

Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated circuit

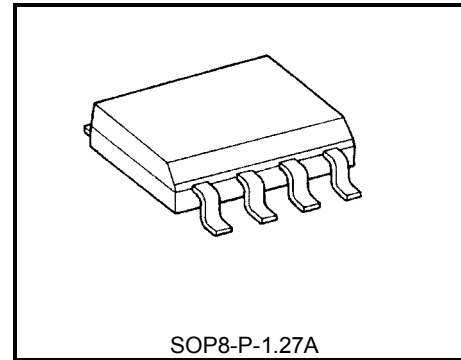
# TPD1038F

Motor, Solenoid, Lamp Drivers  
High Side Power Switch

TPD1038F is a monolithic power IC for high-side switches. The IC has a vertical MOS FET output which can be directly driven from a CMOS or TTL logic circuit (eg, an MPU). The device offers intelligent self-protection and diagnostic functions.

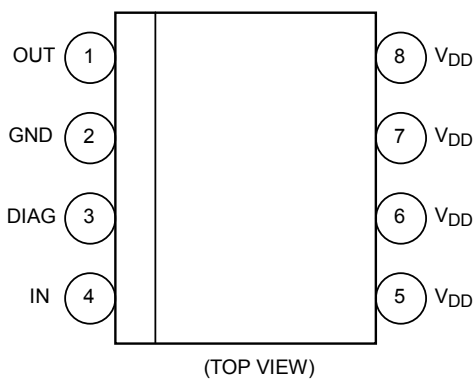
## Features

- A monolithic power IC with a structure combining a control block (Bi-CMOS) and a vertical power MOS FET on a single chip.
- One side of load can be grounded to a high-side switch.
- Can directly drive a power load from a microprocessor.
- Built-in protection against overheating and load short circuiting.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short-circuiting, opening, or overheating.
- Up to  $-(50-V_{DD}) \sim -(60-V_{DD})$  of counterelectromotive force from an L load can be applied.
- Low on Resistance :  $R_{DS(ON)}=120m\Omega$  (max) ( @  $V_{DD} = 12 V$ 、 $T_a = 25^\circ C$ 、 $I_o = 2 A$  )
- 8-pin SOP package for surface mounting can be packed in tape.

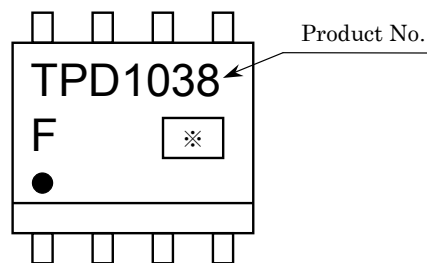


Weight : 0.08g(typ.)

## Pin Assignment



## Marking



(●) on lower left of the marking indicates Pin1.

※Lot Number

Weekly code : (Three digits)

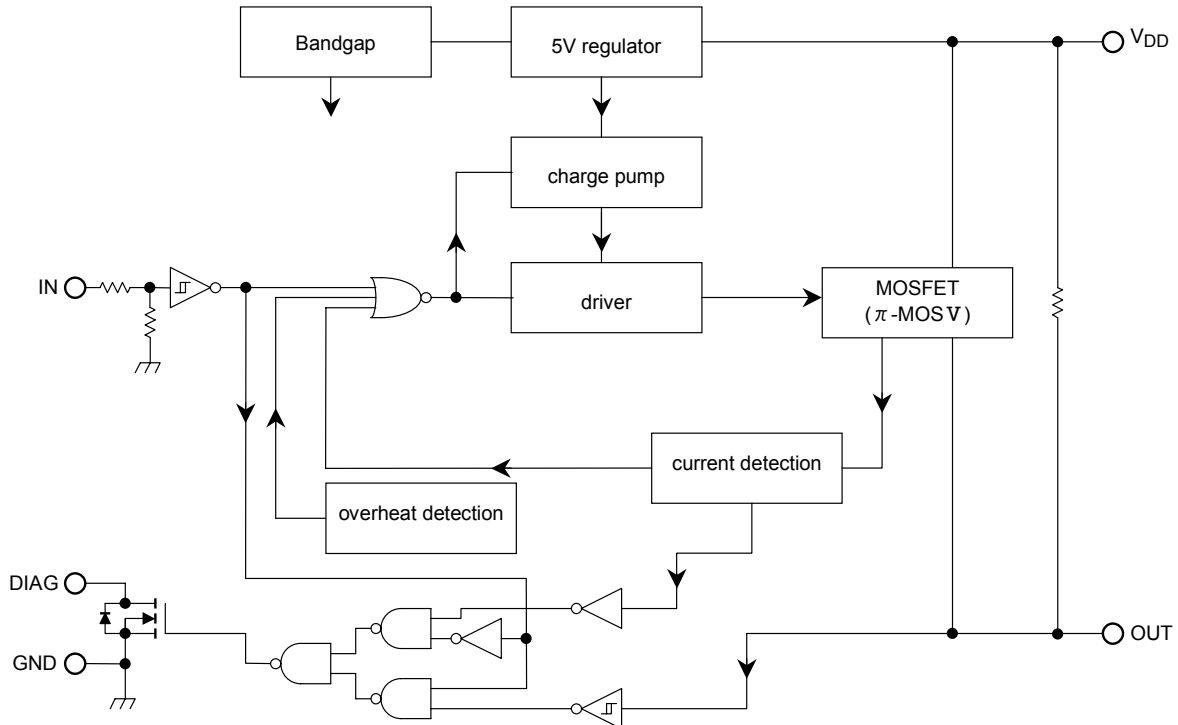


Week of manufacture  
(01 for first of year, continues up to 52 or 53)

Year of manufacture  
(One low-order digits of calendar year)

That because of its MOS structure, this product is sensitive to static electrocity.

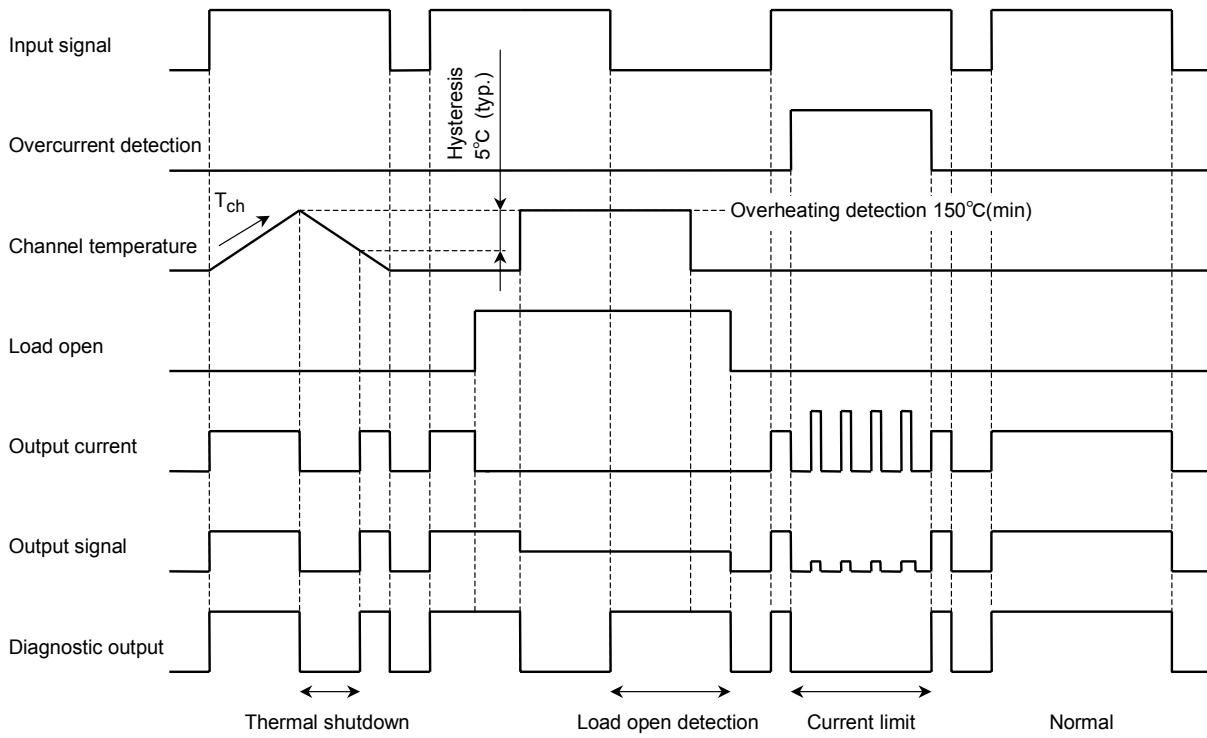
Block Diagram



Pin Description

Pin No.	Symbol	Function
1	OUT	Output pin. When the load is short circuited and current in excess of the detection current (3A min) flows to the output pin , the output automatically turns on or off.
2	GND	Ground pin.
3	DIAG	Self-diagnosis detection pin.Goes low when overheating is detected or when output is short circuit with input on (high). N-channel open drain.
4	IN	Input pin. Input is CMOS compatible, with pull down resistor connected. Even if the input is open, output will not accidentally turn on.
5,6,7,8	V <sub>DD</sub>	Power pin.

Timing Chart



Truth Table

Input signal	Diagnosis output	Output signal	Output state	Operating state
H	H	H	on	Normal
L	L	L	off	
H	L	L	current limit (switching)	Load Short
L	L	L	off	
H	L	L	off	Overheating
L	L	L	off	
H	H	H	on	Load open
L	H	H	off	
H	L	L	off	Overheating and load open
L	H	H	off	

## Maximum Ratings (Ta = 25°C)

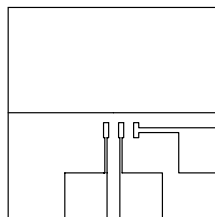
Characteristics		Symbol	Rating	Unit
Drain-Source Voltage		$V_{DS}$	60	V
Supply Voltage	DC	$V_{DD(1)}$	25	V
	Pulse	$V_{DD(2)}$	60( $R_G=1\Omega, \tau=250ms$ )	V
Input Voltage	DC	$V_{IN(1)}$	-0.5~12	V
	Pulse	$V_{IN(2)}$	$V_{DD(1)}+1.5(t=100ms)$	V
Diagnosis Output Voltage		$V_{DIAG}$	-0.5~25	V
Output Current		$I_O$	Internally Limited	A
Input current		$I_{IN}$	$\pm 10$	mA
Diagnosis current		$I_{DIAG}$	5	mA
Power Dissipation (Note 1-a)		$P_{D(1)}$	1.1	W
Power Dissipation (Note 1-b)		$P_{D(2)}$	0.425	W
Operating temperature		$T_{opr}$	-40~110	°C
Channel temperature		$T_{ch}$	150	°C
Storage temperature		$T_{stg}$	-55~150	°C

## Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance	$R_{th(ch-a)}$	113.5 (Note1-a)	°C /W
		294.0 (Note1-b)	

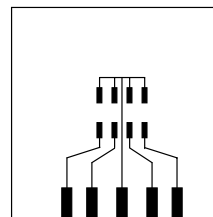
Note 1:

1-a : Mounted on glass epoxy board (a)



FR-4  
25.4 × 25.4 × 0.8  
(Unit : mm)

1-b : Mounted on glass epoxy board (b)



FR-4  
25.4 × 25.4 × 0.8  
(Unit : mm)

## Electrical characteristics (T<sub>a</sub>=25°C)

Characteristics	Symbol	Test circuit	Test condition	min	typ.	max	Unit
Operating supply voltage	V <sub>DD(OPR)</sub>	—	—	6	12	18	V
Current dissipation	I <sub>DD</sub>	—	V <sub>DD</sub> =12V, V <sub>IN</sub> =0V, R <sub>L</sub> =10Ω	—	—	3	mA
H-level input voltage	V <sub>IH</sub>	—	V <sub>DD</sub> =12V	3.5	—	—	V
L-level input voltage	V <sub>IL</sub>	—	V <sub>DD</sub> =12V	—	—	1.5	V
H-level input current	I <sub>IH</sub>	—	V <sub>DD</sub> =12V, V <sub>IN</sub> =5V	—	—	200	μA
On resistance	R <sub>D(S)ON</sub>	—	V <sub>DD</sub> =12V, I <sub>O</sub> =2A	—	—	0.12	Ω
Output leakage current	I <sub>OL</sub>	—	V <sub>DD</sub> =12V	—	—	1	mA
Diagnosis output voltage	V <sub>DL</sub>	—	V <sub>DD</sub> =12V, V <sub>IN</sub> =0V, I <sub>DL</sub> =1mA, R <sub>L</sub> =10Ω	—	—	0.4	V
Diagnosis output current	I <sub>DH</sub>	—	V <sub>DD</sub> =12V, V <sub>IN</sub> =5V, R <sub>L</sub> =10Ω, V <sub>DH</sub> =12V	—	—	10	μA
Over current detection	I <sub>OC(1)</sub> (Note2)	1, 2	V <sub>DD</sub> =12V	3	—	9	A
	I <sub>OC(2)</sub> (Note3)	3	V <sub>DD</sub> =12V, R <sub>L</sub> =0.1Ω	—	—	10	A
Overheating detection	T <sub>OT</sub>	—	V <sub>DD</sub> =12V	150	—	200	°C
Load open detection (Note4)	R <sub>op</sub>	—	V <sub>DD</sub> =12V, V <sub>IN</sub> =0V	5	17	—	kΩ
Switching time	t <sub>on</sub>	4	V <sub>DD</sub> =12V, R <sub>L</sub> =10Ω	—	—	100	μs
	t <sub>off</sub>			—	—	40	μs
Diagnosis delay time	t <sub>DLH</sub>	5	V <sub>DD</sub> =12V, R <sub>L</sub> =10Ω	—	70	—	μs
	t <sub>DHL</sub>			—	22	—	μs
Output clamp voltage	V <sub>clamp</sub>	—	V <sub>DD</sub> =12V, V <sub>IN</sub> =0V, I <sub>O</sub> =1A, L=10mH	-(60-V <sub>DD</sub> )	—	-(50-V <sub>DD</sub> )	V

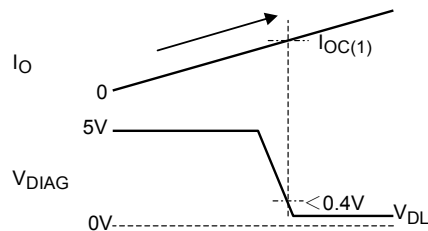
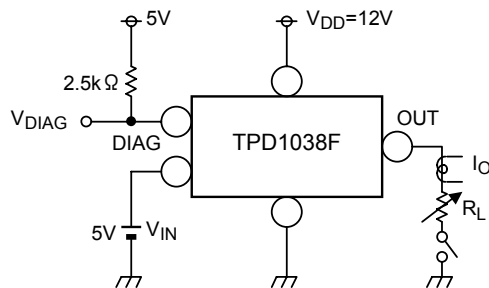
(Note 2) Over current detection

(Note 3) Peak current @ current limit function

(Note 4) Load open detection function : V<sub>DD</sub> = 8 ~ 18V

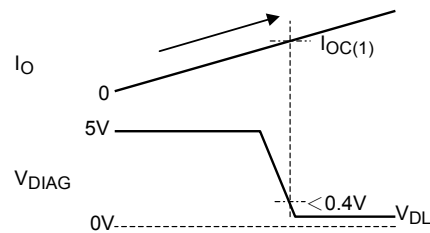
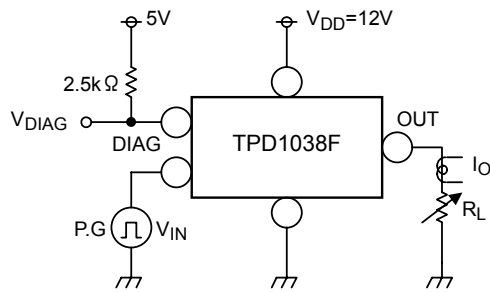
### Test circuit 1

Over current detection I<sub>OC(1)</sub> : Over current detection when load current is increased while V<sub>IN</sub> = "H"



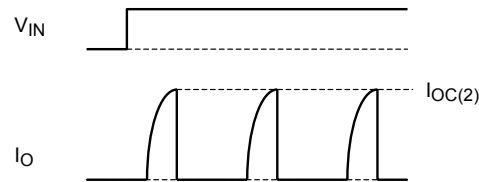
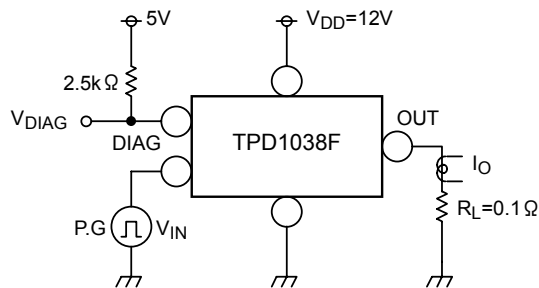
## Test circuit 2

Over current detection  $I_{OC(1)}$  : Over current detection when load is short circuit and  $V_{IN} = "L" \rightarrow "H"$



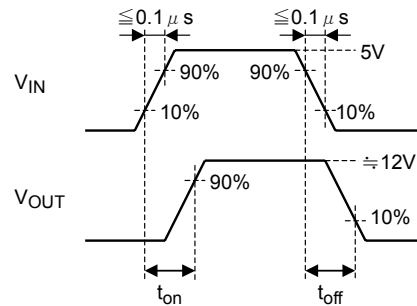
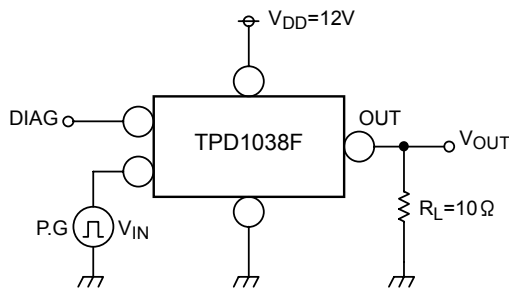
## Test circuit 3

Over current detection  $I_{OC(2)}$



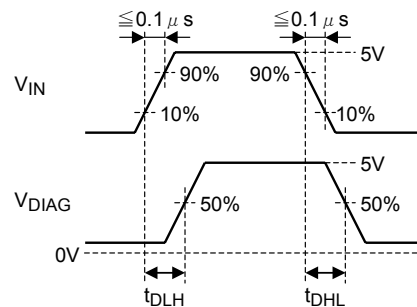
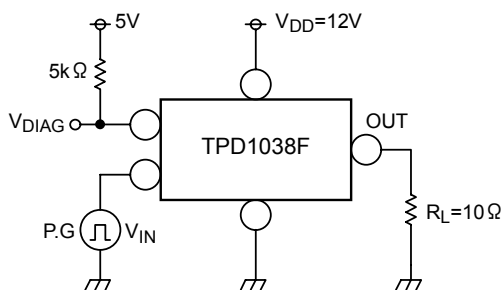
## Test circuit 4

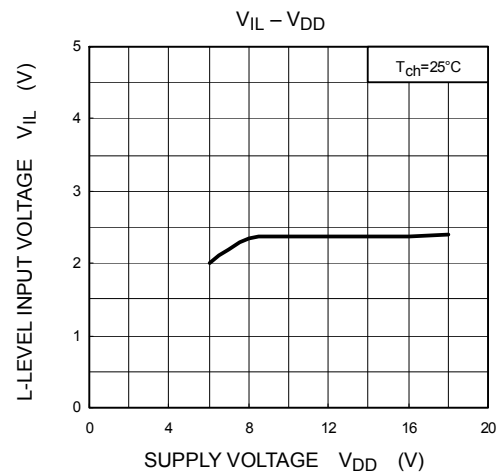
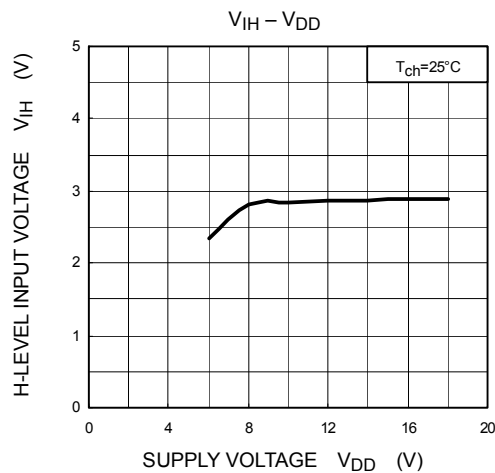
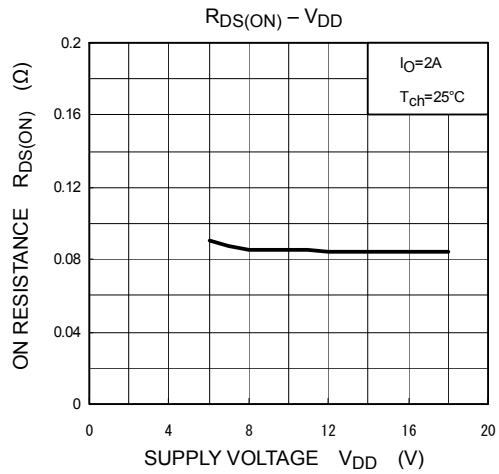
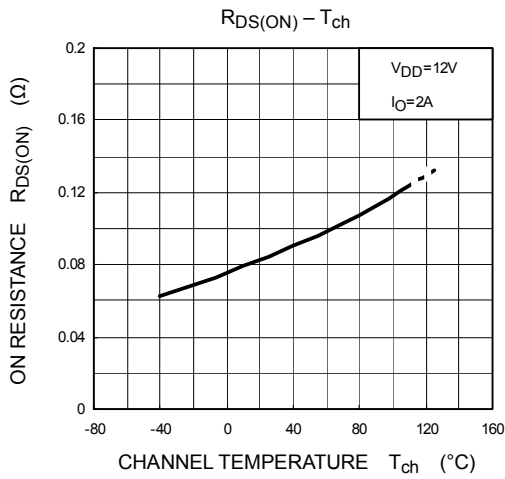
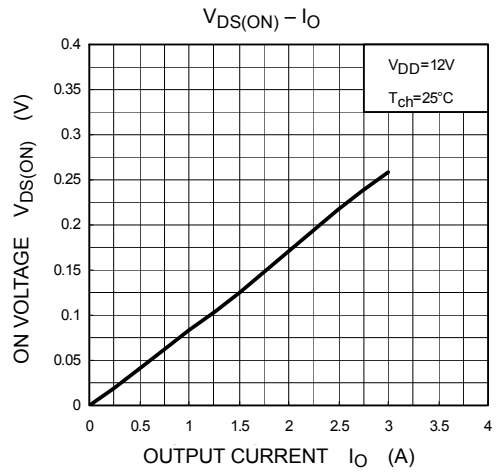
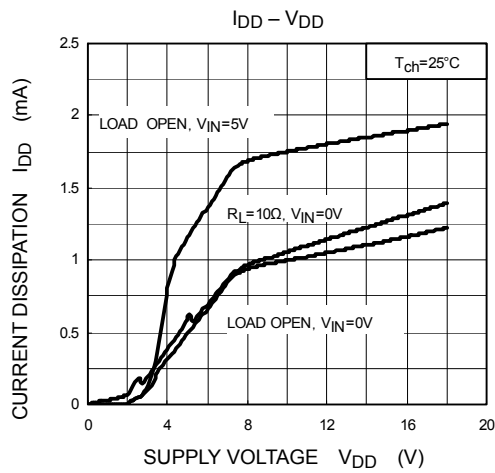
Switching time  $t_{on}$ ,  $t_{off}$

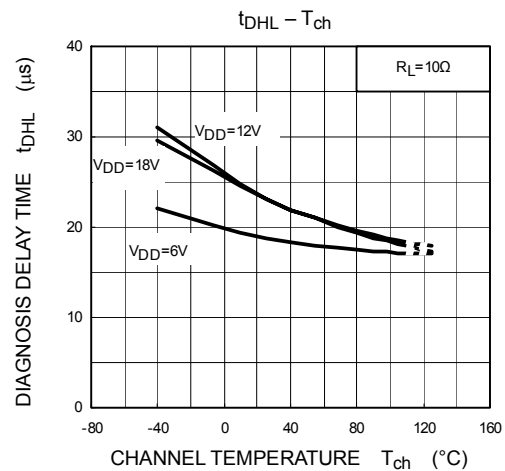
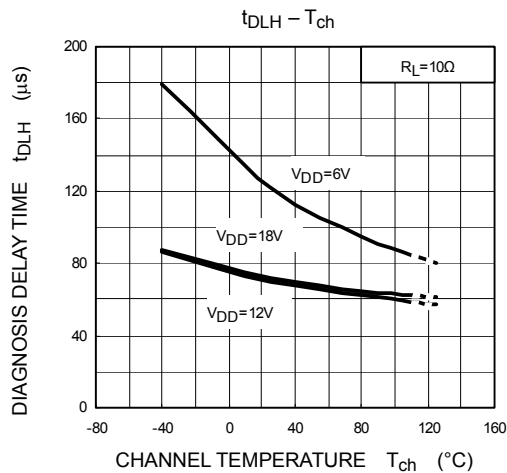
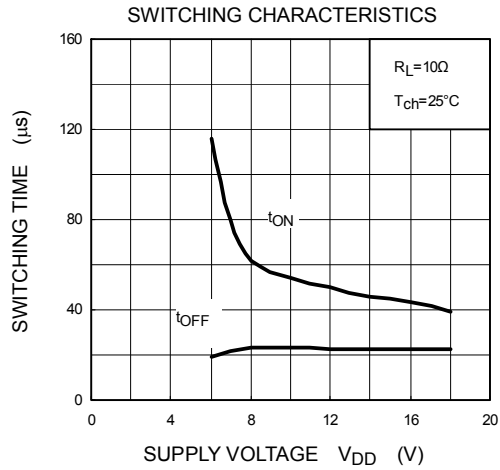
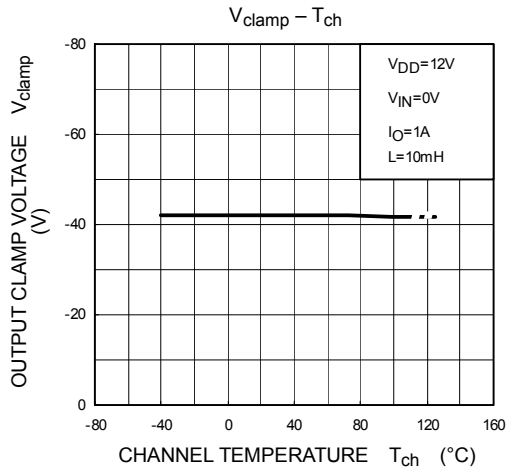
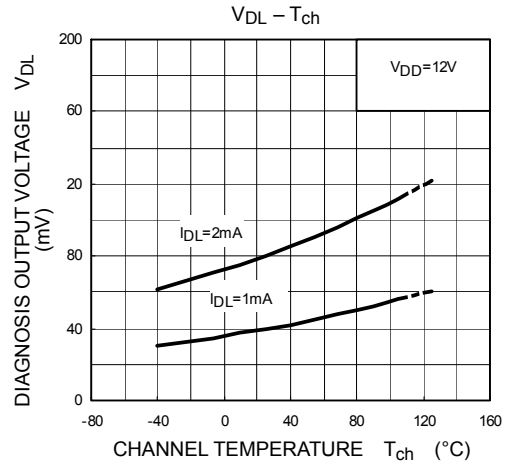
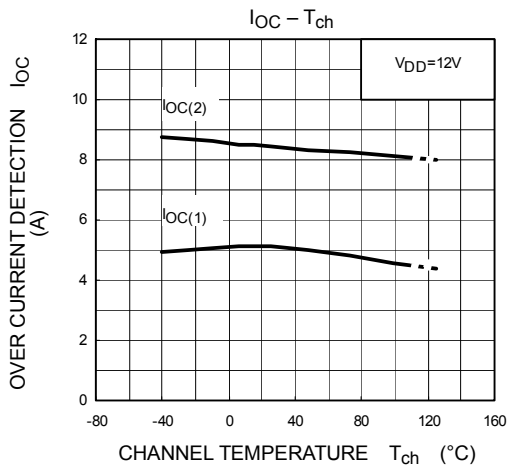


## Test circuit 5

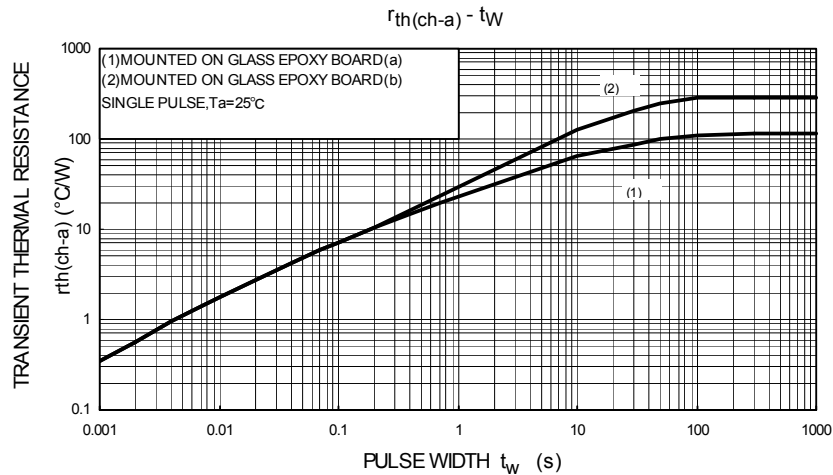
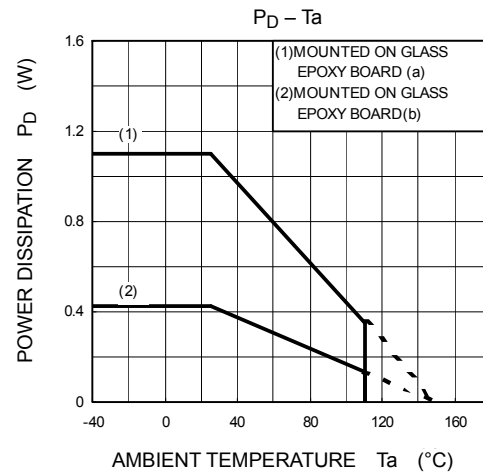
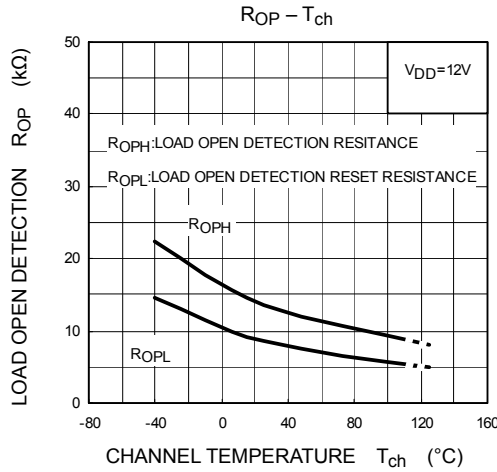
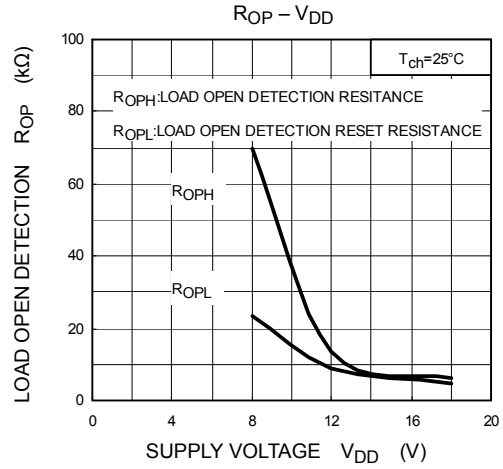
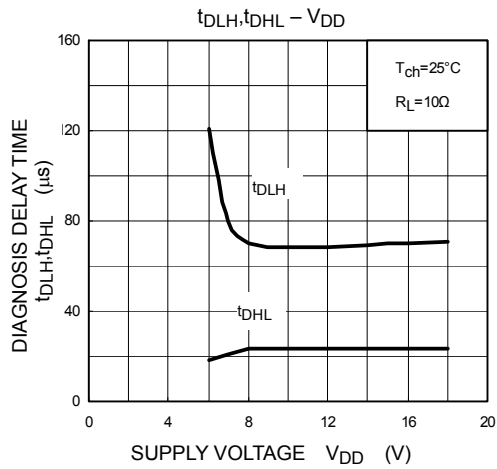
Diagnosis delay time  $t_{DLH}$ ,  $t_{DHL}$



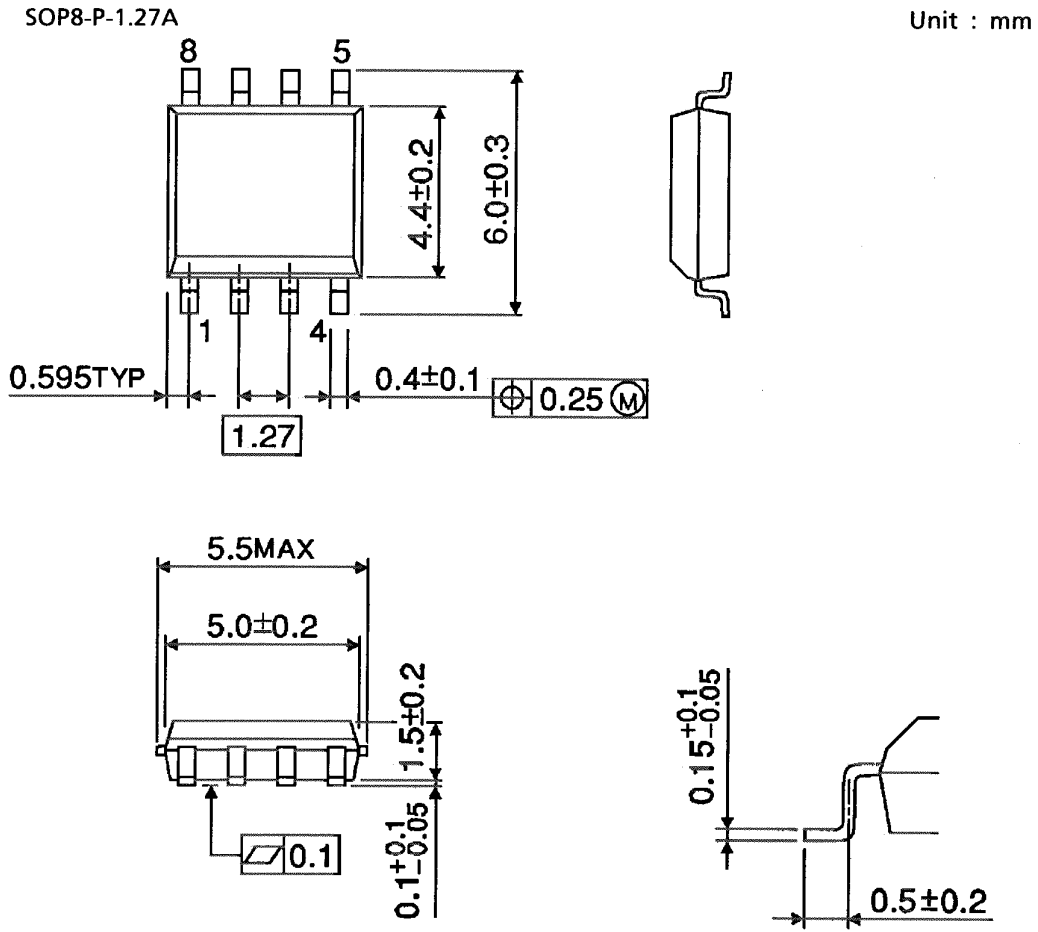








## Package dimensions



Weight : 0.08g (typ.)

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