ-M are a LED source driver with the capability of withstanding high input voltage (50V MAX). The fixed current output can change in the H/L current, and it is the best for automotive LED drive. It is built into LED open/short protection, external resistance open/short protection and overvoltage overheating protection and high reliability can be achieved. When driving two or more LED by using two or more IC, it can be done to control LED all together turning off even if LED causes short/open in a certain row.

### ●Features

- 1) Input voltage range 5.5~40V
- 2) Changeable type fixed current source driver(200 mA max), Current accuracy  $\pm 3\%$ (VIN=13 V, Ta=25°C)
- 3) H/L Current setting switch control
- 4) Built-in LED open/short protection circuit
- 5) Built-in ISET open/short protection circuit
- 6) Built-in overvoltage overheating protection and temperature protection circuit
- 7) Error state output detection function (PBUS)
- 8) HRP7/HTSOP-J8 package

### ●Applications

For automotive (Lear lamp, Interior light, etc.)

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

Parameter	Symbol	Ratings	Unit
Power supply voltage	V <sub>VIN</sub>	50	V
STOP, IOU, PBUS terminal	V <sub>STOP</sub> , V <sub>IOU</sub> , V <sub>PBUS</sub>	50	V
ISETH, ISETL terminal	V <sub>ISETH</sub> , V <sub>ISETL</sub>	7	V
Power Consumption	Pd	2.3(HRP7) <sup>*1</sup>	W
		1.1(HTSOP-J8) <sup>*2</sup>	
Operating temperature range	T <sub>opr</sub>	-40~125	°C
Storage temperature range	T <sub>stg</sub>	-55~150	°C
Joint part temperature	T <sub>jmax</sub>	150	°C
IOU output maximum current	I <sub>IOU</sub>	200	mA

\*1 HRP7

IC mounted on glass epoxy 2 layer board, area 15mmx15mm of the back copper foil, measuring 70mmx70mmx1.6mm less than copper foil share 3%, power dissipated at a rate of 18.4mw/°C at temperatures above 25°C.

\*2 HTSOP-J8

IC mounted on glass epoxy 2 layer board, area 15mmx15mm of the back copper foil, measuring 70mmx70mmx1.6mm less than copper foil share 3%, power dissipated at a rate of 88mw/°C at temperatures above 25°C.

### ●Operating conditions (Ta=-40~+125°C)

[Please set after considering power consumption for the power-supply voltage.]

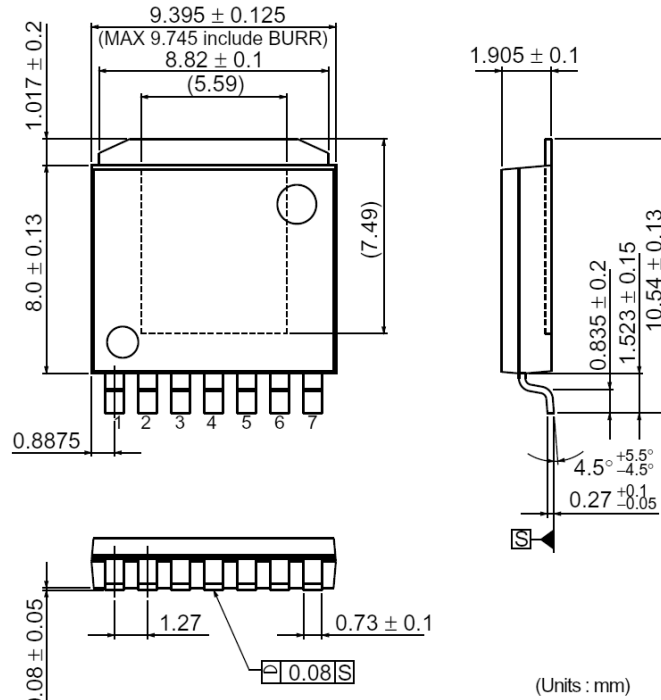
Parameter	Symbol	Ratings			Unit	Conditions
		Min.	Typ.	Max.		
Power supply voltage	V <sub>VIN</sub>	5.5	13	40	V	-
Current setting resistance	R <sub>ISETH</sub>	10k	-	100k	Ω	STOP=H
	R <sub>ISETL</sub>	10k	-	100k	Ω	STOP=L

●Electrical characteristics (unless otherwise specified, Ta=-40~125°C, VIN=13V, R<sub>ISETL</sub>=R<sub>ISETH</sub>=40kΩ, PBUS=10kΩ)

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Circuit current	IVIN	-	2.9	5	mA	
IOUT output current different width H	IOUT_H	48.5	50	51.5	mA	50mA setting (ISET=40kΩ) STOP=High, Ta=25°C
		46	50	54	mA	50mA setting (ISET=40kΩ) STOP=High, Ta=-40~125°C
IOUT output current different width L	IOUT_L	4.85	5	5.15	mA	5mA setting (ISET=40kΩ) STOP=Low, Ta=25°C
		4.6	5	5.4	mA	5mA setting (ISET=40kΩ) STOP=Low, Ta=-40~125°C
IOUT drop voltage H	VDRH_IOUT	-	0.7	1.2	V	200mA setting(ISET=10kΩ) STOP=High
IOUT drop voltage L	VDRL_IOUT	-	0.5	0.7	V	20mA setting(ISET=10kΩ) STOP=Low
IOUT OFF current	I <sub>IOUT_OFF</sub>	-	-	1	μA	V <sub>IOUT</sub> =2V, PBUS=L, Ta=25°C
IOUT current at GND short	I <sub>IOUT_SHORT</sub>	-	-	40	μA	V <sub>IOUT</sub> =0V
ISET current	I <sub>ISET</sub>	-	0.8	-	μA	I <sub>SETH</sub> , I <sub>SETL</sub>
ISET short detection	V <sub>ISET_SHORT</sub>	-	5.1k	7.5k	V	I <sub>SETH</sub> , I <sub>SETL</sub>
ISET open detection	V <sub>ISET_OPEN</sub>	125k	400k	-	V	I <sub>SETH</sub> , I <sub>SETL</sub>
IOUT LED OPEN detection	V <sub>IOUT_OPEN</sub>	VIN-0.3	VIN-0.2	VIN-0.1	V	
IOUT LED short detection	V <sub>IOUT_SHORT</sub>	0.2	0.6	1.0	V	
STOP input voltage H	V <sub>IH_STOP</sub>	4.0	-	VIN+0.2	V	
STOP input voltage L	V <sub>IL_STOP</sub>	GND	-	1.0	V	
STOP input current	V <sub>IN_STOP</sub>	-	40	100	μA	STOP=13V
PBUS input voltage H	V <sub>IH_PBUS</sub>	4.0	-	VIN+0.2	V	
PBUS input voltage L	V <sub>IL_PBUS</sub>	GND	-	2.0	V	
PBUS Low voltage	V <sub>OL_PBUS</sub>	-	-	1.5	V	IPBUS=20mA
PBUS input current	I <sub>IN_PBUS</sub>	-	38	100	μA	PBUS=13V
VIN Reduce voltage open mask	V <sub>UVLO_IOPEN</sub>	7.5	8.0	8.5	V	
VIN Over voltage mute current	V <sub>IN_OVPMUTE</sub>	16	19	24	V	200mA setting (ISET=10kΩ) STOP=High

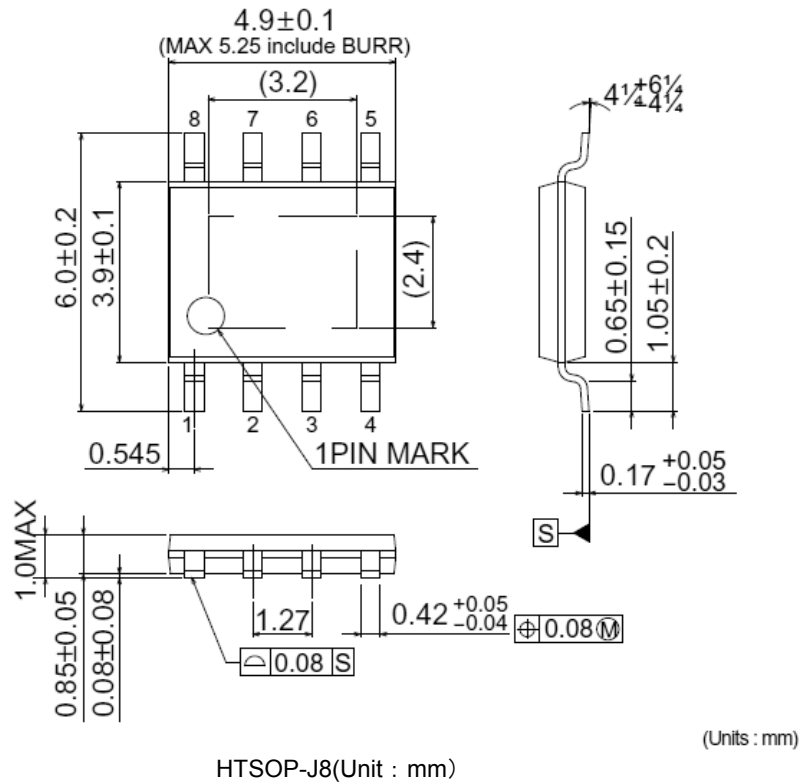
※This product is not designed for use in radioactive environments.

● Package outline



HRP7(Unit : mm)

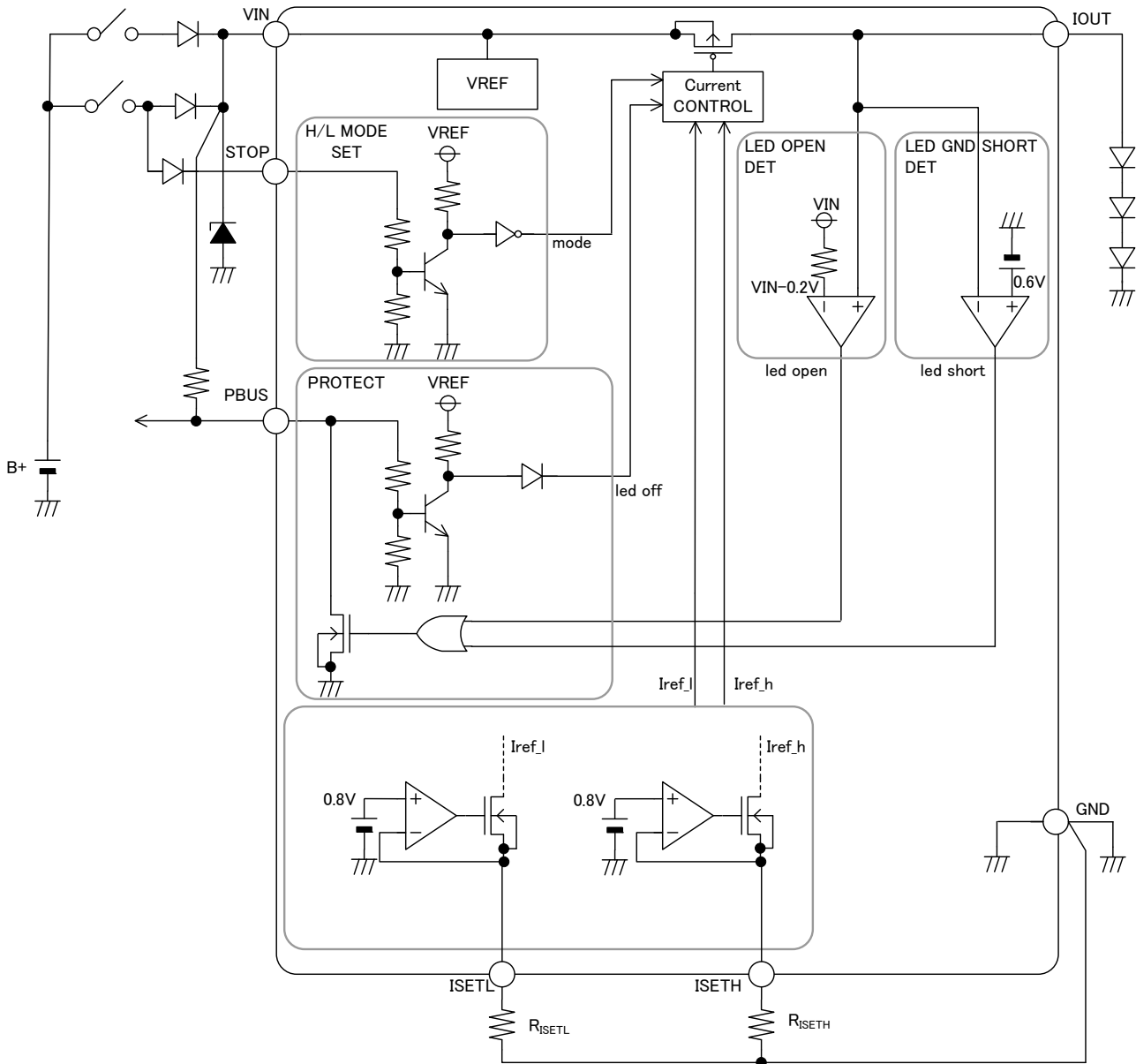
(Units : mm)



HTSOP-J8(Unit : mm)

(Units : mm)

●Block diagram



●Pin description

HRP7

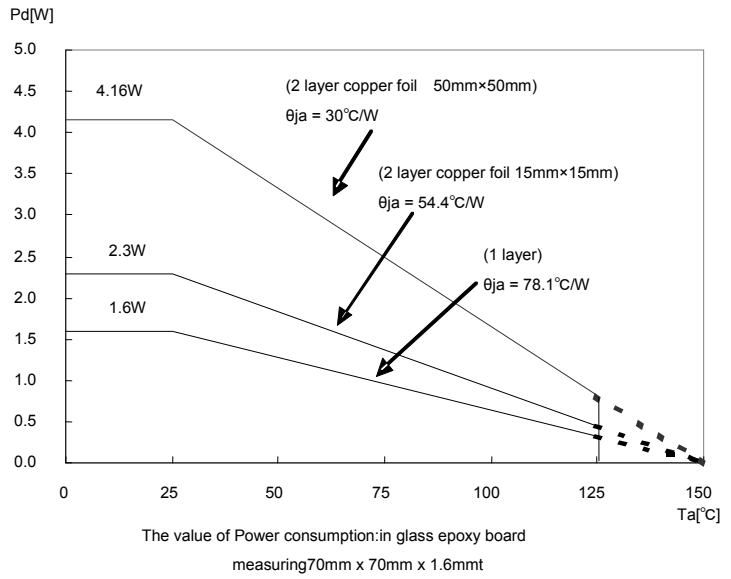
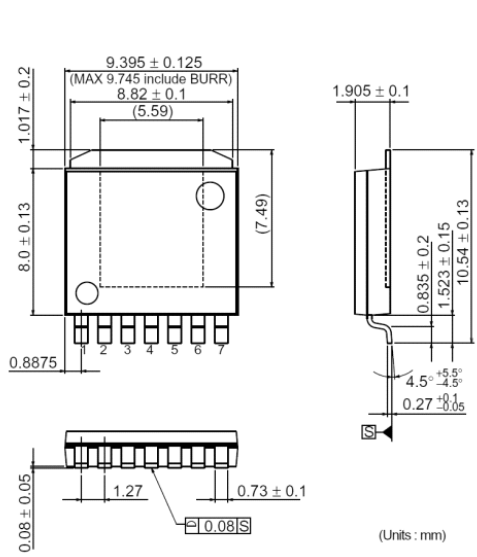
No.	Symbol	Description
1	STOP	Brake light input terminal
2	PBUS	Error detection I/O terminal
3	ISETL	Current setting terminal(L mode)
4	GND	GND
5	ISETH	Current setting terminal(H mode)
6	VIN	Lighting signal
7	IOUT	Current output terminal

HTSOP-J8

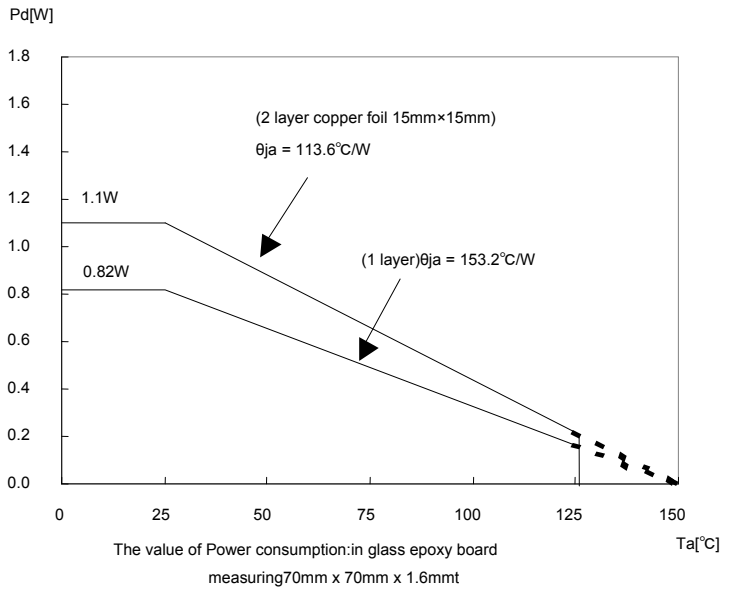
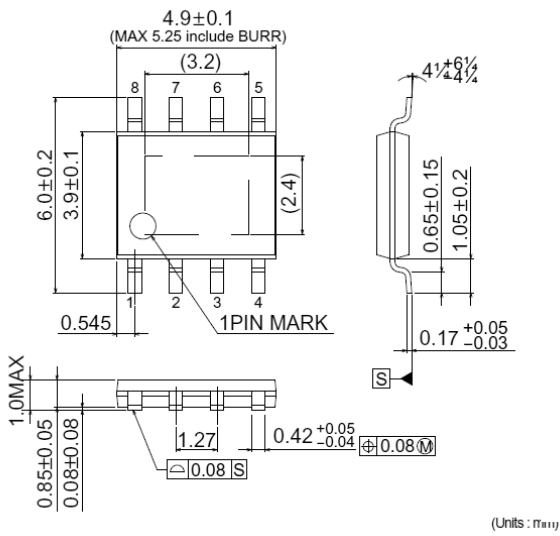
No.	Symbol	Description
1	VIN	Lighting signal
2	IOUT	Current output terminal
3	GND	GND
4	GND	GND
5	STOP	Brake light input terminal
6	PBUS	Error detection I/O terminal
7	ISETL	Current setting terminal(L mode)
8	ISETH	Current setting terminal(H mode)

●Electrical characteristic curves

HRP7



HTSOP-J8



●Equivalent-circuit diagram of the terminals

Pin No.	Pin name	Equivalent-circuit diagram of the terminals
1	STOP	
2	PBUS	
3	ISETL	
4	GND	-

Pin No.	Pin name	Equivalent-circuit diagram of the terminals
5	ISETH	
6	VIN	-
7	IOOUT	

●Function description

(Unless otherwise specified, VIN=13V, R<sub>ISETL</sub>=R<sub>ISETH</sub>=40kΩ, The numerical value in the table has described the TYP value.)

Table for operation

STIOP	VIOUT	R <sub>ISETL</sub>	R <sub>ISETH</sub>	MODE	IOUT_	PBUS
L	2.V<VIOUT<12.3V	10kΩV≤R <sub>ISETL</sub> ≤100kΩ	-	L mode normal operation	2mA~20mA	Hi-Z
H	2V<VIOUT<11.8V	-	10kΩV≤R <sub>ISETH</sub> ≤100kΩ	H mode normal operation	20mA~200mA	Hi-Z
L/H	VIOUT≤0.6V	-	-	Output short	40μA(max)	LOW output
L/H	12.8V≤VIOUT	-	-	Output open	1μA(max)	LOW output
L	-	R <sub>ISETL</sub> <7.5kΩ/ 125kΩ<R <sub>ISETL</sub>	-	ISETL short / ISETL open	1μA(max)	LOW output
H	-	-	R <sub>ISETH</sub> <7.5Ω/ 125kΩ<R <sub>ISETH</sub>	ISETH short / ISETH open	1μA(max)	LOW output
L	2.V<VIOUT<12.3V	10kΩV≤R <sub>ISETL</sub> ≤100kΩ	-	PBUS control OFF	1μA(max)	LOW input
H	2.V<VIOUT<11.8V	-	10kΩV≤R <sub>ISETH</sub> ≤100kΩ	PBUS control OFF	1μA(max)	LOW input

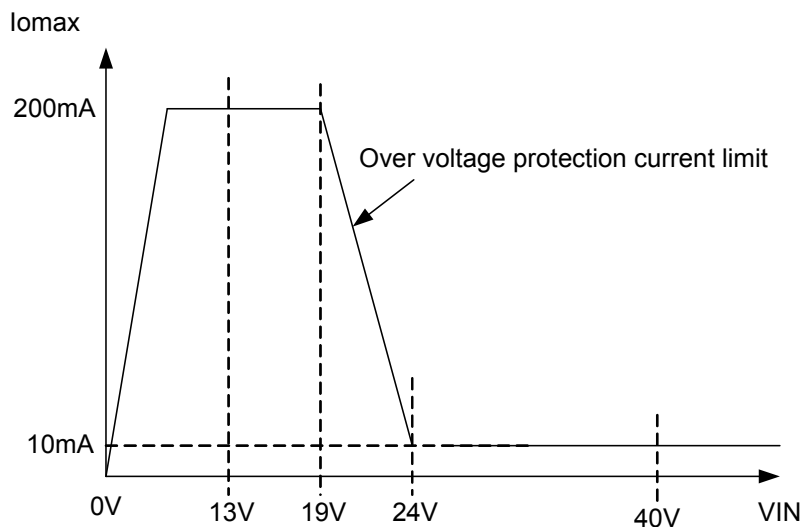
Protection mode operation voltage

VIN	LED open	LED short	ISET open	ISET short	PBUS	Overvoltage protection
5.5V<VIN≤8V	×	○	○	○	○	×
8V≤VIN	○	○	○	○	○	×
19V≤VIN	○	○	○	○	○	○

○ : Protection mode effective

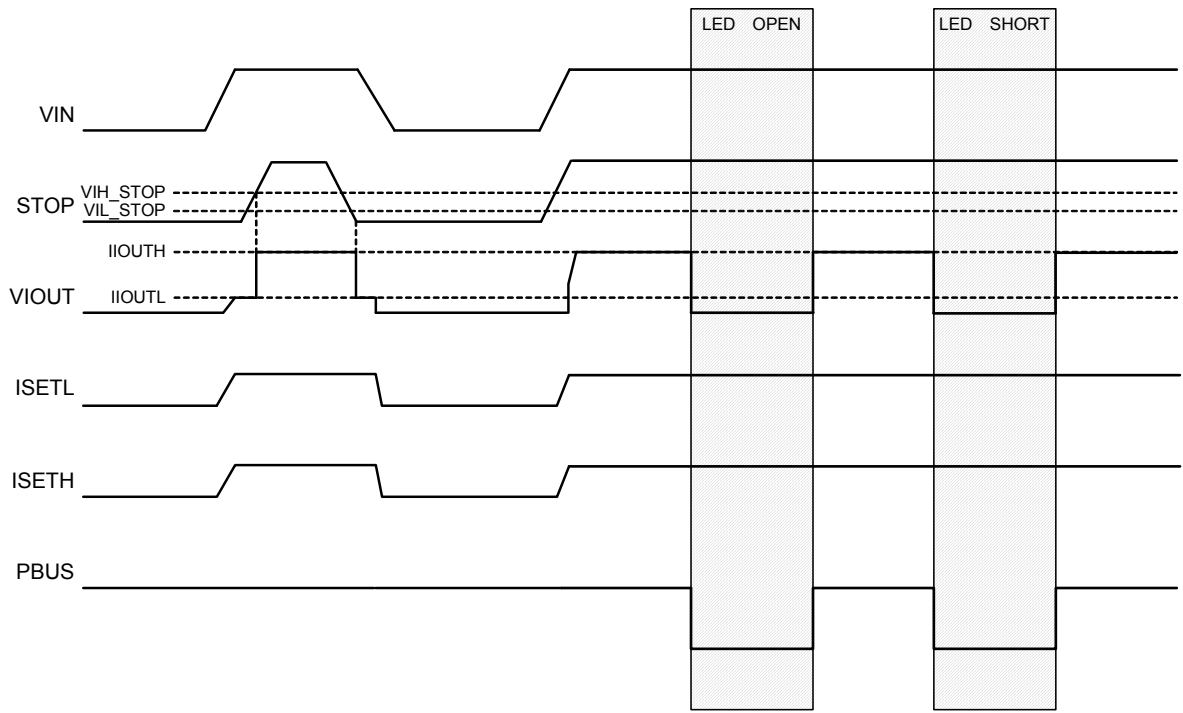
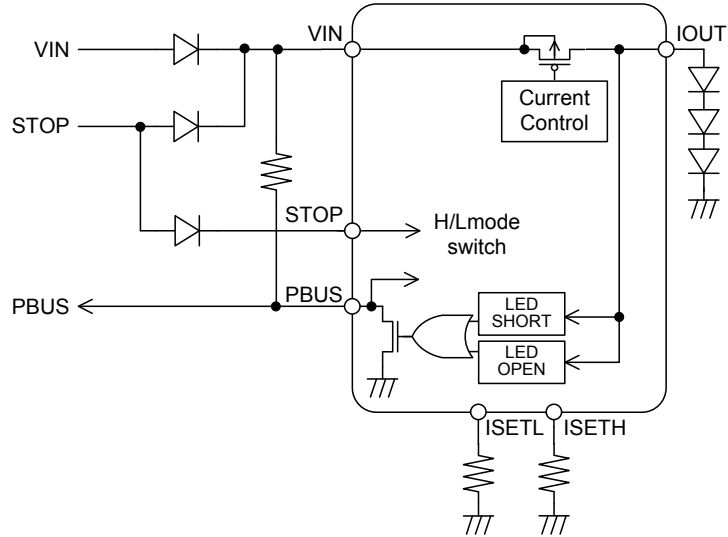
× : Protection mode invalidity

The LED open function is masked with VIN≤8V. For the over voltage protection to operate in 18V≤VIN, and the output current is derating to suppress the generation of heat rise of IC.



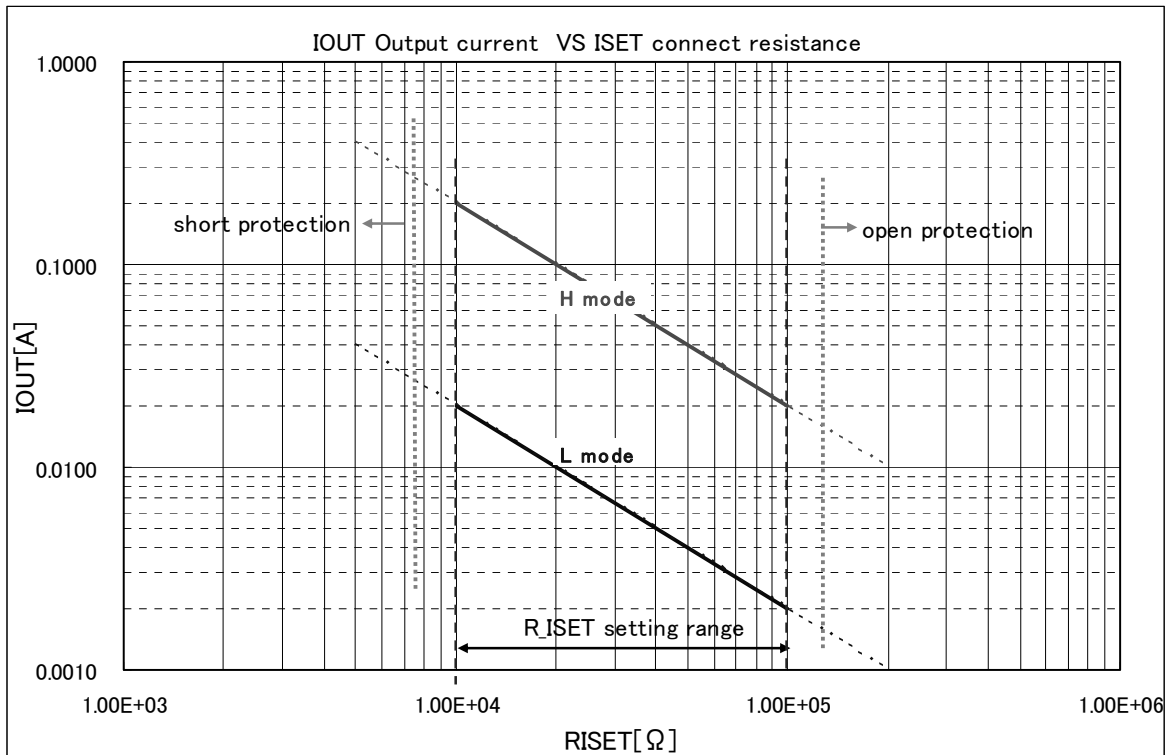
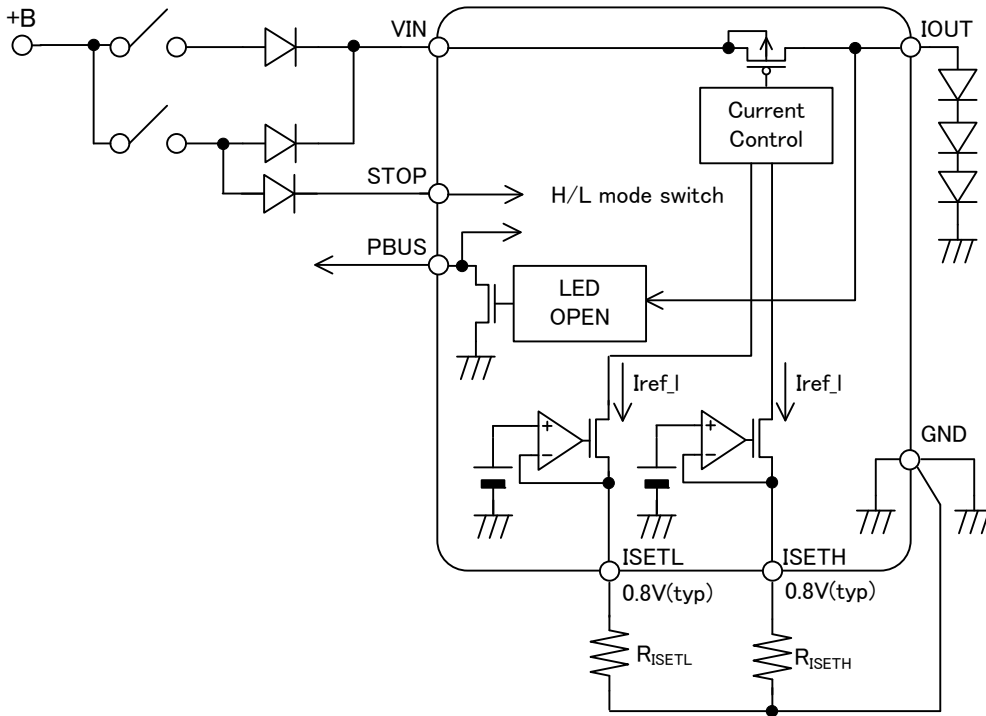


●Timing chart



● Method of setting current

ISETL/ISETH generates a standard Voltage respectively in IC (0.8V typ). A standard current is generated by connecting resistance with ISET terminal, and the current is converted internally and it outputs.



• L mode(STOP=Low)

• H mode(STOP=High)

$$I_{OUT} = \frac{0.8V}{R_{ISETL}} \times 250[A]$$

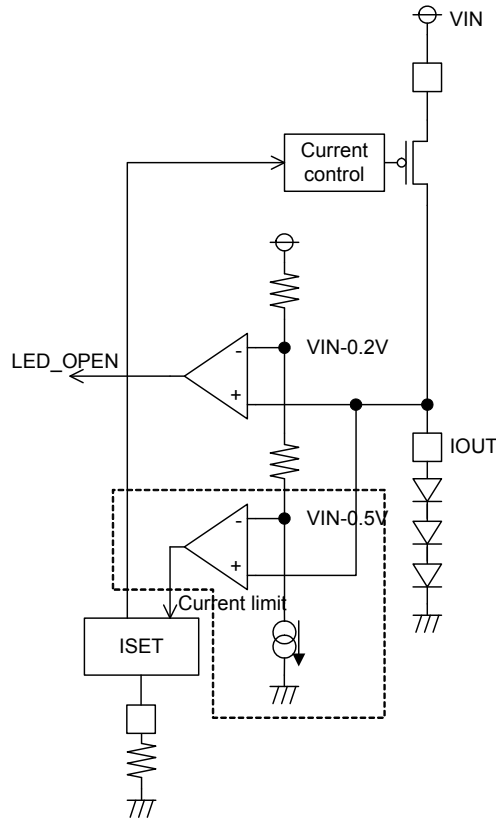
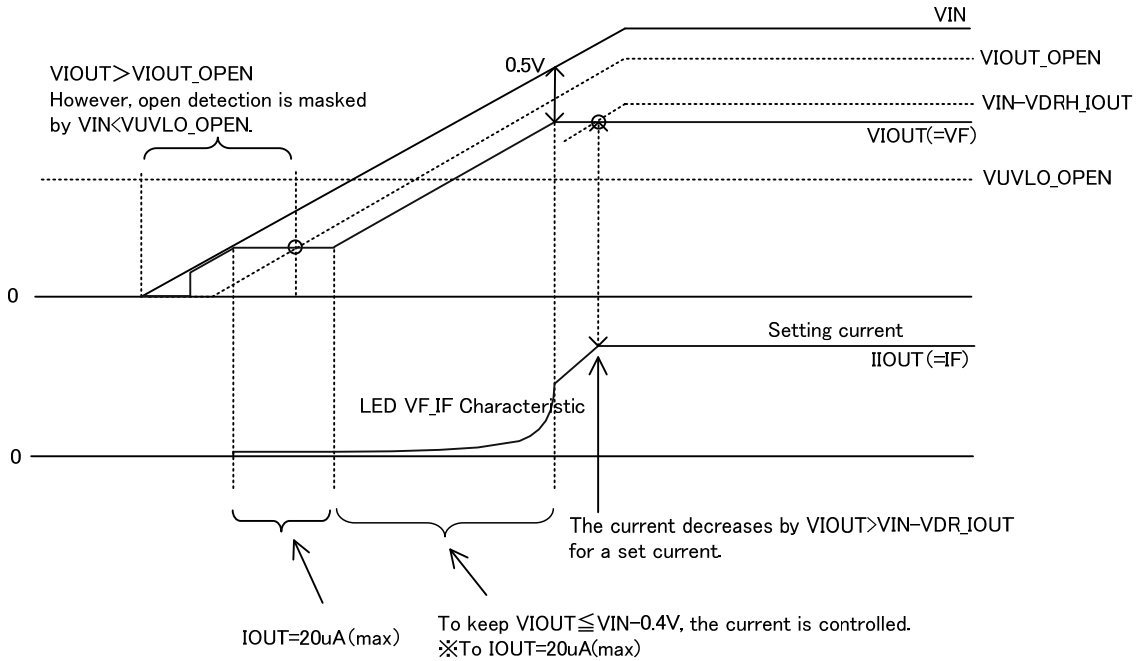
$$I_{OUT} = \frac{0.8V}{R_{ISETH}} \times 2500[A]$$

exp)  $R_{ISETL} = 1.6k\Omega$   $I_{OUT} = \frac{0.8V}{40k\Omega} \times 250 = 5[mA]$

exp)  $R_{ISETH} = 40k\Omega$   $I_{OUT} = \frac{0.8V}{40k\Omega} \times 2500 = 50[mA]$

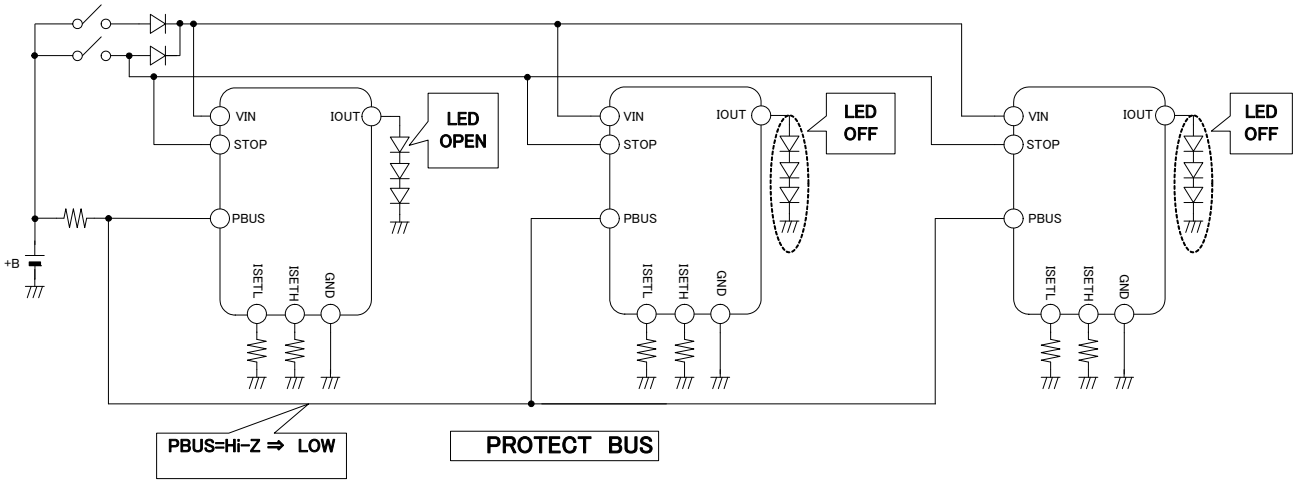
●Current control at output saturation

When  $V_{IOUT}(=V_F)$  exceeds  $V_{IN}-0.4V$ , the current is decreased for a set current. Therefore, because  $V_F$  decreases due to  $I_F$  decrease of LED, Threshold  $V_{IOUT}=V_{IN}-0.2V$  of open detection can be prevented keeping the relation of  $V_{IOUT} \leq V_{IN}-0.4V$ , and being exceeded. The current control must become  $I_{OUT} < 20\mu A$  and  $I_F$  must select LED for  $V_F$  not to exceed  $V_{UVLO\_OPEN}$  by  $20\mu A$ .

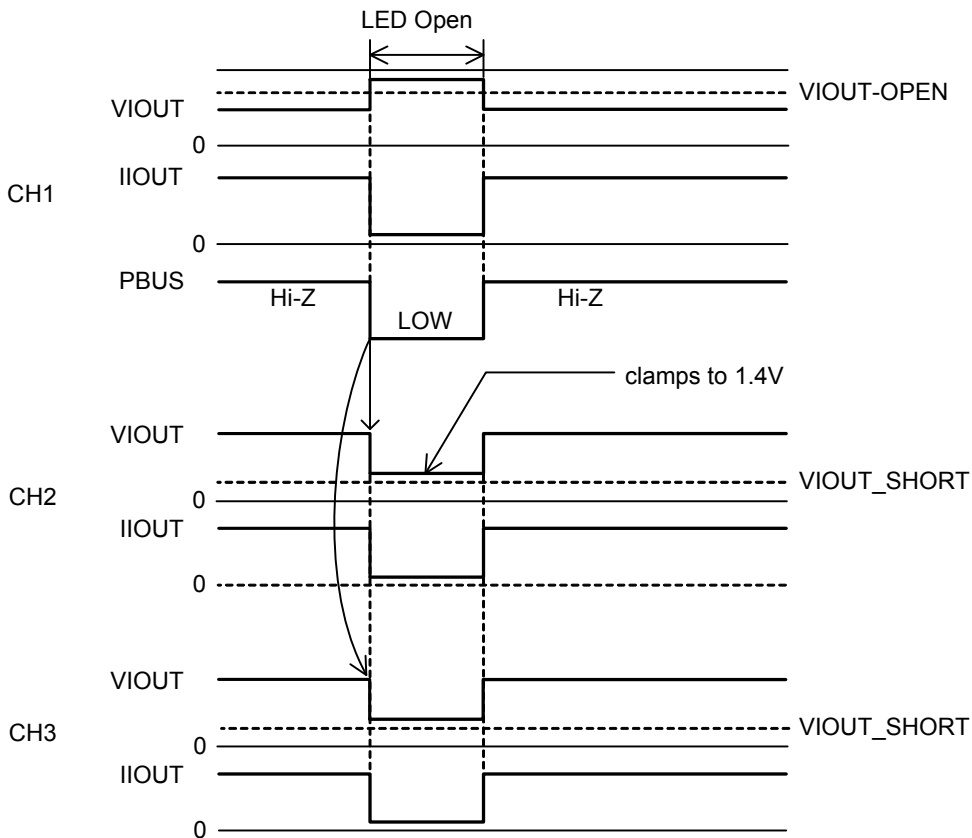


●PROTECT BUS (PBUS)

PBUS is an I/O terminal that outputs error and the terminal that detects error. When error occurs because of open/short of external parts etc. , Low is output from Hi(Hi-Z) with PBUS terminal, and it is possible to detect error from the outside. The output current can be turned off by controlling. PUBS to Hi→Low from outside. LED of all rows can control turning off even if open/short circuit of LED occurs because it connects the terminal PBUS of each CH as shown in following figure when driving two or mode LED by using two or mode this IC.



- Example of operating protection by LED open



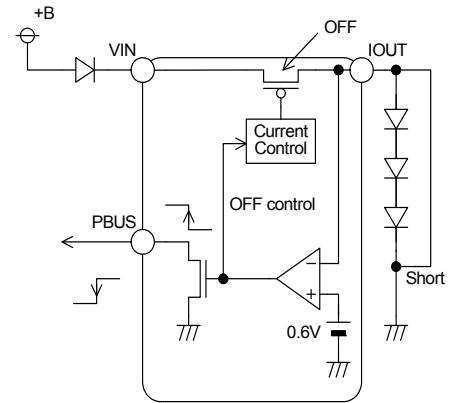
PBUS becomes LOW from Hi-Z because of the LED open. Turning off the LED driver of another CH detects error and LED is controlled by PUBS becomes Low. VIOUT clamps to 1.4V and prevents GND short detection in the matrix at turning off.

## ● Protection function

As for this IC, short/open protection of external parts is built into, and it is possible to detect error with the terminal PUBS.

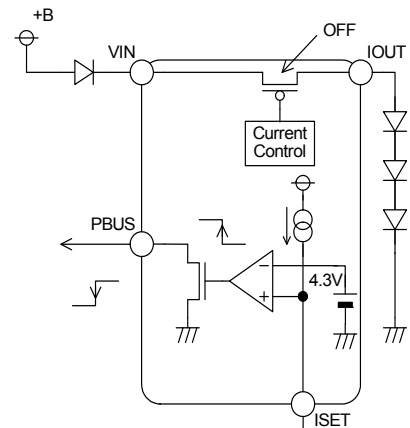
### ① LED open detecting function

When LED connected with the terminal IOOUT is opened, open detection is done by the terminal IOOUT becomes an overvoltage. The terminal PUBS is made Low and it informs of error.



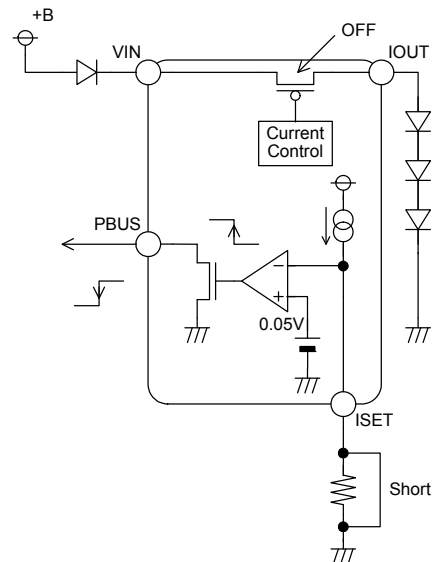
### ② LED short detecting function

When LED connected with the terminal IOOUT becomes short, it detects short by the terminal IOOUT becomes a low voltage. The output current is turned off, the heat destruction of IC is prevented, the terminal PUBS is made Low, and it informs of error.



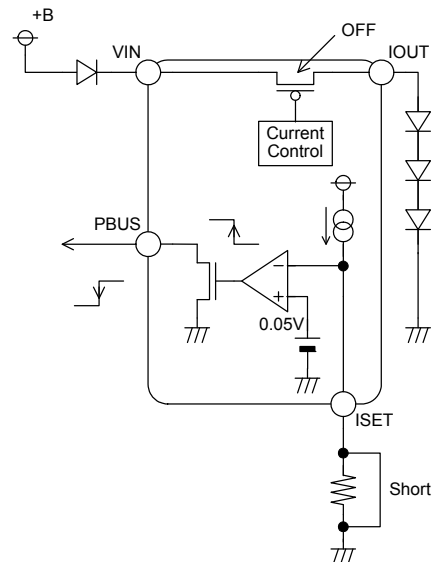
### ③ ISET(H/L) open detecting function

When the external resistance connected with the terminal ISET is opened, open detection is done. The output current is turned off, PUBS is made Low, and it informs of error. When it doesn't depend on the mode and either terminal is opened, the terminal ISET is detected for H mode and for L mode though it exists by two terminals.



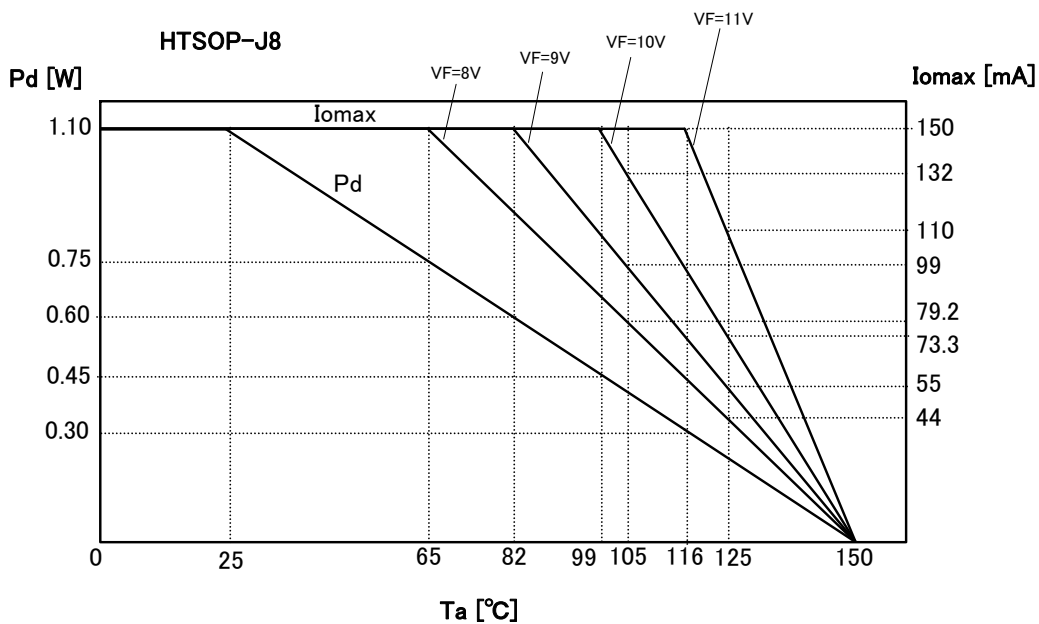
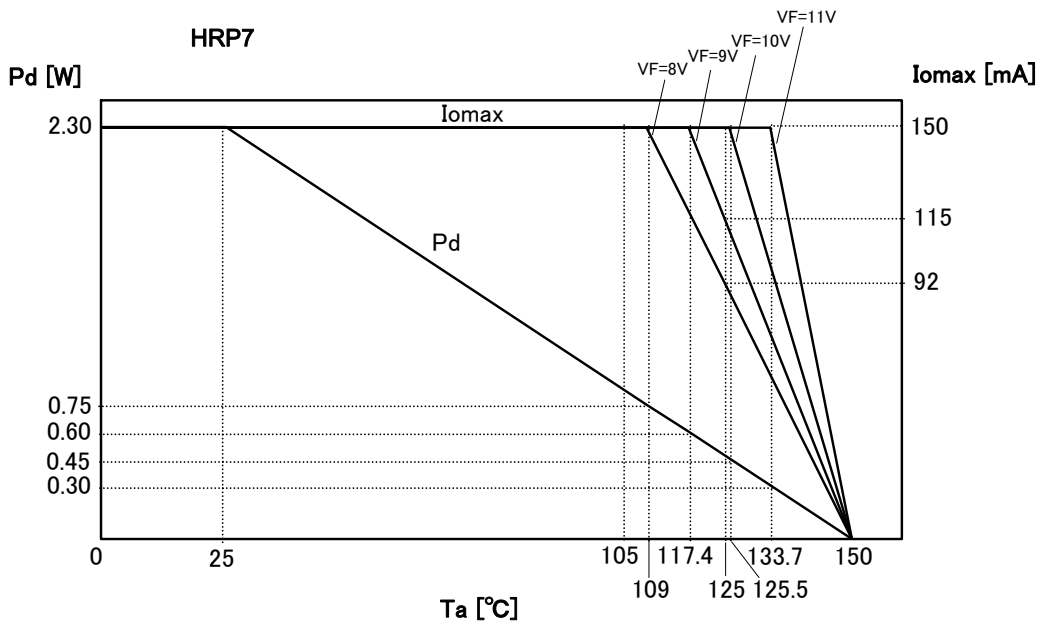
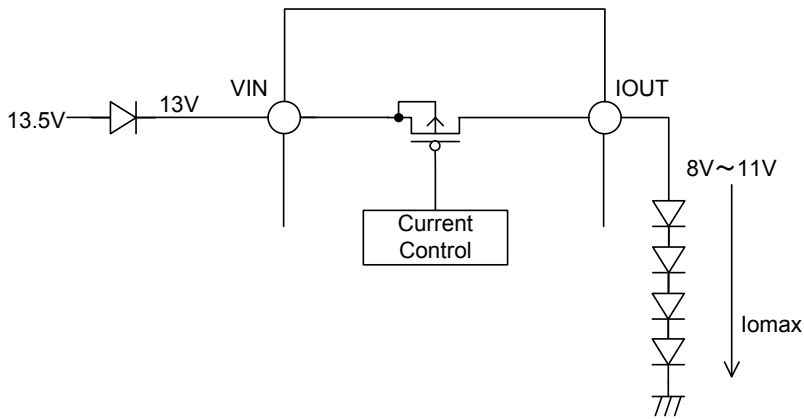
### ④ ISET(H/L) short detecting function

When the external resistance connected with the terminal ISET becomes short, it detects short. The output is turned off, the overcurrent is prevented, PUBS is made Low, and it informs of error. When it doesn't depend on the mode and either terminal becomes short, the terminal ISET is detected for H mode and for L mode though it exists by two terminals.



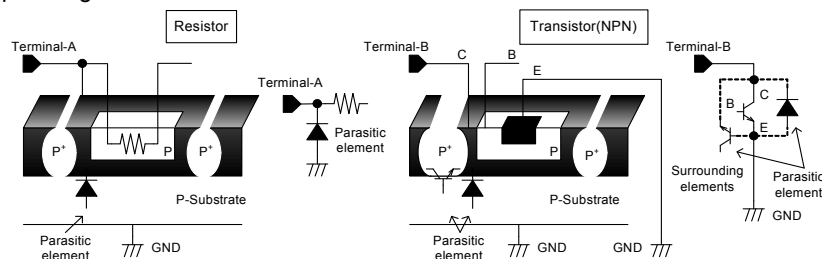
●Pd(Power dissipation) and Iomax (Permissible current)

The relation between Pd and Iomax by VF of LED connected with IOOUT is shown.



### ●Notes for use

- Absolute maximum ratings**  
We are careful enough for quality control about this IC. So, there is no problem under normal operation, excluding that it exceeds the absolute maximum ratings. However, this IC might be destroyed when the absolute maximum ratings, such as impressed voltages or the operating temperature range ( $T_{opr}$ ), is exceeded, and whether the destruction is short circuit mode or open circuit mode cannot be specified. Please take into consideration the physical countermeasures for safety, such as fusing, if a particular mode that exceeds the absolute maximum rating is assumed.
- Reverse polarity connection**  
Connecting the power line to the IC in reverse polarity (from that recommended) will damage the part. Please utilize the direction protection device as a diode in the supply line.
- Power supply line**  
Please design the power supply line where a large current is thrown to reduce the resistance of the wiring for the power supply pattern so that there is a possibility of usually influencing operation.
- GND line**  
The ground line is where the lowest potential and transient voltages are connected to the IC.  
Please confirm whether there is actually terminal that is the voltage of GND or less including transients.
- Thermal design**  
Do not exceed the power dissipation ( $P_d$ ) of the package specification rating under actual operation, and please design enough temperature margins. This product has exposed the frame to the back side of the package, but please note that it is assumed to use heat radiation efficiency by the heat radiation for this part. Please take the heat radiation pattern on not only the surface of the substrate but also the back of the substrate widely.
- Short circuit mode between terminals and wrong mounting**  
Do not mount the IC in the wrong direction and displacement, and be careful about the reverse-connection of the power connector. Moreover, this IC might be destroyed when the dust short the terminals between them or GND.  
(The outputs of CH1(pin2,3) have NO protection circuit. So please especially be careful about them.)
- Radiation**  
Strong electromagnetic radiation can cause operation failures.
- TSD (Thermal Shut-Down)**  
The TSD is activated when the junction temperature ( $T_j$ ) exceeds  $T_{jmax}$ , and the output terminal is switched to OPEN.  
The guarantee and protection of set are not purpose. Therefore, please do not use this IC after TSD circuit operates, nor use it for assumption that operates the TSD circuit.
- Inspection by the set circuit board**  
The stress might hang to IC by connecting the capacitor to the terminal with low impedance. Then, please discharge electricity in each and all process. Moreover, when attaching or detaching from jig in the inspection process, please turn off the power before mounting the IC, and turn on after mounting the IC, and vice versa. In addition, please take into consideration the countermeasures for electrostatic damage, such as giving the earth in assembly process, transportation or preservation.
- Input terminal**  
This IC is a monolithic IC, and has  $P^+$  isolation and P substrate for the element separation. Therefore, a parasitic PN junction is formed in this P-layer and N-layer of each element. For instance, the resistor or the transistor is connected to the terminal as shown in the figure below. When the GND voltage potential is greater than the voltage potential at Terminals A on the resistor, at Terminal B on the transistor, the PN junction operates as a parasitic diode. In addition, the parasitic NPN transistor is formed in said parasitic diode and the N layer of surrounding elements close to said parasitic diode. These parasitic elements are formed in the IC because of the voltage relation. The parasitic element operating causes the interference of circuit operation, then the wrong operation and destruction. Therefore, please be careful so as not to operate the parasitic elements by impressing to input terminals lower voltage than GND (P substrate). Please do not apply the voltage to the input terminal when the power-supply voltage is not impressed. Moreover, please impress each input terminal lower than the power-supply voltage or equal to the specified range in the guaranteed voltage when the power-supply voltage is impressing.



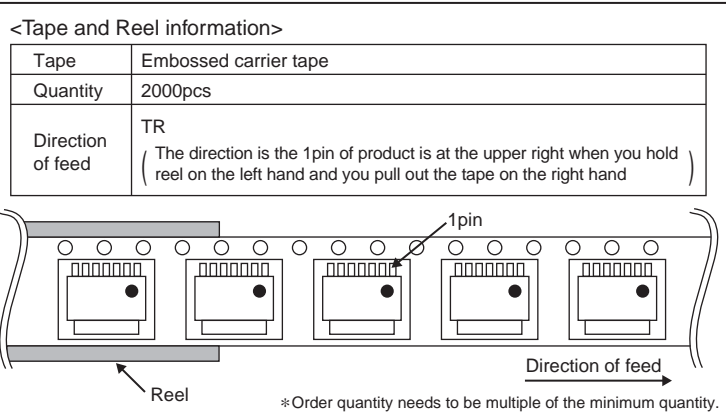
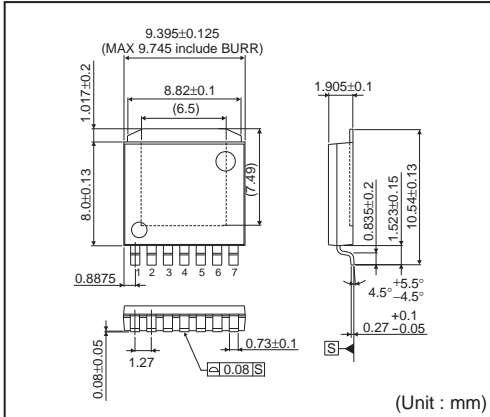
Example of IC of simple structure

- About a steep change of the  $V_{cc}$  voltage**  
There is a possibility of generating a large current because MOS is used for the output transistor when the input voltage change is steep. Please select external parts after it verifies it enough by a real application including the transition change.

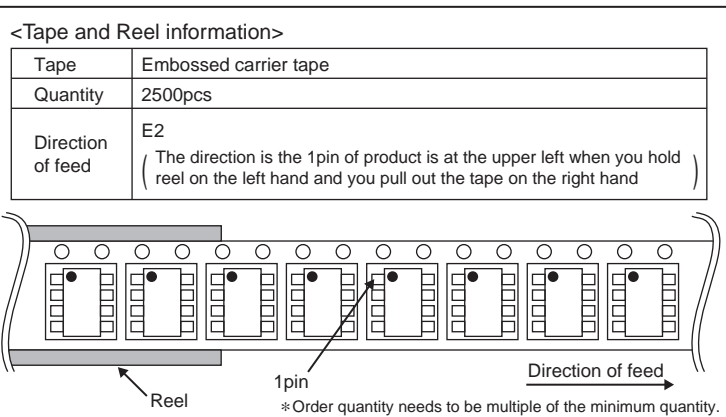
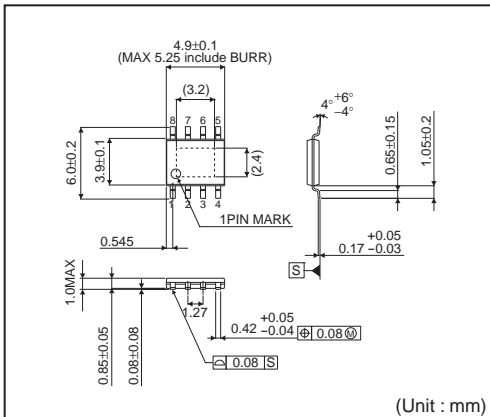
● Ordering part number

B	D	8	3	7	2	H	F	P	-	M	T	R
Part No.		Part No. 8372				Package HFP : HRP7 EFJ : HTSOP-J8			for Automotive		Packaging and forming specification TR: Embossed tape and reel (HRP7) E2: Embossed tape and reel (HTSOP-J8)	

HRP7



HTSOP-J8





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