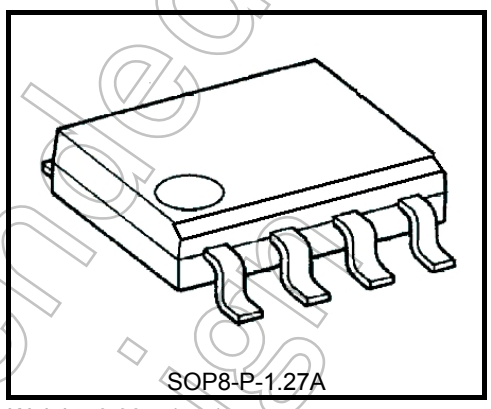
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

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.

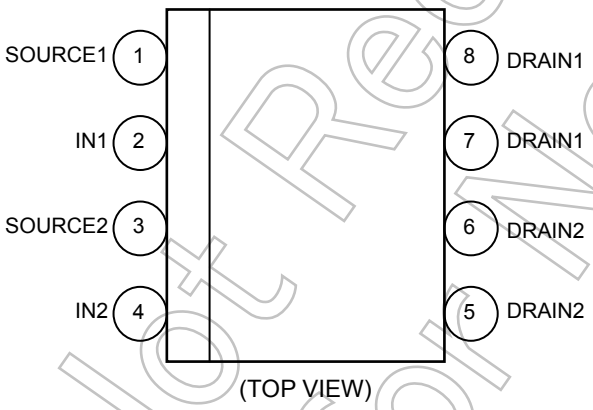


Weight: 0.08 g (typ.)

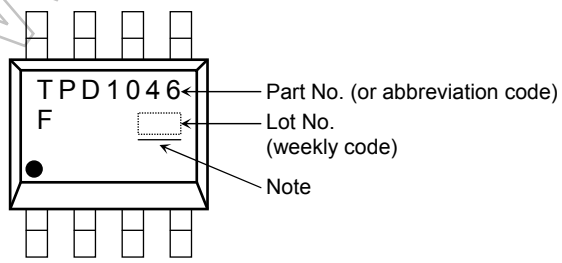
Features

- 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)



Marking



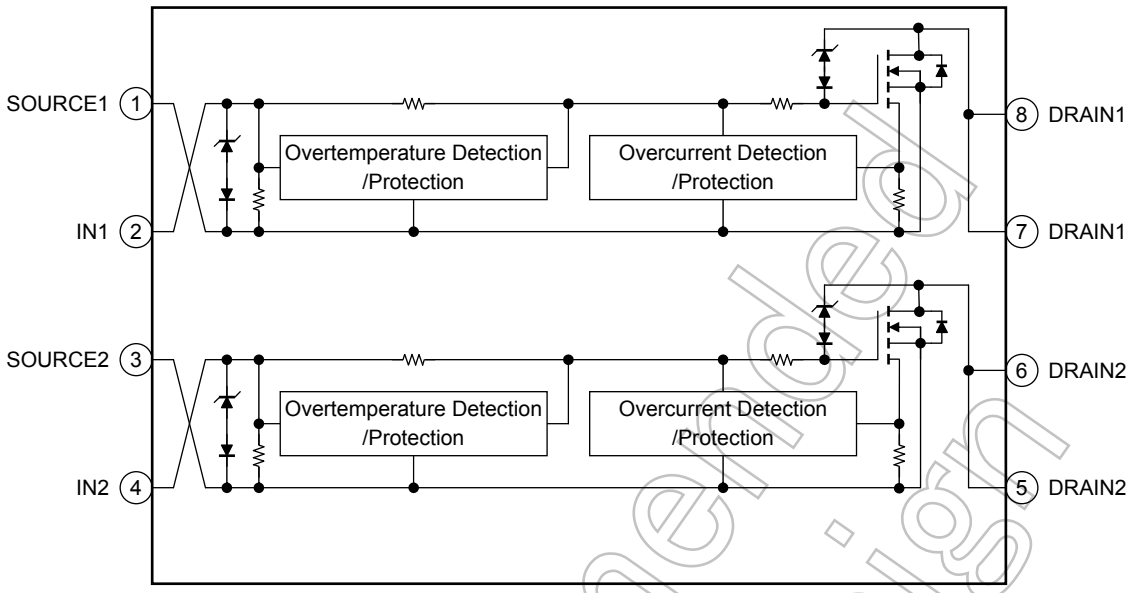
Note: A line under a Lot No. identifies the indication of product Labels
Not underlined: [[Pb]]/INCLUDES > MCV
Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.
The RoHS is Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 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.

Start of commercial production
2005-05

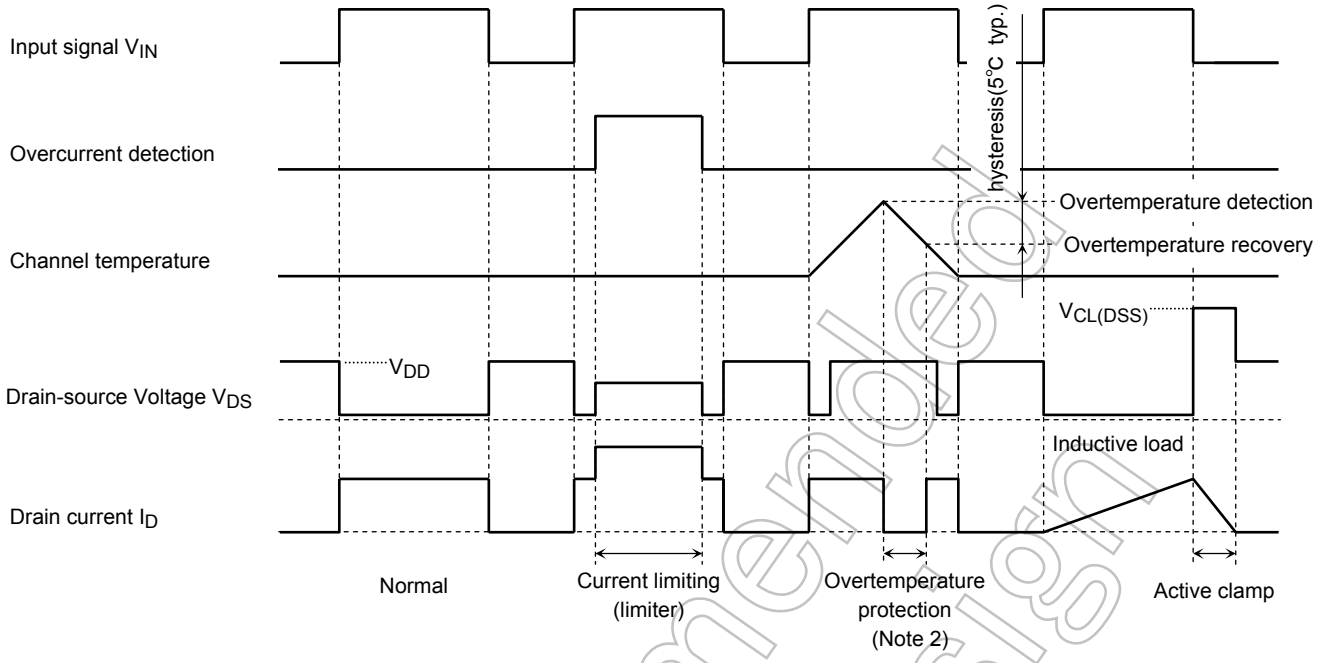
Block Diagram



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

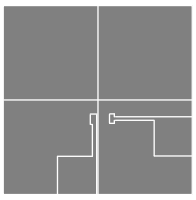
Thermal Characteristics

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

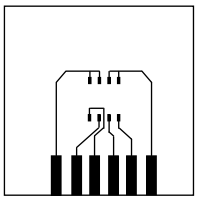
3-a : glass epoxy board (a)



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.

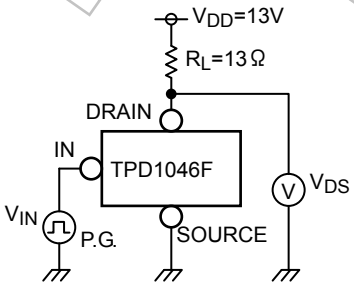
Electrical Characteristics

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

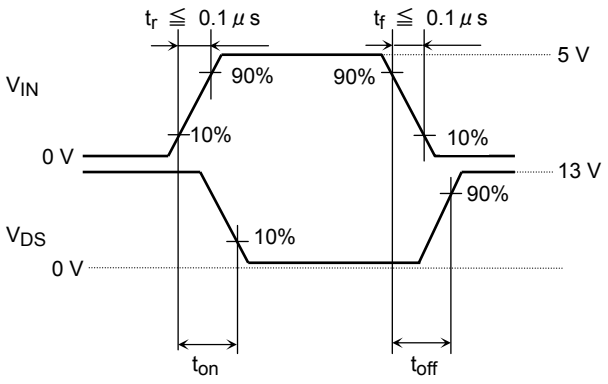
Test Circuit 1

Switching time measuring circuit

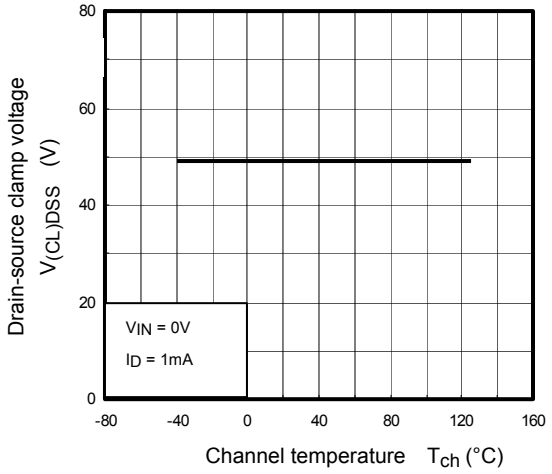
Test circuit



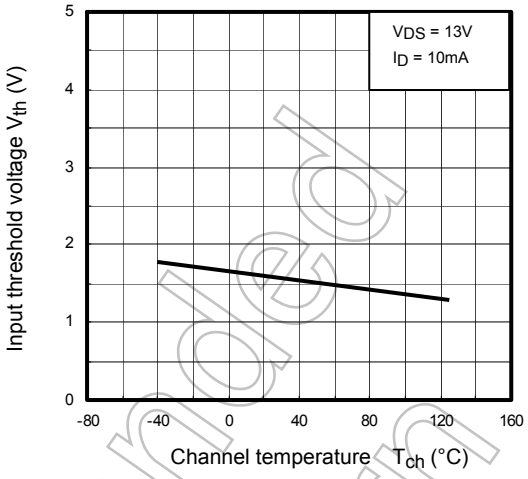
Measured waveforms



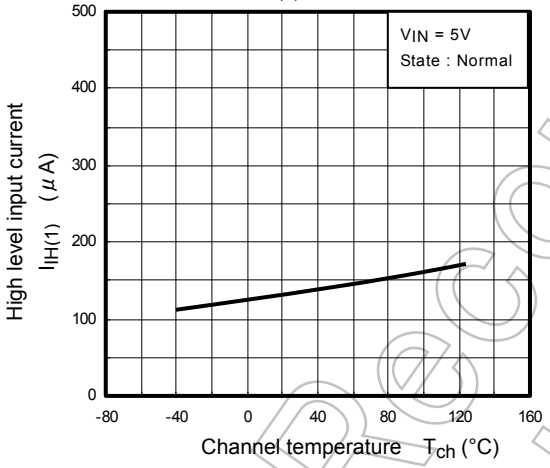
$V_{(CL)DSS} - T_{ch}$



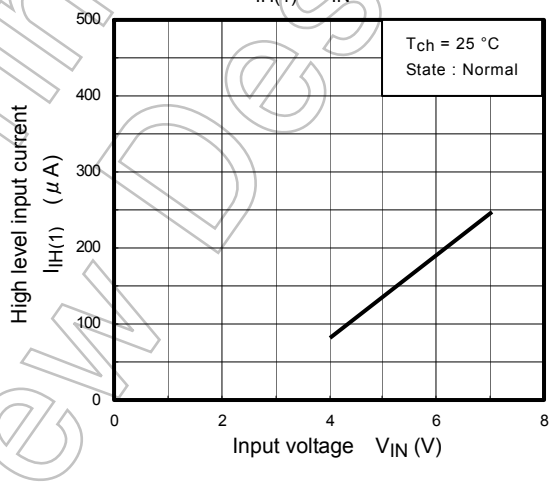
$V_{th} - T_{ch}$



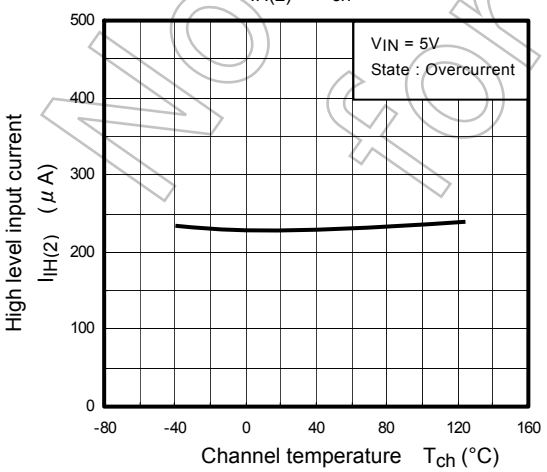
$I_{IH(1)} - T_{ch}$



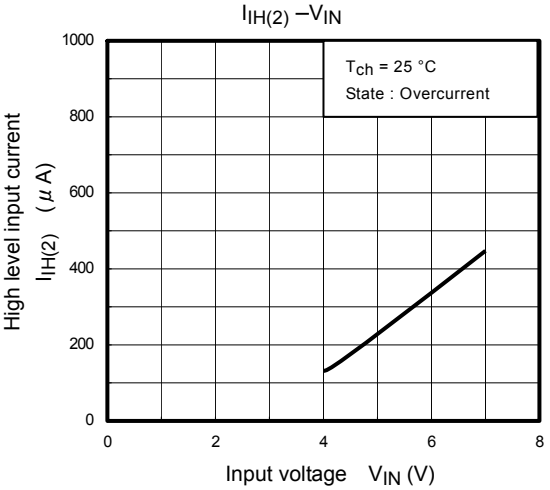
$I_{IH(1)} - V_{IN}$



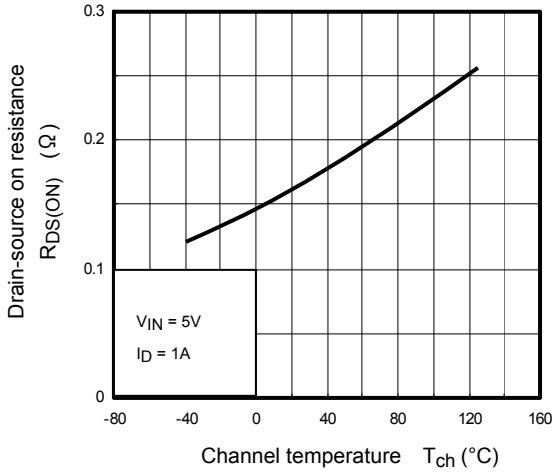
$I_{IH(2)} - T_{ch}$



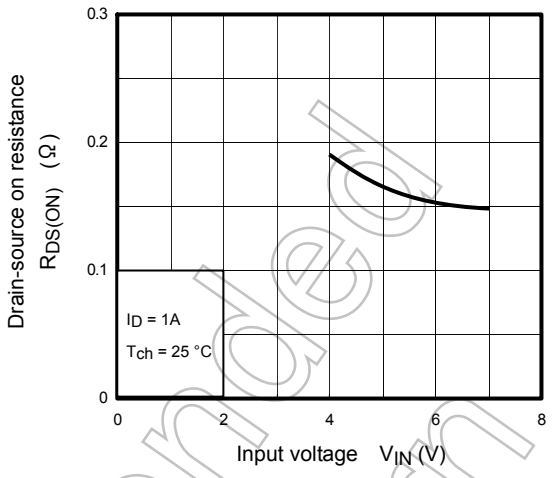
$I_{IH(2)} - V_{IN}$



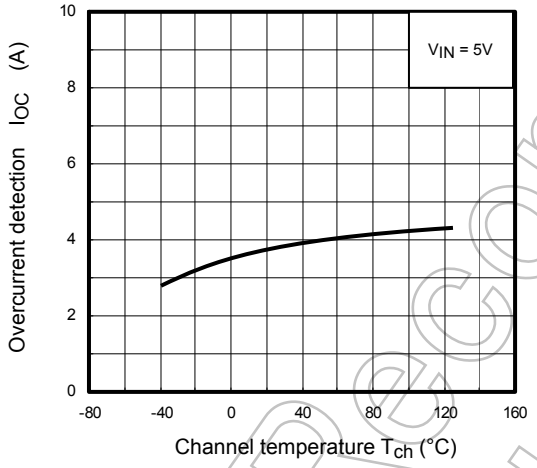
$R_{DS(ON)} – T_{ch}$



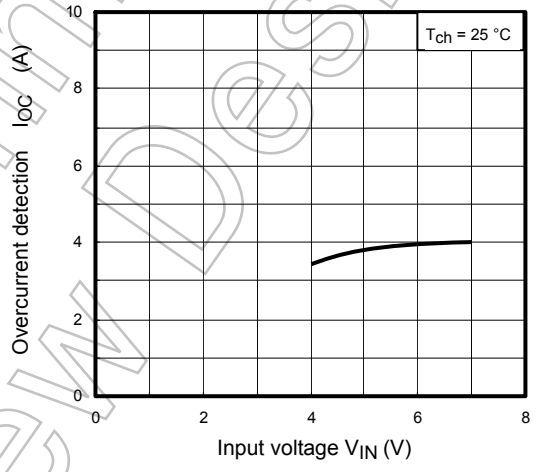
$R_{DS(ON)} – V_{IN}$



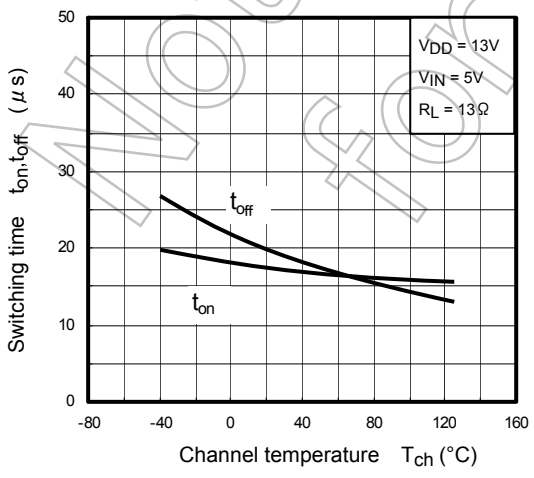
$I_{OC} – T_{ch}$



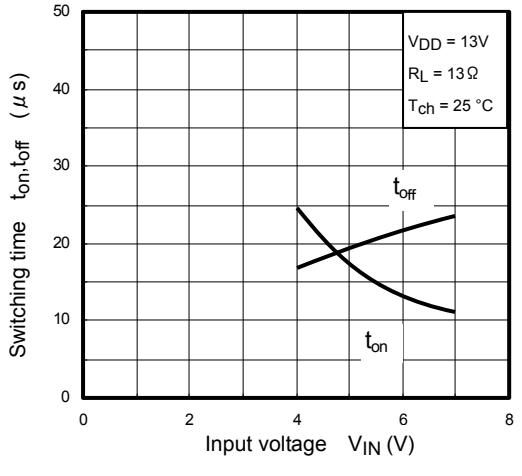
$I_{OC} – V_{IN}$



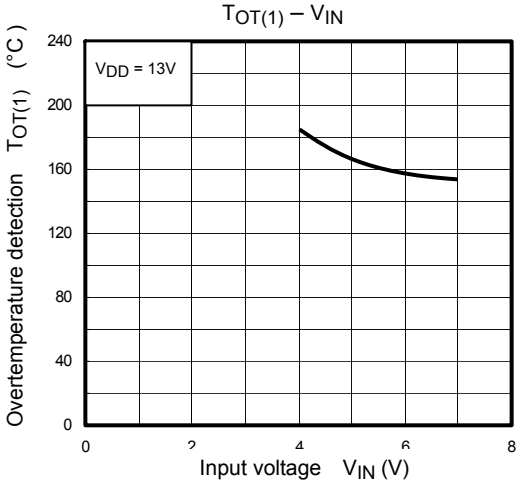
$t_{on}, t_{off} – T_{ch}$



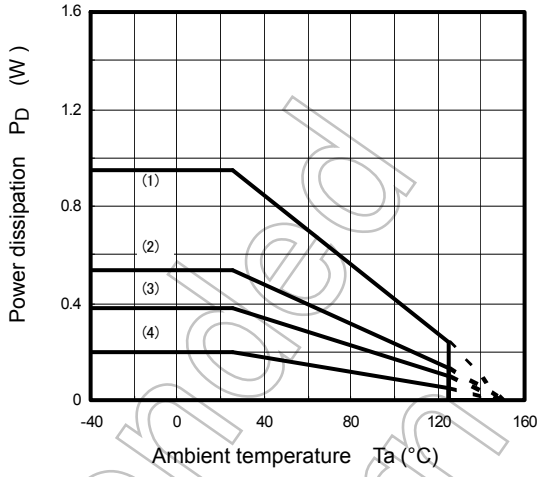
$t_{on}, t_{off} – V_{IN}$



$T_{OT(1)} - V_{IN}$

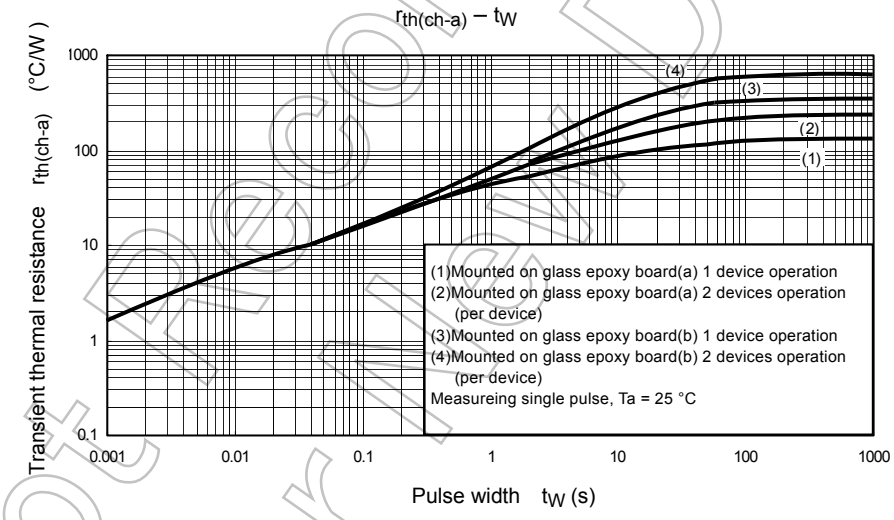


$P_D - Ta$



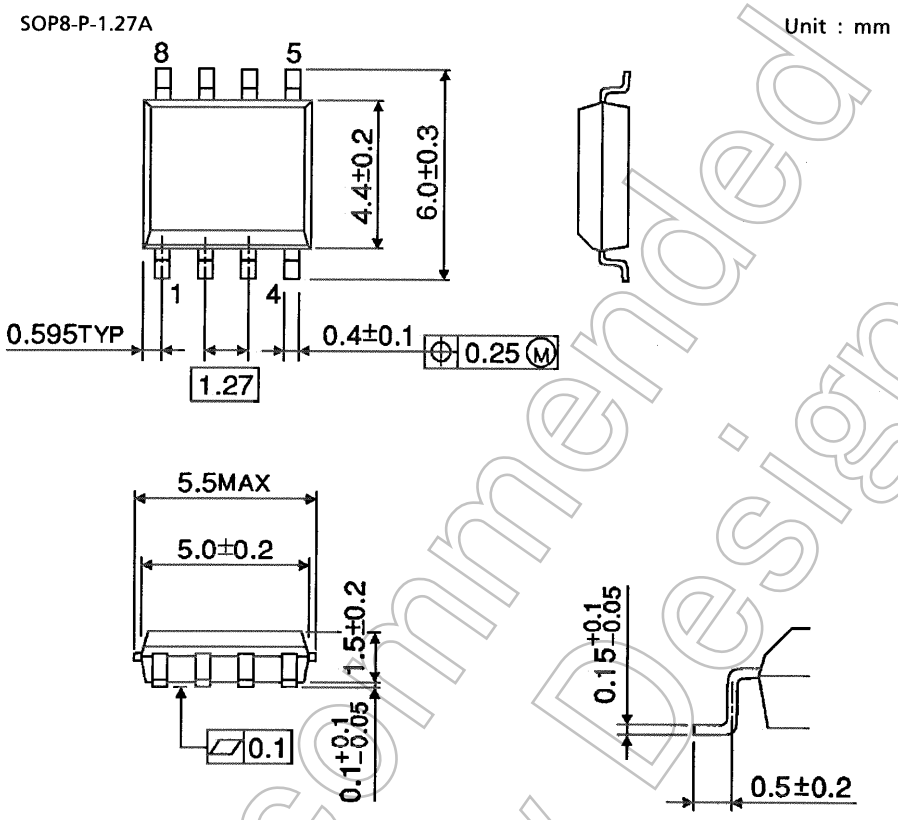
(1)Mounted on glass epoxy board(a) 1 device operation
(2)Mounted on glass epoxy board(a) 2 devices operation (per device)
(3)Mounted on glass epoxy board(b) 1 device operation
(4)Mounted on glass epoxy board(b) 2 devices operation (per device)

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



(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)
Measureing single pulse, Ta = 25 °C

Package Dimensions



Weight: 0.08 g (typ.)

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