

Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

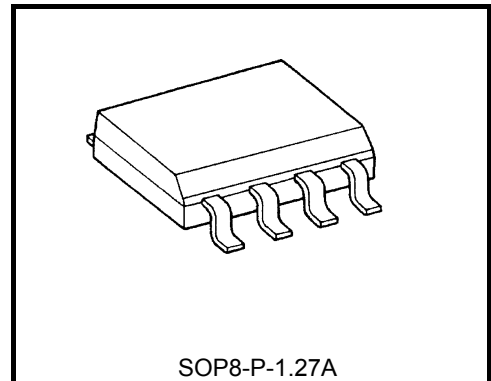
# TPD1038F

Motor, Solenoid, Lamp Drivers  
High-side Power Switch

The 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 (e.g., an MPU). The device offers intelligent self-protection and diagnostic functions.

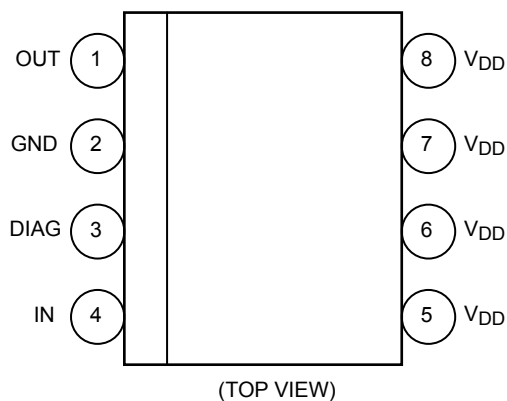
## Features

- 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 :  $R_{DS(ON)}=120m\Omega(\text{max})$  ( @  $V_{DD} = 12\text{ V}$ ,  $T_a = 25^\circ\text{C}$ ,  $I_o = 2\text{ A}$  )
- 8-pin SOP package for surface mounting that can be packed in tape

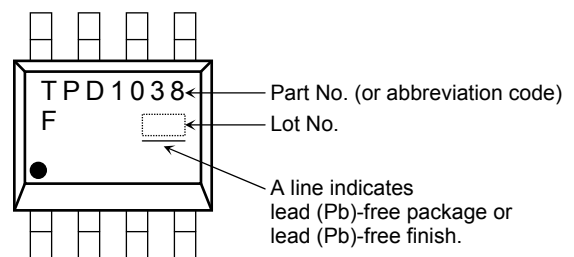


Weight : 0.08g(typ.)

## Pin Assignment

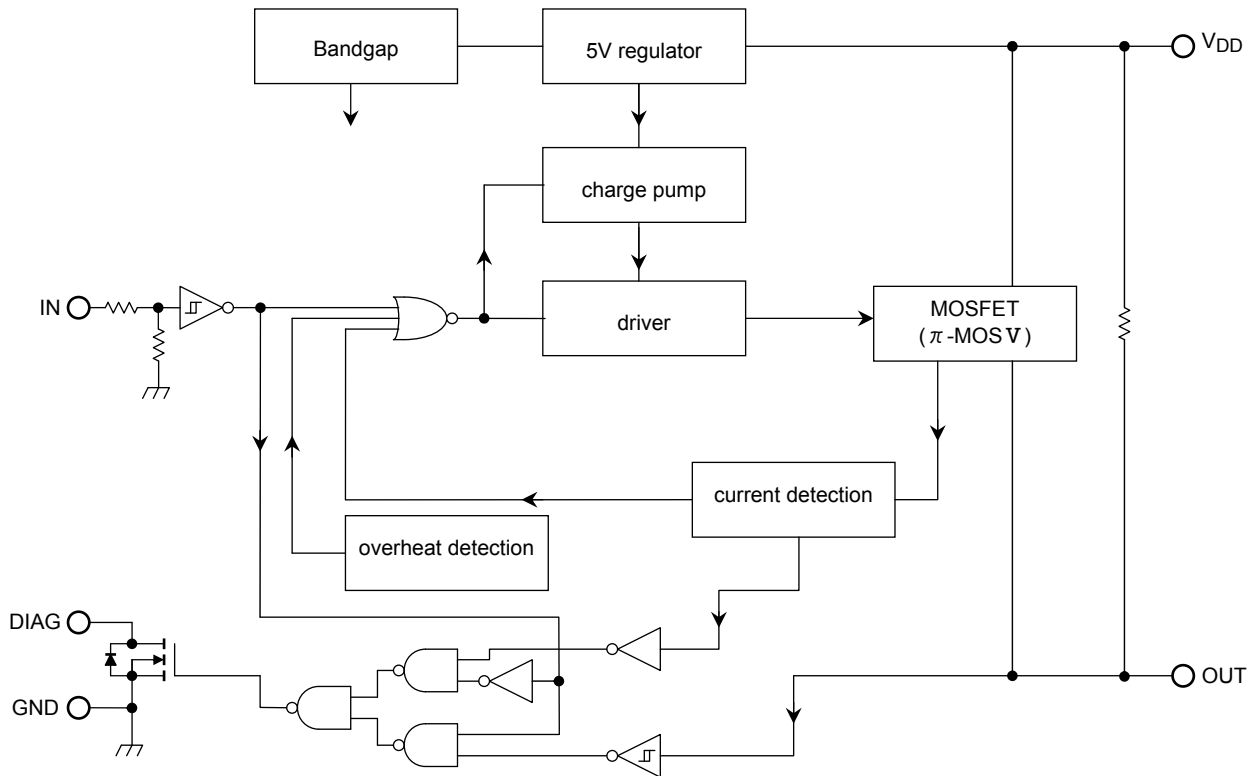


## Marking



Due to its MOS structure, this product is sensitive to static electricity.

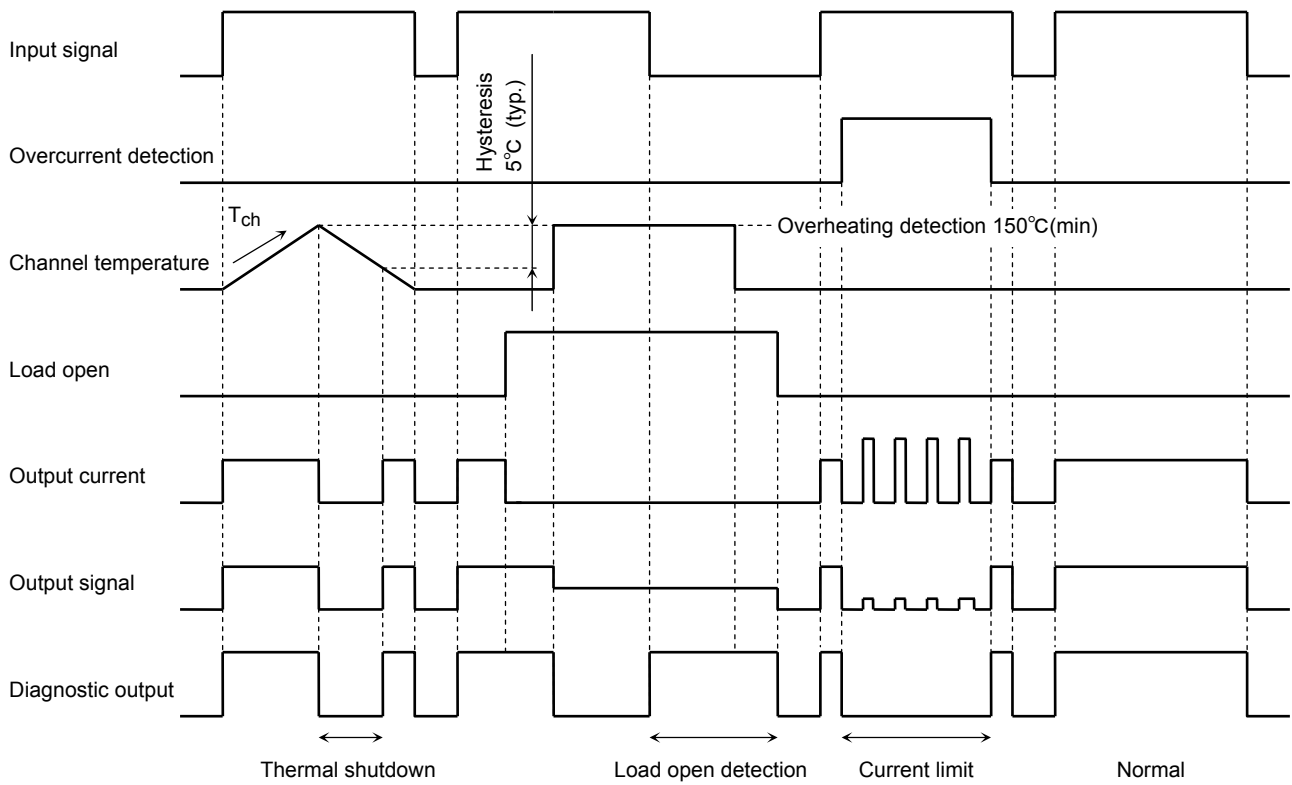
**Block Diagram**



**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	

## Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V <sub>DS</sub>	60	V
Supply voltage	DC	V <sub>DD(1)</sub>	25
	Pulse	V <sub>DD(2)</sub>	60(R <sub>S</sub> =1Ω, τ=250ms)
Input voltage	DC	V <sub>IN(1)</sub>	-0.5~12
	Pulse	V <sub>IN(2)</sub>	V <sub>DD(1)</sub> +1.5(t=100ms)
Diagnosis output voltage	V <sub>DIAG</sub>	-0.5~25	V
Output current	I <sub>O</sub>	Internally limited	A
Input current	I <sub>IN</sub>	±10	mA
Diagnosis current	I <sub>DIAG</sub>	5	mA
Power dissipation (Note 1-a)	P <sub>D(1)</sub>	1.1	W
Power dissipation (Note 1-b)	P <sub>D(2)</sub>	0.425	W
Operating temperature	T <sub>opr</sub>	-40~110	°C
Channel temperature	T <sub>ch</sub>	150	°C
Storage temperature	T <sub>stg</sub>	-55~150	°C

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

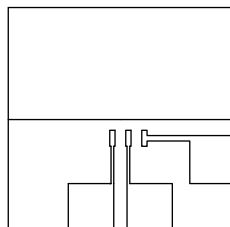
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/Derating Concept and Methods) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

## Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal resistance	R <sub>th(ch-a)</sub>	113.5 (Note1-a)	°C /W
		294.0 (Note1-b)	

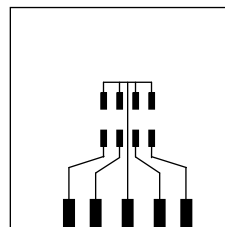
Note 1:

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>DS(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	"L"-level	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	"H"-level	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

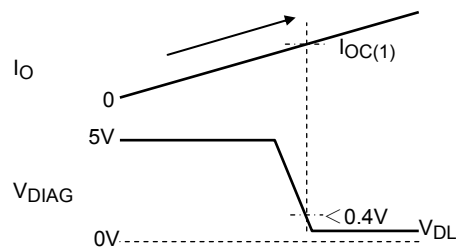
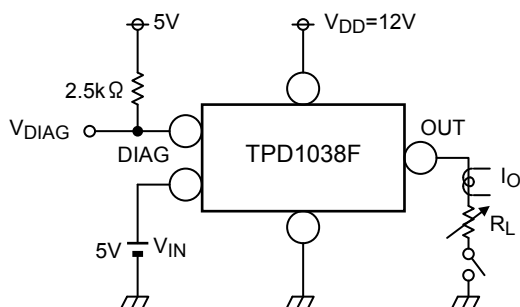
(Note 2) Over-current detection

(Note 3) Peak current @ current limit function

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

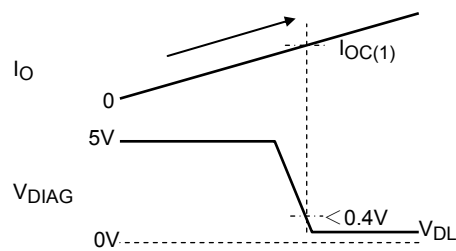
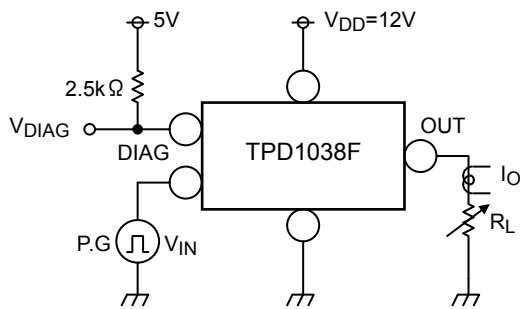
### Test Circuit 1

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



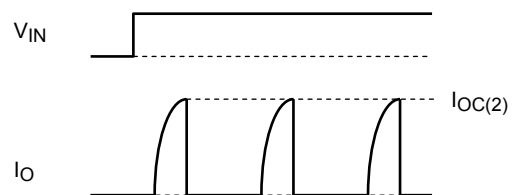
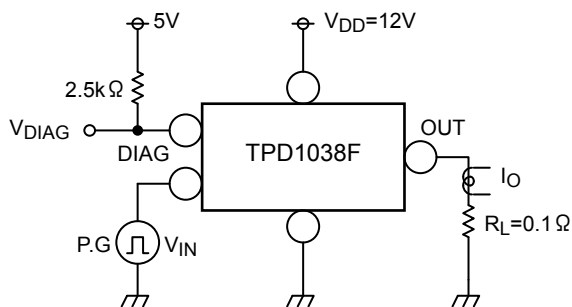
## Test Circuit 2

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



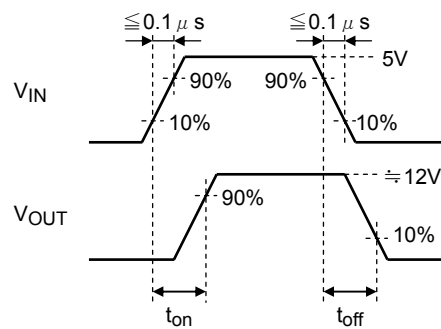
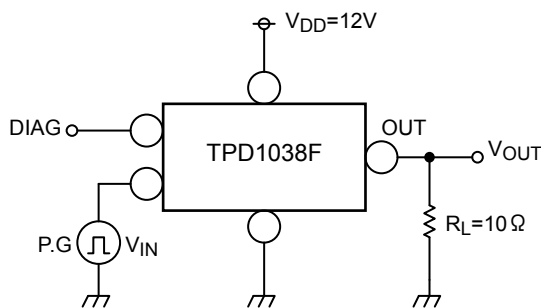
## Test Circuit 3

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



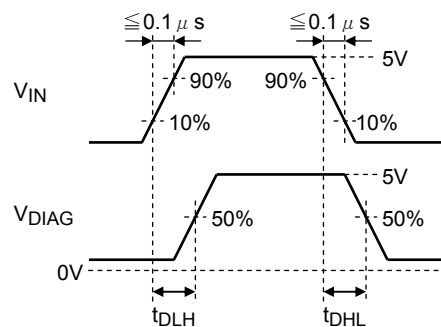
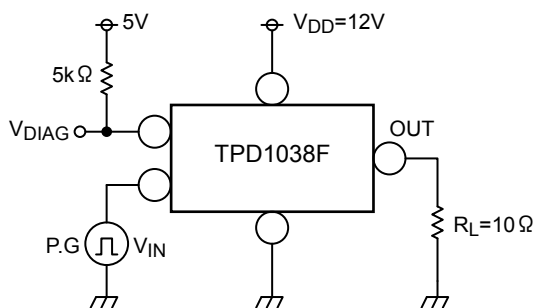
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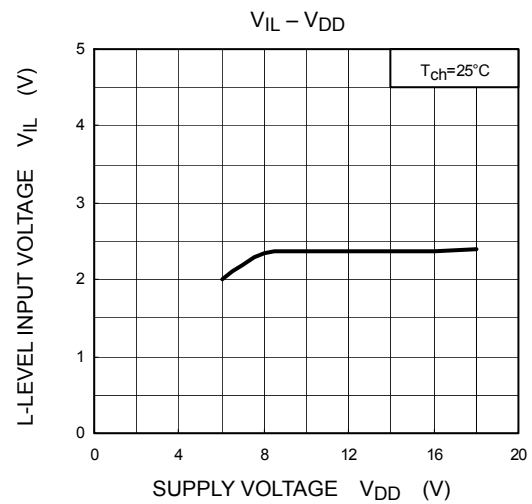
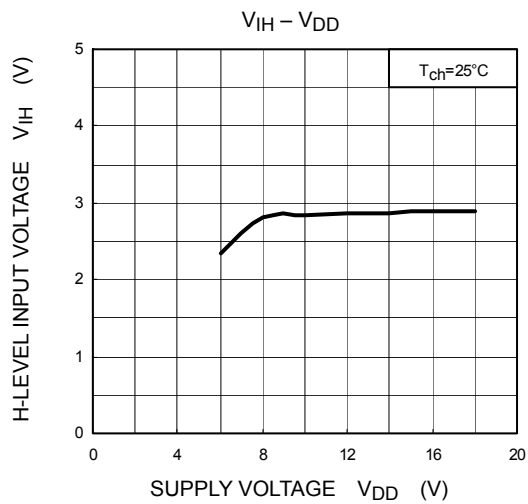
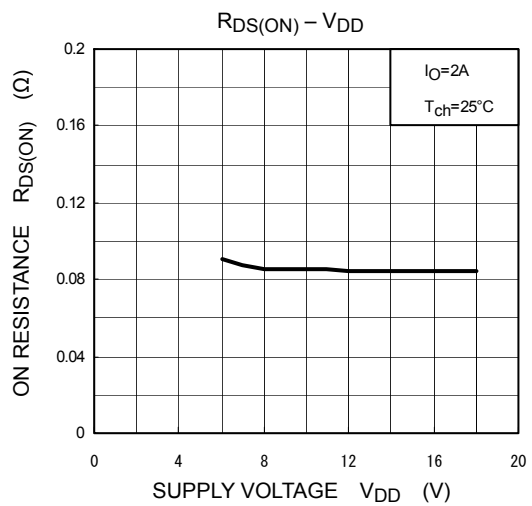
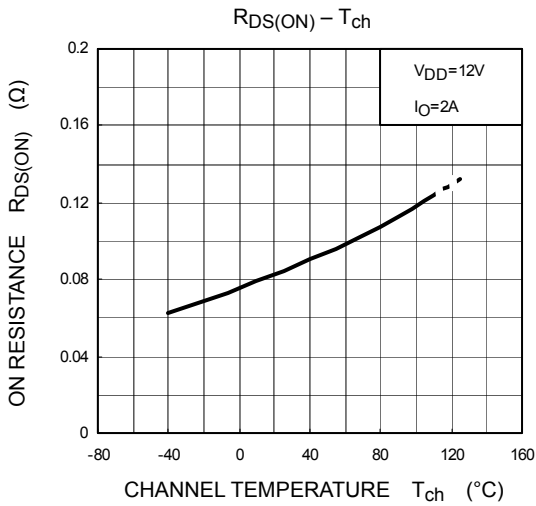
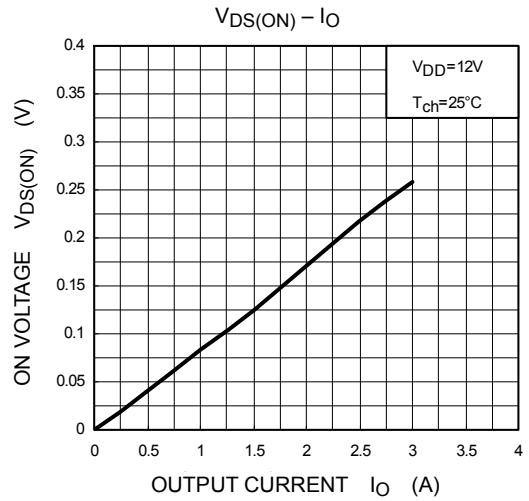
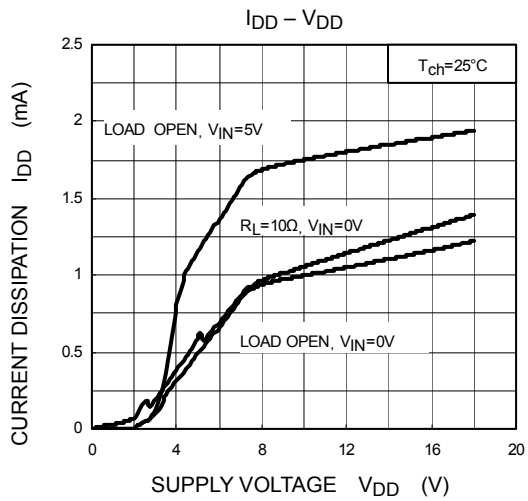
Switching time  $t_{on}$ ,  $t_{off}$

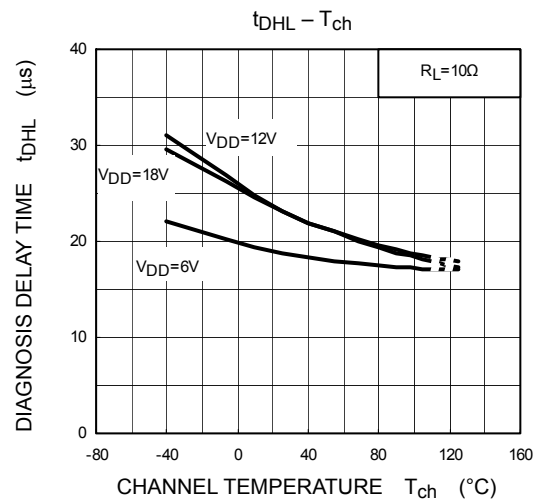
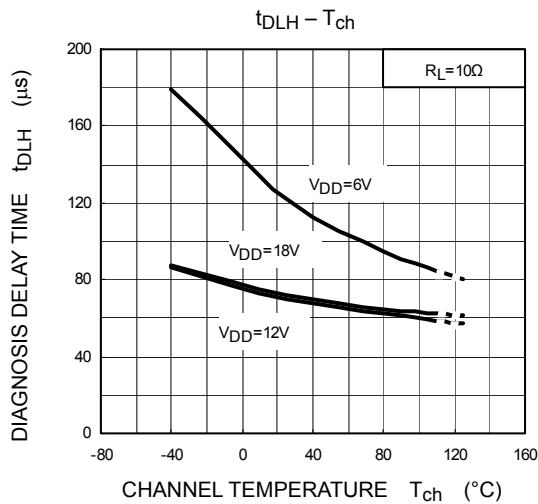
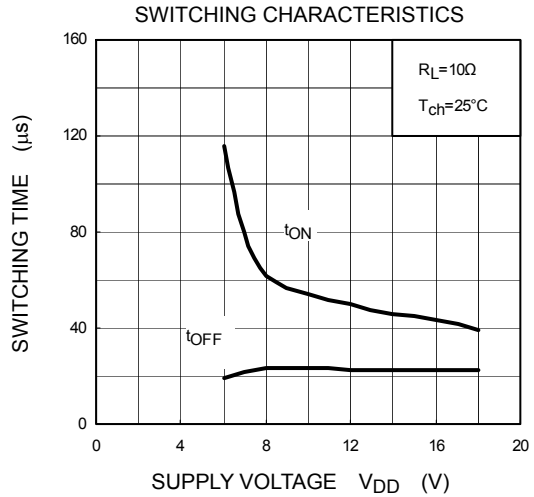
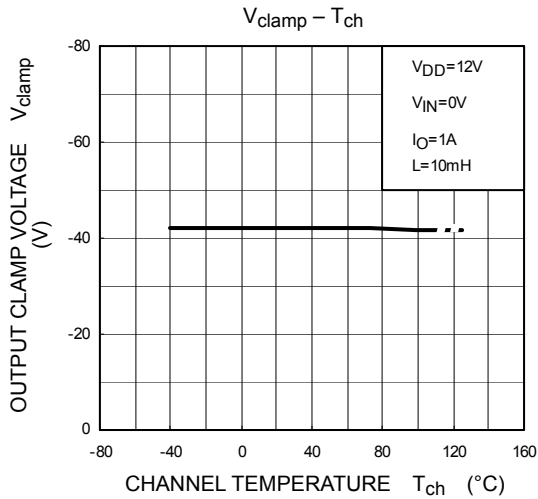
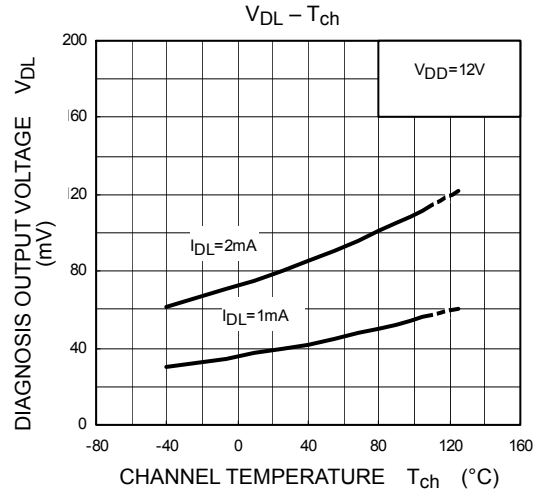
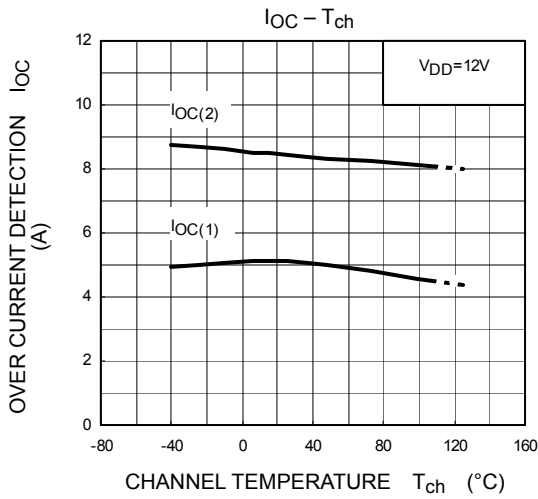


## Test Circuit 5

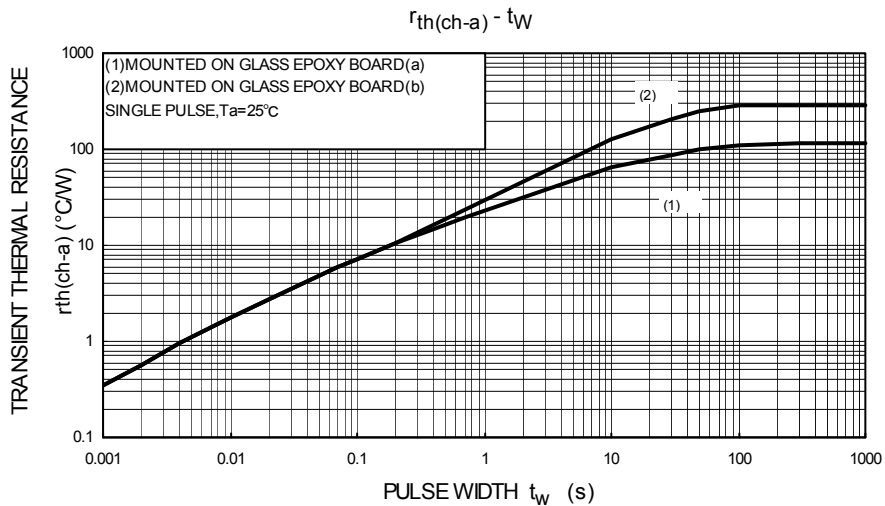
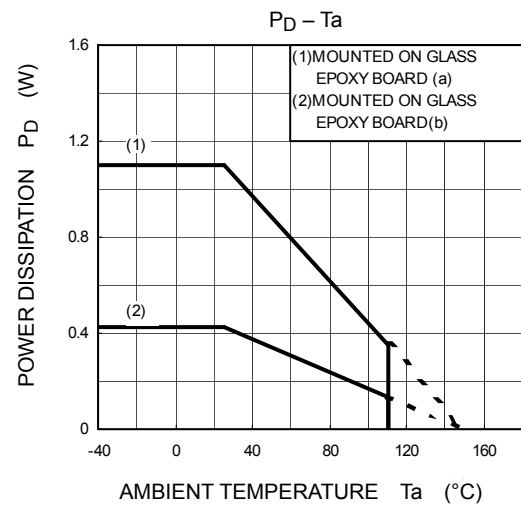
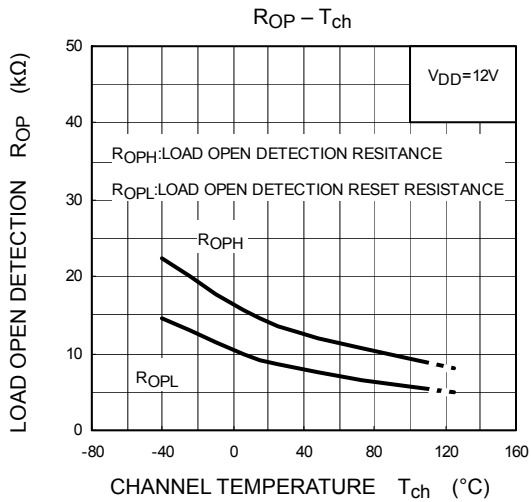
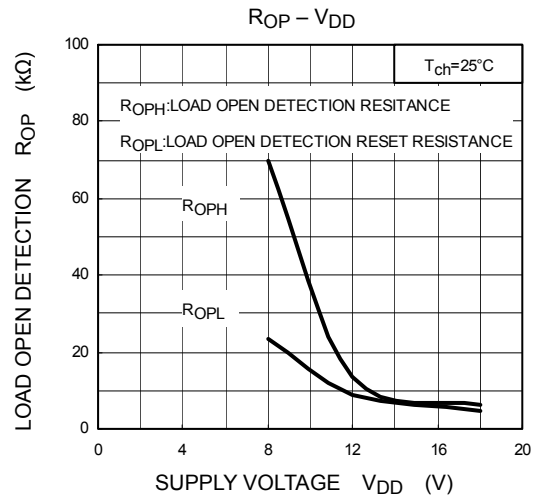
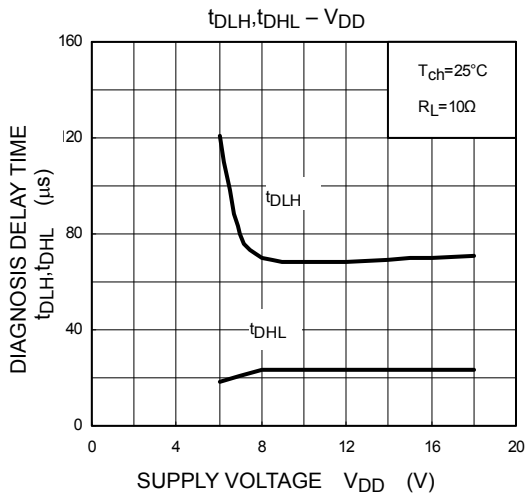
Diagnosis delay time  $t_{DLH}$ ,  $t_{DHL}$



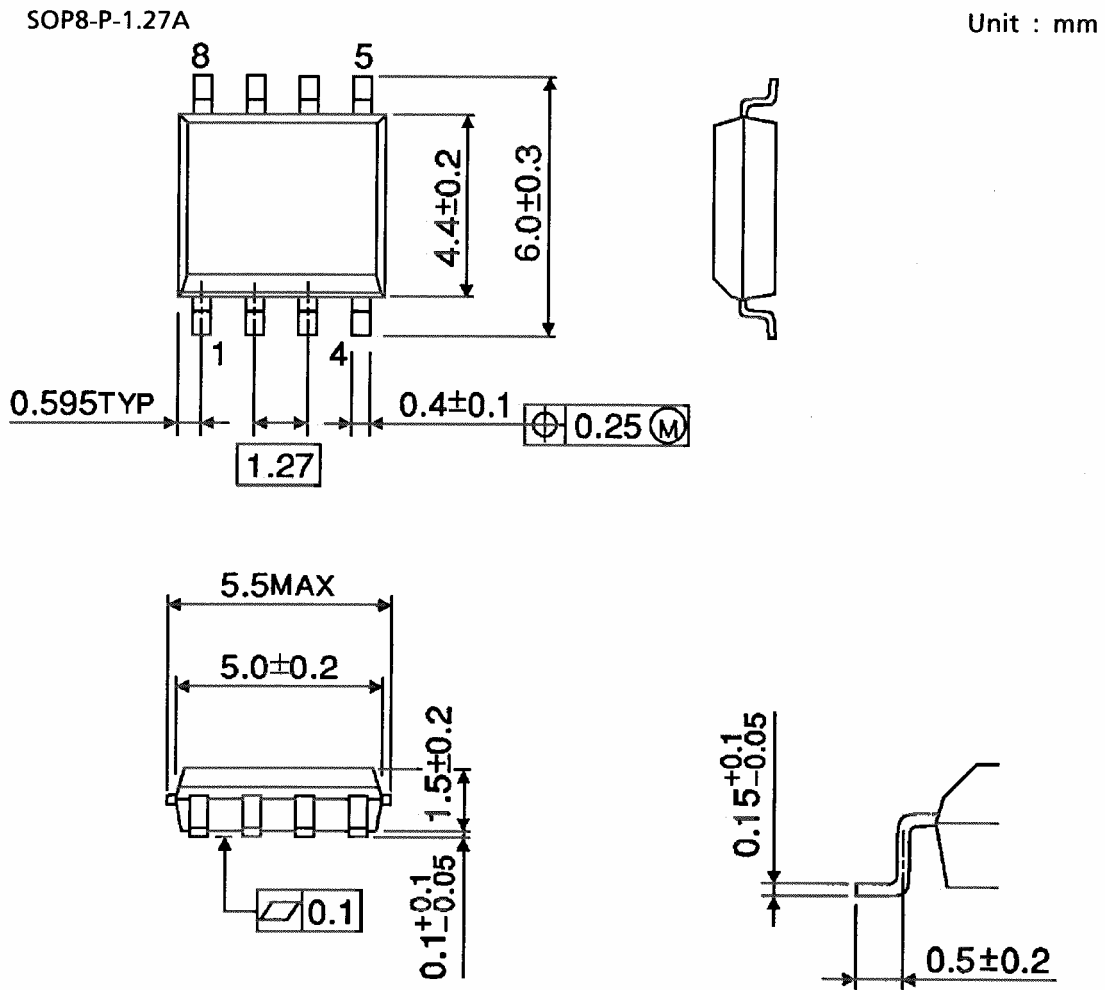








## Package Dimensions



Weight: 0.08g (typ.)

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20070701-EN

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