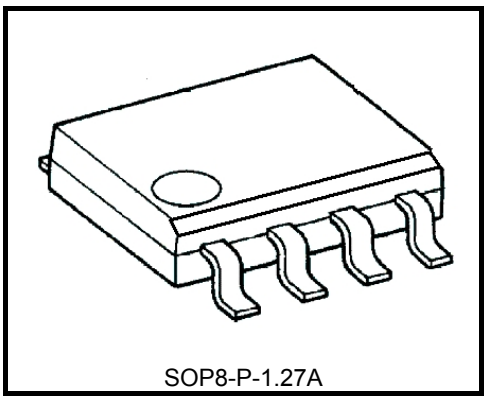
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1046F

2-IN-1 Low-Side Power Switch for Motor, Solenoid and Lamp Drive

The TPD1046F is a 2-IN-1 low-side 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.



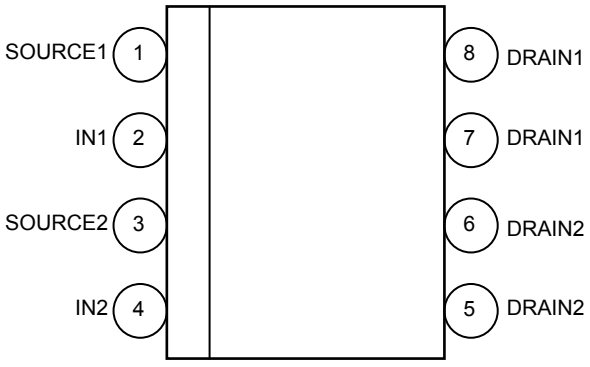
SOP8-P-1.27A

Weight: 0.08 g (typ.)

Features

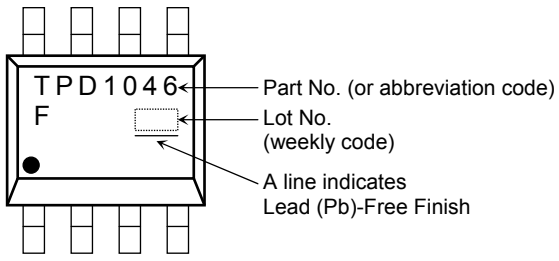
- Two built-in power IC chips with a structure combining a control block and a vertical power MOSFET (L^2-π-MOS) on each chip.
- Can directly drive a power load from a CMOS or TTL logic.
- Built-in protection circuits against overvoltage (active clamp), overtemperature (thermal shutdown), and overcurrent (current limiter).
- Low Drain-Source ON-resistance: $R_{DS\ (ON)}$ = 0.2 Ω (max) (@V_{IN} = 5 V, I_D = 1 A, T_{ch} = 25°C)
- Low Leakage Current: I_{DSS} = 10 μA (max) (@V_{IN} = 0 V, V_{DS} = 30 V, T_{ch} = 25°C)
- Low Input Current: I_{IN} = 600 μA (max) (@V_{IN} = 5 V, T_{ch} = -40~125°C)
- 8-pin SOP package with embossed-tape packing.

Pin Assignment (top view)



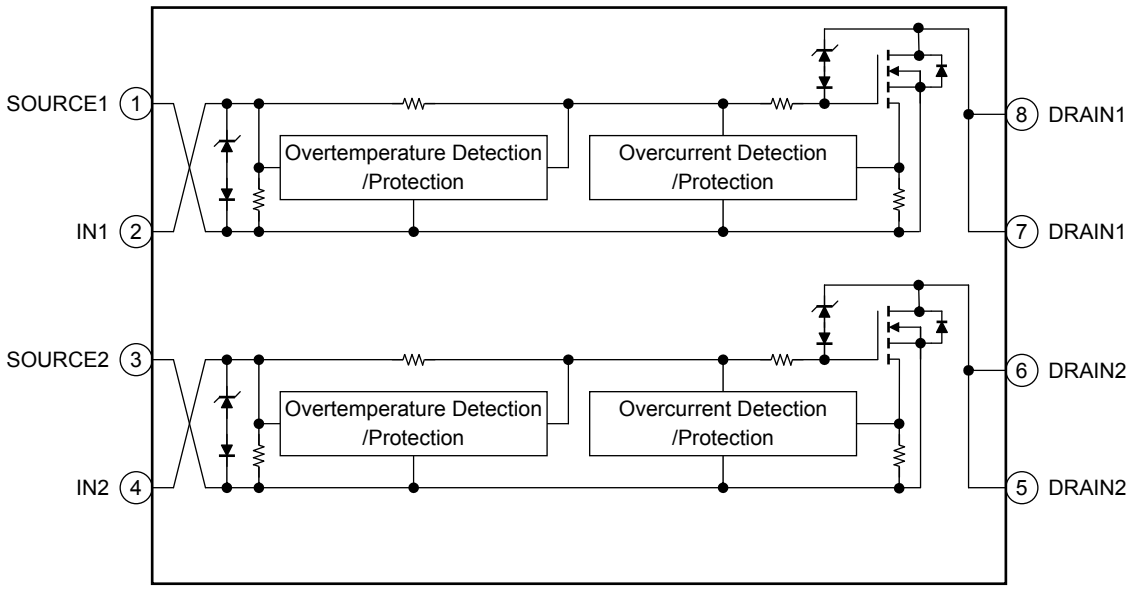
(TOP VIEW)

Marking



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

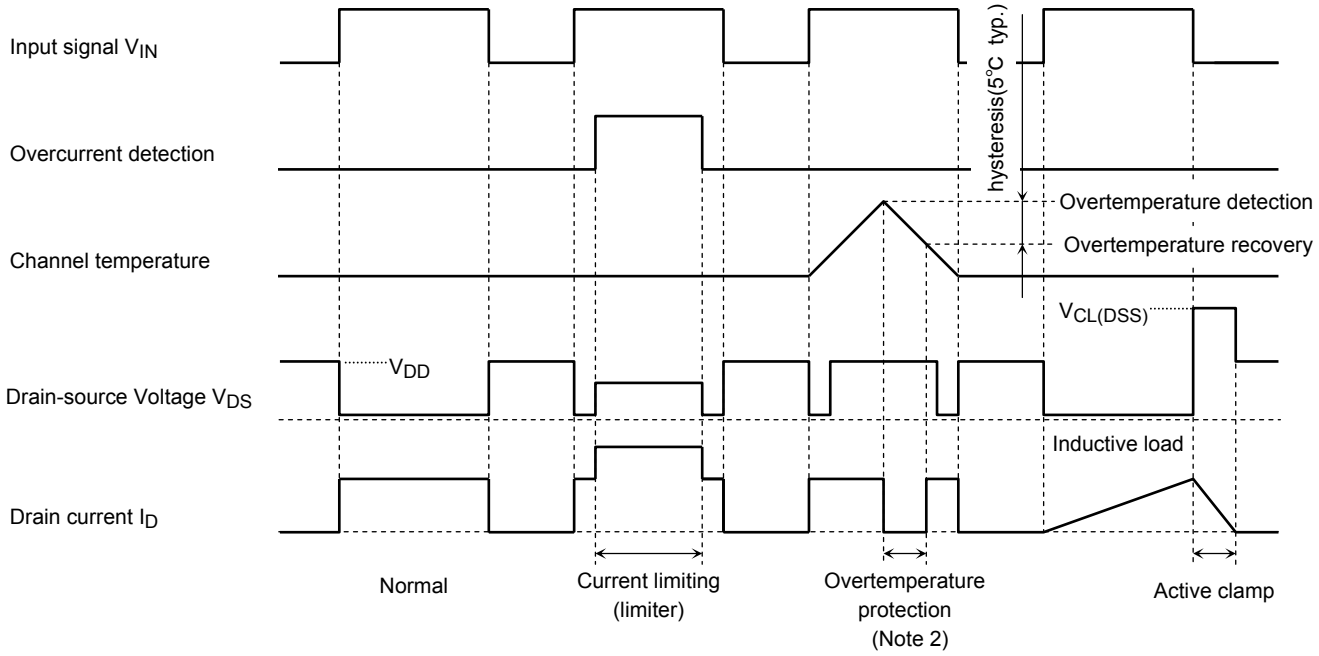
Block Diagram



Pin Description

Pin No.	Symbol	Pin Description
1	SOURCE1	Source pin 1
2	IN1	Input pin 1 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.
3	SOURCE2	Source pin 2
4	IN2	Input pin 2 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	DRAIN2	Drain pin 2 Drain current is limited (by current limiter) if it exceeds 3 A (min) in order to protect the IC.
7, 8	DRAIN1	Drain pin 1 Drain current is limited (by current limiter) if it exceeds 3 A (min) in order to protect the IC.

Timing Chart



Note 2: The overtemperature detector circuits feature hysteresis. After overtemperature is detected, normal operation is restored only when the channel temperature falls by the hysteresis amount (5°C typ.) in relation to the overtemperature detection temperature.

Truth Table

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

Absolute Maximum Ratings (Ta = 25°C)

Characteristics		Symbol	Rating	Unit
Drain-source voltage		$V_{DS(DC)}$	40	V
Drain current		I_D	Internally Limited	A
Input voltage		V_{IN}	−0.3~7	V
Power dissipation (Ta = 25°C) (Note 3-a)	1device operation (Note 4a)	$P_{D(1)}$	0.95	W
	2 devices operation per device (Note 4b)	$P_{D(2)}$	0.54	W
Power dissipation (Ta = 25°C) (Note 3-b)	1device operation (Note 4a)	$P_{D(1)}$	0.38	W
	2 devices operation per device (Note 4b)	$P_{D(2)}$	0.20	W
Single pulse active clamp tolerance (Note 5)		E_{AS}	97	mJ
Active clamp current		I_{AR}	3	A
Repetitive active clamp tolerance (Note 3-a) (Note 6)		E_{AR}	54	μJ
Operating temperature		T_{opr}	−40~125	°C
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	−55~150	°C

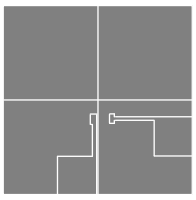
Thermal Characteristics

Characteristics		Symbol	max	Unit
Thermal resistance, channel to ambient (Note 3-a)	1device operation (Note 4a)	$R_{th\ (ch-a)(1)}$	132	°C/W
	2 devices operation per device (Note 4b)	$R_{th\ (ch-a)(2)}$	231	
Thermal resistance, channel to ambient (Note 3-b)	1device operation (Note 4a)	$R_{th\ (ch-a)(1)}$	330	°C/W
	2 devices operation per device (Note 4b)	$R_{th\ (ch-a)(2)}$	625	

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).

Note 3:

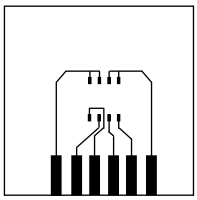
3-a : glass epoxy board (a)



FR-4
25.4 × 25.4 × 0.8
(unit: mm)

(a)

3-b : glass epoxy board (b)



FR-4
25.4 × 25.4 × 0.8
(unit: mm)

(b)

Note 4:

a) 1 device operation : power dissipation value or thermal resistance of one side device.

b) 2 devices operation per device : power dissipation value or thermal resistance per device when power is impressed evenly.

Note 5: V_{DD} = 25 V, T_{ch} = 25°C(initial), L = 10.8 mH, I_{AR} = 3 A, R_G = 25 Ω

Note 6: Repetitive rating : Pulse width limited by maximum channel temperature.

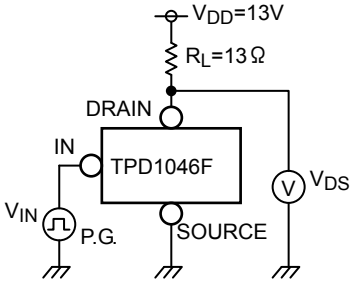
Electrical Characteristics

Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.	Max	Unit
Drain-source clamp voltage		$V_{(CL)\ DSS}$	-	T_{ch} = 25°C	V_{IN} = 0 V, I_D = 1 mA	40	49	60	V
				T_{ch} = −40~125°C		40	-	60	
Input threshold voltage		V_{th}	-	T_{ch} = 25°C	V_{DS} = 13 V, I_D = 10 mA	1.0	1.6	2.8	V
				T_{ch} = −40~125°C		0.9	-	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	-	130	600	μA
				T_{ch} = −40~125°C		-	-	600	
		$I_{IH\ (2)}$	-	T_{ch} = −40~125°C	V_{IN} = 5 V, when protective circuit is actuated	-	-	2000	
Drain-source on resistance		$R_{DS\ (ON)}$	-	T_{ch} = 25°C	V_{IN} = 5 V, I_D = 1 A	-	0.14	0.2	Ω
				T_{ch} = −40~125°C		-	-	0.3	
Load-short tolerance		V_{DS}	-	T_{ch} = −40~125°C	V_{IN} = 4~6 V	20	-	-	V
Overtemperature detection	temperature detection	$T_{OT(1)}$	-	-	V_{IN} = 5 V	150	160	-	°C
	temperature recovery	$T_{OT2()}$	-			125	155	-	°C
Overcurrent detection		I_{OC}	-	T_{ch} = 25°C	V_{IN} = 5 V	3.0	3.7	-	A
				T_{ch} = −40~125°C		2.0	-	-	
Switching time		t_{on}	1	T_{ch} = 25°C	V_{DD} = 13 V, V_{IN} = 0 V/5 V, R_L = 13 Ω	-	15	100	μs
				T_{ch} = −40~125°C		-	-	100	
		t_{off}		T_{ch} = 25°C		-	30	100	
				T_{ch} = −40~125°C		-	-	100	
Drain-source diode forward voltage		V_{DSF}	-	T_{ch} = 25°C	V_{IN} = 0 V, I_F = 1 A	-	-	1.7	V

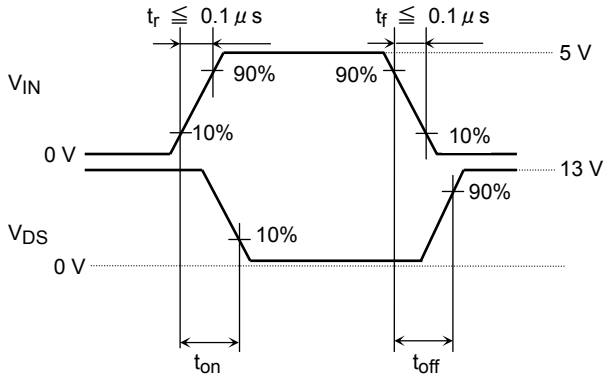
Test Circuit 1

Switching time measuring circuit

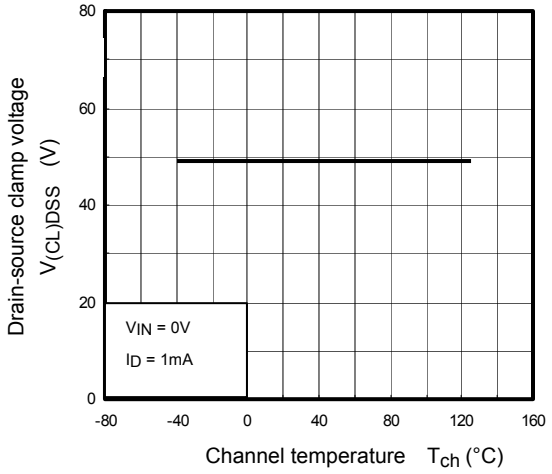
Test circuit



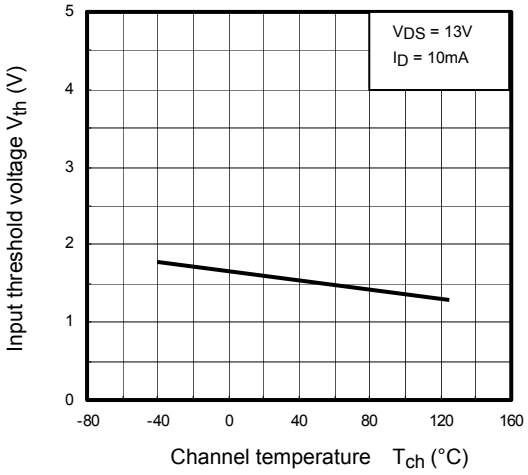
Measured waveforms



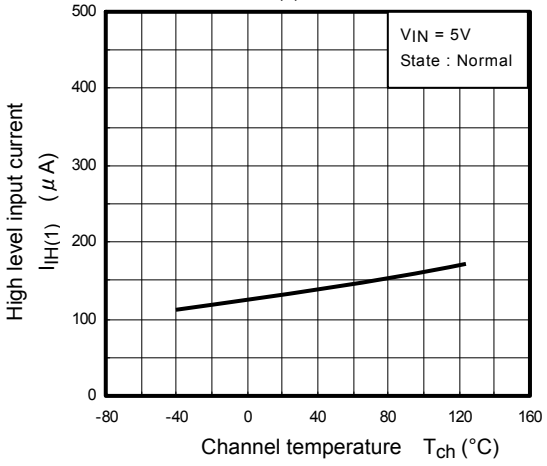
$V_{(CL)DSS} - T_{ch}$



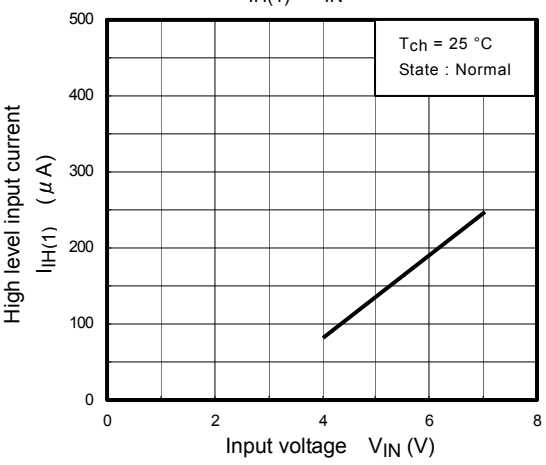
$V_{th} - T_{ch}$



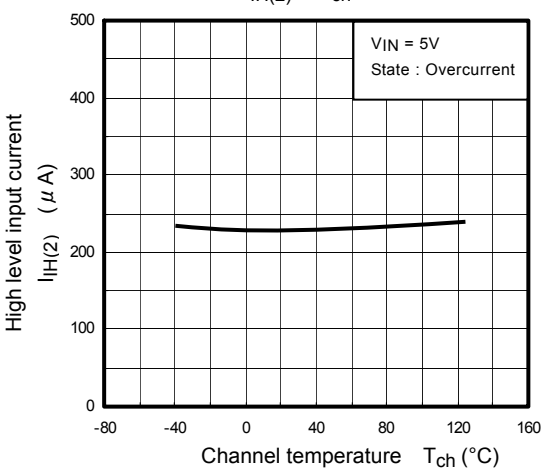
$I_{IH(1)} - T_{ch}$



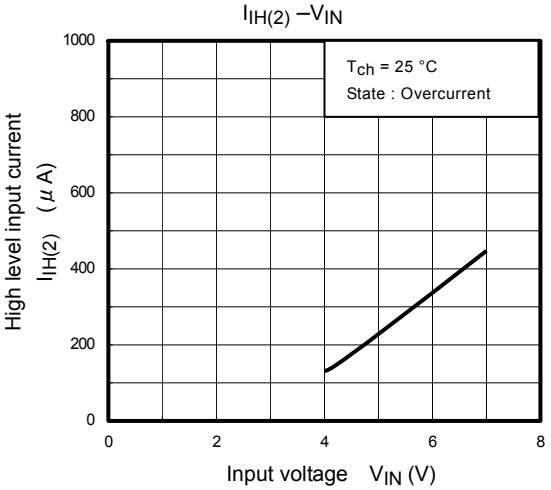
$I_{IH(1)} - V_{IN}$



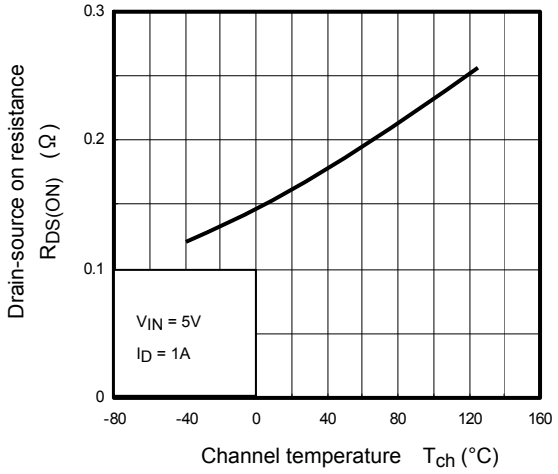
$I_{IH(2)} - T_{ch}$



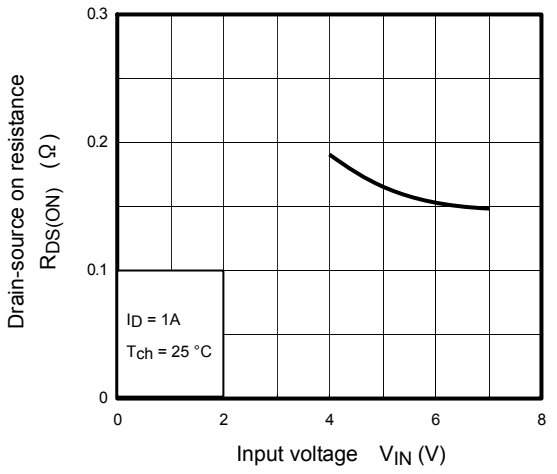
$I_{IH(2)} - V_{IN}$



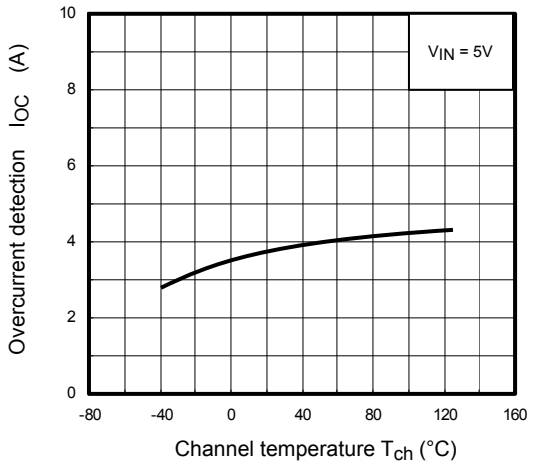
$R_{DS(ON)} – T_{ch}$



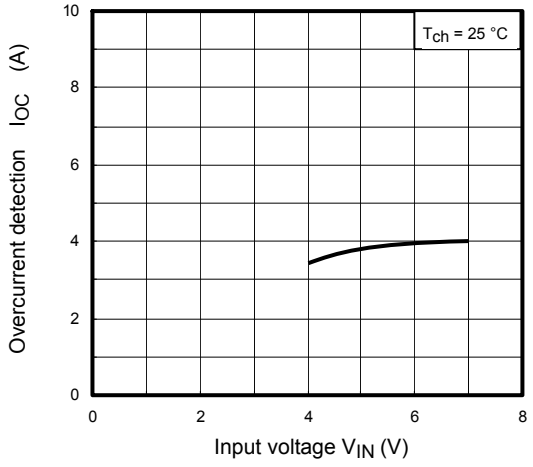
$R_{DS(ON)} – V_{IN}$



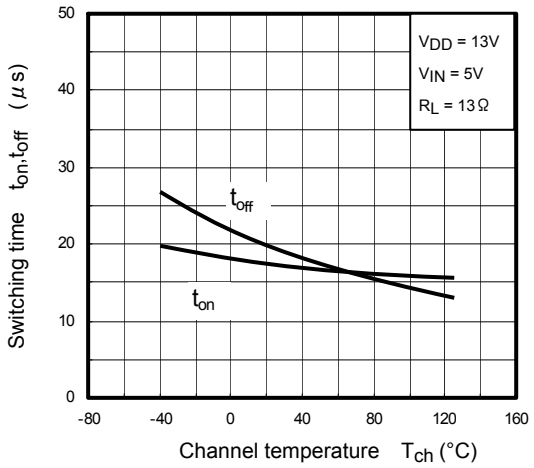
$I_{OC} – T_{ch}$



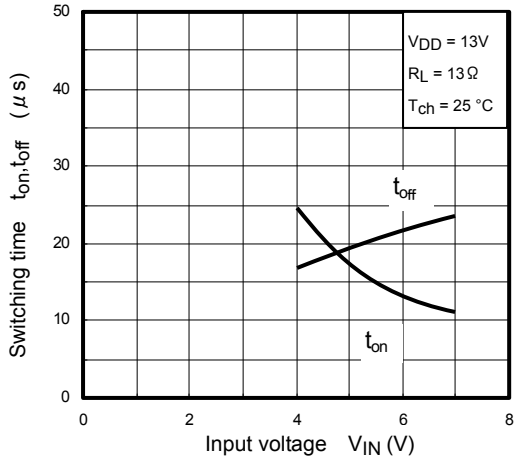
$I_{OC} – V_{IN}$



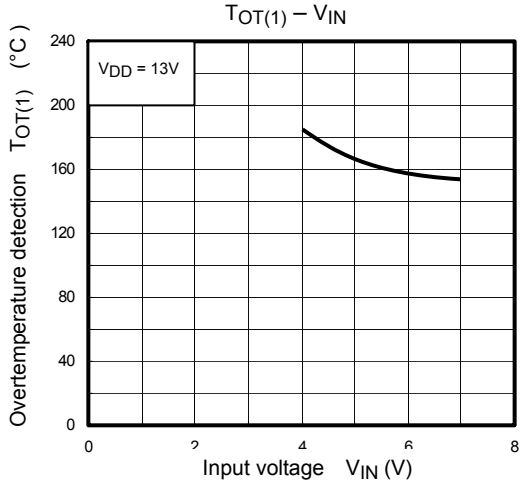
$t_{on}, t_{off} – T_{ch}$



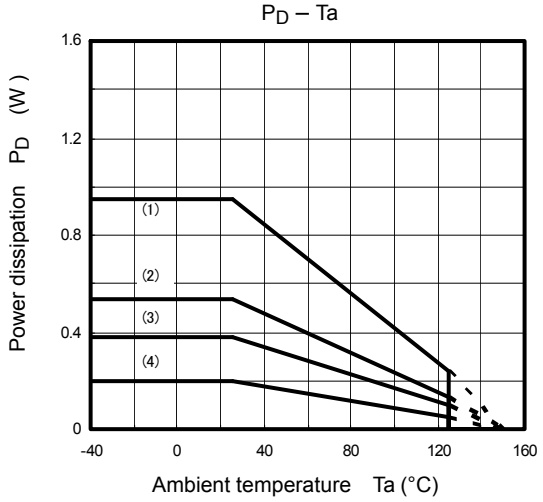
$t_{on}, t_{off} – V_{IN}$



$T_{OT(1)} – V_{IN}$

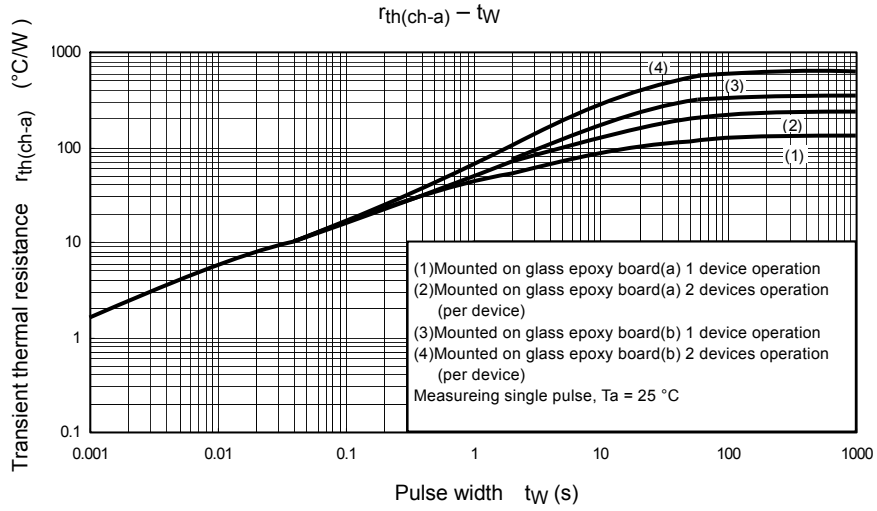


$P_D – Ta$

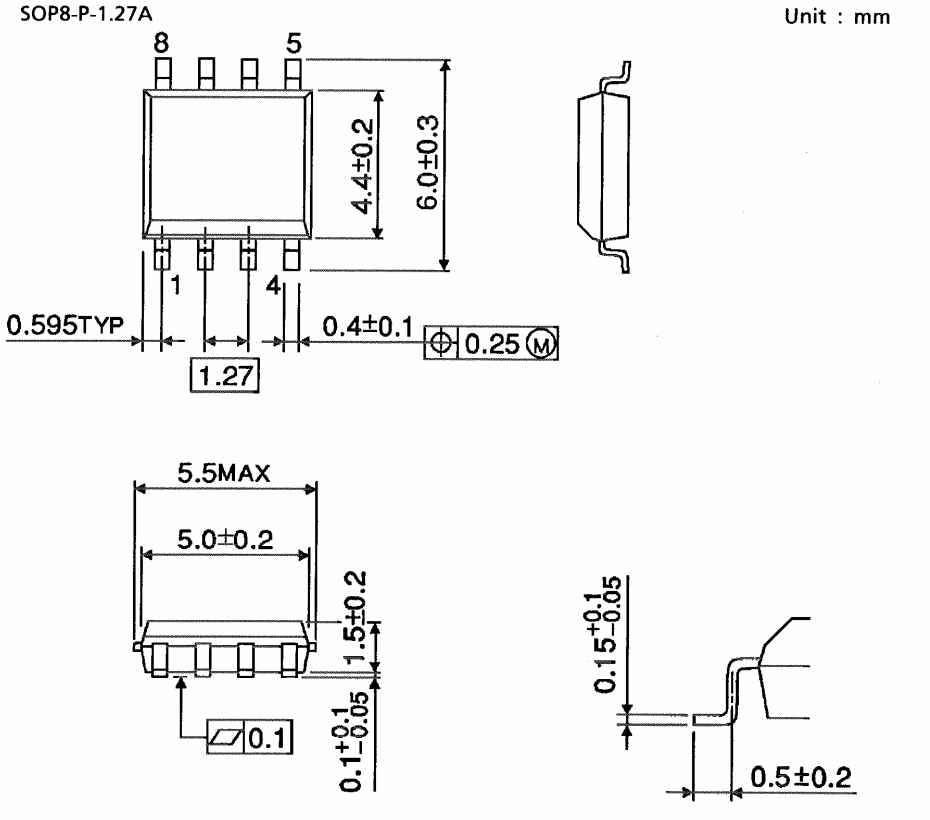


(1)Mounted on glass epoxy board(a) 1 device operation
(2)Mounted on glass epoxy board(a) 2 devices operation (per device)
(3)Mounted on glass epoxy board(b) 1 device operation
(4)Mounted on glass epoxy board(b) 2 devices operation (per device)

$r_{th(ch-a)} – t_W$



Package Dimensions



Weight: 0.08 g (typ.)

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20070701-EN GENERAL

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