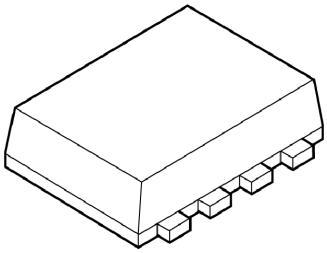
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1052F

High-side Power Switch for Motor, Solenoid and Lamp Drivers

The TPD1052F is a monolithic power IC intended for high-side load switching applications. The input can be directly driven from CMOS or TTL logic (e.g., an MPU). The TPD1052F provides intelligent protection and diagnostic functions.



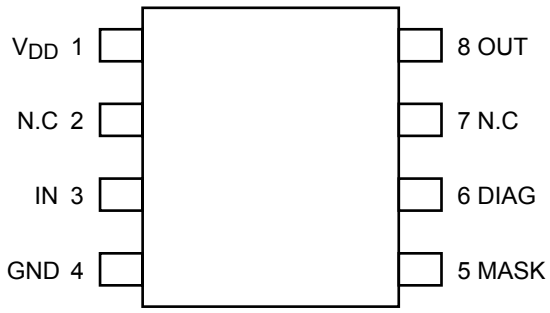
SON8-P-0303-0.65

Weight: 0.017g (typ.)

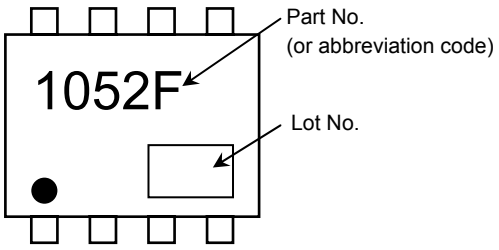
Features

- A structure that incorporates Bi-CMOS control circuitry and a power MOSFET (DMOS) on a single chip.
- One side of the load can be grounded.
- Can be directly driven from a microprocessor.
- Overtemperature and load short-circuit (Overcurrent) protections are built in.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short (Overcurrent), overtemperature.
- Low ON- resistance. : $R_{DS(ON)}$ = 0.8Ω (Max) @V_{DD} = 12V, I_O = 0.5A, T_{ch}=25℃
- Low supply current. : I_{DD} = 10μA (Max), @V_{DD} = 12V, V_{IN} = 0V, T_{ch}=25℃
- Housed in the PS-8 package and supplied in embossed carrier tape.

Pin Assignment (top view)

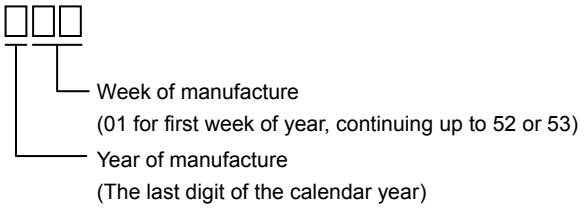


Marking



・Note:● on the lower left of the marking indicates Pin 1

※Weekly code: (Three digits)

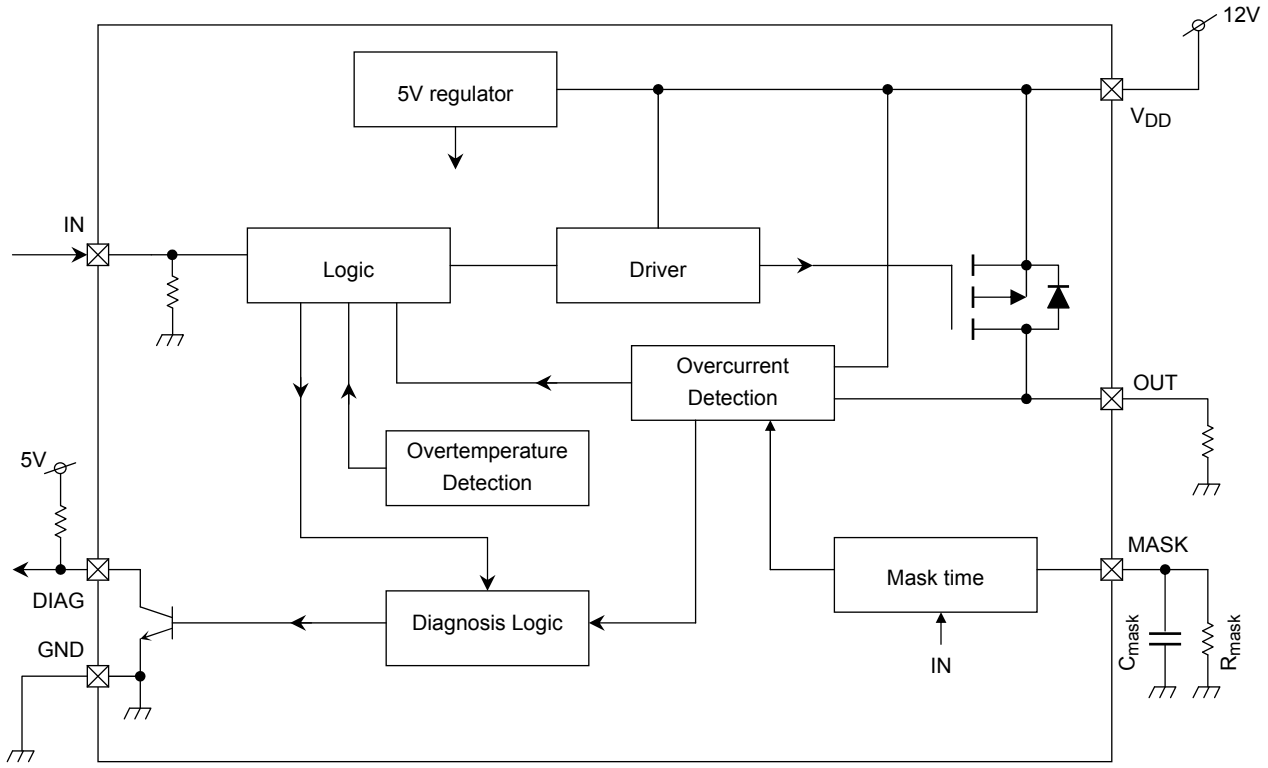


Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.
The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain

Note: That because of its MOS structure, this product is sensitive to static electricity.

Start of commercial production
2009-03

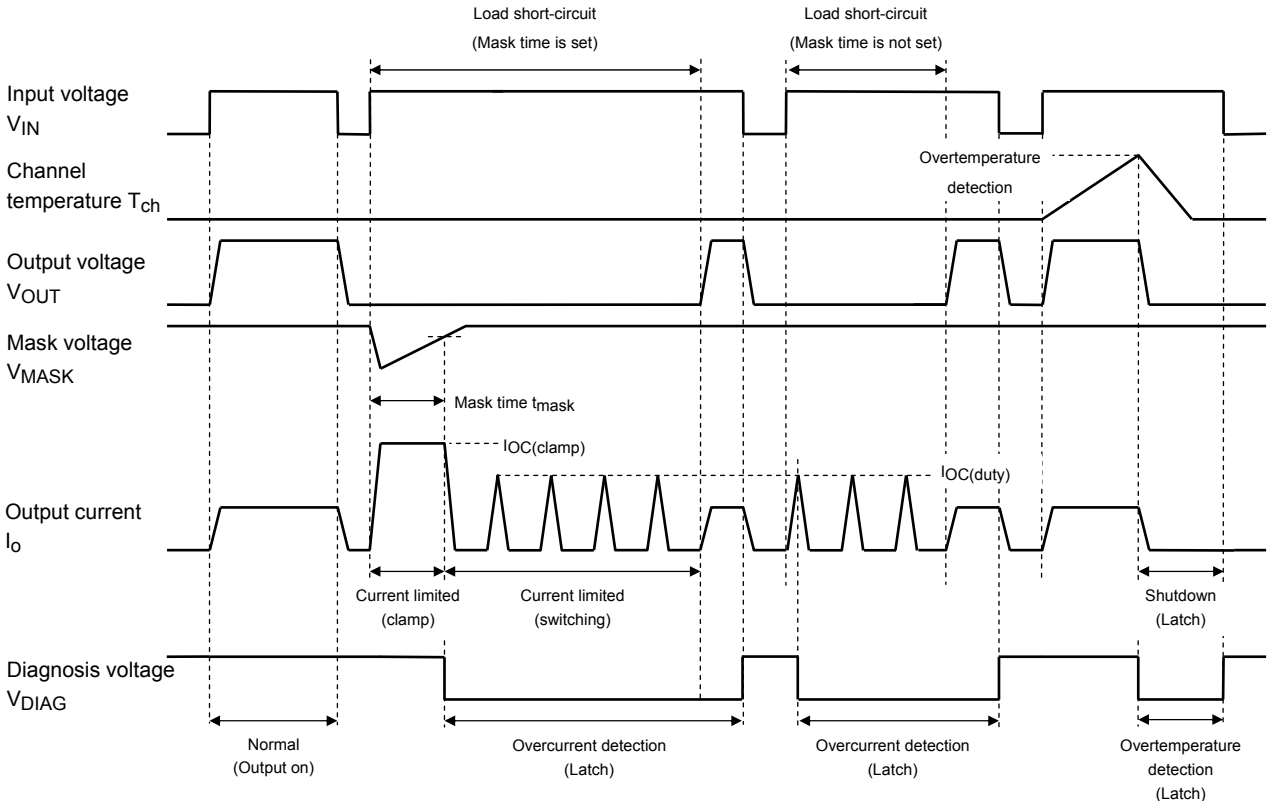
Block Diagram



Pin Description

Pin No.	Symbol	Function
1	V_{DD}	Power supply pin.
2, 7	N.C	No-Connect pin.
3	IN	Input pin. The IN pin has an internal pull-down resistor. Even if the IN pin is open, the output will not accidentally turn on.
4	GND	Ground pin.
5	MASK	Overcurrent detection/protection is $I_{OC(clamp)}$ in the Mask time. If the capacitor and the resistance is not connected to MASK pin, overcurrent protection is $I_{OC(duty)}$.
6	DIAG	Self-diagnosis detection pin. npn open collector. When Input is “H”(Output on), and Overcurrent or Overtemperature is detected, DIAG becomes low level and it is latched. When input is low level, the state of latch is reseted.
8	OUT	Output pin. When a load short-circuit causes an overcurrent (0.8A Min) to flow into a device, output current is limited in order to protect the IC.

Timing Chart



Truth Table

Input Signal		Output MOSFET State	Diagnosis Output	Operating State
H		On	H	Normal
L		Off	H	
H	$t \leq t_{mask}$ (Note)	Current limiting (clamp)	H	Overcurrent (Load short-circuit)
	$t > t_{mask}$ (Note)	Current limiting (switching)	L (Latch)	
L		Off	H	
H		Off (Latch)	L (Latch)	Overtemperature
L		Off	H	

※Note : t is time from the V_{IN}=H input.

Absolute Maximum Ratings (T_a = 25°C)

Characteristics		Symbol	Rating	Unit
Drain-source voltage		V_{DS}	40	V
Supply voltage	DC	$V_{DD\ (1)}$	-0.3 to 25	V
	Pulse	$V_{DD\ (2)}$	40 (t ≤ 200ms)	V
Input voltage		V_{IN}	−0.3 to 6	V
Diagnosis output voltage		V_{DIAG}	−0.3 to 6	V
Output current		I_O	Internally limited	A
Diagnosis output current		I_{DIAG}	5	mA
Power dissipation (Note 1a)		$P_{D(1)}$	0.7	W
Power dissipation (Note 1b)		$P_{D(2)}$	0.35	W
Operating temperature		T_{opr}	−40 to 125	°C
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	−55 to 150	°C

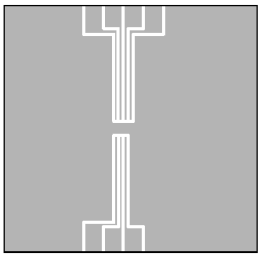
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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

Characteristics	Symbol	Rating	Unit
Thermal resistance, channel to ambient	$R_{th\ (ch–a)}$	178.6(Note 1a)	°C / W
		357.2(Note 1b)	

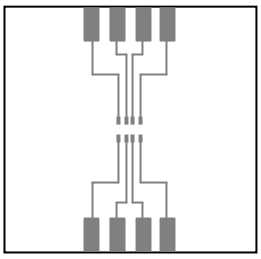
Note 1:

(a) Glass epoxy board



Glass epoxy board
Material：FR-4
25.4mm × 25.4mm × 0.8mm

(b) Glass epoxy board



Glass epoxy board
Material：FR-4
25.4mm × 25.4mm × 0.8mm

Electrical Characteristics (Unless otherwise specified T_{ch} = −40 to 125°C, V_{DD} = 5 to 18V)

Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Operating supply voltage		$V_{DD\ (opr)}$	—	—	5	12	18	V
Supply current		I_{DD}	—	V_{DD} = 12V, V_{IN} = 0V, Output open.	—	—	10	μA
Output leakage current		I_{OL}	—	V_{IN} = V_{OUT}=0V	—	—	10	μA
Input voltage		V_{IH}	—	V_{DD} = 8 to 18V	2.0	—	—	V
		V_{IL}	—	V_{DD} = 8 to 18V	—	—	0.8	V
Input current		$I_{IN\ (1)}$	—	V_{IN} = 5V	—	—	200	μA
		$I_{IN\ (2)}$	—	V_{IN} = 0V	−0.2	—	0.2	μA
Drain-source ON-resistance		$R_{DS\ (ON)}$	—	V_{DD} = 8 to 18V, I_O = 0.5A, V_{IN} = 5V, T_{ch} = 25°C	—	0.5	0.8	Ω
Diagnosis output voltage	Low level	V_{DL}	—	I_{DIAG} = 1mA	—	—	0.4	V
Diagnosis output current	High level	I_{DH}	—	V_{DIAG} = 5V	—	—	10	μA
Overcurrent detection		$I_{OC(clamp)}$	—	V_{DD} = 8 to 18V	1.2	1.7	2.3	A
		$I_{OC(duty)}$	—		0.8	1.3	1.8	A
Overtemperature detection		T_{OT}	—	—	150	160	200	°C
Mask time(Note 2)		t_{mask}	—	C_{mask}=0.033μF, R_{mask}=1MΩ, V_{DD}=8 to 18V, T_{ch}=25°C	—	3.8	—	ms
Switching times		t_{ON}	1	V_{DD} = 12V, R_L = 24Ω, T_{ch} = 25°C	1	10	30	μs
		t_{OFF}	1		1	20	60	μs

Note 2: About the Mask time function

Mask time function is built in TPD1052F. Mask time is decided to prevent discharge electricity by switching-mode overcurrent protection that occur by inrush current. To prevent discharge electricity by overcurrent protection(switching) that operate by inrush current, Mask time is used. Overcurrent protection is clamp current in Mask time from V_{IN}=H.

Mask time can roughly set at nether expression.

$$t_{mask} = -C_{mask} \times R_{mask} \times \ln\left(1 - \frac{R_{ref}}{R_{mask}}\right) \quad [s]$$

R_{ref} : Internal resistance 110kΩ (typ.)

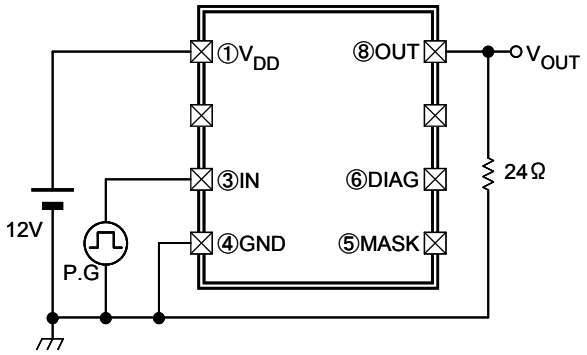
※ When the Mask time is changed, please change C_{mask} in the state of R_{mask}=1MΩ.

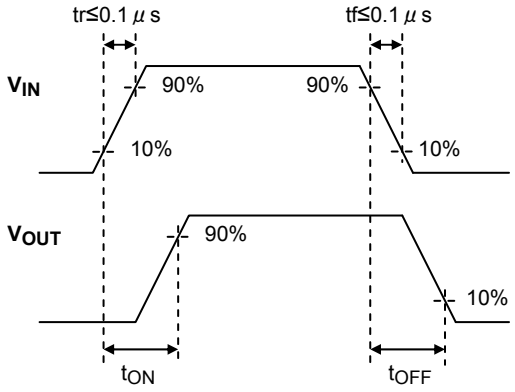
※ When overcurrent protection(clamp) is operating, TPD1052F becomes high temperature. Therefore please set Mask time for channel temperature to become 150℃ or less.

※ If you do not use Mask time, please open the MASK pin.

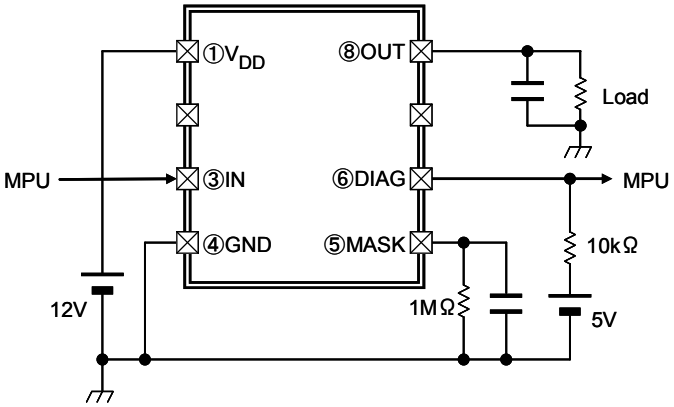
Test Circuit 1

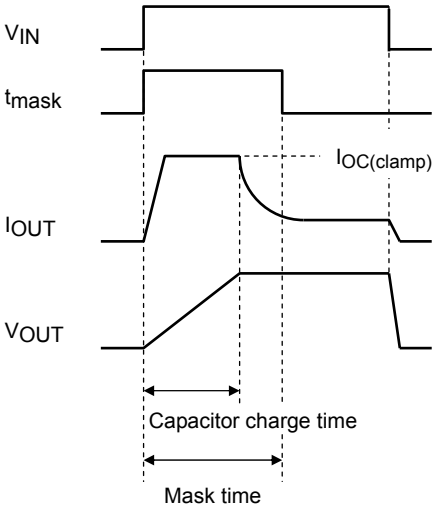
Switching times



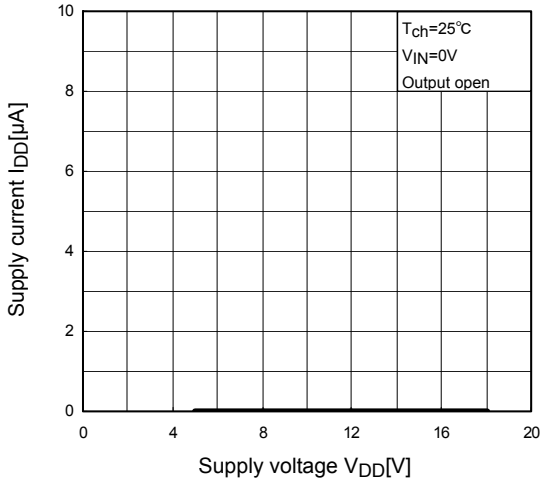


Application circuit

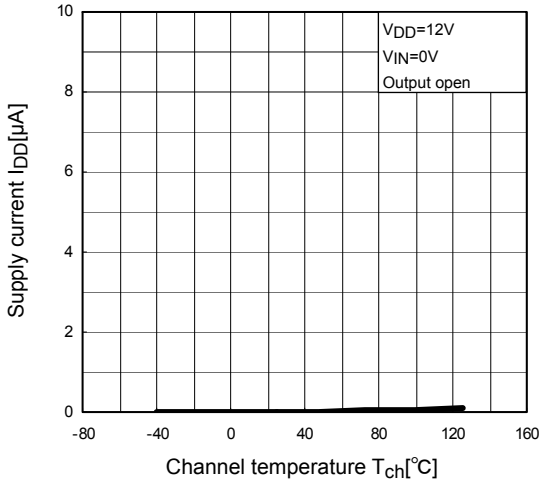




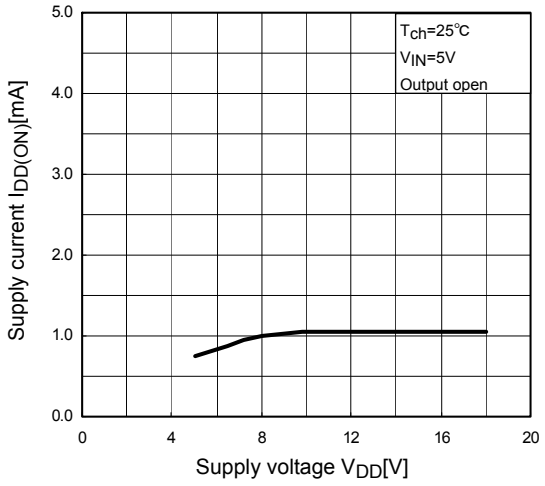
I_{DD} - V_{DD}



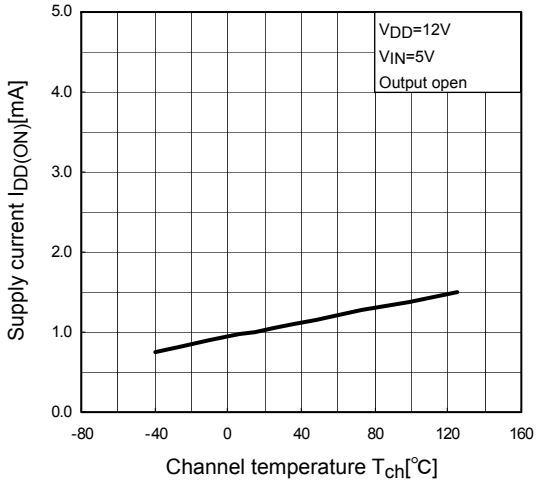
I_{DD} - T_{ch}



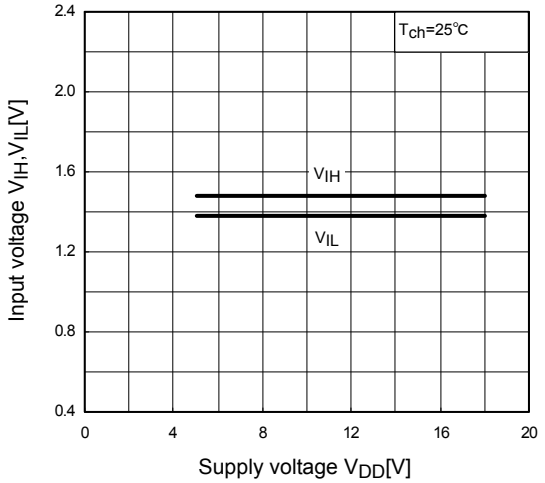
$I_{DD(ON)}$ - V_{DD}



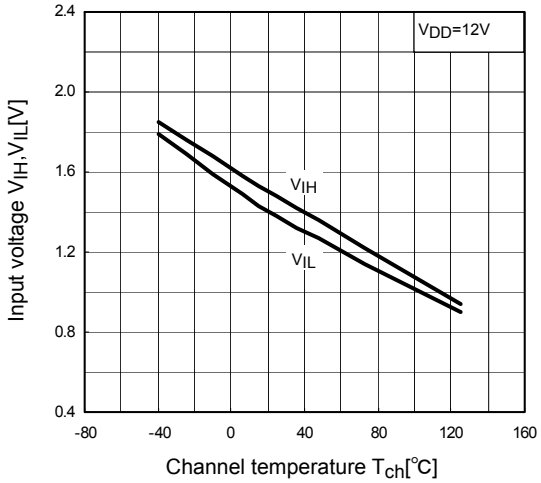
$I_{DD(ON)}$ - T_{ch}



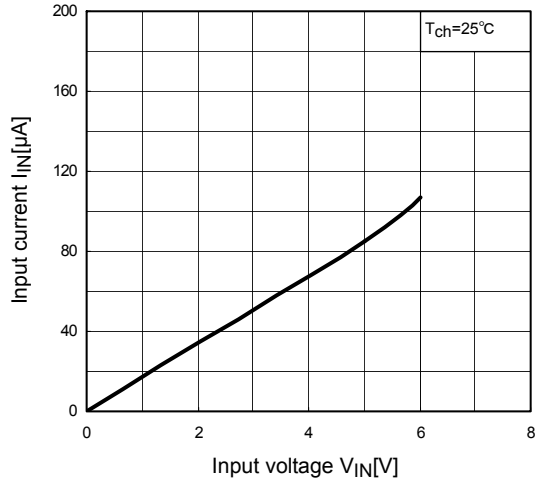
V_{IH},V_{IL} - V_{DD}



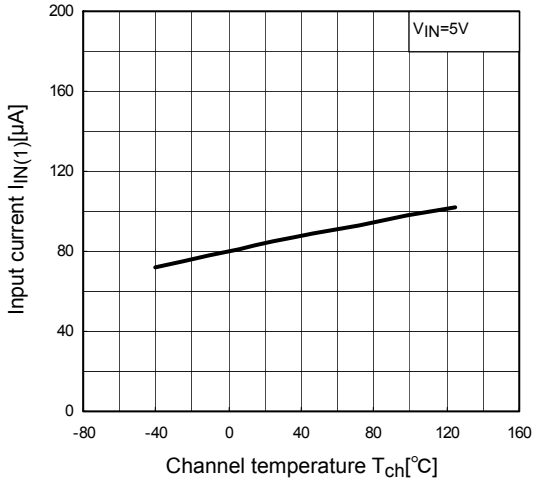
V_{IH},V_{IL} - T_{ch}



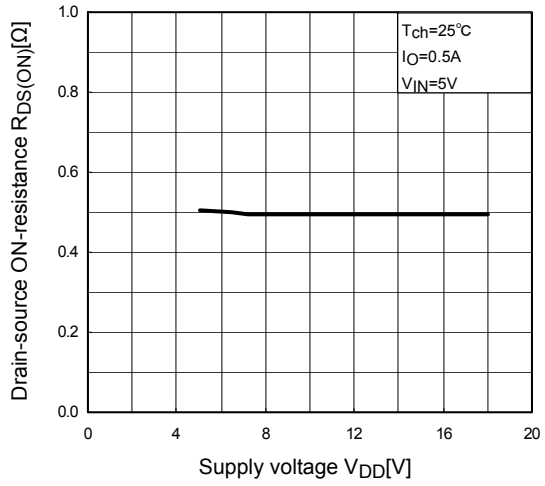
I_{IN} – V_{IN}



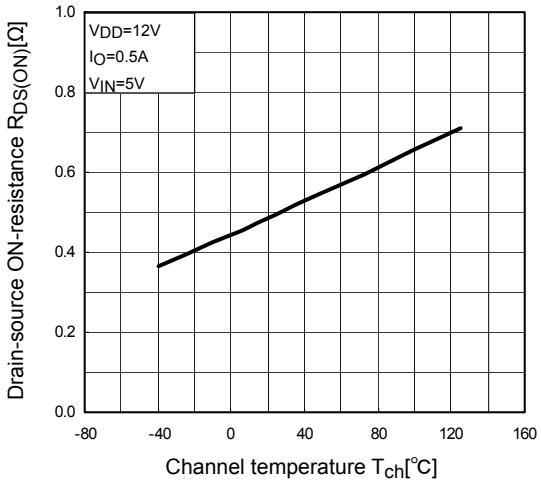
$I_{IN(1)}$ - T_{ch}



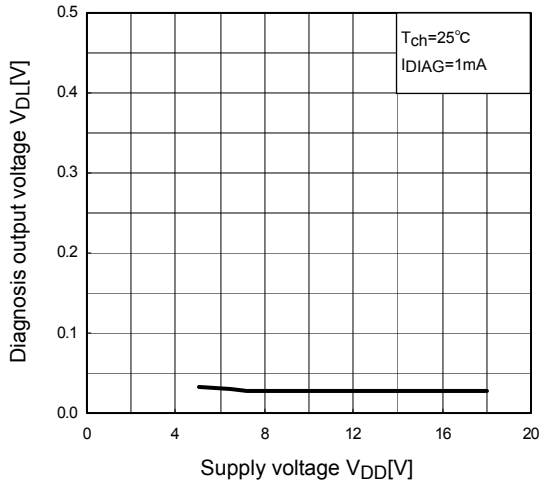
$R_{DS(ON)}$ - V_{DD}



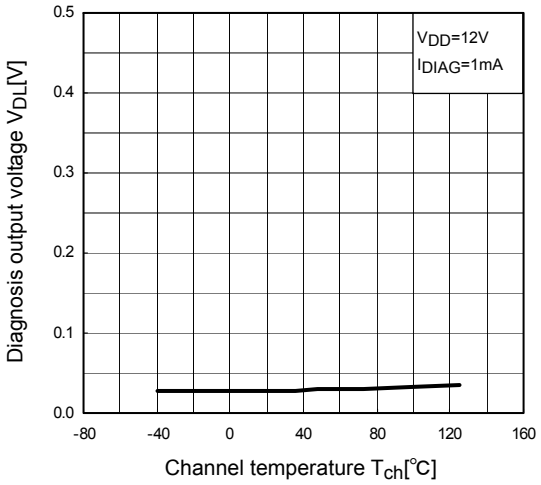
$R_{DS(ON)}$ - T_{ch}



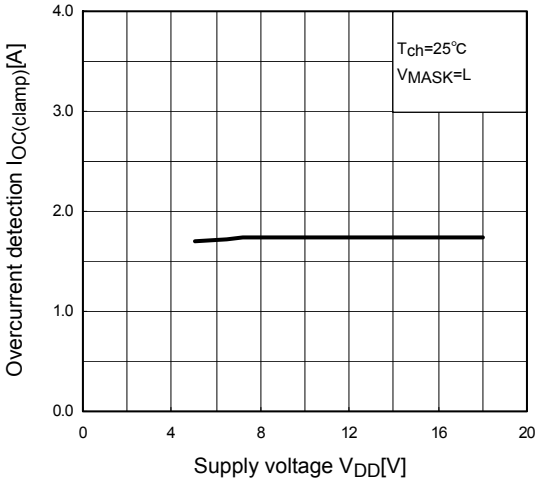
V_{DL} - V_{DD}



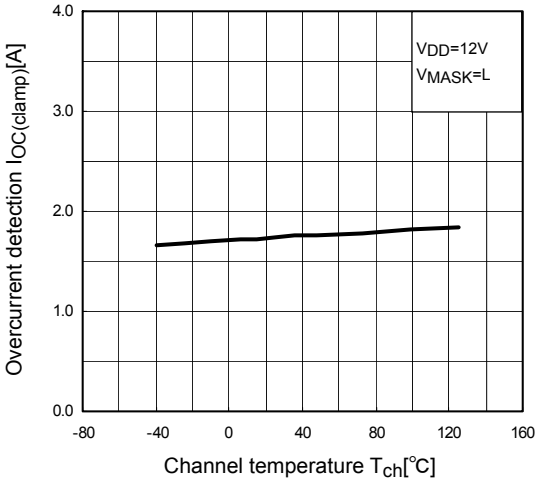
V_{DL} - T_{ch}



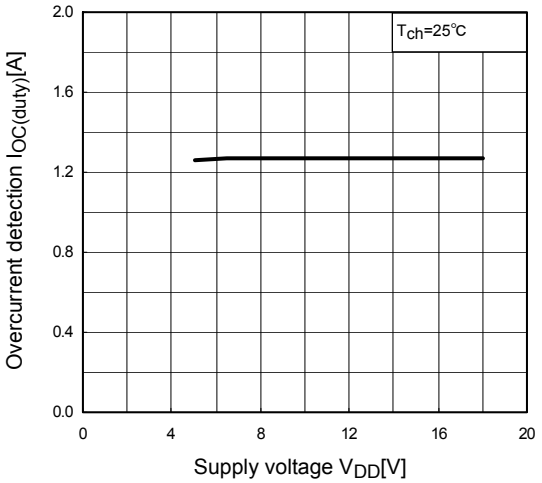
$I_{OC(clamp)}$ - V_{DD}



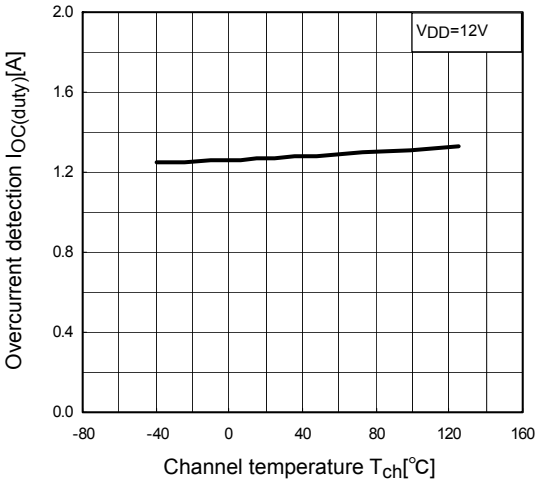
$I_{OC(clamp)}$ - T_{ch}



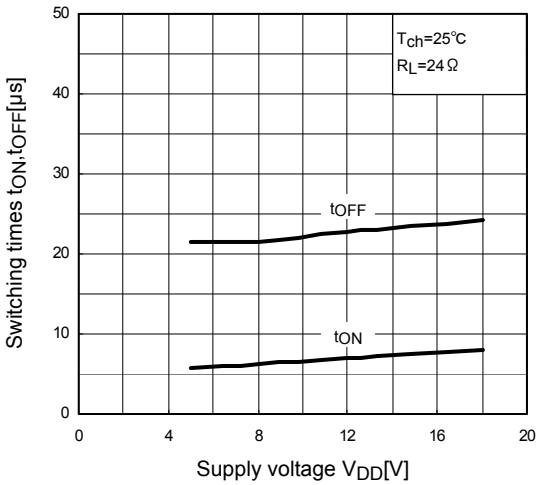
$I_{OC(duty)}$ - V_{DD}



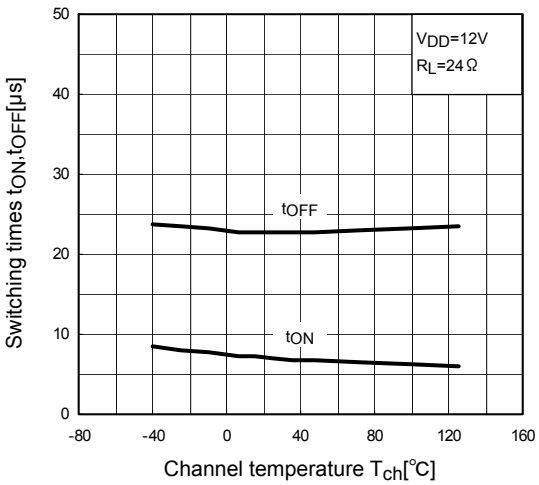
$I_{OC(duty)}$ - T_{ch}



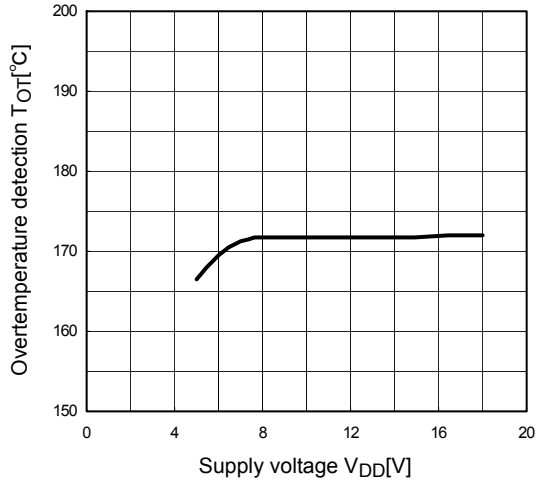
t_{ON},t_{OFF} - V_{DD}



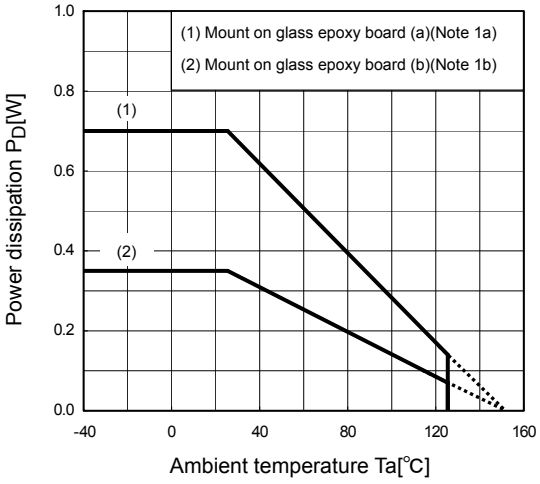
t_{ON},t_{OFF} - T_{ch}



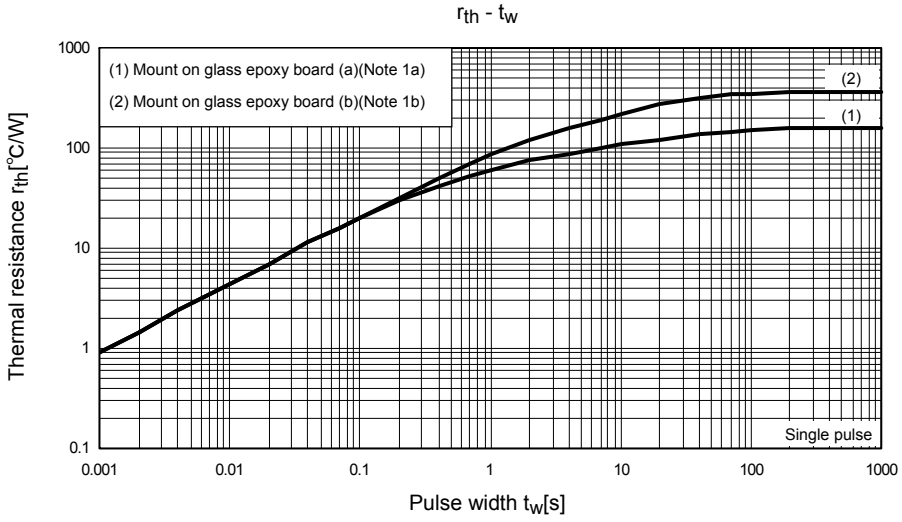
$T_{OT} – V_{DD}$



P_D - Ta

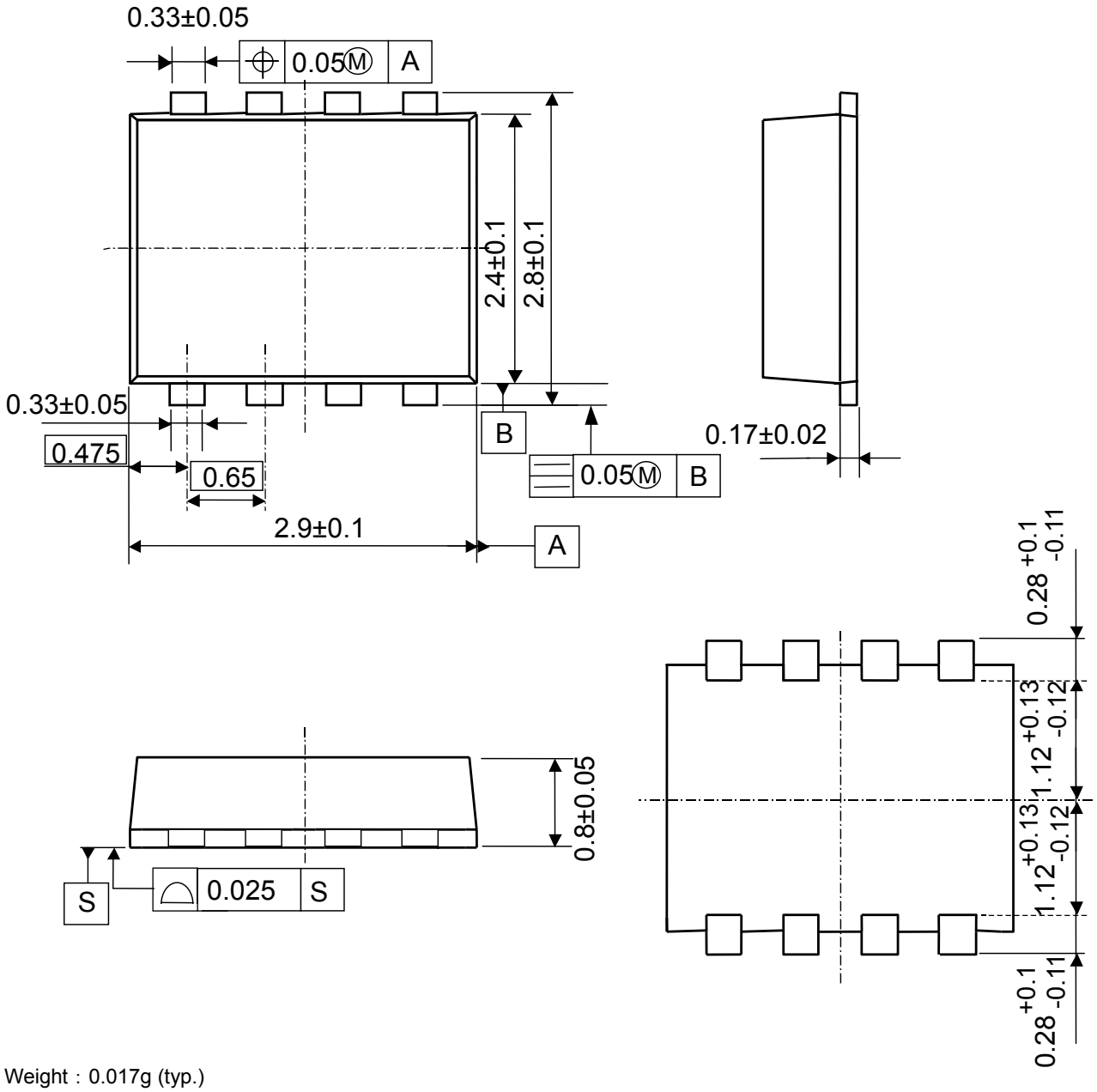


r_{th} - t_w



Package Dimensions

Unit; mm



Weight：0.017g (typ.)

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