

Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

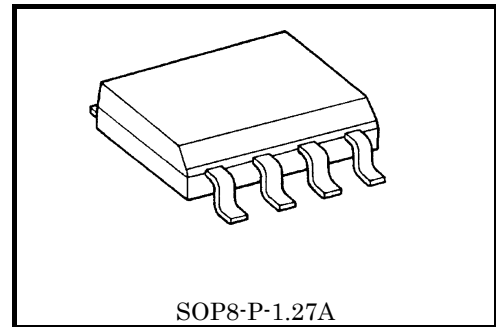
# TPD1053F

Motor, Solenoid, Lamp Drivers  
High-side Power Switch

The TPD1053F is a monolithic power IC for high-side switches. The IC has a vertical MOSFET 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.

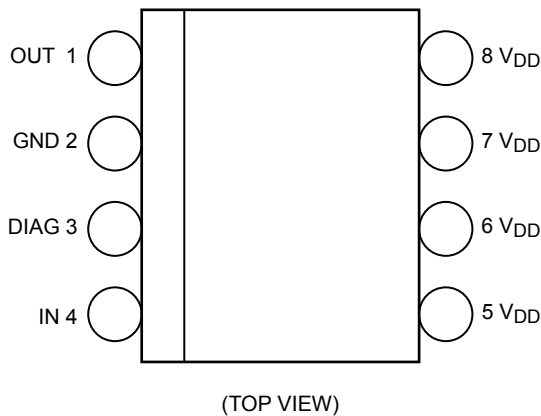
## Features

- A monolithic power IC with a structure combining a control block (Bi-CMOS) and a vertical power MOSFET 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 over temperature and load short-circuiting.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short-circuiting, opening, or over temperature.
- Up to -16(Typ.) of counter electromotive force from an inductance load can be applied.
- Low on-resistance :  $R_{DS(ON)}=0.12\Omega(\text{Max})$  (@  $V_{DD} = 12 \text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$ ,  $I_O = 2 \text{ A}$ )
- 8-pin SOP package for surface mounting that can be packed in tape.

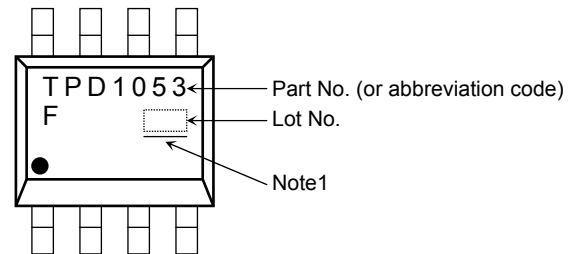


Weight: 0.08 g (Typ.)

## Pin Assignment

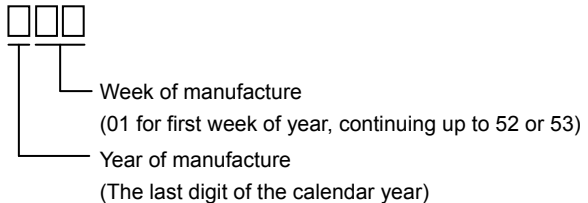


## Marking



• on the lower left of the marking indicates Pin 1.

\* Weekly code : (Three digits)



Note 1 : A line under a Lot No. identifies the indication of product Labels.

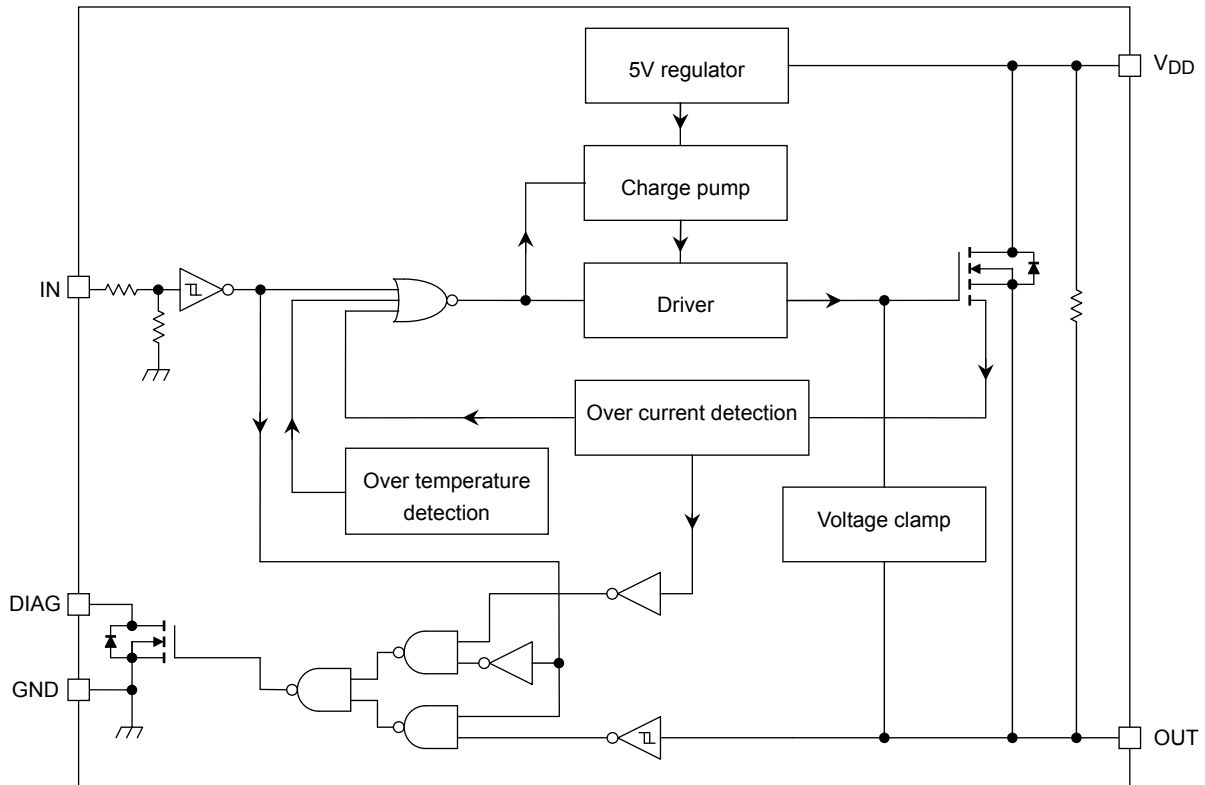
Not underlined :  $[[\text{Pb}]]/\text{INCLUDES} > \text{MCV}$

Underlined :  $[[\text{G}]]/\text{RoHS COMPATIBLE}$  or  $[[\text{G}]]/\text{RoHS}[[\text{Pb}]]$

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. The RoHS is the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

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

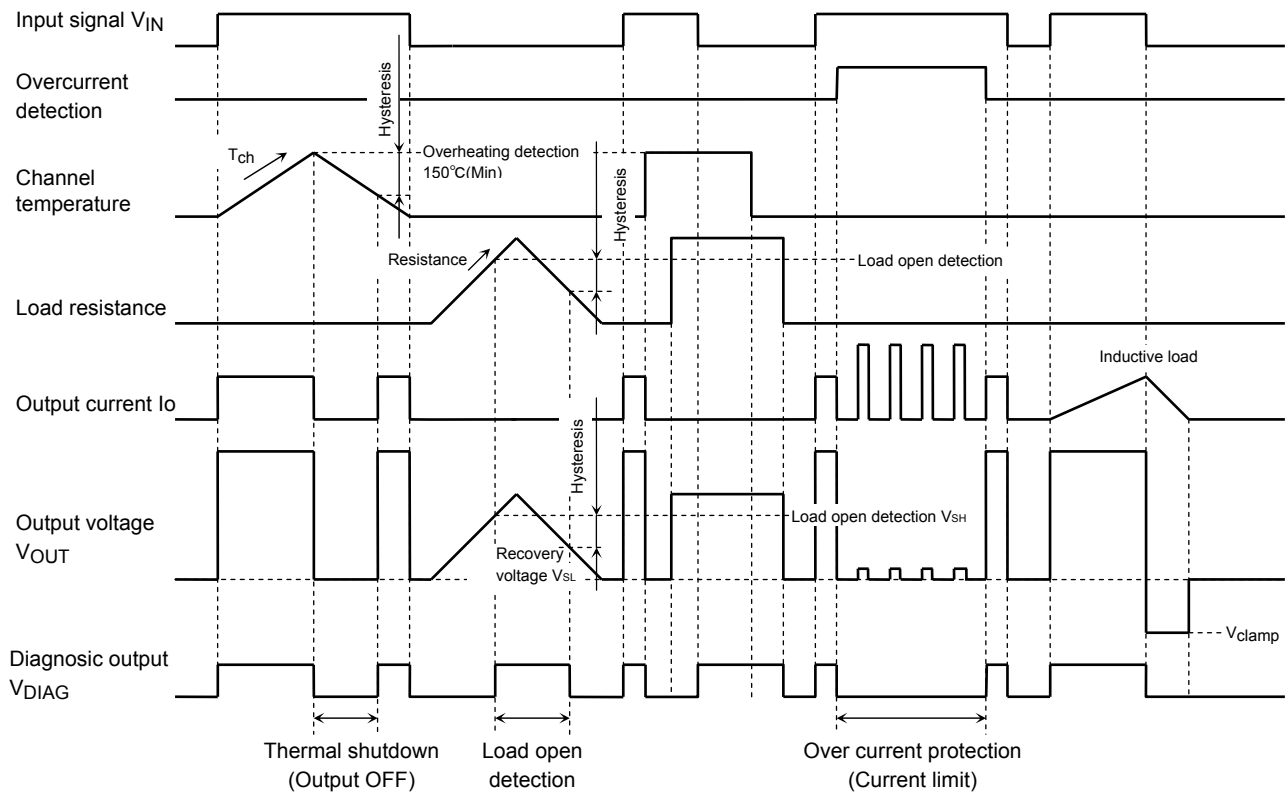
**Block Diagram**



**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 over temperature 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	VDD	Power pin.

## Timing Chart



## Truth Table

Input signal $V_{IN}$	Output voltage $V_{OUT}$	Output state	Operating state
L	L	off	Normal
H	H	on	
L	H (Note 2)	off	Load open
H	H	on	
L	L	off	Load short
H	L	Current limit (Switching)	
L	L	off	Over temperature
H	L	off	

Note 2: Internal voltage in TPD1053F and external voltage decide this output voltage.

Input signal $V_{IN}$	Output voltage $V_{OUT}$	Diagnosis $V_{DIAG}$	Diagnosis state
L	$V_{OUT} < V_{SL}$	L	Normally off
	$V_{OUT} \geq V_{SH}$	H	Load open
H	$V_{OUT} \geq V_{DD}-V_{OC}$	H	Normally on
	$V_{OUT} < V_{DD}-V_{OC}$	L	Over current (Load short), Over temperature

$V_{SH}, V_{SL}$  : Schmitt inverter threshold voltage ( $V_{SH}=2.2\text{V}(\text{Typ.})$ ,  $V_{SL}=1.8\text{V}(\text{Typ.})$ ) @  $V_{DD}=12\text{V}$ ,  $T_{ch}=25^{\circ}\text{C}$

$V_{OC}$  : Over current detection threshold voltage

## Absolute Maximum Ratings (T<sub>a</sub> = 25°C)

Characteristics		Symbol	Rating	Unit
Drain-source voltage		V <sub>DS</sub>	60	V
Supply voltage	DC	V <sub>DD(1)</sub>	-0.5 to 25	V
	Pulse	V <sub>DD(2)</sub>	60(R <sub>S</sub> =1Ω,τ=250ms)	V
Input voltage	DC	V <sub>IN(1)</sub>	-0.5 to 12	V
	Pulse	V <sub>IN(2)</sub>	V <sub>DD(1)</sub> +1.5(t=100ms)	V
Diagnosis output voltage		V <sub>DIAG</sub>	-0.5 to 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 3-a)		P <sub>D(1)</sub>	1.1	W
Power dissipation (Note 3-b)		P <sub>D(2)</sub>	0.425	W
Operating temperature		T <sub>opr</sub>	-40 to 125	°C
Channel temperature		T <sub>ch</sub>	150	°C
Storage temperature		T <sub>stg</sub>	-55 to 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.

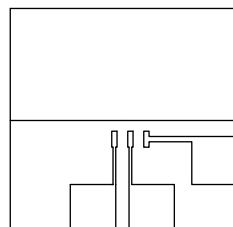
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

## Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal resistance	R <sub>th(ch-a)</sub>	113.5 (Note 3a)	°C /W
		294.0 (Note 3b)	

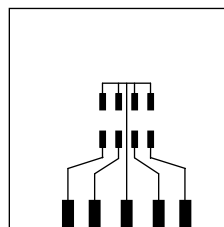
Note 3:

3-a : Glass epoxy board (a)



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

3-b : Glass epoxy board (b)



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

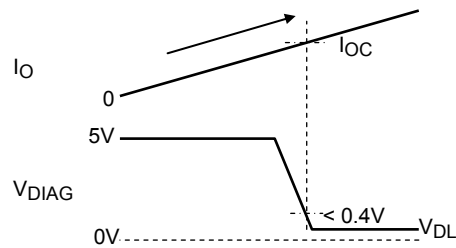
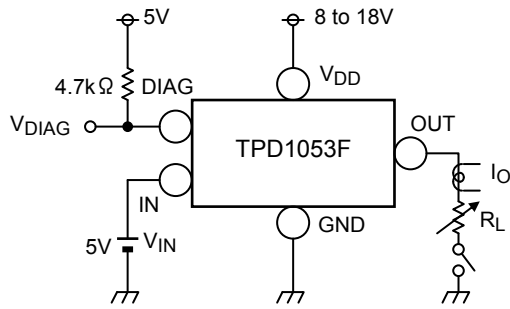
## Electrical Characteristics (Unless otherwise specified, $T_{ch} = -40$ to $125\text{ }^{\circ}\text{C}$ , $V_{DD} = 5$ to $18\text{ V}$ )

Characteristics	Symbol	Test circuit	Test condition	Min	Typ.	Max	Unit
Operating supply voltage	$V_{DD(opr)}$	-	-	5	12	18	V
Supply current	$I_{DD(off)}$	-	$V_{IN}=0V$ , Output open	-	0.8	4.5	mA
	$I_{DD(on)}$	-	$V_{IN}=5V$ , Output open	-	1.4	5	mA
Input voltage	$V_{IH}$	-	$V_{DD}=8$ to $18V$	3.5	-	-	V
	$V_{IL}$	-	$V_{DD}=8$ to $18V$	-	-	1.5	V
Input current	$I_{IN(1)}$	-	$V_{IN}=5V$	-	25	200	$\mu\text{A}$
	$I_{IN(2)}$	-	$V_{IN}=0V$	-1	-	1	$\mu\text{A}$
On resistance	$R_{DS(ON)}$	-	$V_{DD}=8$ to $18V$ , $I_O=2A$ , $T_{ch}=25^{\circ}\text{C}$	-	0.09	0.12	$\Omega$
Output leakage current	$I_{OL}$	-	$V_{IN}=0V$ , $V_{OUT}=0V$	-	0.2	2	mA
Diagnosis output voltage	"L"-level $V_{DL}$	-	$I_{DIAG}=1\text{mA}$	-	-	0.4	V
Diagnosis output current	"H"-level $I_{DH}$	-	$V_{DIAG}=18V$	-	-	10	$\mu\text{A}$
Over current detection	$I_{OC}$	1, 2	$V_{DD}=8$ to $18V$	3	6	9	A
Over temperature detection	Temperature $T_{OT}$	-	-	150	170	200	$^{\circ}\text{C}$
	Hysteresis $\Delta T_{OT}$	-	-	-	10	-	$^{\circ}\text{C}$
Load open detection	$R_{OP}$	3	$V_{DD}=8$ to $18V$ , $V_{IN}=0V$	0.5	15	250	k $\Omega$
Switching time	$t_{on}$	4	$V_{DD}=12V$ , $R_L=10\Omega$ , $T_{ch}=25^{\circ}\text{C}$	-	50	100	$\mu\text{s}$
	$t_{off}$			-	40	80	$\mu\text{s}$
Diagnosis delay time	$t_{DLH}$	5	$V_{DD}=12V$ , $R_L=10\Omega$ , $T_{ch}=25^{\circ}\text{C}$	-	40	-	$\mu\text{s}$
	$t_{DHL}$			-	40	-	$\mu\text{s}$
Output clamp voltage	$V_{clamp}$	-	$V_{IN}=0V$ , $I_O=1A$ , $T_{ch}=25^{\circ}\text{C}$	-25	-16	-10	V

\*Typical characteristic conditions are  $V_{DD}=12V$ ,  $T_{ch}=25^{\circ}\text{C}$ .

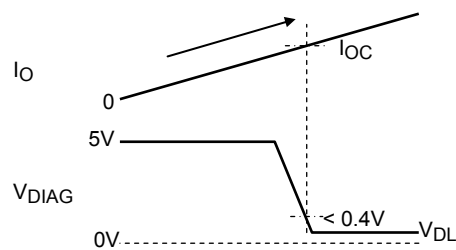
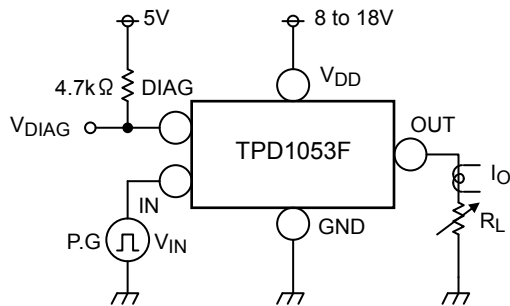
**Test Circuit 1**

Over current detection  $I_{OC}$  : Over current detection when load current is increased while  $V_{IN} = "H"$ .



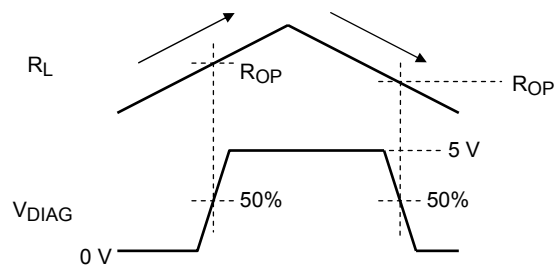
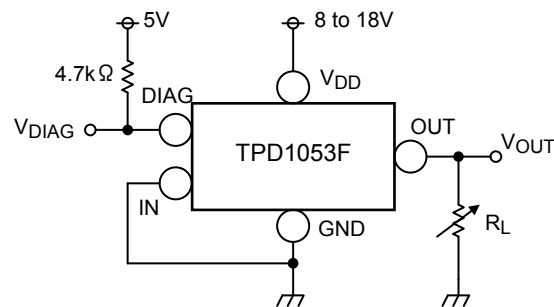
**Test Circuit 2**

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



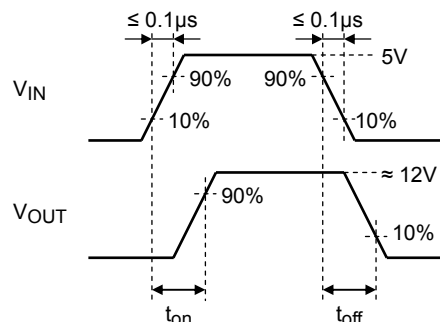
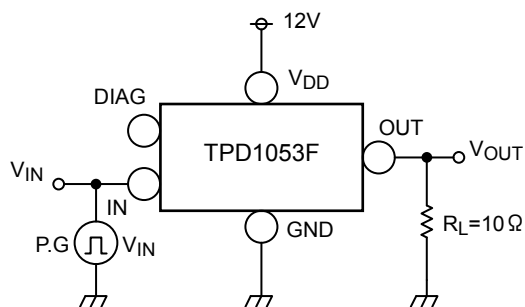
**Test Circuit 3**

Load open detection  $R_{OP}$



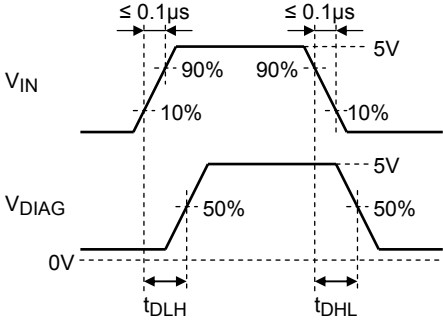
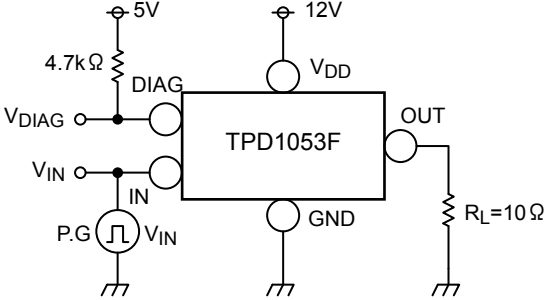
**Test Circuit 4**

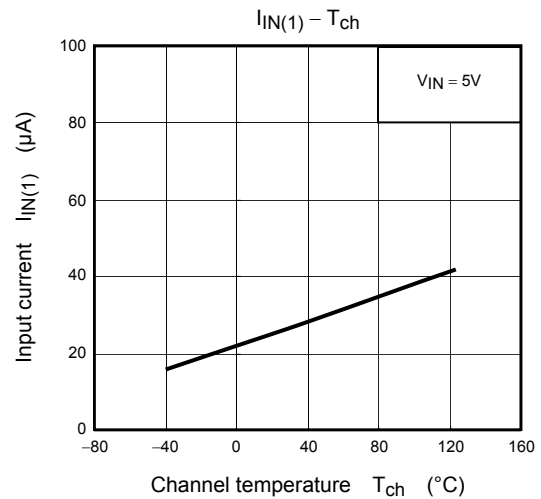
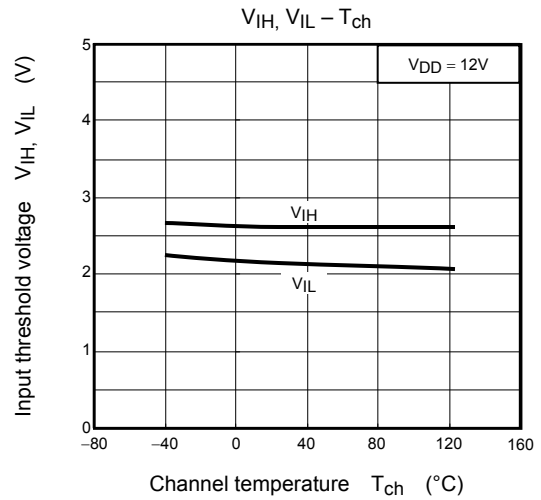
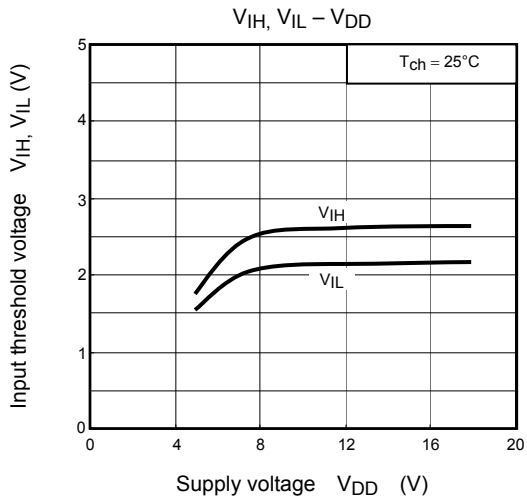
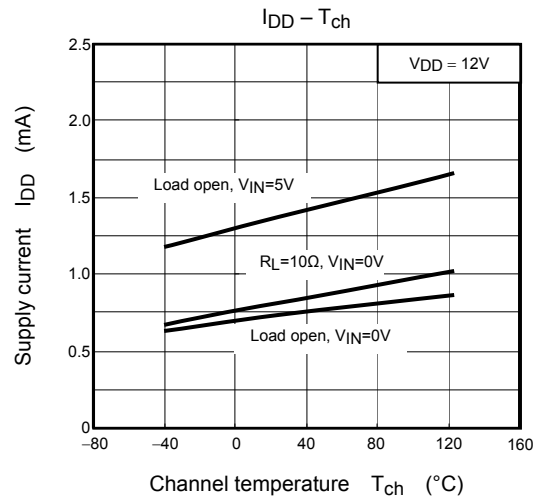
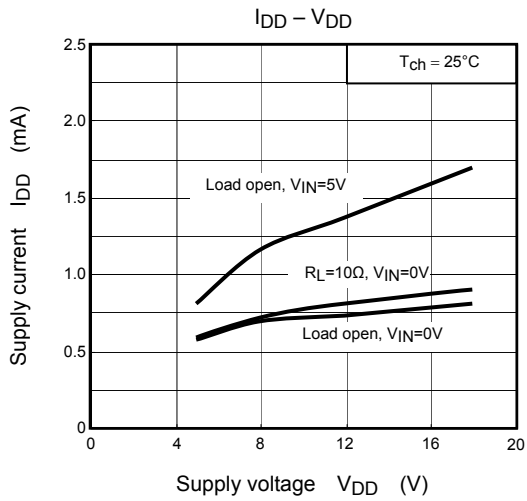
Switching times  $t_{on}$ ,  $t_{off}$



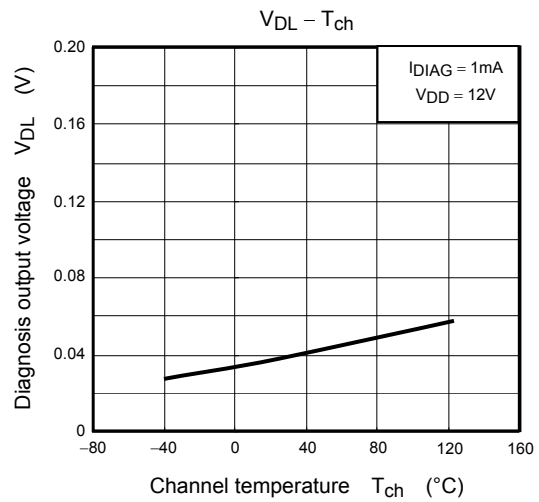
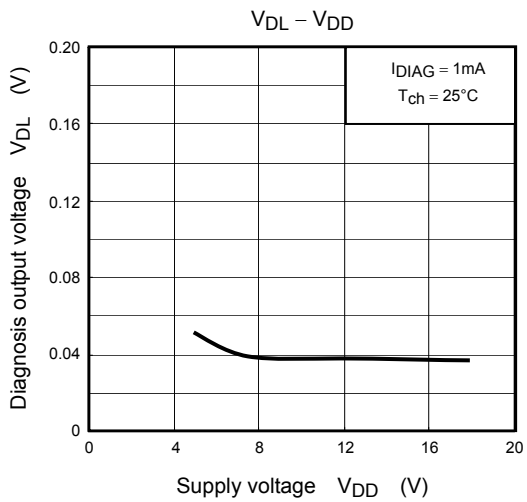
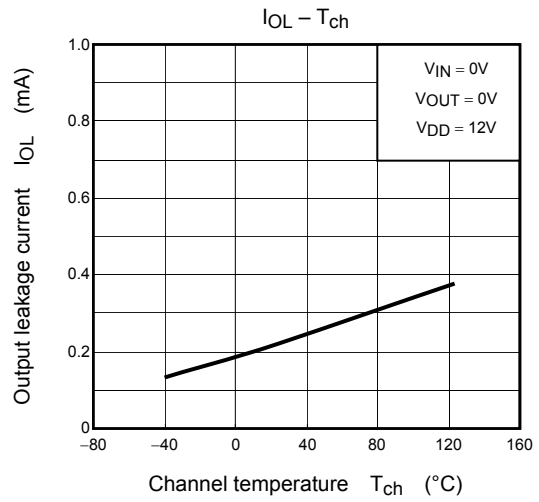
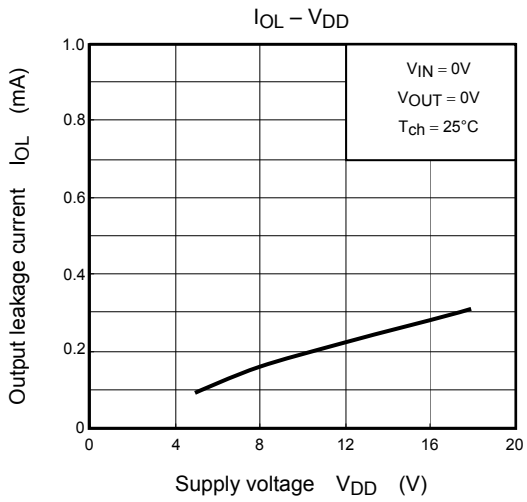
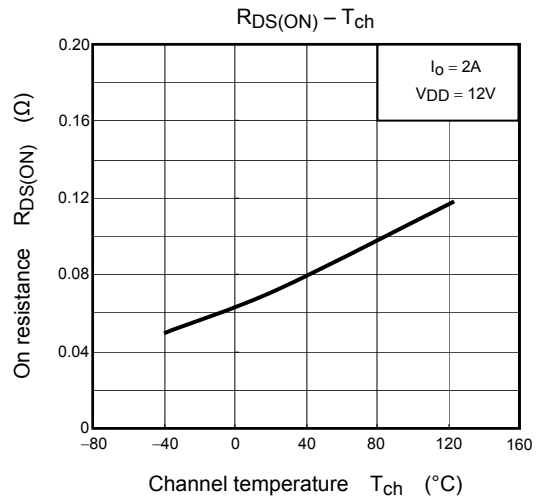
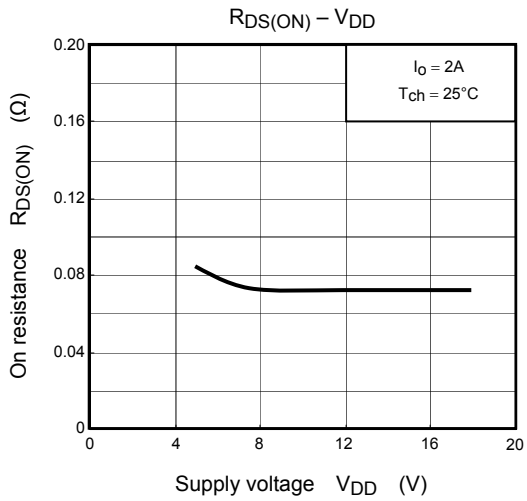
Test Circuit 5

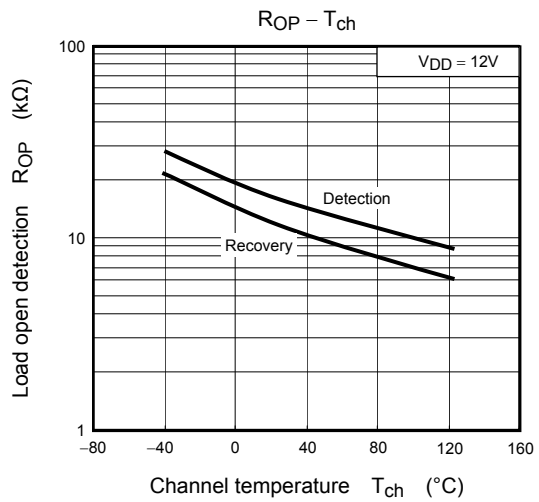
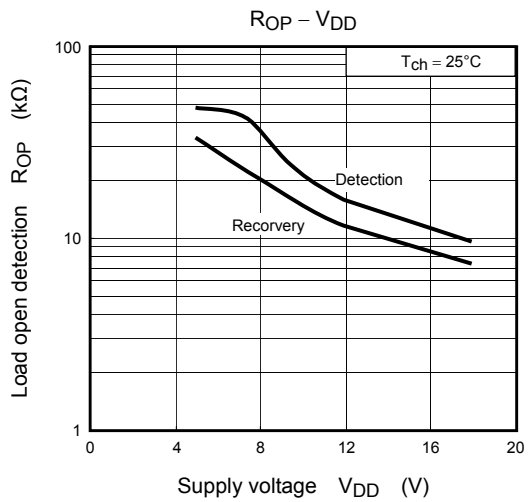
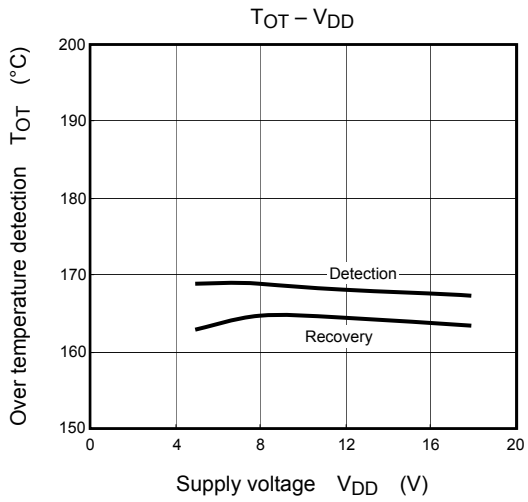
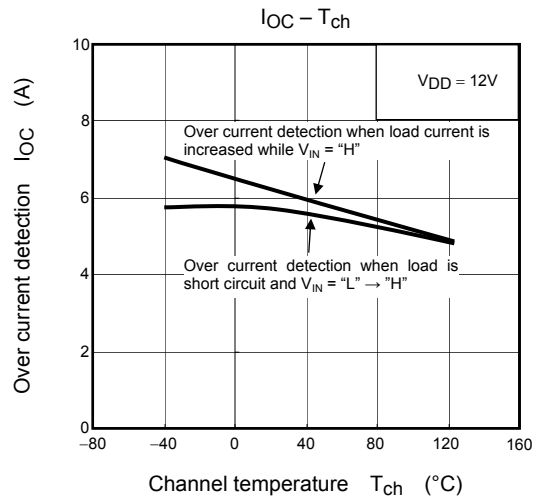
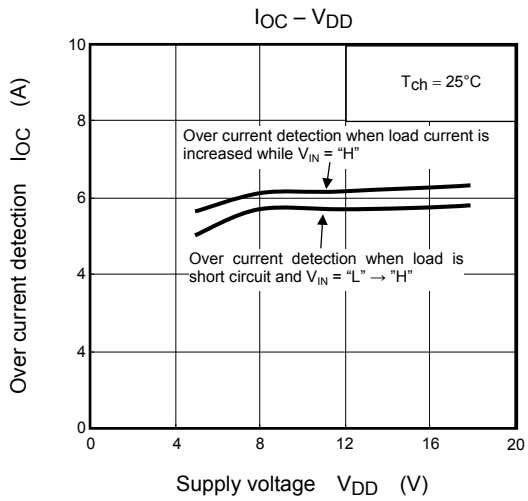
Diagnosis delay time  $t_{DLH}$ ,  $t_{DLH}$

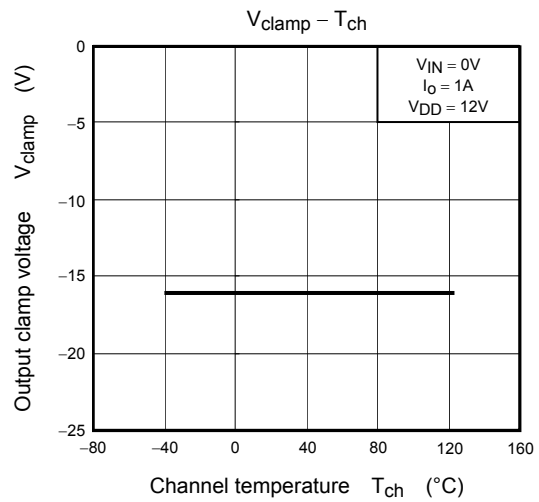
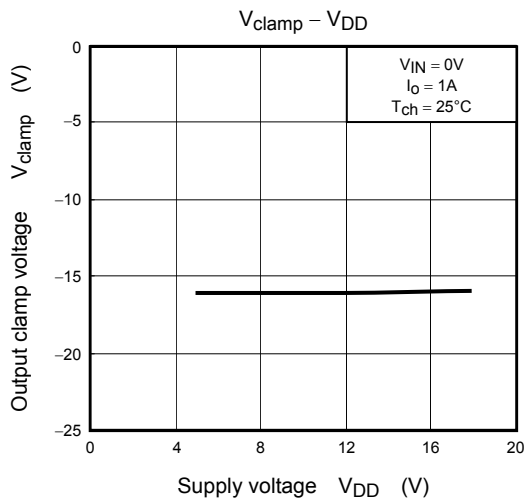
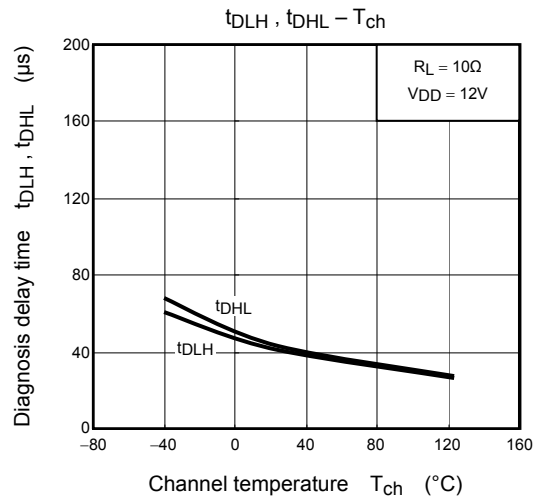
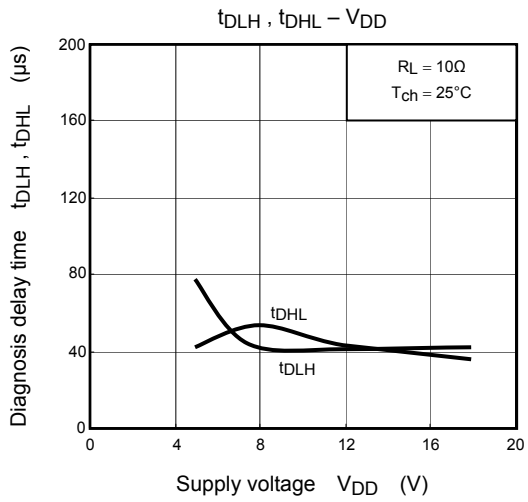
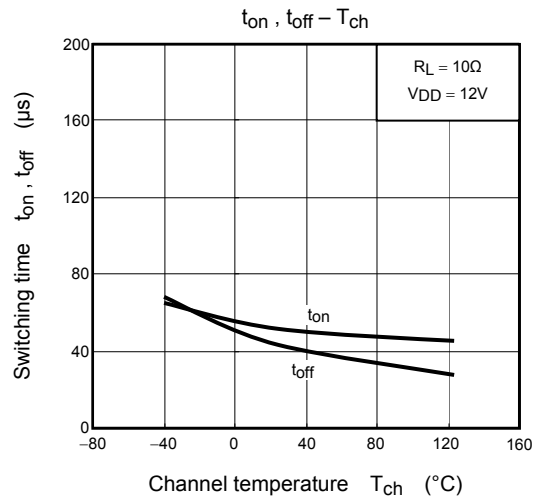
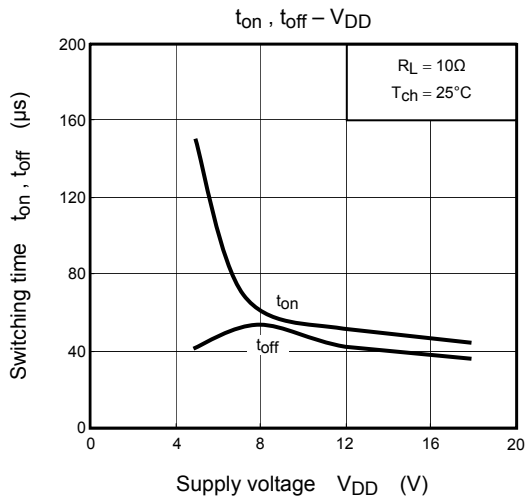


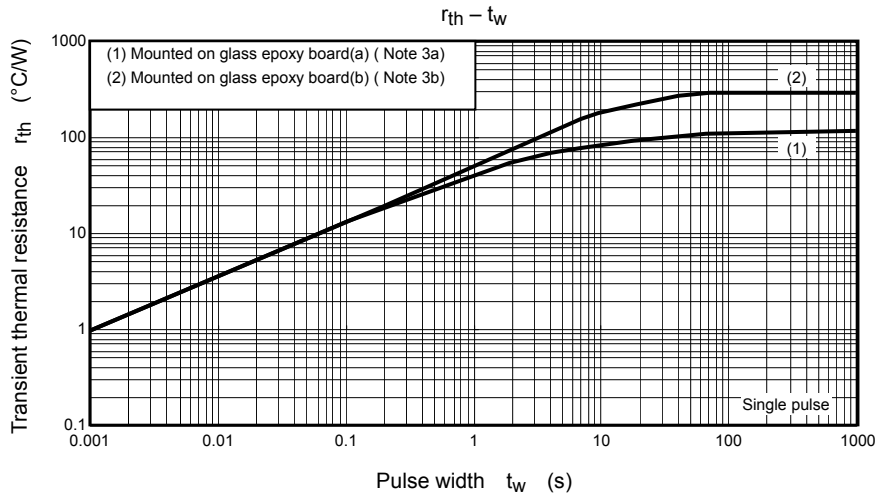
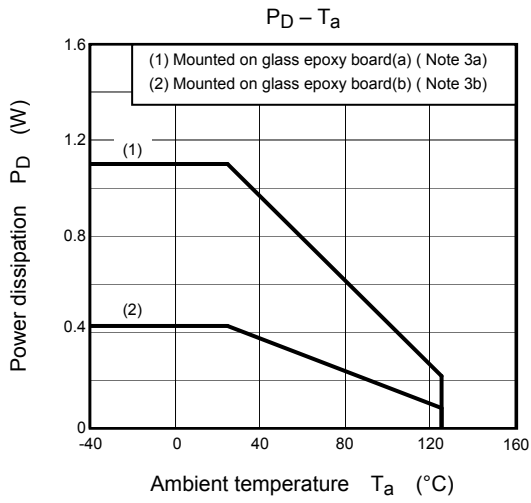




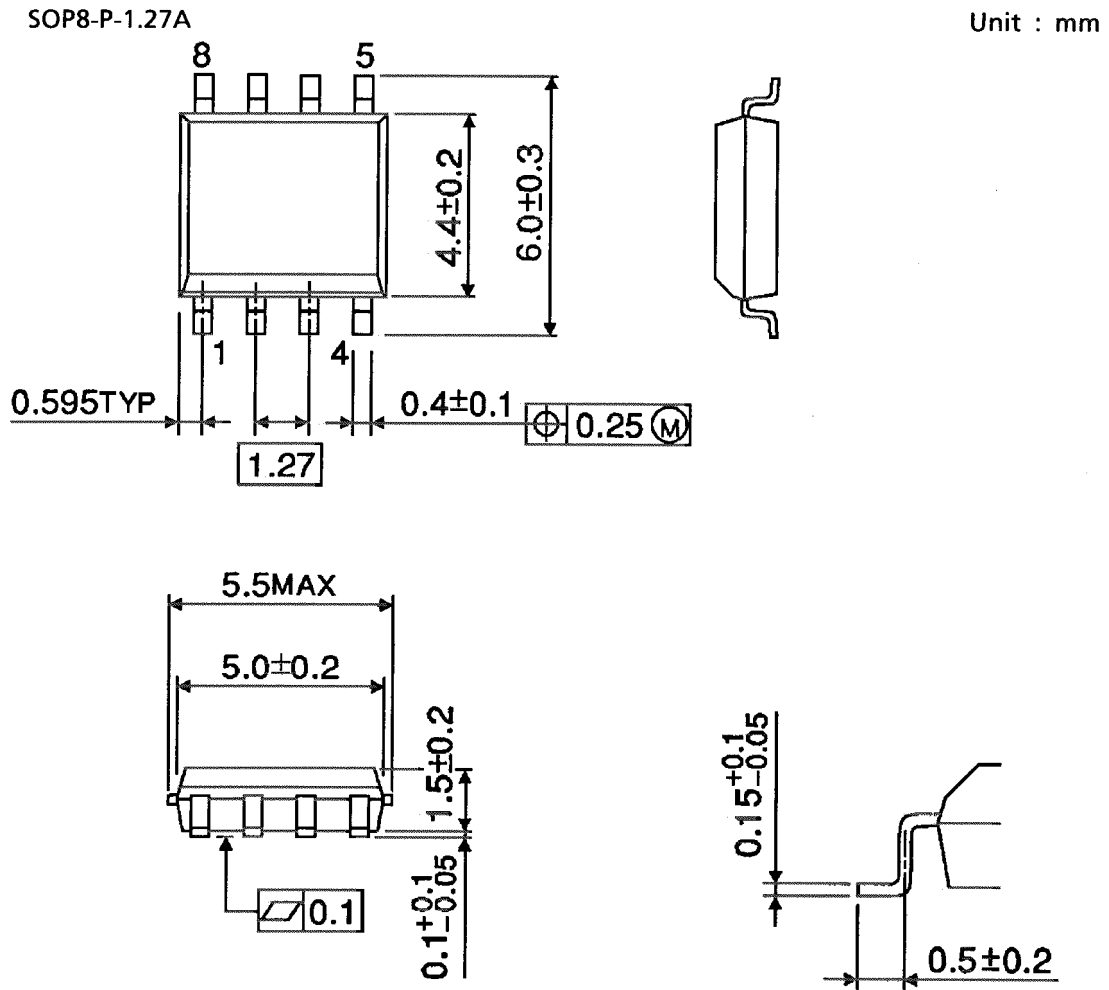








## Package Dimensions



Weight: 0.08 g (Typ.)

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