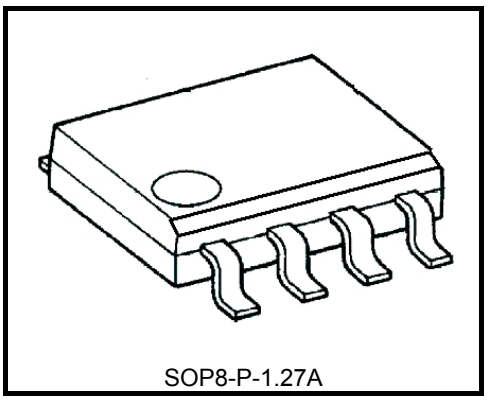
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1045F

Low-Side Power Switch for Motor, Solenoid and Lamp Drive

The TPD1045F is a low-side power switch.
The IC has a vertical MOSFET output which can be directly driven from a CMOS or TTL logic circuit (e.g., an MPU). The IC is equipped with intelligent self-protection functions.



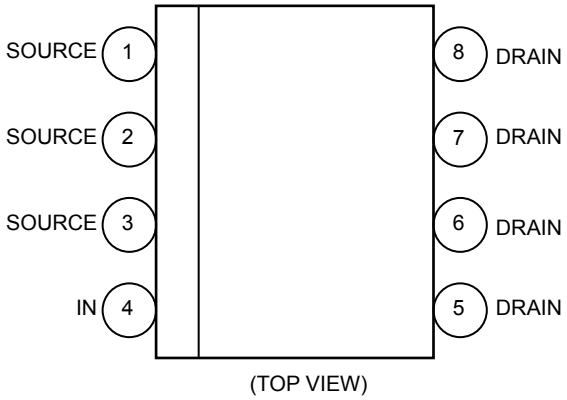
SOP8-P-1.27A

Weight: 0.08 g (typ.)

Features

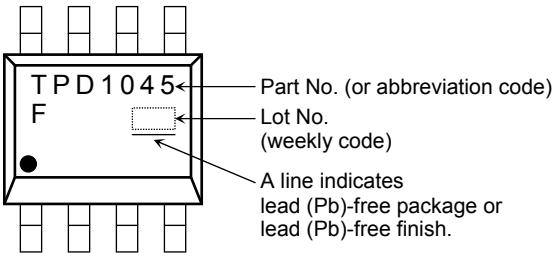
- A monolithic power IC with a new structure combining a control block and a vertical power MOSFET (L^2-π-MOSV) on single chip.
- Can directly drive a power load from a CMOS or TTL logic.
- Built-in protection circuits against overvoltage (active clamp), Over temperature (thermal shutdown), and overcurrent (switching mode).
- Low Drain-Source ON-resistance: $R_{DS\ (ON)}$ = 100 mΩ (max) (@V_{IN} = 5 V, I_D = 2 A, T_{ch} = 25°C)
- 8-pin SOP package with embossed-tape packing.

Pin Assignment (top view)



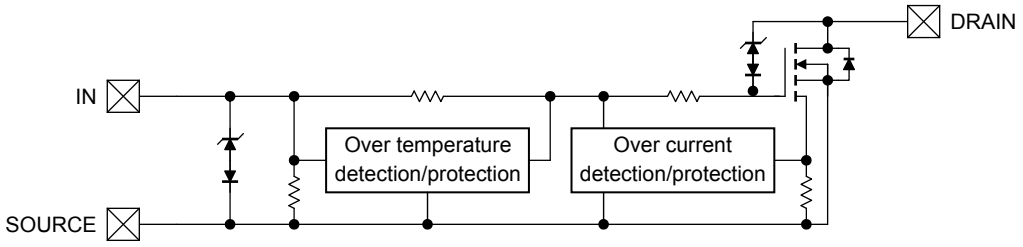
(TOP VIEW)

Marking



Note 1: Due to its MOS structure, this product is sensitive to static electricity.

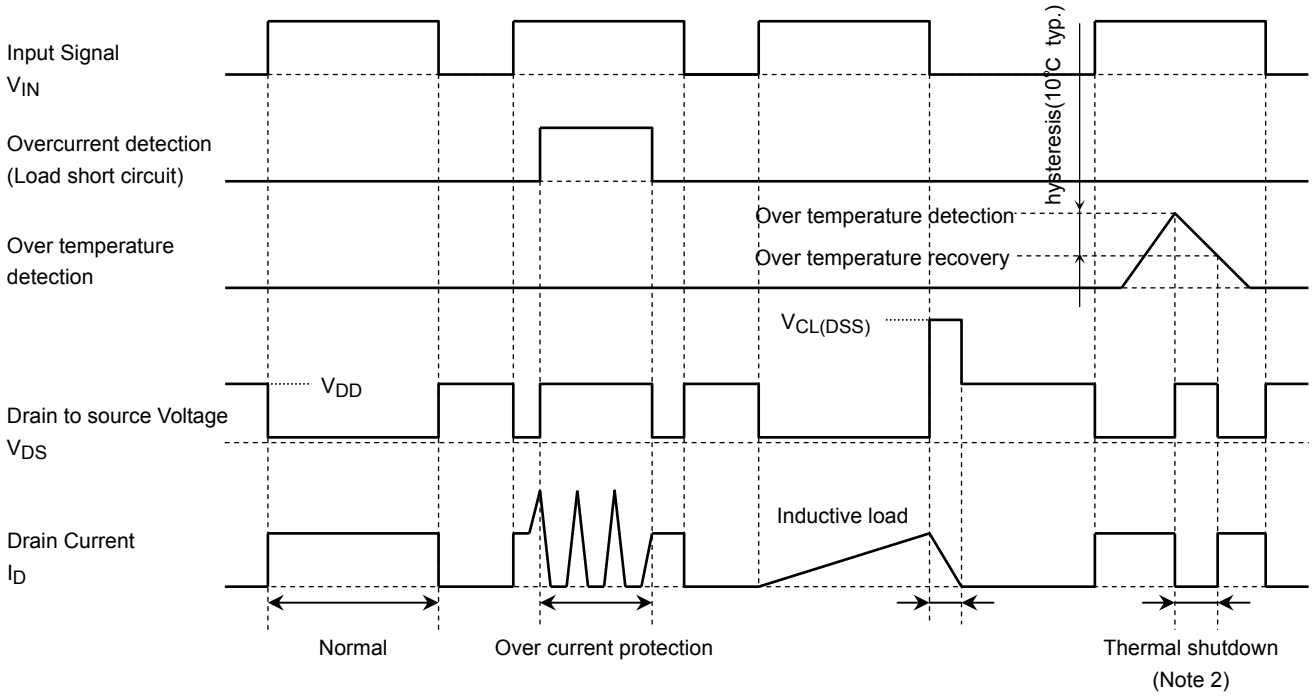
Block Diagram



Pin Description

Pin No.	Symbol	Pin Description
1, 2, 3	SOURCE	Source (ground) pin
4	IN	Input pin. This pin is connected to a pull-down resistor internally, so that even when input wiring is open-circuited, output can never be turned on inadvertently.
5 ,6, 7, 8	DRAIN	Drain pin. When the load is short circuited and current in excess of the detection current (10A min) flows to the drain (output) pin, the drain (output) automatically turns on or off.

Timing Chart



Note 2: The overheating detector circuits feature hysteresis. After overheating is detected, normal operation is restored only when the channel temperature falls by the hysteresis amount (10°C typ.) in relation to the overheating detection temperature.

Truth Table

V_{IN}	V_{DS}	Output State	State
L	H	OFF	Normal
H	L	ON	
L	H	OFF	Overcurrent
H	H	current limiting(switcing)	
L	H	OFF	Overtemperature
H	H	ON	

Absolute Maximum Ratings (Ta = 25°C)

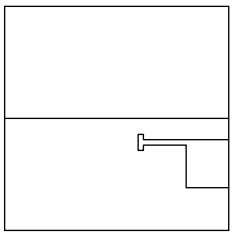
Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DS\ (DC)}$	50	V
Drain current	$I_{D\ (DC)}$	Internally Limited	A
Input voltage	V_{IN}	−0.3~7	V
Power dissipation(Note 3-a)	$P_{D(1)}$	1.1	W
Power dissipation(Note 3-b)	$P_{D(2)}$	0.425	W
Single Pulse Active Clamp Tolerance (Note 4)	E_{AS}	158	mJ
Active Clamp Current	I_{AR}	5	A
Repetitive Active Clamp Tolerance (Note 3-a) (Note 5)	E_{AR}	0.11	mJ
Operating temperature	T_{opr}	−40~125	°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).

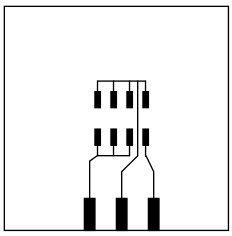
Thermal Characteristics

Characteristics	Symbol	max	Unit
Thermal resistance, channel to ambient	$R_{th(ch-a)}$	113.5 (Note 3-a)	°C /W
		294.0 (Note 3-b)	

Note 3: 3-a : glass epoxy board (a) 3-b : glass epoxy board (b)



FR-4
25.4 × 25.4 × 0.8
(unit : mm)



FR-4
25.4 × 25.4 × 0.8
(unit : mm)

Note 4 : V_{DD} = 25 V、T_{ch} = 25 ℃ (initial)、L = 7.4 mH、I_{AR} = 5 A、R_G = 25 Ω
Note 5 : Repetitive rating : Pulse Width limited by maximum channel temperature.

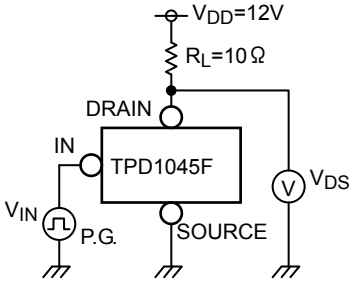
Electrical Characteristics

Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ	Max	Unit
Drain to Source clamp voltage		$V_{(CL)\ DSS}$	-	T_{ch} = 25°C	V_{IN} = 0 V, I_D = 10 mA	50	58	-	V
				T_{ch} = −40~125°C		50	-	-	
Input threshold voltage		V_{th}	-	T_{ch} = 25°C	V_{DS} = 12 V, I_D = 10 mA	1.0	1.5	2.8	V
				T_{ch} = −40~125°C		0.8	-	3.0	
Protective circuit operation input voltage range		$V_{IN\ (opr)}$	-	T_{ch} = −40~125°C	-	4	-	7	V
Drain cut-off current		I_{DSS}	-	T_{ch} = 25°C	V_{IN} = 0 V, V_{DS} = 12 V	-	-	10	μA
				T_{ch} = −40~125°C		-	-	30	
High level input current		$I_{IH\ (1)}$	-	T_{ch} = 25°C	V_{IN} = 5 V, at normal operation	-	300	750	μA
				T_{ch} = −40~125°C		-	-	750	
		$I_{IH\ (2)}$	-	T_{ch} = −40~125°C	V_{IN} = 5 V, when protective circuit is actuated	-	-	1200	
Drain to Source on resistance		$R_{DS\ (ON)}$	-	T_{ch} = 25°C	V_{IN} = 5 V, I_D = 2 A	-	70	100	mΩ
				T_{ch} = −40~125°C		-	-	150	
Load-short tolerance		V_{DS}	-	T_{ch} = −40~125°C	V_{IN} = 4~7 V	18	-	-	V
Over temperature detection	temperature detection	$T_{OT(1)}$	-	-	V_{IN} = 5 V	150	170	200	°C
	temperature recovery	$T_{OT(2)}$	-			125	160	-	℃
Over current detection		I_{OC}	-	T_{ch} = 25°C	V_{IN} = 5 V	5	10	-	A
				T_{ch} = −40~125°C		5	-	-	
Switching time		t_{on}	1	T_{ch} = 25°C	V_{DD} = 12 V, V_{IN} = 0 V/5 V, R_L = 10Ω	-	25	100	μs
				T_{ch} = −40~125°C		-	-	100	
		t_{off}		T_{ch} = 25°C		-	30	100	
				T_{ch} = −40~125°C		-	-	100	
Drain to Source diode forward voltage		V_{DSF}	-	T_{ch} = 25°C	V_{IN} = 0 V, I_F = 5 A	-	-	1.8	V

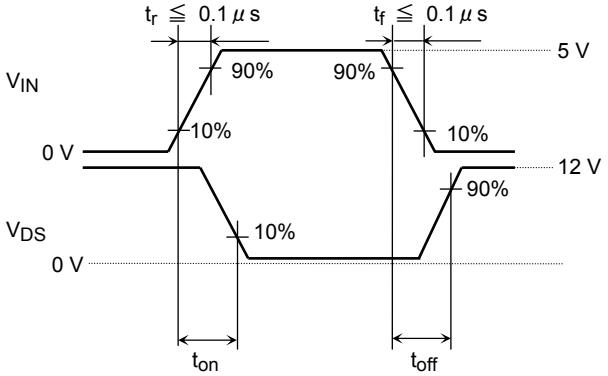
Test Circuit 1

Switching time measuring circuit

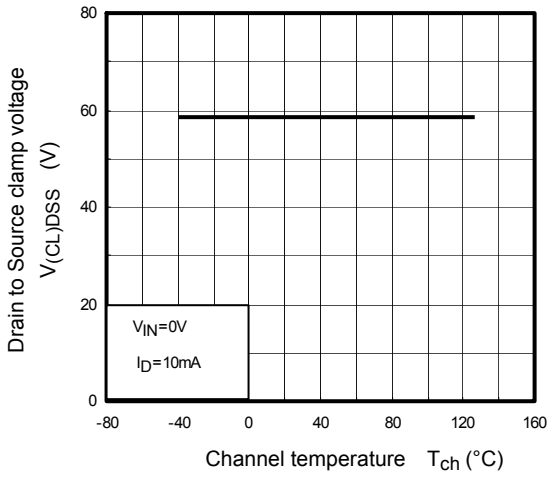
Test circuit



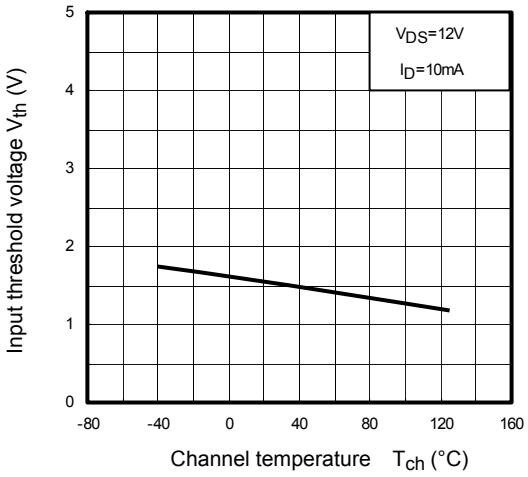
Measured waveforms



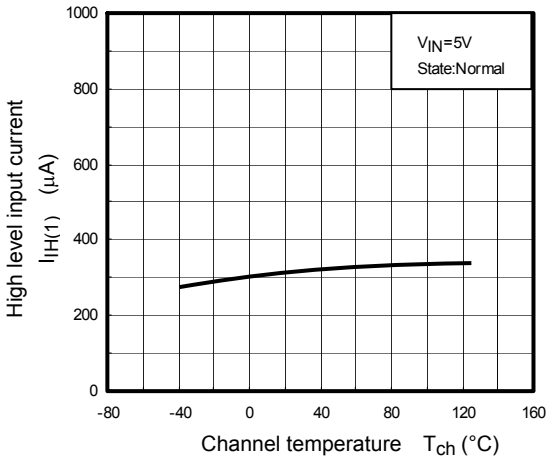
$V_{(CL)DSS} - T_{ch}$



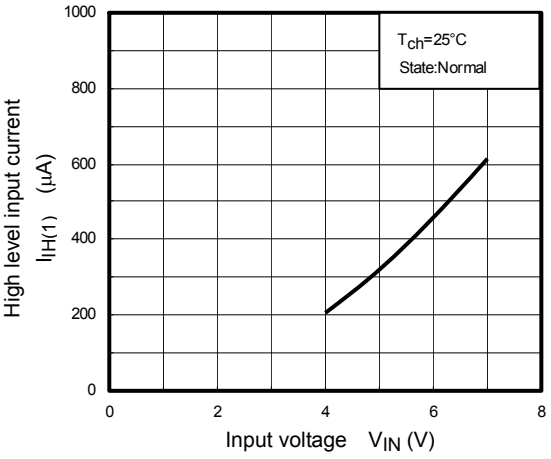
$V_{th} - T_{ch}$



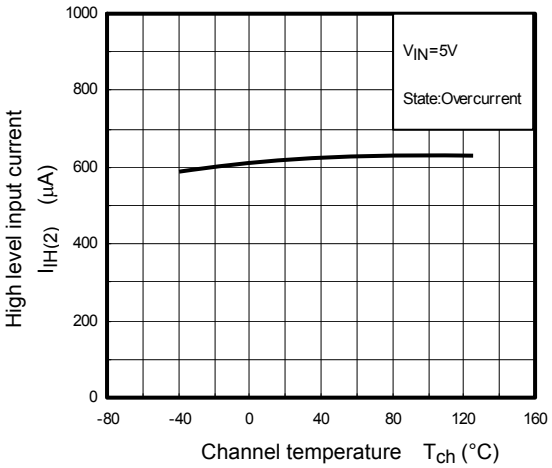
$I_{IH(1)} - T_{ch}$



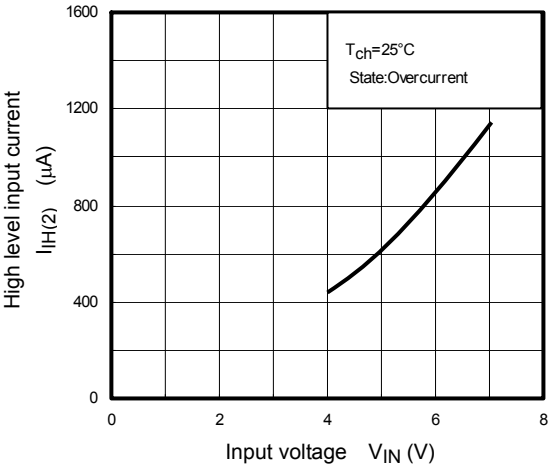
$I_{IH(1)} - V_{IN}$



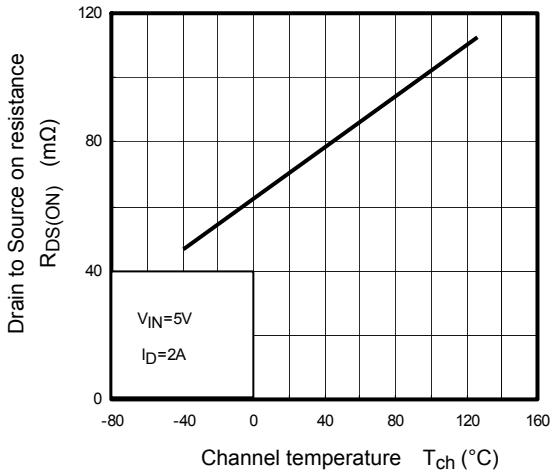
$I_{IH(2)} - T_{ch}$



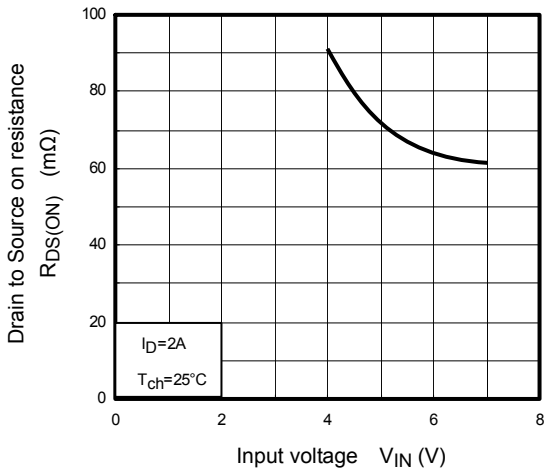
$I_{IH(2)} - V_{IN}$



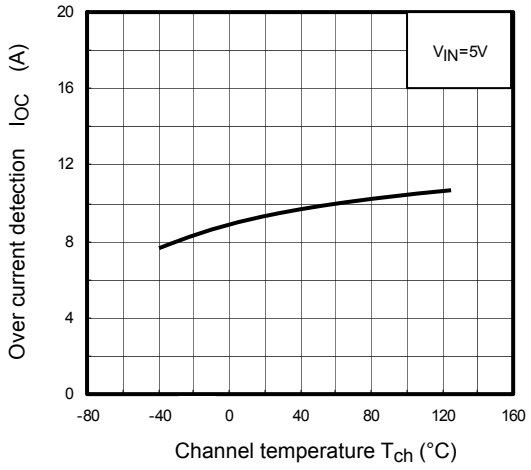
$R_{DS(ON)} - T_{ch}$



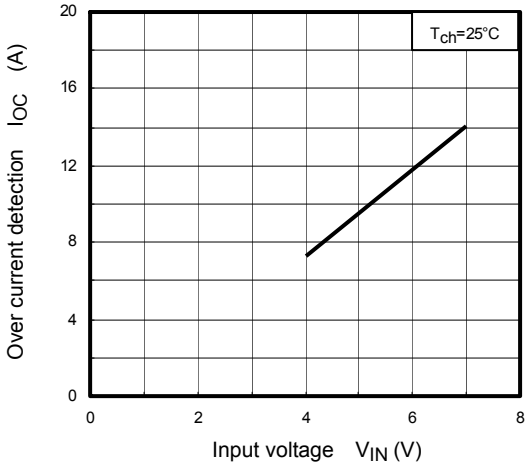
$R_{DS(ON)} - V_{IN}$



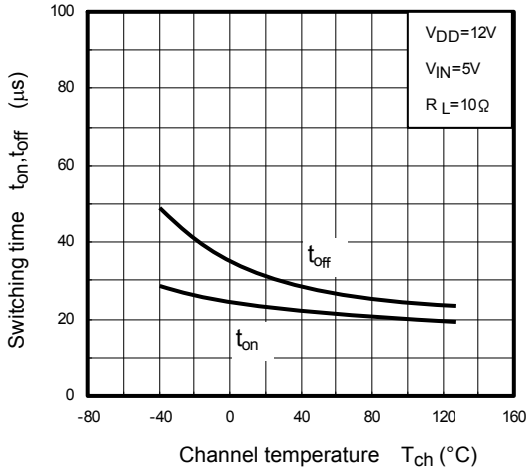
$I_{OC} - T_{ch}$



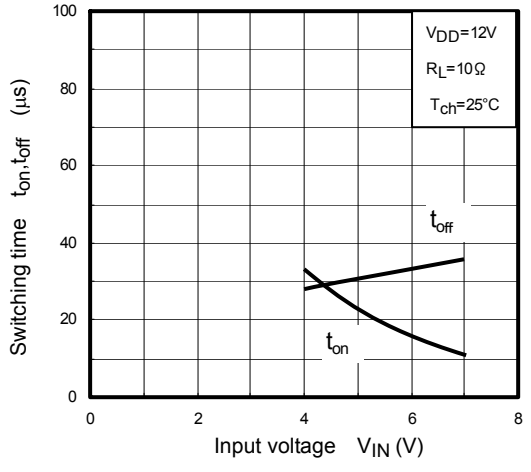
$I_{OC} - V_{IN}$

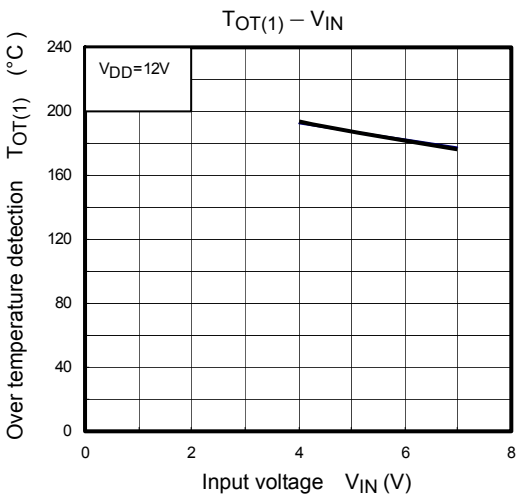


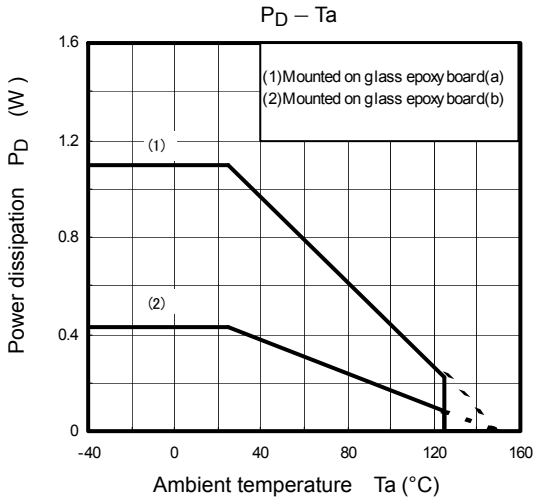
$t_{on}, t_{off} - T_{ch}$

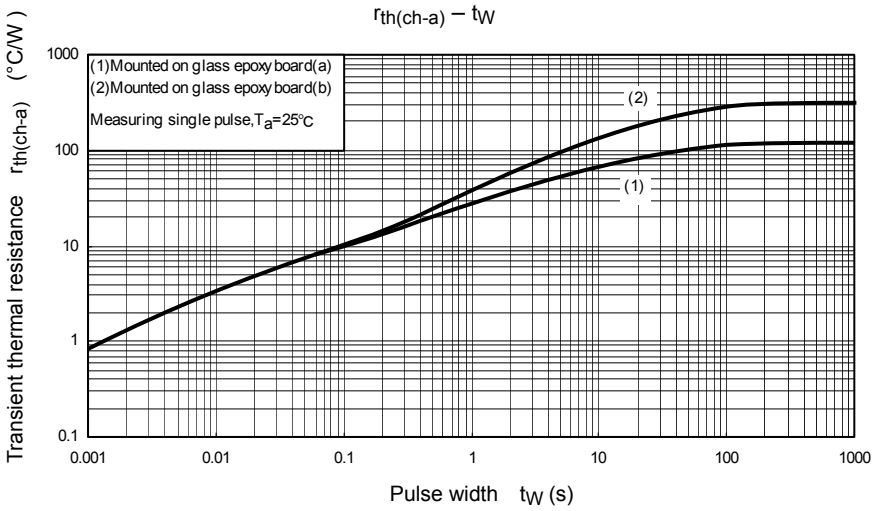


$t_{on}, t_{off} - V_{IN}$

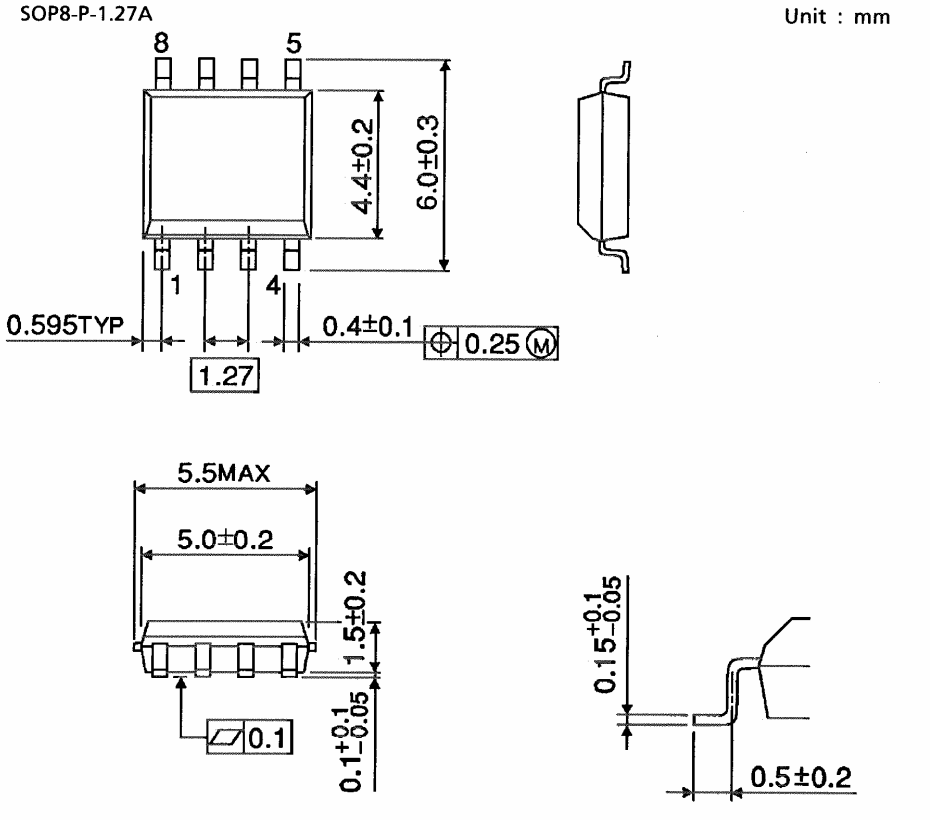



$T_{OT(1)} - V_{IN}$
V_{DD}=12V
Over temperature detection $T_{OT(1)}$ (°C)
Input voltage V_{IN} (V)
240
200
160
120
80
40
0
0
2
4
6
8


$P_D - Ta$
(1)Mounted on glass epoxy board(a)
(2)Mounted on glass epoxy board(b)
(1)
(2)
Power dissipation P_D (W)
Ambient temperature Ta (°C)
1.6
1.2
0.8
0.4
0
-40
0
40
80
120
160


$r_{th(ch-a)} - t_W$
(1)Mounted on glass epoxy board(a)
(2)Mounted on glass epoxy board(b)
Measuring single pulse, T_a=25°C
(1)
(2)
Transient thermal resistance $r_{th(ch-a)}$ (°C/W)
Pulse width t_W (s)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000

Package Dimensions



Weight: 0.08 g (typ.)

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20070701-EN

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