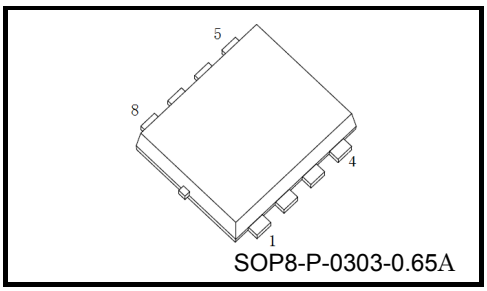
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1054F

Low-Side Switch for Motor, Solenoid and Lamp Drive

The TPD1054F is a low-side switch.

The IC has a MOSFET (D-MOS) 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.



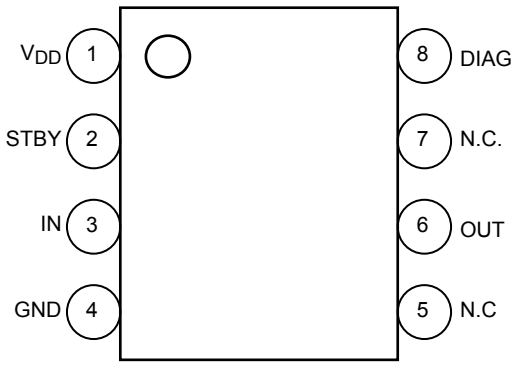
SOP8-P-0303-0.65A

Weight: 0.017 g (typ.)

Features

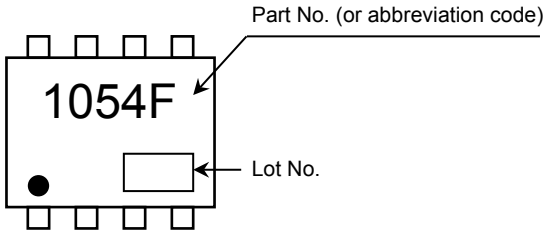
- A monolithic power IC with a new structure combining a control block and a power MOSFET (D-MOS) on single chip.
- Can directly drive a power load from a CMOS or TTL logic.
  Built-in protection circuits against overvoltage (active clamp), overtemperature (thermal shutdown) .
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short-circuiting, opening, or over temperature
- Low Drain-Source ON-resistance:
  $R_{DS\ (ON)}$ = 0.8 Ω (max)(@V_{DD} = 5 V, V_{STBY} = 5 V, V_{IN} = 5 V, I_O = 0.5 A, T_{ch} = 25°C)
- Low Leakage Current:
  I_{DD1} = 10 μA (max) (@V_{IN} = 0 V, V_{STBY} = 0 V, V_{DD} = 5 V, T_{ch} = -40 to 125°C)
  I_{OL} = 10 μA (max) (@V_{IN} = 0 V, V_{STBY} = 0 V, V_{DD} = 5 V, V_{OUT} = 8 to 16 V, T_{ch} = -40 to 125°C)
- "PS-8" package with embossed-tape packing.

Pin Assignment (top view)



(TOP VIEW)

Marking



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

*Weekly code: (Three digits)

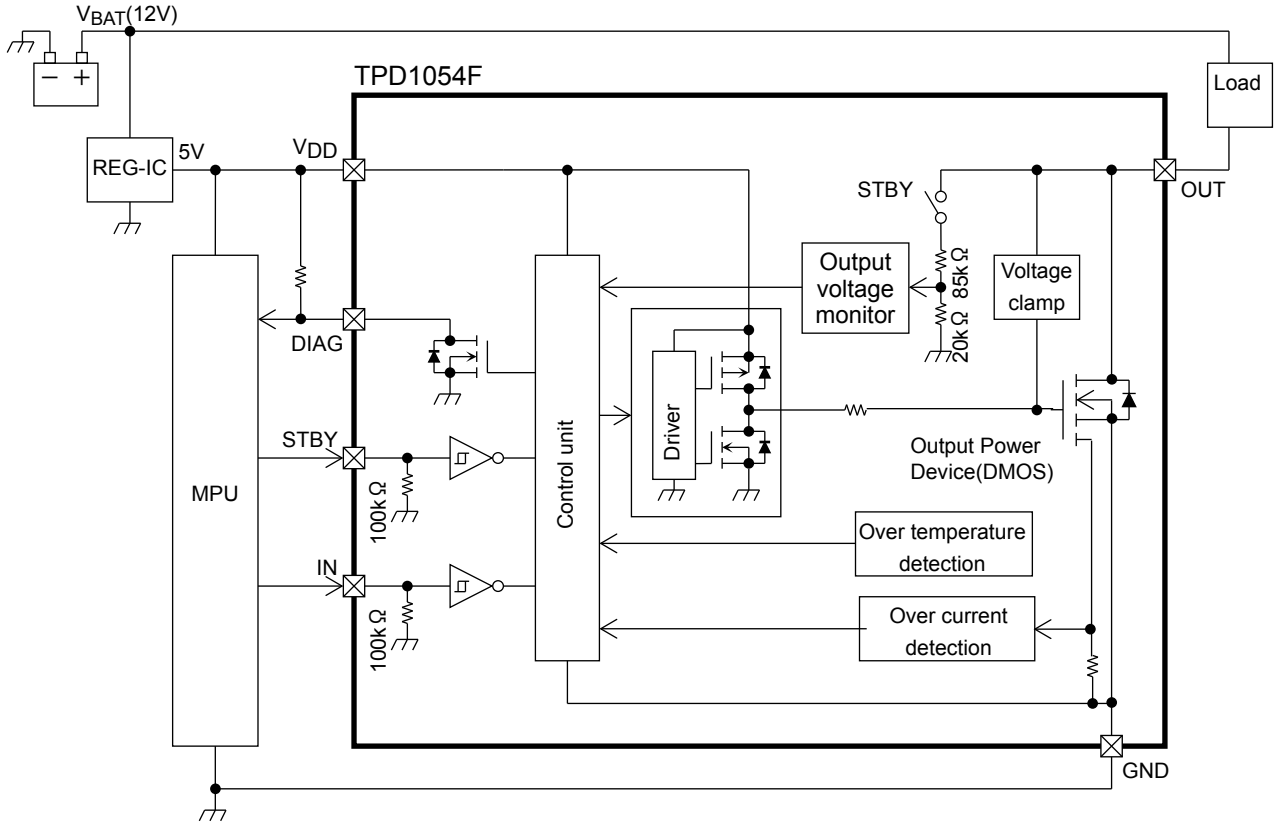
Week of manufacture

Year of manufacture
(The last digit of the calendar year)

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

Start of commercial production
2013-12

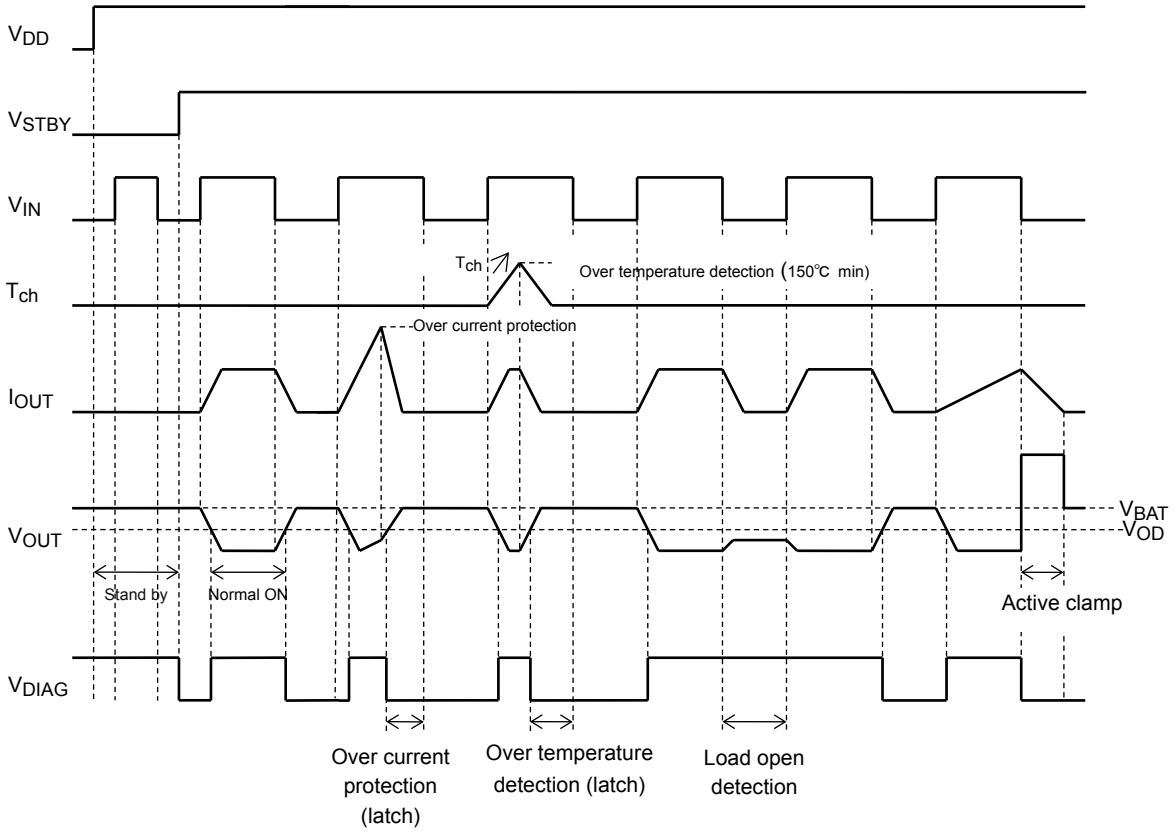
Block Diagram



Pin Description

Pin No.	Symbol	Pin Description
1	V_{DD}	Power supply pin.
2	STBY	STBY pin. V_{STBY}=L/Open：I_{DD}≦10μA（Standby mode） V_{STBY}=H：Active control
3	IN	I 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	N.C	No-Connect pin. (not connected to the chip.)
6	OUT	Output pin. When a load short-circuit causes an overcurrent (1.0A min) to flow into a device, output current is limited in order to protect the IC.
7	N.C	No-Connect pin. (not connected to the chip.)
8	DIAG	Self-diagnosis detection. open Drain. 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 reset.

Timing chart



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Truth table

STBY	IN	Output state	VOUT	DIAG	Operating state
L	L	OFF	H	H	Standby mode
L	H	OFF	H	H	
H	L	OFF	H	L	Normal OFF
H	H	ON	L	H	Normal ON
H	H	OFF(latch)	H	L(latch)	Overcurrent (load short)
H	H	OFF(latch)	H	L(latch)	Over temperature
H	L	OFF	L	H	Load open

*V_{OUT}=H>=V_{OD} , V_{OUT}=L<V_{OD}

*Latch reset condition: V_{STBY}<V_{IL} or V_{STBY}<V_{IL}

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	PIN	Rating	Unit	Note
Supply voltage	V_{DD}	VDD	−0.3 to 6.0	V	-
Input voltage	V_{IN} , V_{STBY}	IN,STBY	−0.3 to 6.0	V	-
Diagnosis output voltage	V_{DIAG}	DIAG	−0.3 to 6.0	V	-
Diagnosis output current	I_{DIAG}	DIAG	5.0	mA	-
Output voltage	V_{OUT}	OUT	−0.3 to 40	V	-
Output current	I_{OUT}	OUT	Internally Limited	A	-
Power dissipation (Note 2)	$P_{D(1)}$	-	0.7	W	(Note 2-a)
	$P_{D(2)}$	-	0.35	W	(Note 2-b)
Single pulse active clamp capability (Note 3)	E_{AS}	-	125	mJ	-
Active clamp current	I_{AR}	-	1.0	A	-
Operating temperature	T_{opr}	-	−40 to 125	°C	-
Channel temperature	T_{ch}	-	150	°C	-
Storage temperature	T_{stg}	-	−55 to 150	°C	-

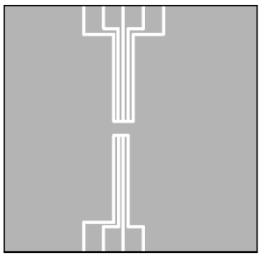
Note1: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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	Max	Unit
Thermal resistance, channel to ambient	$R_{th\ (ch-a)}$	178.6(Note 2a)	°C/W
		357.2(Note 2b)	

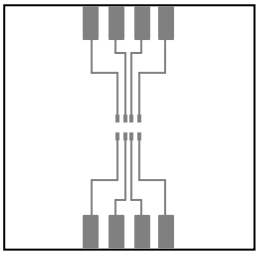
Note 2:

(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

Note 3: Active clamp capability (single pulse) test condition
V_{DD}=40 V, T_{ch}=25°C(initial), L=50 mH, I_{AR}=1 A

Electrical Characteristics

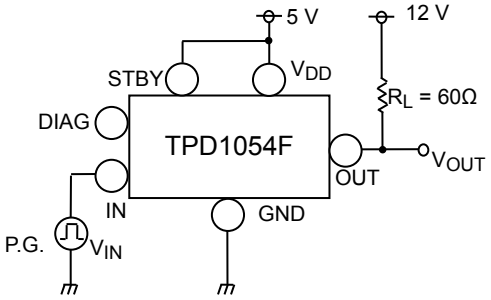
(Unless otherwise specified T_{ch} = −40 to 125°C, V_{DD} = 4.5 to 5.5V)

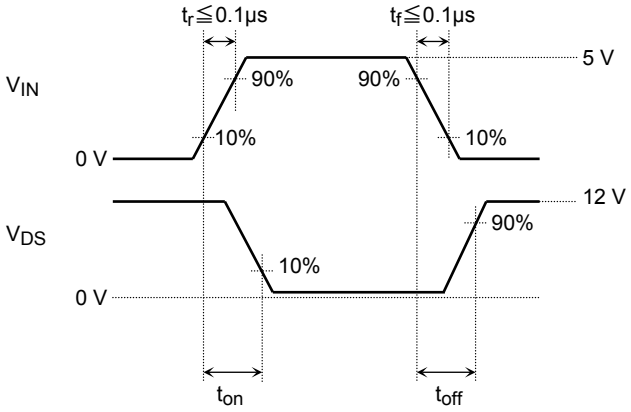
Characteristics	Symbol	Test Circuit	Pin	Test condition	Min	Typ.	Max	Unit
Drain-source clamp voltage	$V_{(CL)\ DSS}$	-	OUT	I_O=1mA, V_{STBY}=5V, V_{IN}=0V	40	45	50	V
Operating supply voltage	$V_{DD\ (opr)}$	-	VDD	-	4.5	5	5.5	
Supply current	I_{DD1}	-	VDD	V_{STBY}=0V, V_{IN}=0V, V_{DD}=5V,	-	-	10	μA
	I_{DD2}	-	VDD	V_{STBY}=5V, V_{IN}=0V, V_{DD}=5V	-	0.5	2	mA
	I_{DD3}	-	VDD	V_{STBY}=5V, V_{IN}=5V, V_{DD}=5V	-	0.5	2	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	-	120	300	μA
Input voltage	V_{IH}	-	IN,STBY	-	2.3	-	-	V
	V_{IL}	-	IN,STBY	-	-	-	0.8	V
Input current	I_{IH}	-	IN,STBY	V_{IN}(V_{STBY})=5V, V_{DD}=5V	-	-	200	μA
	I_{IL}	-	IN,STBY	V_{IN}(V_{STBY})=0V, V_{DD}=5V	-1	-	1	μA
Diagnosis output voltage	V_{DL}	-	DIAG	I_{DIAG}=1mA	-	0.1	0.5	V
Diagnosis output current	I_{DH}	-	DIAG	V_{DIAG}=5.5V	-	-	10	μA
Drain-source ON-resistance	$R_{DS(ON)1}$	-	OUT	I_O=+0.5A, T_{ch}=25°C, V_{DD}=5V, V_{STBY}=V_{IH}, V_{IN}=V_{IH}	-	0.45	0.8	Ω
	$R_{DS(ON)2}$	-	OUT	I_O=+0.5A, T_{ch}=-40 to 125°C, V_{DD}=5V, V_{STBY}=V_{IH}, V_{IN}=V_{IH}	-	-	1.2	Ω
Overtemperature detection	T_{OT}	-	-	V_{STBY}=5V, V_{IN}=5V,	150	175	200	°C
Overcurrent detection	I_{OC}	-	OUT	V_{STBY}=5V, V_{IN}=5V,	1.0	2.2	3.5	A
Load open threshold resistance	R_{OP}	-	OUT	V_{STBY}=5V, V_{IN}=0V, V_{BAT}=8 to 16V	10	300	1000	kΩ
	ΔR_{OP}	-	OUT	V_{STBY}=5V, V_{IN}=0V, V_{BAT}=8 to 16V	-	30	-	kΩ
Diagnosis output threshold voltage	V_{OD}	-	OUT	V_{STBY}=5V,	2	3	4	V
	ΔV_{OD}	-	OUT	V_{STBY}=5V,	-	0.3	-	V
OUT-GND internal resistance	R_{OUT1}	-	OUT	V_{STBY}=5V, V_{IN}=0V, T_{ch}=25°C	50	105	170	kΩ
	R_{OUT2}	-	OUT	V_{STBY}=5V, V_{IN}=0V, T_{ch}=-40 to 125°C	40	105	200	kΩ
Switching time	t_{on}	1	OUT	V_{STBY}=5V, V_{IN}=0→5V, V_{DD}=5V, T_{ch}=25°C, V_{BAT}=12V, R_L=60Ω	-	0.5	1	μs
	t_{off}	1	OUT	V_{STBY}=5V, V_{IN}=5→0V, V_{DD}=5V, T_{ch}=25°C, V_{BAT}=12V, R_L=60Ω	-	0.5	1	

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

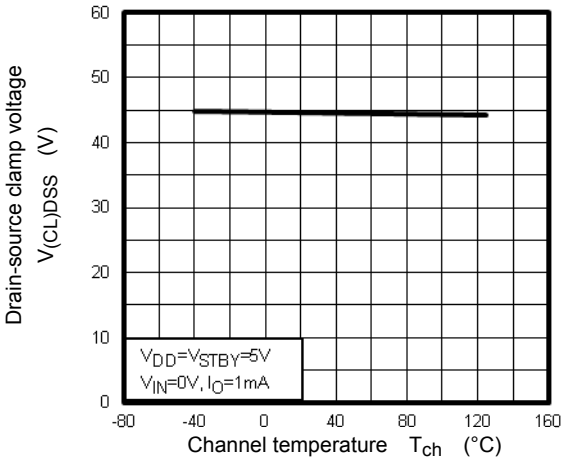
Test Circuit

Switching time t_{on}, t_{off}

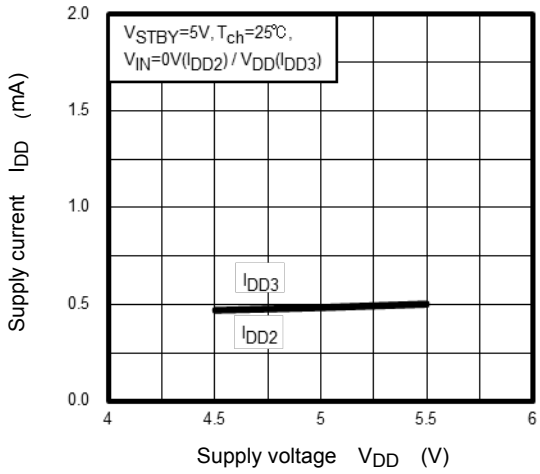




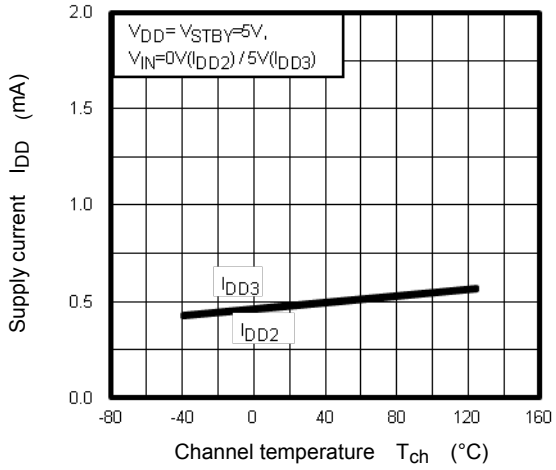
$V_{(CL)DSS} - T_{ch}$



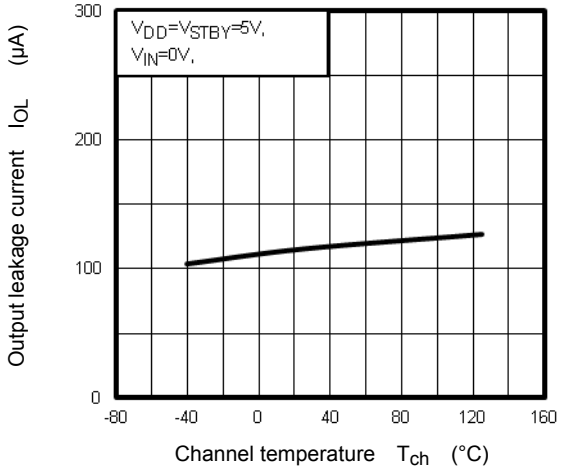
$I_{DD} - V_{DD}$



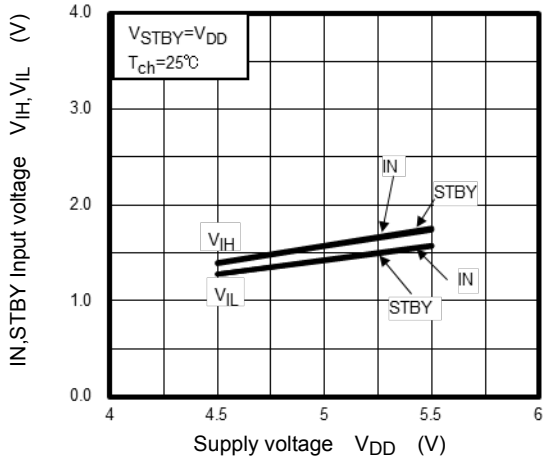
$I_{DD} - T_{ch}$



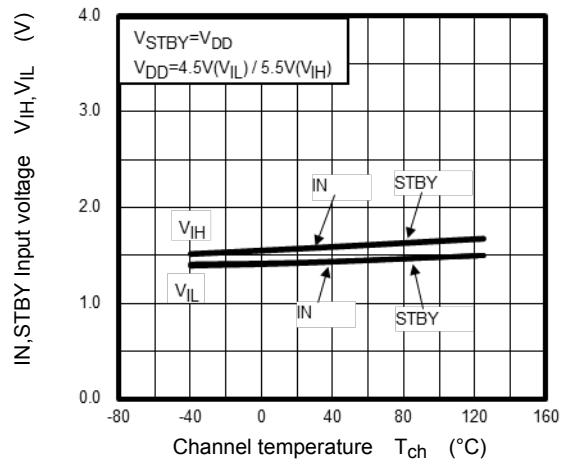
$I_{OL} - T_{ch}$



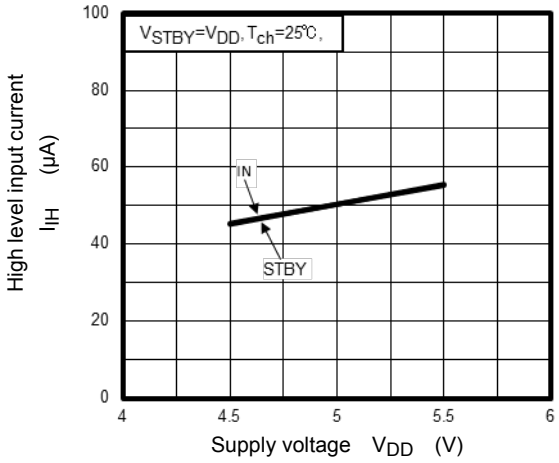
$V_{IH}, V_{IL} - V_{DD}$



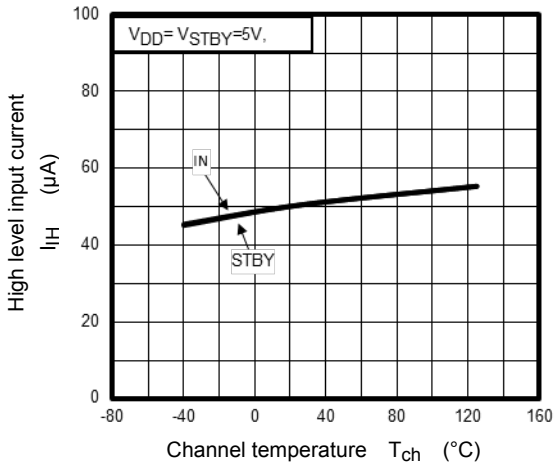
$V_{IH}, V_{IL} - T_{ch}$



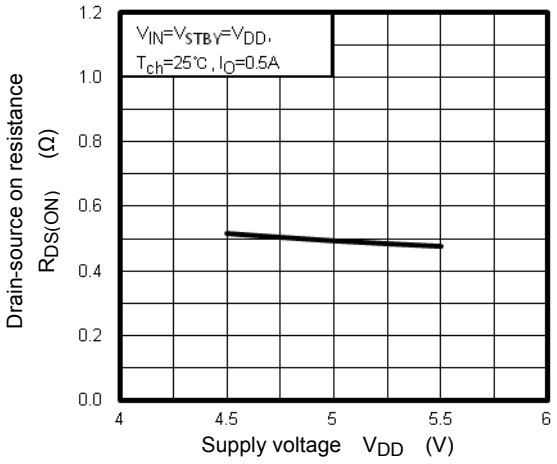
I_{IH} –V_{DD}



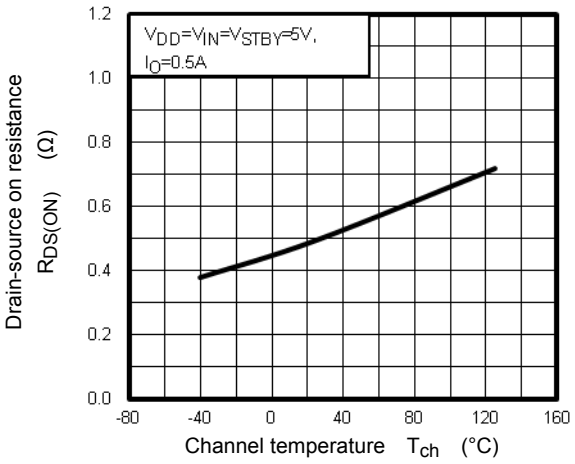
I_{IH} – T_{ch}



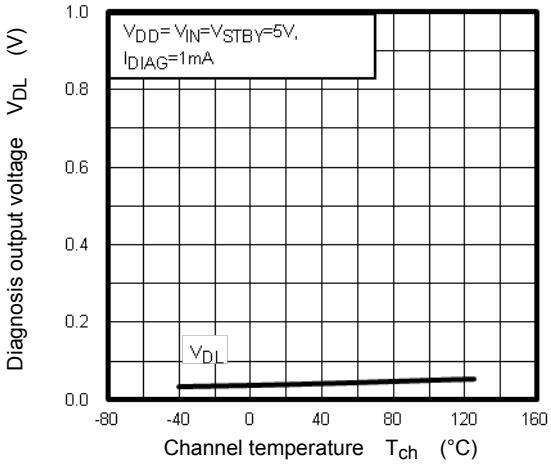
$R_{DS(ON)}$ – V_{DD}



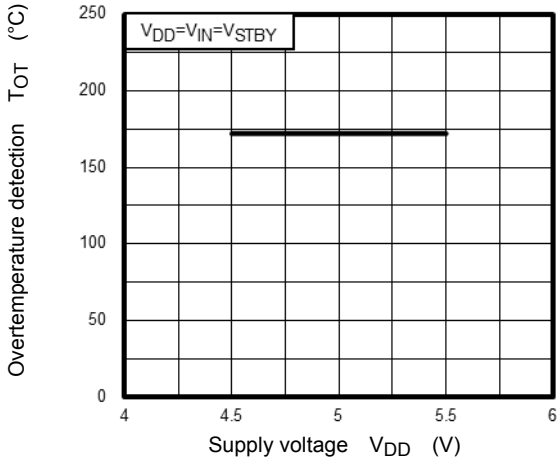
$R_{DS(ON)}$ – T_{ch}



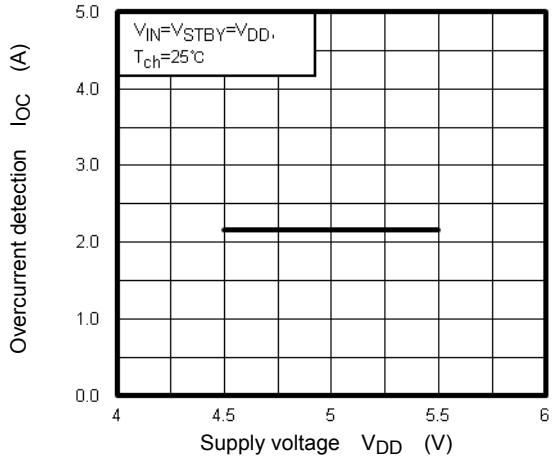
V_{DL} – T_{ch}



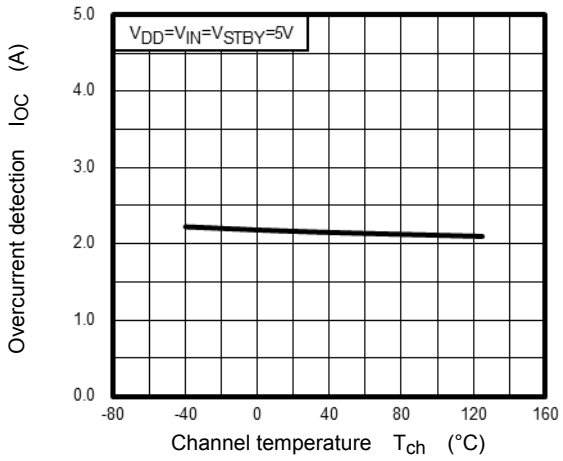
T_{OT} – V_{DD}



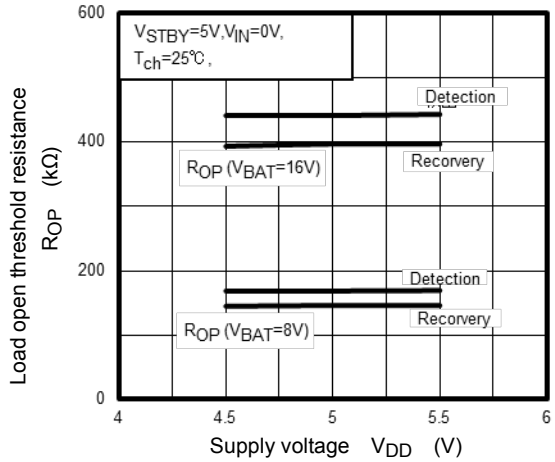
I_{OC} – V_{DD}



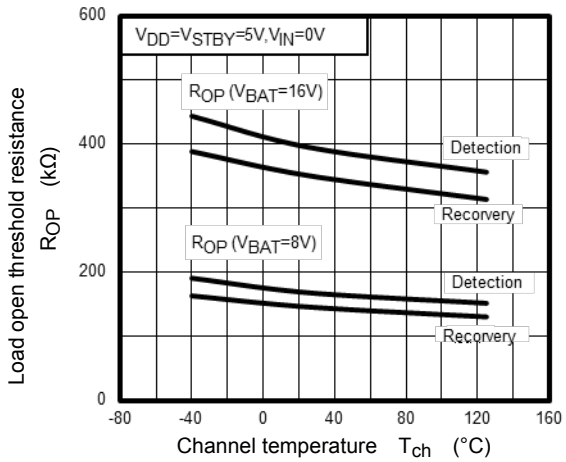
I_{OC} – T_{ch}



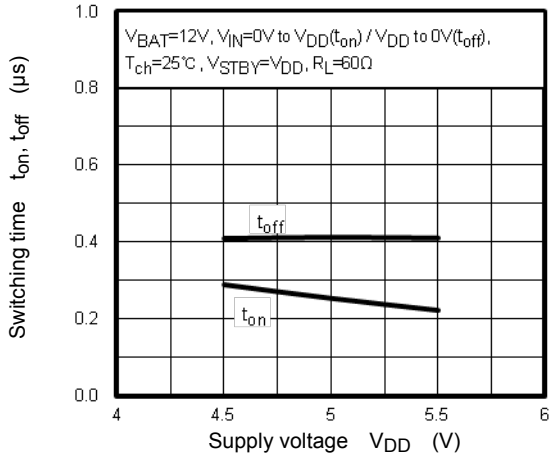
R_{OP} – V_{DD}



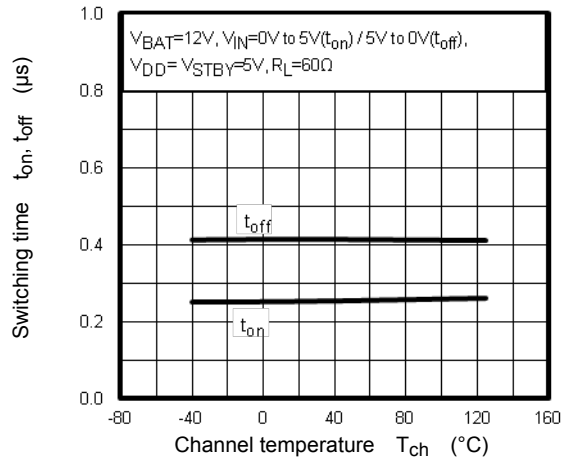
R_{OP} – T_{ch}

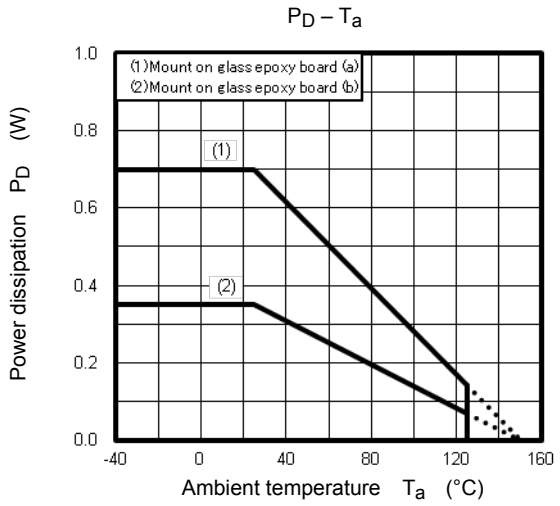


t_{on}, t_{off} –V_{DD}



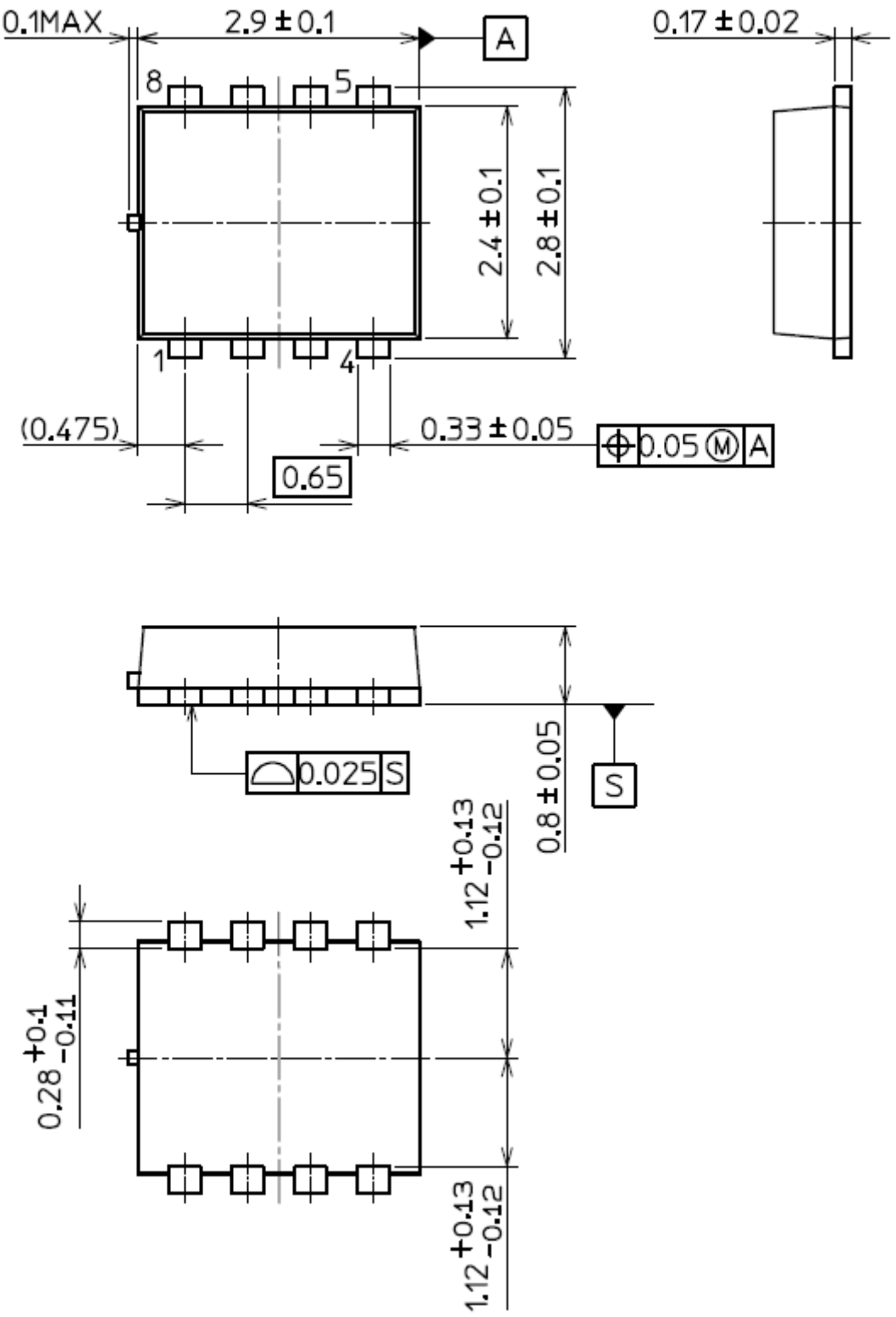
t_{on}, t_{off} – T_{ch}




$P_D - T_a$
(1) Mount on glass epoxy board (a)
(2) Mount on glass epoxy board (b)
(1)
(2)
Power dissipation P_D (W)
1.0
0.8
0.6
0.4
0.2
0.0
-40
0
40
80
120
160
Ambient temperature T_a (°C)

Package Dimensions

SOP8-P-0303-0.65A Unit : mm



Weight: 0.017 g (Typ.)

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