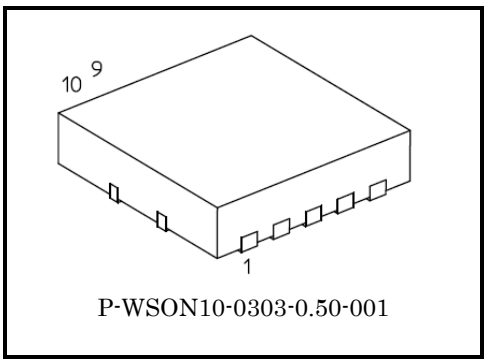
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1058FA

Low-Side Switch for Solenoid, Motor and Lamp Drive

The TPD1058FA is a monolithic power IC for low-side switches. The IC has a MOSFET (DMOS) output which can be directly driven from a CMOS or TTL logic circuit (e.g., an MPU). The IC is equipped with intelligent self-protective functions and diagnostic functions.



P-WSON10-0303-0.50-001

Weight: 0.02 g (typ.)

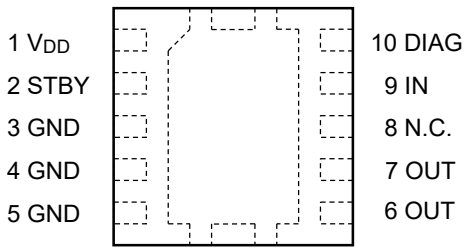
Features

- A monolithic power IC with a new structure combining a control block and a power MOSFET (DMOS) on single chip.
- AEC-Q100 qualified.
- Can directly drive a power load from CMOS or TTL logic.
- Built-in protection against overvoltage (active clamp), over temperature (thermal shutdown), and over current.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short-circuiting, opening, or over temperature
- Low Drain-Source ON-resistance:

  $R_{DS\ (ON)}$ = 0.1 Ω (Max) @V_{DD} = 5 V, V_{STBY} = V_{IN} = 5V, I_O = 2 A, T_{ch} = 25 °C
- Low Standby Current:

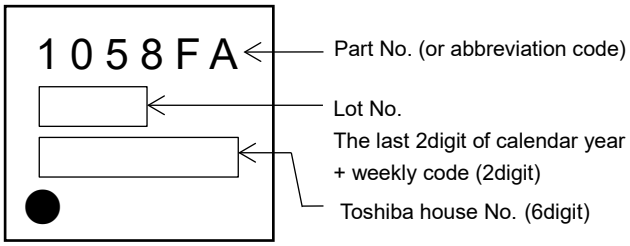
  I_{DD} = 10μA (Max) @V_{STBY} = V_{IN} = 0V, V_{DD} = 5V, T_{ch} = -40 to 125°C
- WSON10 package with embossed-tape packing.

Pin Assignment (top view)



(TOP VIEW)

Marking

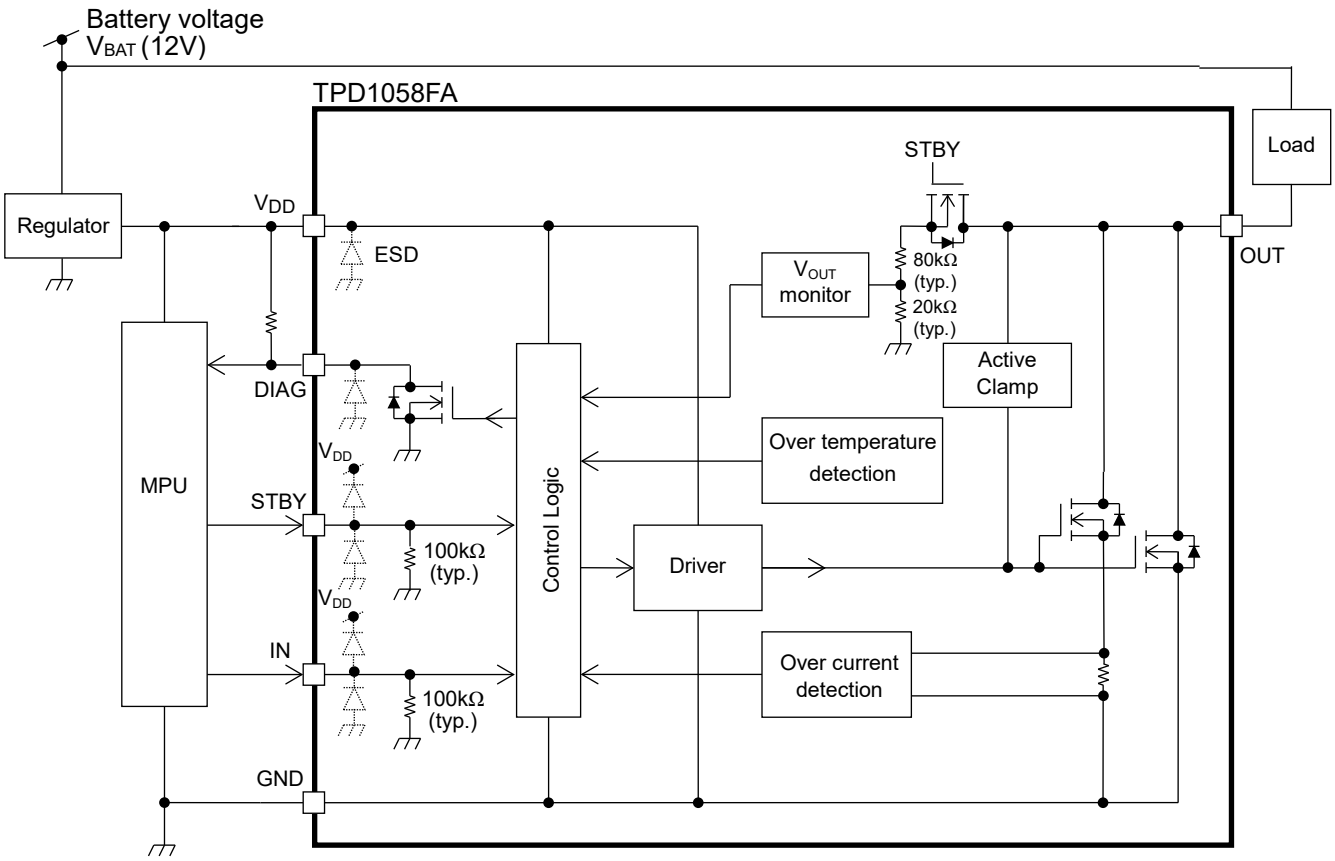


● on the lower left of the marking indicates Pin 1

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

Start of commercial production
2015-04

Block Diagram / Application Circuit

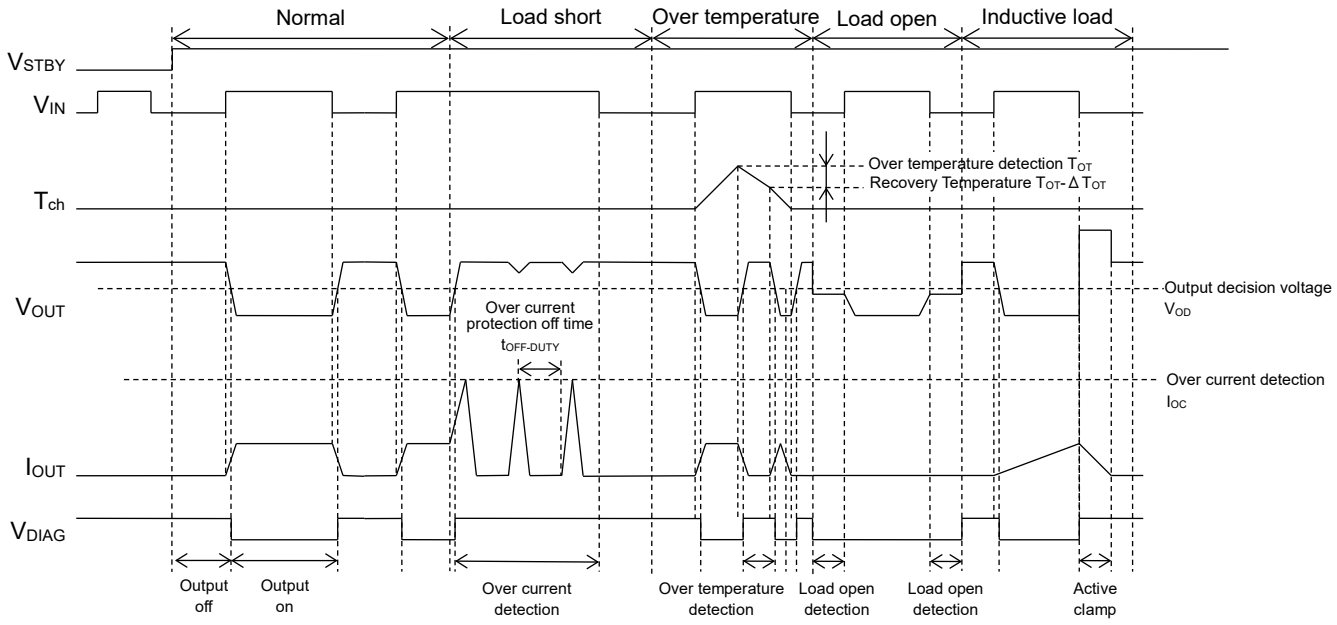


Note1: The value in block diagram is a standard value in Tch = 25°C.

Pin Description

Pin No.	Symbol	Pin Description
1	V_{DD}	Power supply pin.
2	STBY	Standby pin. This pin has an internal pull-down resistor (100kΩ (typ.)). In the case of open state, it becomes standby mode same as $V_{STBY}=V_{IL}$. $V_{STBY}=V_{IL}$: $I_{DD}\leq 10\mu A$ (Standby mode) $V_{STBY}=V_{IH}$: Active control
3,4,5	GND	Ground pin.
6,7	OUT	Output pin. When a load short-circuit causes an overcurrent (6A min) to flow into a device, output current is limited in order to protect the IC.
8	N.C.	No-Connect pin. (not connected to the chip.)
9	IN	Input pin. The IN pin has an internal pull-down resistor (100kΩ (typ.)). Even if the IN pin is open, the output will not accidentally turn on.
10	DIAG	Self-diagnosis output pin. N-channel open drain.

Timing chart



Truth table

STBY	IN	OUT	DIAG	Output DMOS	Operating state
L	L	H	H	OFF	Standby mode
	H	H	H	OFF	
H	L	H	H	OFF	Normal operation
	H	L	L	ON	
	L	H	H	OFF	Over current (Short to V_{BAT} / GND)
	H	H(*1)	H	ON/OFF	
	L	H	H	OFF	Over temperature
	H	H(*1)	H	OFF	
	L	L(*2)	L	OFF	Load open (Disconnection)
	H	L	L	ON	

*1: Case of STBY=H and IN=H, the output voltage conditions to output a diagnosis are more than V_{OD}. ($V_{OUT} > V_{OD}$)

*2: Case of STBY=H and IN=L, the output voltage conditions to output a diagnosis are less than V_{OD}. ($V_{OUT} < V_{OD}$)

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	PIN	Rating	Unit	Note
Supply voltage	V_{DD}	V_{DD}	−0.3 to 6.0	V	-
Input voltage	V_{IN} , V_{STBY}	IN,STBY	−0.3 to 6.0	V	-
DIAG output voltage	V_{DIAG}	DIAG	−0.3 to 6.0	V	-
DIAG output current	I_{DIAG}	DIAG	5	mA	-
Output voltage	V_{OUT}	OUT	-0.3 to 40.0	V	N channel DMOS (V_{DSS}=60V)
Output current	I_{OUT}	OUT	Internally limited	A	-
Power dissipation (Note 2)	P_D	-	1.84	W	-
Single pulse active clamp capability (Note 3)	E_{AS}	-	95	mJ	-
Active clamp current	I_{AR}	OUT	6	A	-
Operating temperature	T_{opr}	-	−40 to 125	°C	-
Channel temperature	T_{ch}	-	150	°C	-
Storage temperature	T_{stg}	-	−40 to 150	°C	-

Note1: 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	Rating	Unit
Thermal resistance, channel to ambient	$R_{th\ (ch-a)}$	67.6	°C / W

Note 2: Glass epoxy board
Material: FR-4(4 layer)
Board size: 76.2mm×114.3mm×1.6mm
Via: ⌀0.3mm(2 point)

Note 3: Active clamp capability (single pulse) test condition
V_{DD}=12V, T_{ch} =25°C(initial), L=3.9 mH, I_{AR}=6 A

Electrical Characteristics

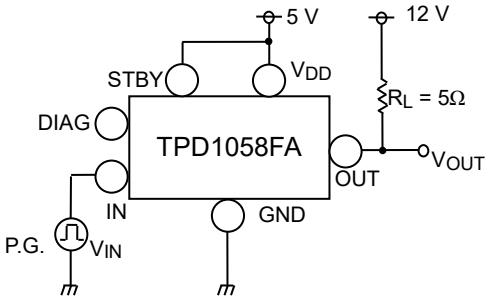
(Unless otherwise specified T_{ch} = −40 to 125°C, V_{DD} = 4.5 to 5.5V)

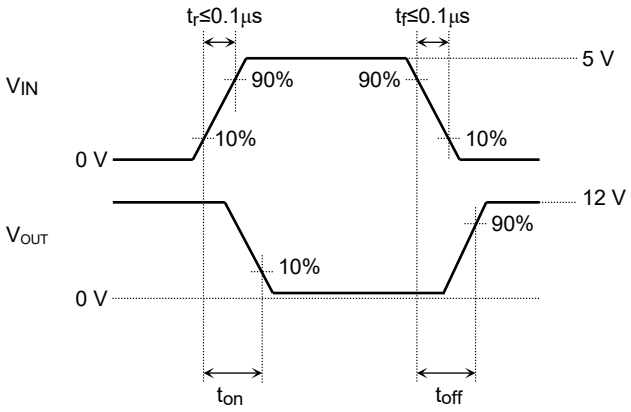
Characteristics	Symbol	Pin	Test condition	Min	Typ.	Max	Unit
Output clamp voltage	$V_{(CL)DSS}$	OUT	I_{OUT}=1mA, V_{STBY}=5V, V_{IN}=0V	40	46	60	V
Operating supply voltage	$V_{DD(opr)}$	V_{DD}	-	4.5	5.0	5.5	V
Under voltage protection	$V_{DD(UV)}$	V_{DD}	-	2.5	2.9	3.5	V
Supply current	I_{DD1}	V_{DD}	V_{STBY}=0V,V_{IN}=0V, V_{DD}=5V,	-	0	10	μA
	I_{DD2}	V_{DD}	V_{STBY}=5V, V_{IN}=0V, V_{DD}=5V	-	0.61	2.00	mA
	I_{DD3}	V_{DD}	V_{STBY}=5V, V_{IN}=5V, V_{DD}=5V	-	0.62	5.00	mA
Output leakage current	I_{OL1}	OUT	V_{STBY}=V_{IL}, V_{IN}=V_{IL}, V_{OUT}=8 to 16V	-	-	10	μA
	I_{OL2}	OUT	V_{STBY}=V_{IH}, V_{IN}=V_{IL}, V_{OUT}=8 to 16V	-	160	300	μA
High level input voltage	V_{IH}	IN,STBY	-	2.0	-	-	V
Low level input voltage	V_{IL}	IN,STBY	-	-	-	0.8	V
High level input current	I_{IH}	IN,STBY	V_{IN}(V_{STBY})=5V, V_{DD}=5V	-	50	200	μA
Low level input current	I_{IL}	IN,STBY	V_{IN}(V_{STBY})=0V, V_{DD}=5V	-1	-	1	μA
DIAG leakage current	I_{DH}	DIAG	V_{DIAG}=5V	-	-	3	μA
DIAG output voltage	V_{DL}	DIAG	I_{DIAG}=+1mA	-	0.01	0.20	V
Output resistance (output DMOS on)	$R_{DS(ON)1}$	OUT	I_{OUT}=+2A, T_{ch}=25°C, V_{DD}=5V, V_{STBY}=V_{IH},V_{IN}=V_{IH}	-	0.07	0.10	Ω
	$R_{DS(ON)2}$	OUT	I_{OUT}=+2A, T_{ch}=-40 to 125°C, V_{DD}=5V, V_{STBY}=V_{IH},V_{IN}=V_{IH}	-	-	0.16	Ω
Over temperature detection	T_{OT}	-	V_{STBY}=V_{IH},V_{IN}=V_{IH}	150	172	200	°C
	ΔT_{OT}	-		-	12	-	
Over current detection	I_{OC}	OUT	V_{STBY}=V_{IH},V_{IN}=V_{IH}, V_{DD}=5V	6	13	-	A
Over current protection off time	$t_{OFF-DUTY}$	OUT	V_{BAT}=12V, R_L=0.1Ω, V_{DD}=5V, V_{STBY}=V_{IH},V_{IN}=V_{IH}	3	7	12	ms
Load open detection resistance	R_{op}	OUT	V_{STBY}=V_{IH}, V_{IN}=V_{IL}, V_{OUT}=8 to 16V	10	300	1000	kΩ
	ΔR_{op}	OUT	V_{STBY}=V_{IH}, V_{IN}=V_{IL}, V_{OUT}=8 to 16V	-	40	-	kΩ
Output detection voltage	V_{OD}	OUT	V_{STBY}=V_{IH}, V_{OUT}=L→H	2	3	4	V
	ΔV_{OD}	OUT	V_{STBY}=V_{IH}	-	0.3	-	V
Output resistance (output DMOS off)	R_{OUT1}	OUT	V_{STBY}=V_{IH}, V_{IN}=V_{IL}, V_{DD}=4.5 to 5.5V T_{ch}=25°C	75	100	125	kΩ
	R_{OUT2}	OUT	V_{STBY}=V_{IH}, V_{IN}=V_{IL}, V_{DD}=4.5 to 5.5V T_{ch}=-40 to 125°C	60	100	140	kΩ
Switching time	Δt_f	OUT	V_{STBY}=V_{IH}, V_{DD}=5V,T_{ch}=25°C, V_{BAT}=12V,R_L=5Ω, Slew rate : VOUT10% to 90%	7.0	16.4	-	V/μs
	t_{on}	OUT		-	0.8	5.0	μs
	Δt_r	OUT		7.0	15.5	-	V/μs
	t_{off}	OUT		-	2.1	5.0	μs

*The condition of the typical value is T_{ch}=25°C, V_{DD}=5V.

Test Circuit

Switching time t_{on}, t_{off}

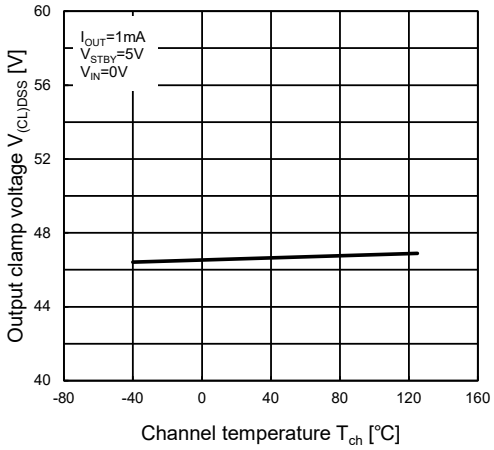




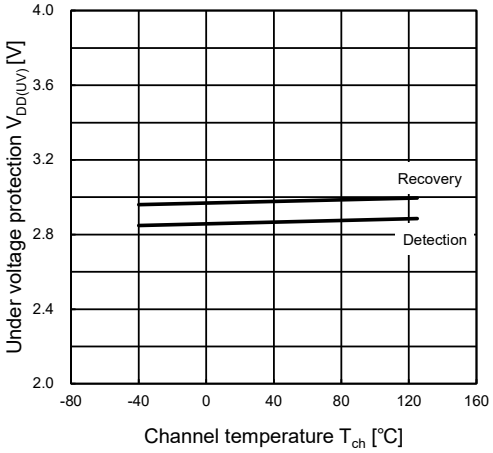
Characteristic curves

The below characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

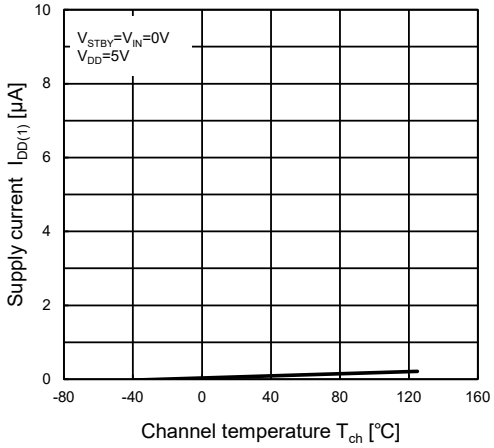
$V_{(CL)DSS}$ – T_{ch}



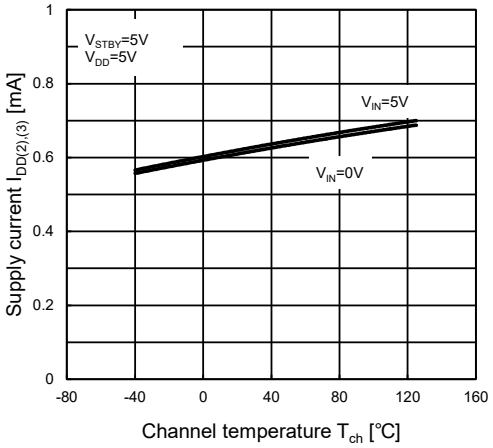
$V_{DD(UV)}$ – T_{ch}



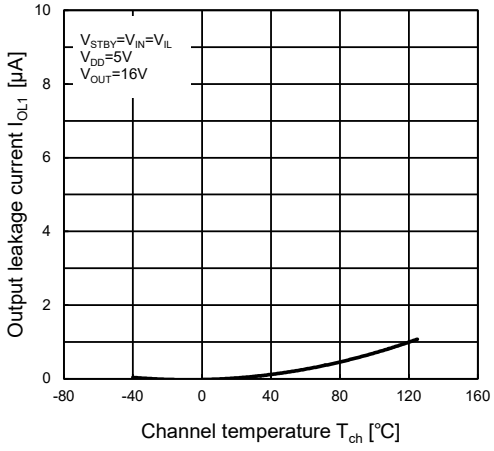
$I_{DD(1)}$ – T_{ch}



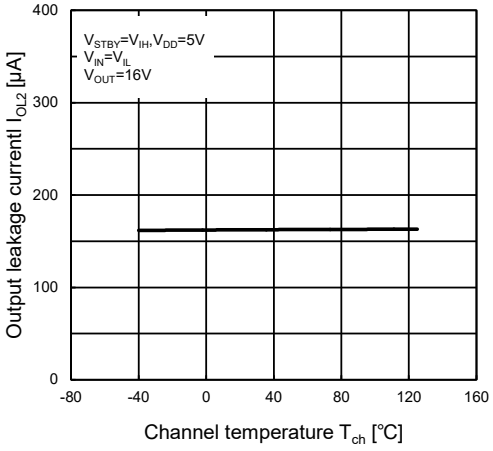
$I_{DD(2),(3)}$ – T_{ch}



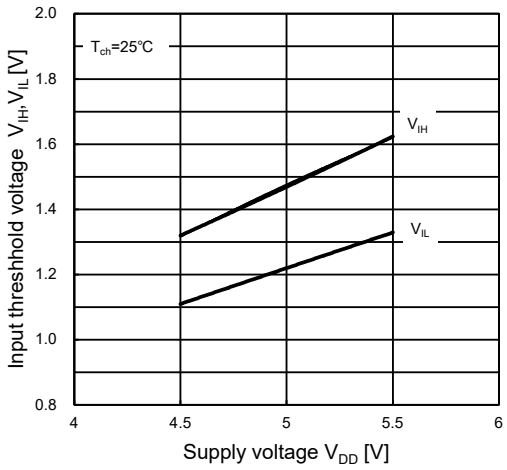
I_{OL1} – T_{ch}



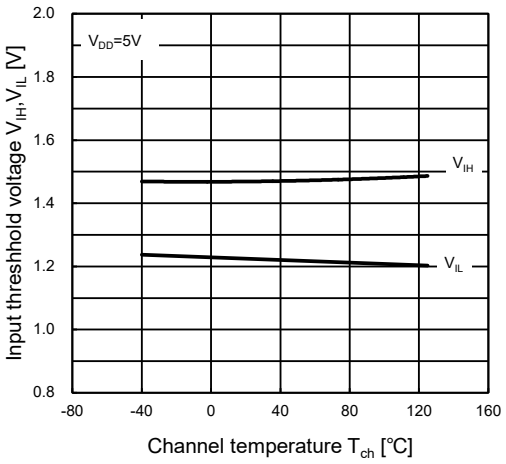
I_{OL2} – T_{ch}



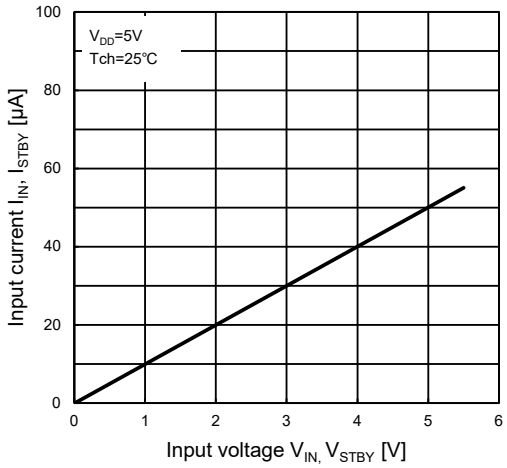
V_{IH}, V_{IL} – V_{DD}



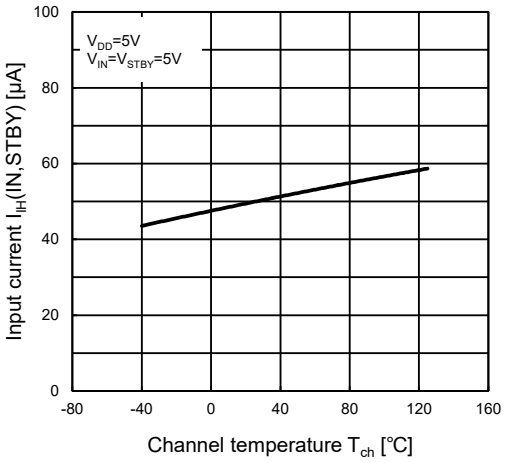
V_{IH}, V_{IL} – T_{ch}



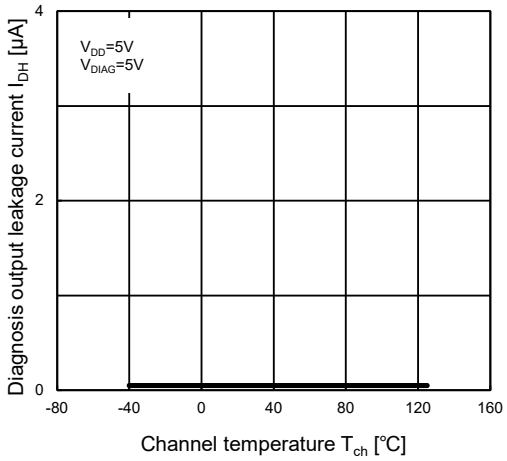
I_{IN} – V_{IN}



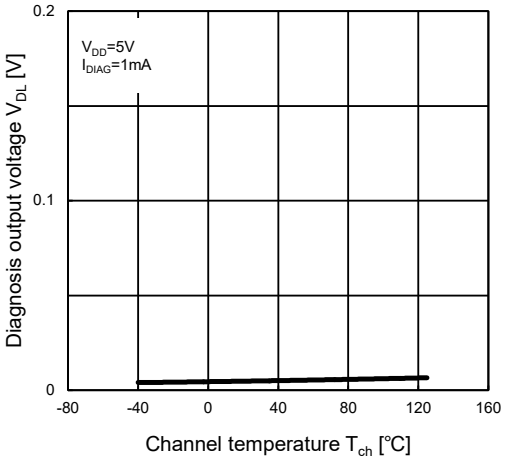
I_{IH} – T_{ch}



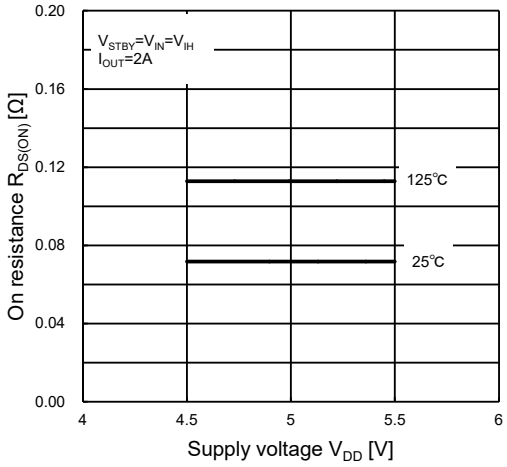
I_{DH} – T_{ch}



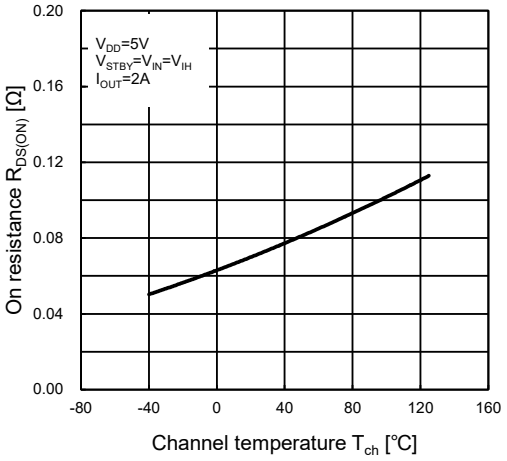
V_{DL} – T_{ch}



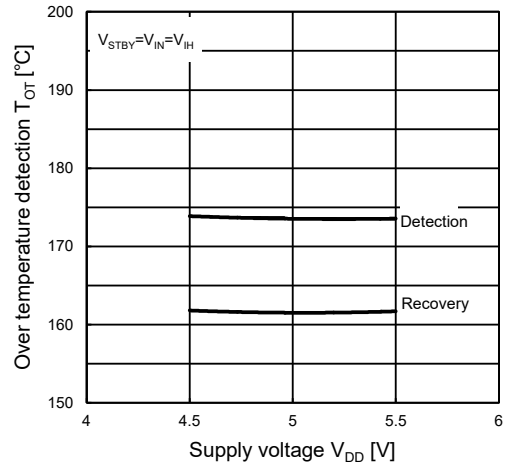
$R_{DS(ON)}$ – V_{DD}



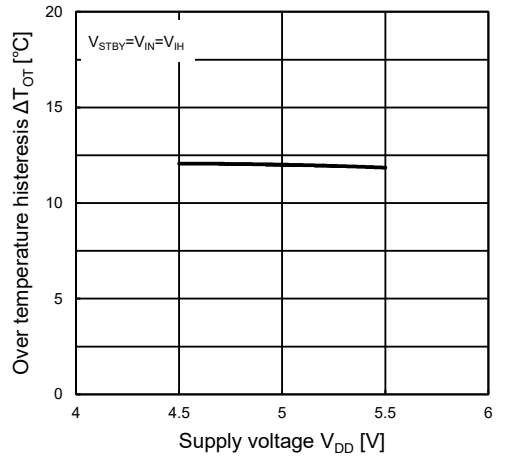
$R_{DS(ON)}$ – T_{ch}



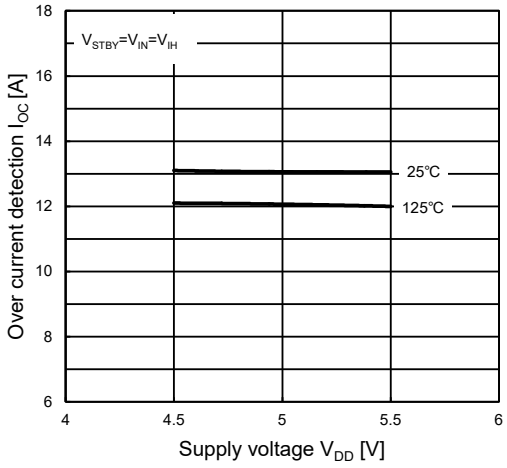
T_{OT} – V_{DD}



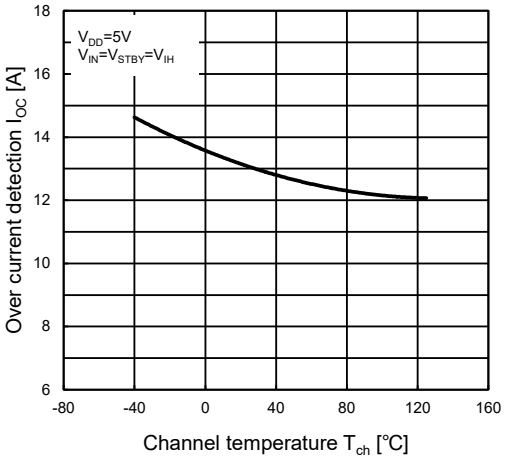
ΔT_{OT} – V_{DD}



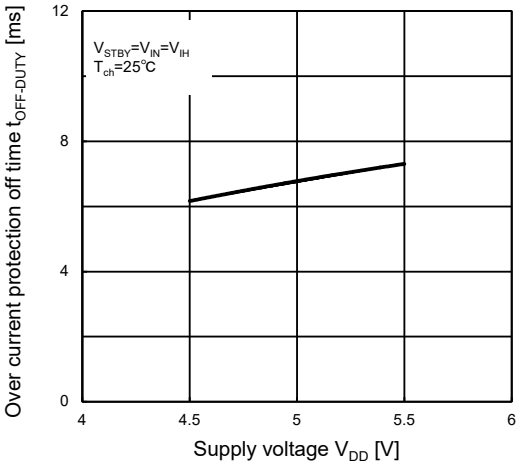
I_{OC} – V_{DD}



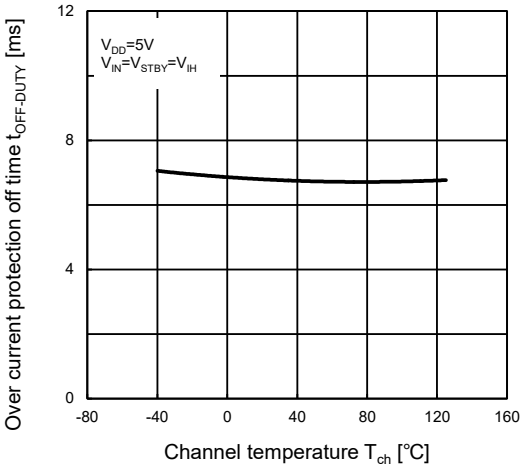
I_{OC} – T_{ch}



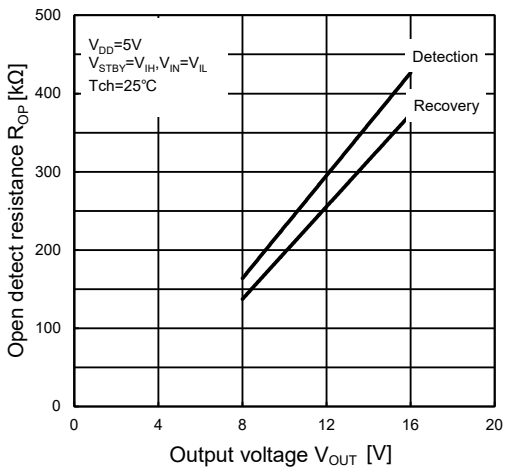
$t_{OFF\text{-}DUTY}$ – V_{DD}



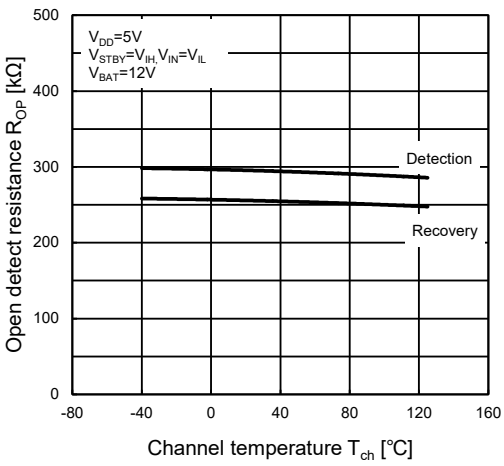
$t_{OFF\text{-}DUTY}$ – T_{ch}



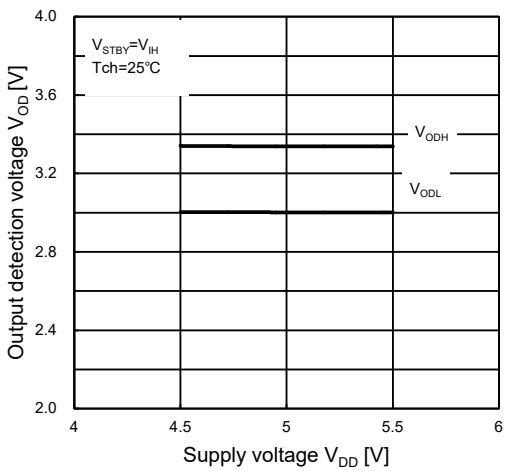
R_{OP} – V_{OUT}



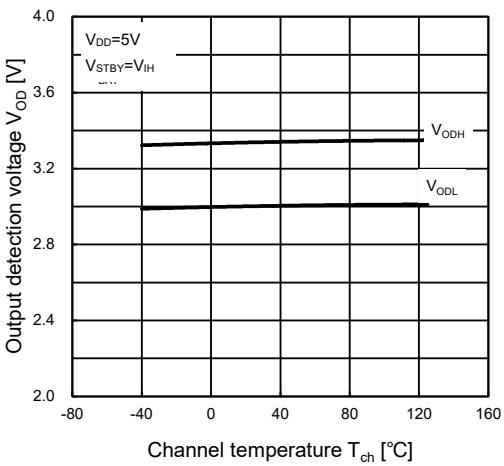
R_{OP} – T_{ch}



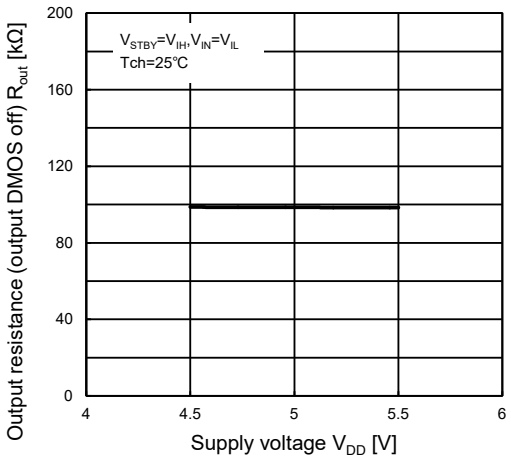
V_{OD} – V_{DD}



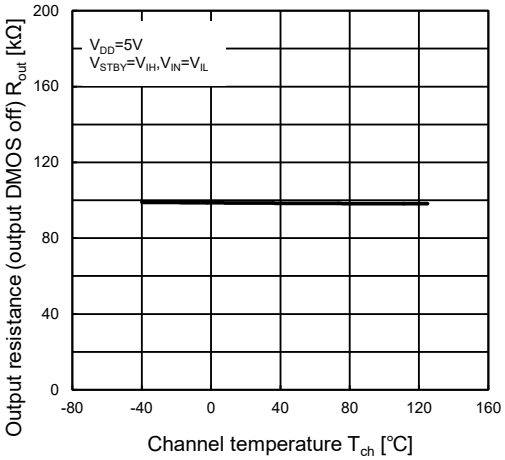
V_{OD} – T_{ch}



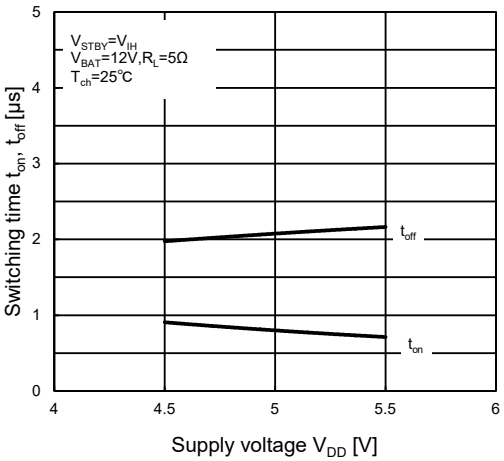
R_{out} – V_{DD}



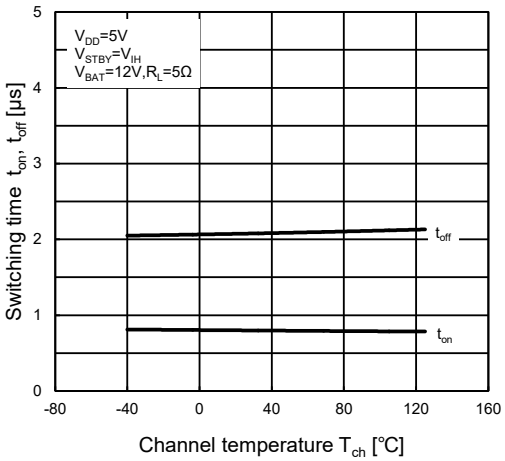
R_{OUT} – T_{ch}



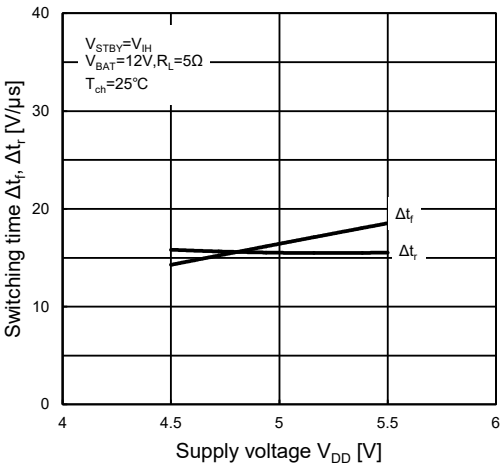
Switching time – V_{DD}



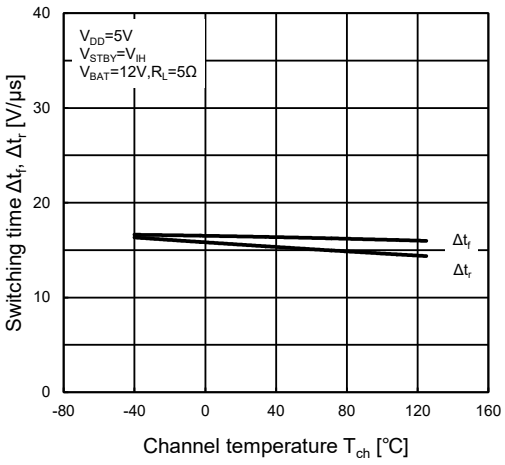
Switching time – T_{ch}

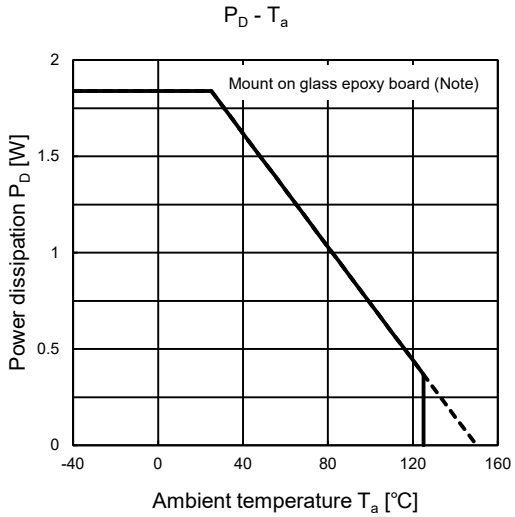


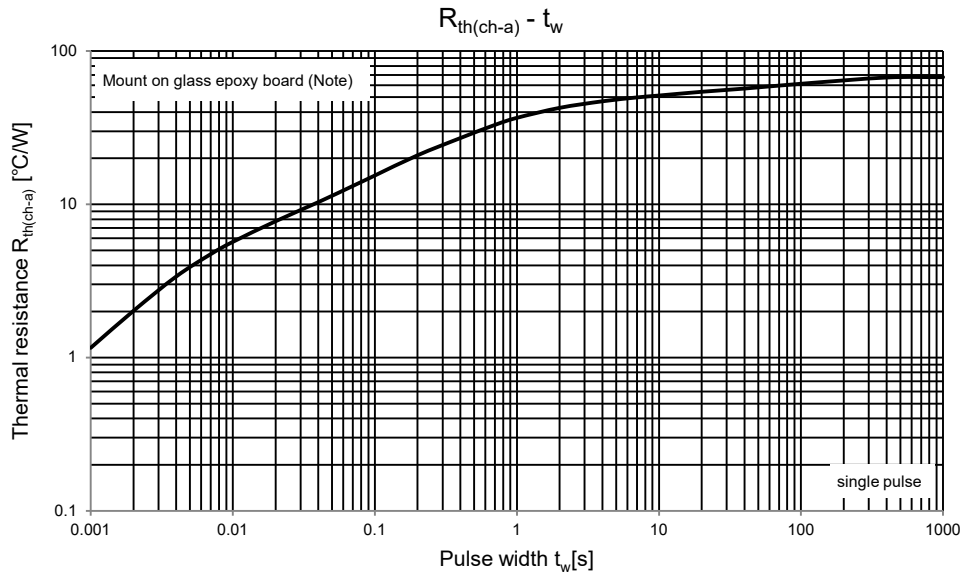
Switching time – V_{DD}



Switching time – T_{ch}





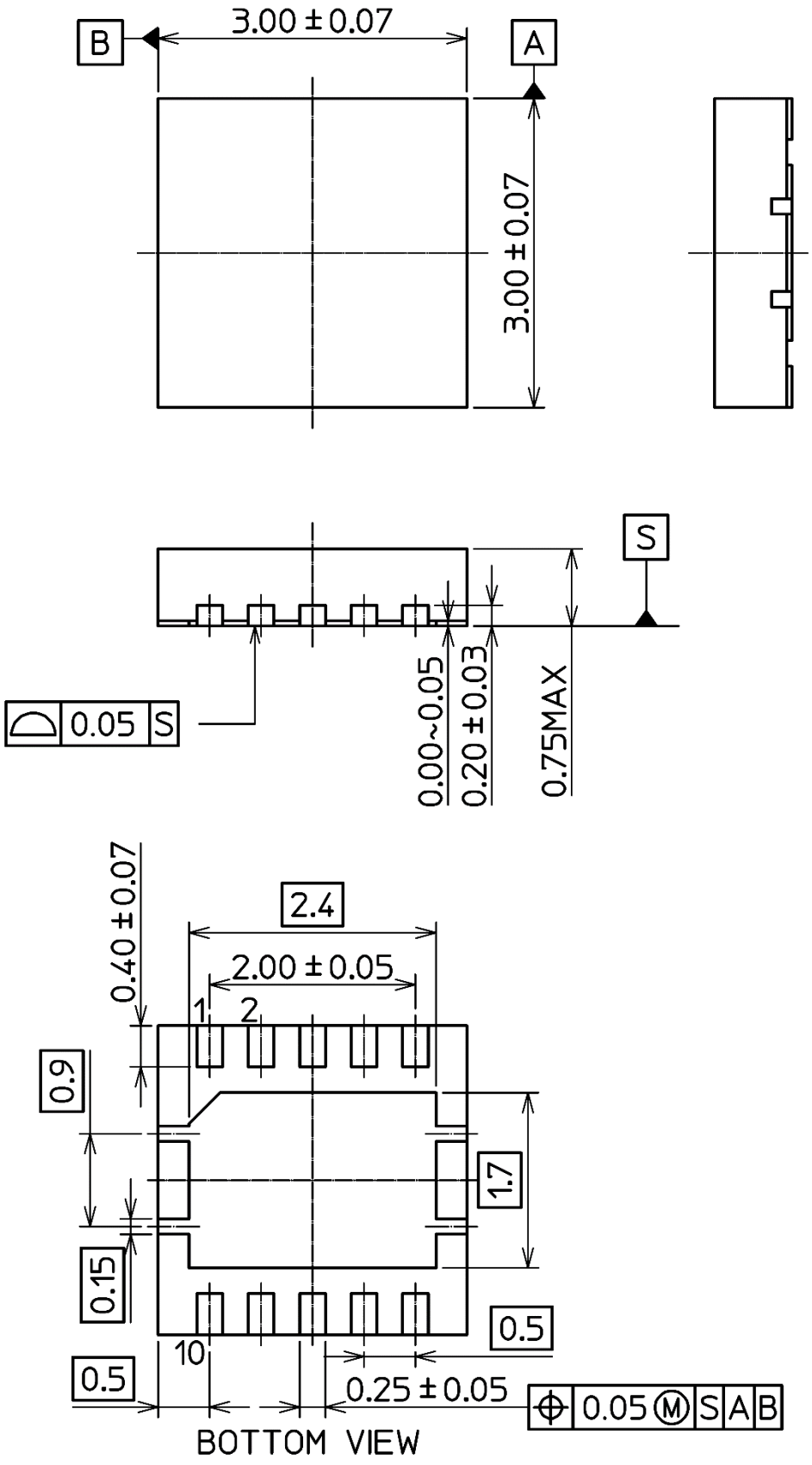


Note: Glass epoxy board
Material: FR-4 (4 layer)
Board size: 76.2mm×114.3mm×1.6mm
Via: ⌀0.3mm (2 point)

Package Dimensions

P-WSON10-0303-0.50-001

Unit: mm



Weight: 0.02 g (Typ.)

Note: Please connect exposed pad to electrical open or GND.

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