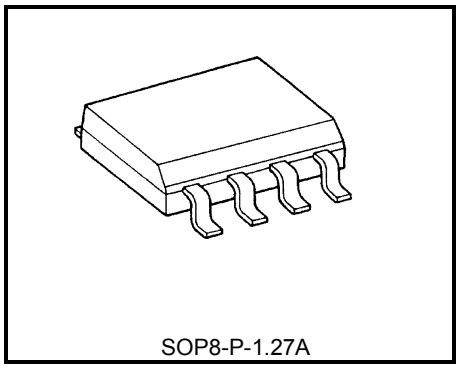
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

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.



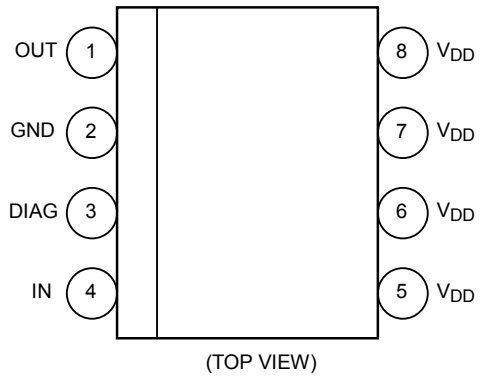
SOP8-P-1.27A

Weight : 0.08g(typ.)

Features

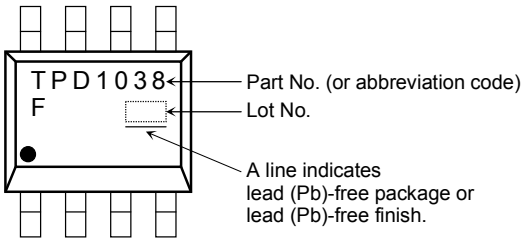
- A monolithic power IC with a structure combining a control block (Bi-CMOS) and a vertical power MOS FET on a single chip.
- One side of load can be grounded to a high-side switch.
- Can directly drive a power load from a microprocessor.
- Built-in protection against overheating and load short-circuiting.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

Pin Assignment



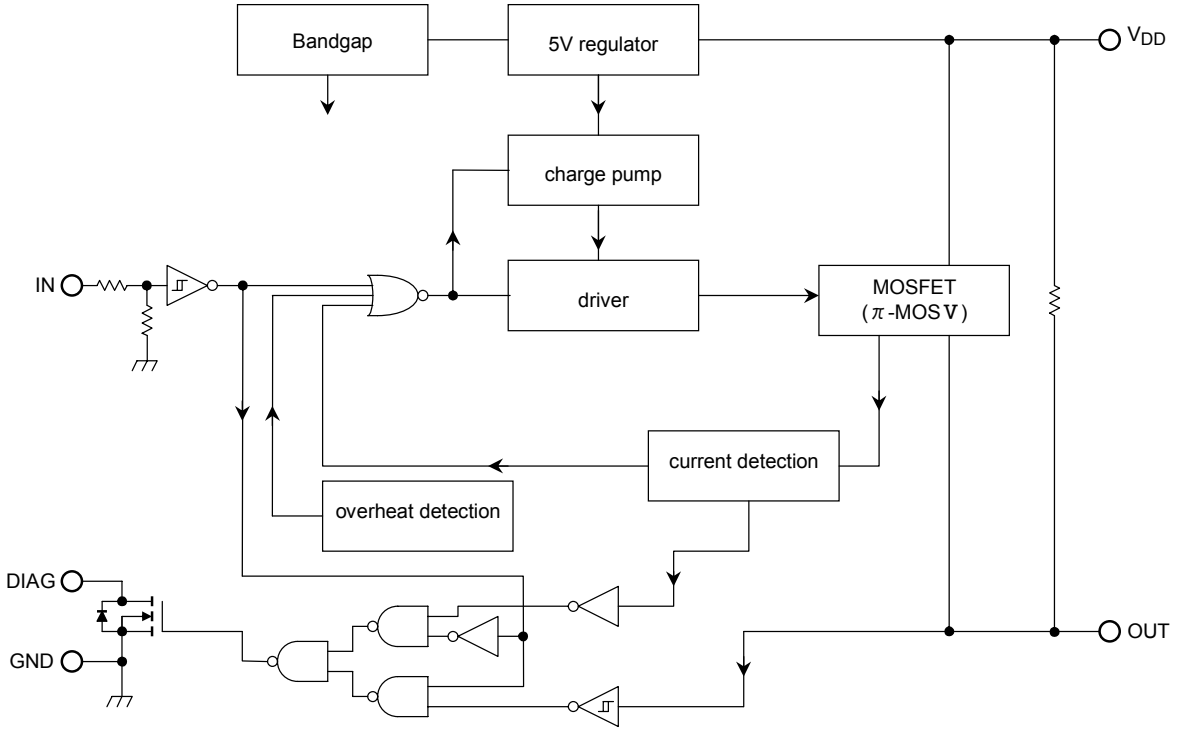
(TOP VIEW)

Marking



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

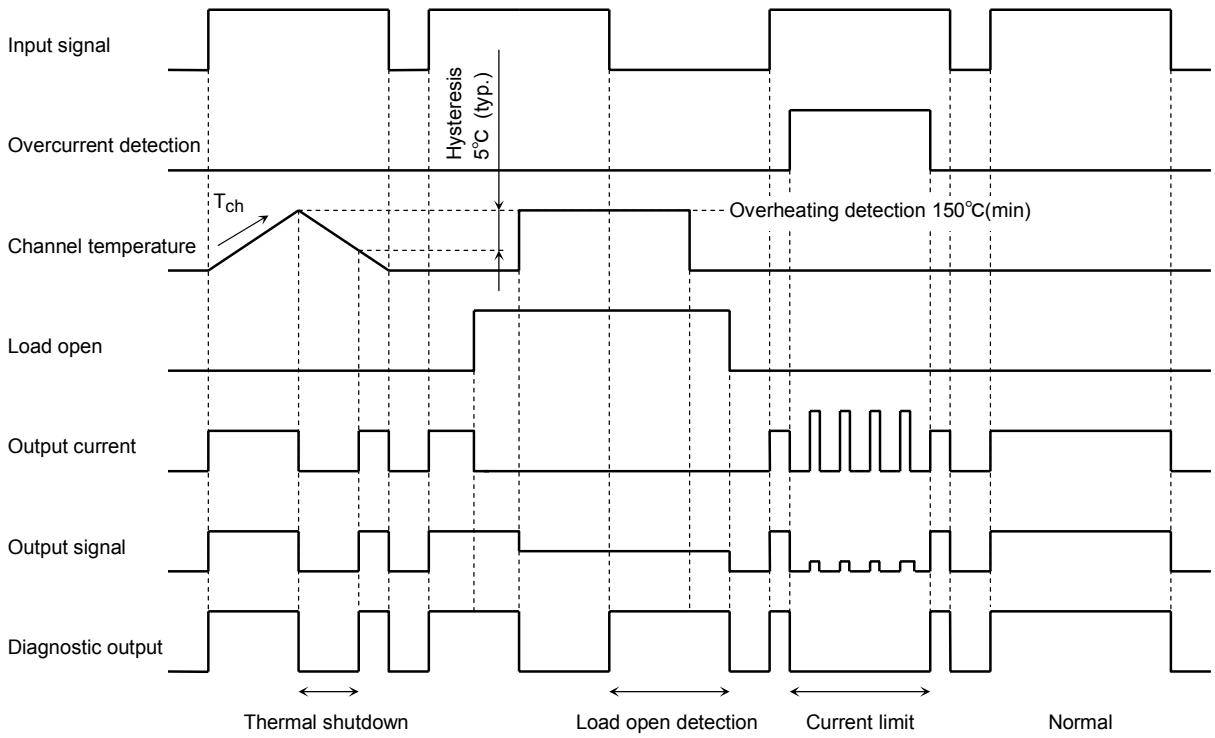
Block Diagram



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_{DD}	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_{DS}	60	V
Supply voltage	DC	$V_{DD(1)}$	25	V
	Pulse	$V_{DD(2)}$	60(R_S=1Ω, τ =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}	±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		Topr	−40～110	°C
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	−55～150	°C

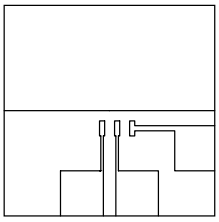
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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	$R_{th(ch-a)}$	113.5 (Note1-a)	°C /W
		294.0 (Note1-b)	

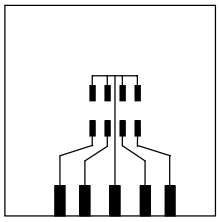
Note 1:

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_a=25°C)

Characteristics		Symbol	Test circuit	Test condition	min	typ.	max	Unit
Operating supply voltage		$V_{DD(OPR)}$	—	—	6	12	18	V
Current dissipation		I_{DD}	—	V_{DD}=12V, V_{IN}=0V, R_L=10Ω	—	—	3	mA
H-level input voltage		V_{IH}	—	V_{DD}=12V	3.5	—	—	V
L-level input voltage		V_{IL}	—	V_{DD}=12V	—	—	1.5	V
H-level input current		I_{IH}	—	V_{DD}=12V, V_{IN}=5V	—	—	200	μA
On resistance		$R_{DS(ON)}$	—	V_{DD}=12V, I_O=2A	—	—	0.12	Ω
Output leakage current		I_{OL}	—	V_{DD}=12V	—	—	1	mA
Diagnosis output voltage	"L"-level	V_{DL}	—	V_{DD}=12V, V_{IN}=0V, I_{DL}=1mA R_L=10Ω	—	—	0.4	V
Diagnosis output current	"H"-level	I_{DH}	—	V_{DD}=12V, V_{IN}=5V, R_L=10Ω, V_{DH}=12V	—	—	10	μA
Over current detection		$I_{OC(1)}$(Note2)	1、2	V_{DD}=12V	3	—	9	A
		$I_{OC(2)}$(Note3)	3	V_{DD}=12V, R_L=0.1Ω	—	—	10	A
Overheating detection		T_{OT}	—	V_{DD}=12V	150	—	200	℃
Load open detection (Note4)		R_{op}	—	V_{DD}=12V, V_{IN}=0V	5	17	—	kΩ
Switching time		t_{on}	4	V_{DD}=12V, R_L=10Ω	—	—	100	μs
		t_{off}			—	—	40	μs
Diagnosis delay time		t_{DLH}	5	V_{DD}=12V, R_L=10Ω	—	70	—	μs
		t_{DHL}			—	22	—	μs
Output clamp voltage		V_{clamp}	—	V_{DD}=12V, V_{IN}=0V, I_O=1A, L=10mH	−(60−V_{DD})	—	−(50−V_{DD})	V

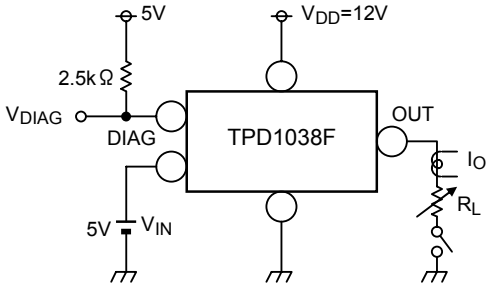
(Note 2) Over-current detection

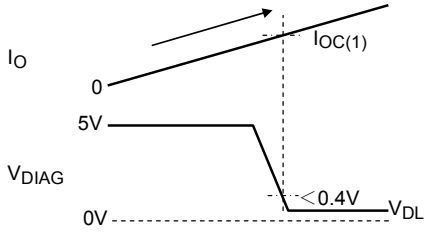
(Note 3) Peak current @ current limit function

(Note 4) Load open detection function : V_{DD} = 8 ～ 18V

Test Circuit 1

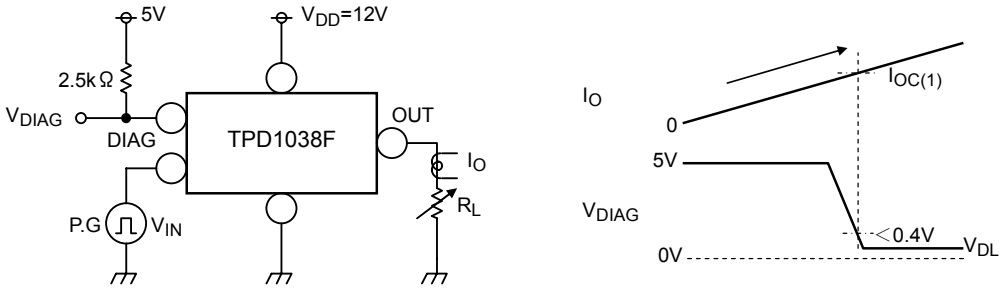
Over current detection $I_{OC(1)}$: Over current detection when load current is increased while VIN = "H"





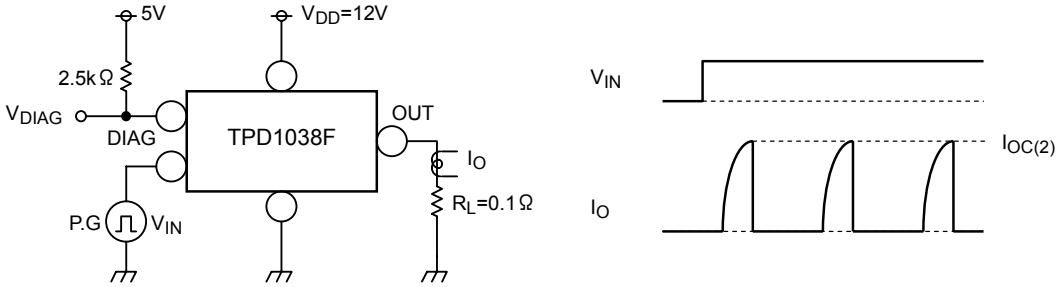
Test Circuit 2

Over current detection $I_{OC(1)}$: Over current detection when load is short circuit and VIN = "L" → "H"



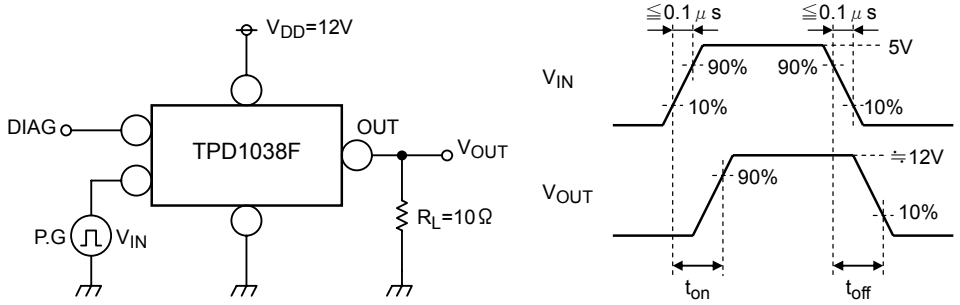
Test Circuit 3

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



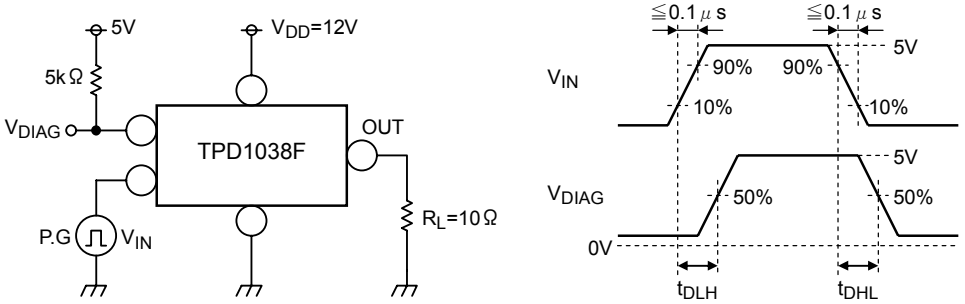
Test Circuit 4

Switching time t_{on}, t_{off}

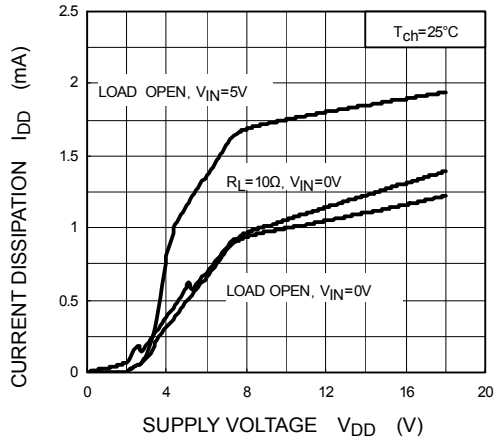


Test Circuit 5

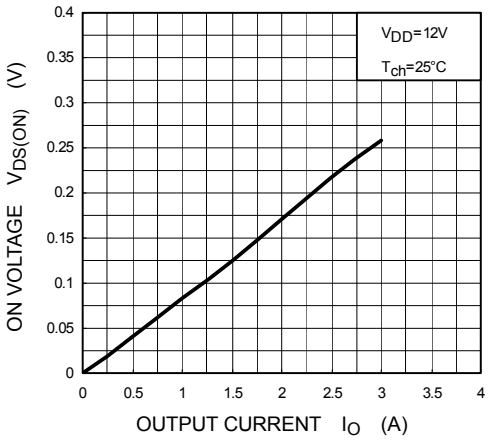
Diagnosis delay time t_{DLH}, t_{DHL}



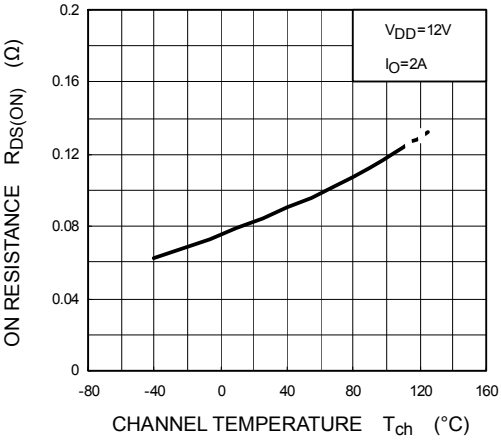
$I_{DD} - V_{DD}$



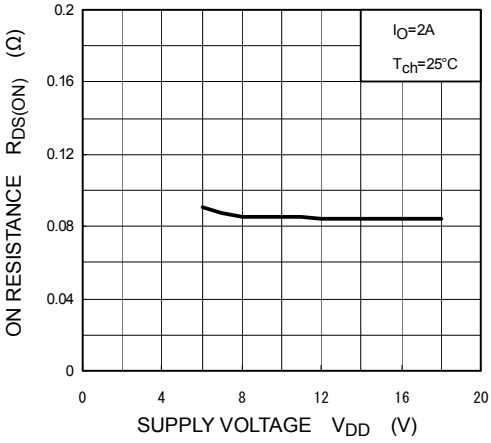
$V_{DS(ON)} - I_O$



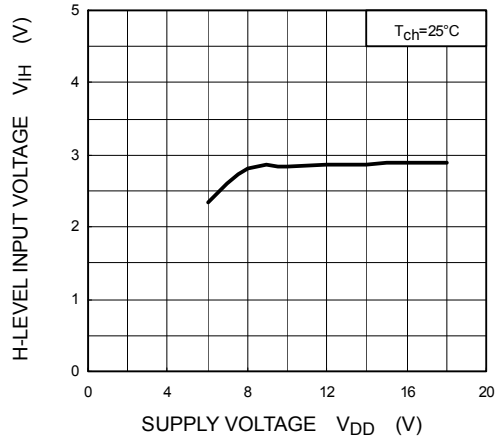
$R_{DS(ON)} - T_{ch}$



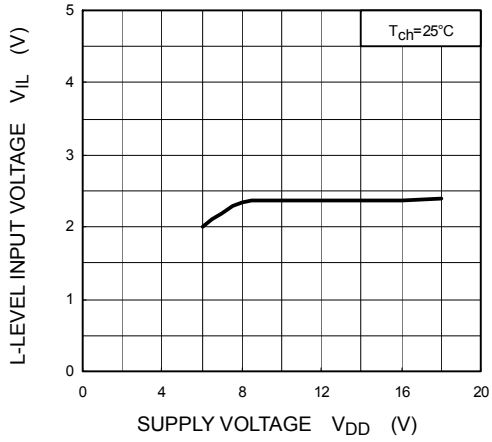
$R_{DS(ON)} - V_{DD}$



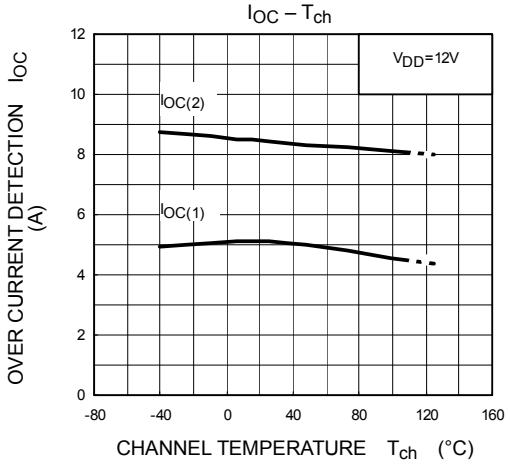
$V_{IH} - V_{DD}$



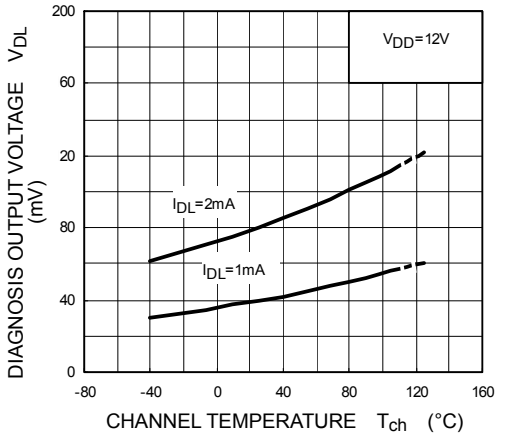
$V_{IL} - V_{DD}$



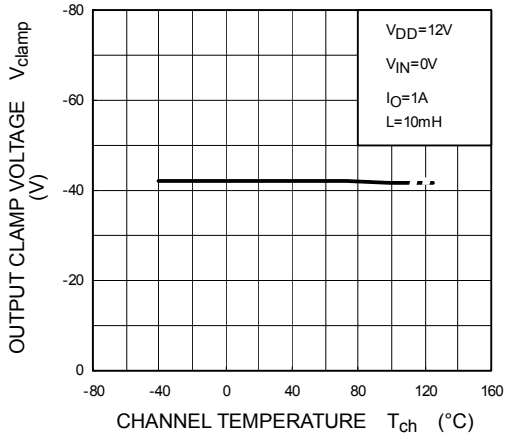
$I_{OC} - T_{ch}$



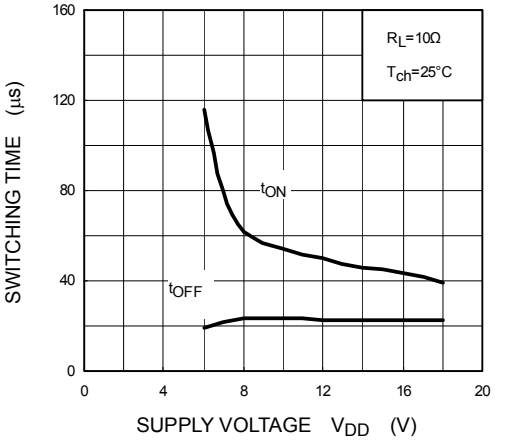
$V_{DL} - T_{ch}$



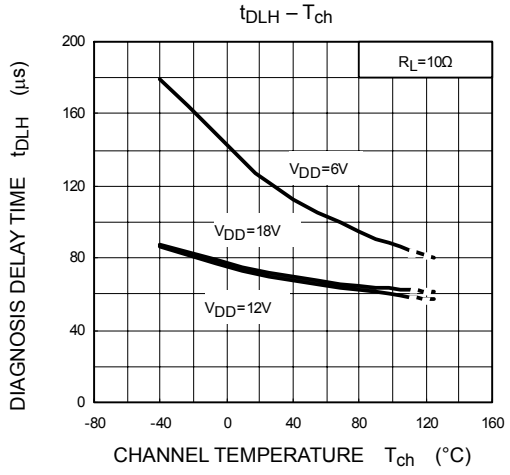
$V_{clamp} - T_{ch}$



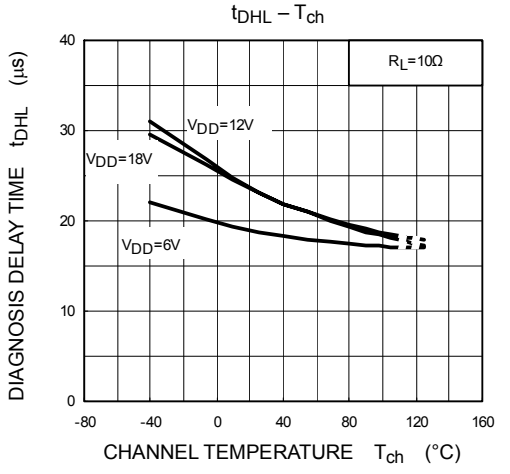
SWITCHING CHARACTERISTICS



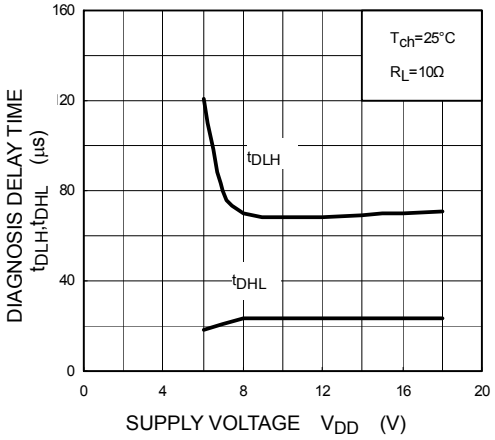
$t_{DLH} - T_{ch}$



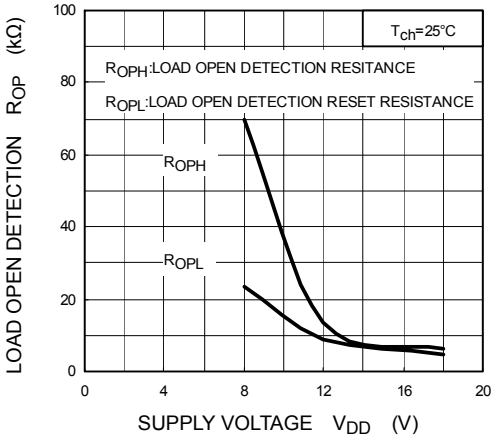
$t_{DHL} - T_{ch}$



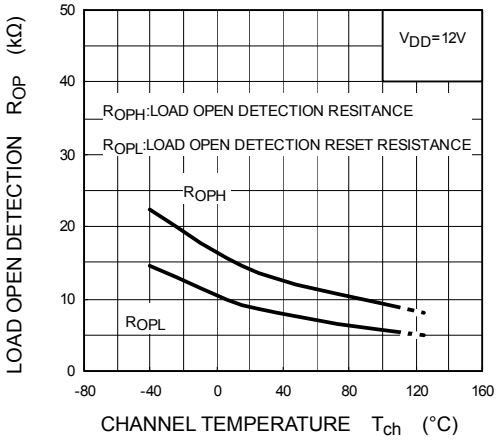
$t_{DLH}, t_{DHL} - V_{DD}$



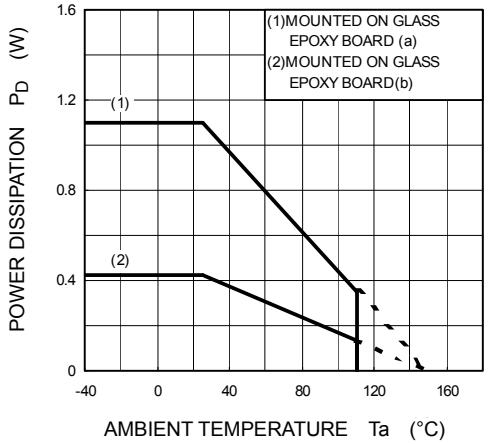
$R_{OP} - V_{DD}$



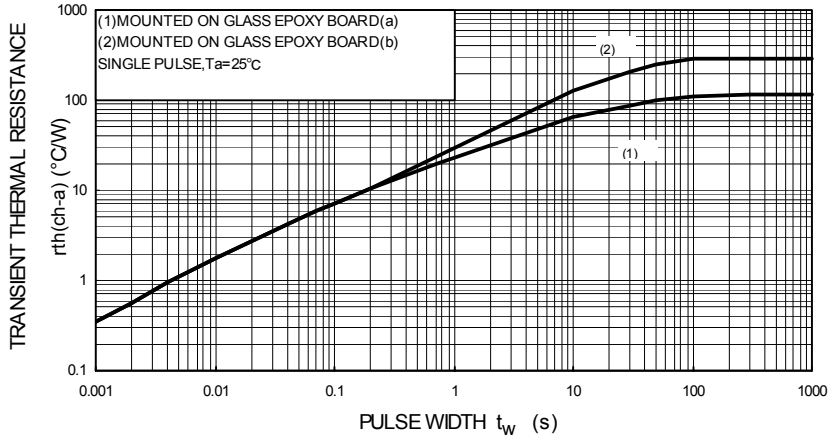
$R_{OP} - T_{ch}$



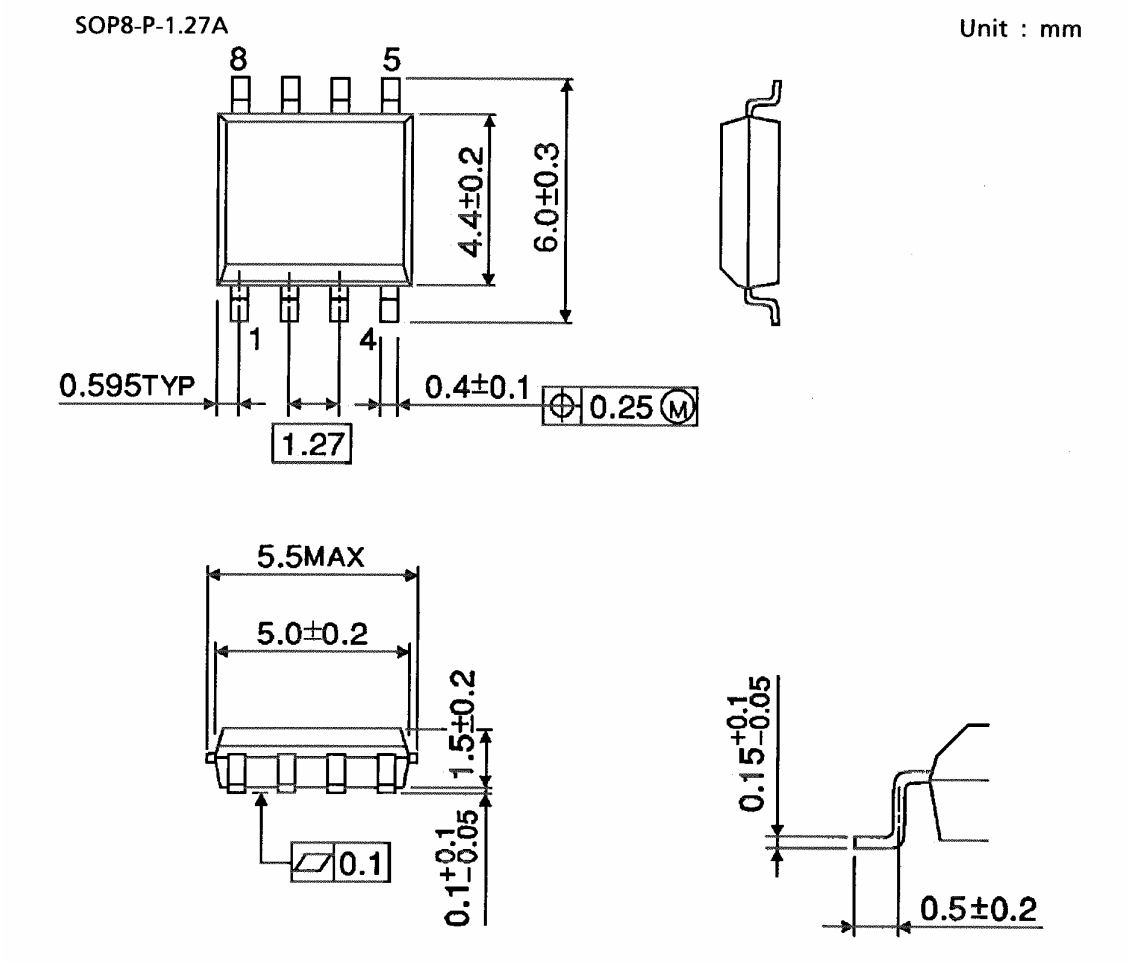
$P_D - Ta$



$r_{th(ch-a)} - t_W$



Package Dimensions



Weight: 0.08g (typ.)

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