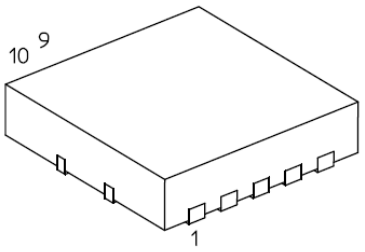
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1055FA

For Motor, Solenoid and Lamp

High side power switch

TPD1055FA is a High-side switch of a P channel DMOS output. It is monolithic power IC which the drive was directly completed from CMOS and TTL logic circuits (MPU etc.), and was equipped with the intelligent function of protection and diagnosis.



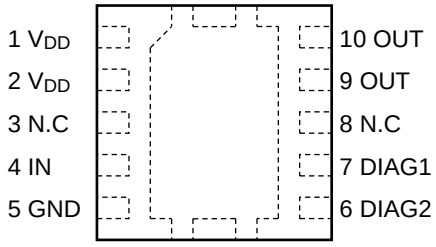
P-WSON10-0303-0.50-001

Weight:0.02g(typ.)

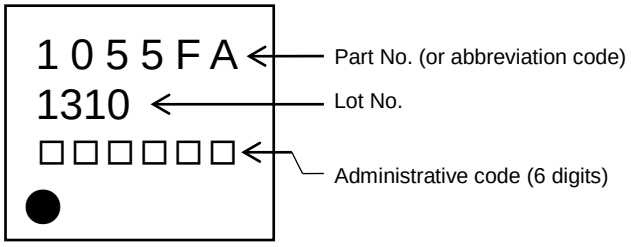
Features

- A monolithic power IC with a structure combining a control block and a power MOSFET (D-MOS) on single chip.
- One side of load can be grounded to a high-side switch.
- Can directly drive a power load from CMOS or TTL logic.
- Built-in protection circuits against over temperature, over current.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at battery short, load short-circuiting, opening, or over temperature.
- Up to V_{DD} - 40V (Min) of counter electromotive force from an inductance load can be applied.
- Low on-resistance: $R_{DS(ON)}$=0.12Ω(Max) (@ V_{DD} = 12 V, T_{ch} = 25°C, I_O = -2 A)
- WSON10 package for surface mounting that can be packed in tape.

Pin Assignment (top view)



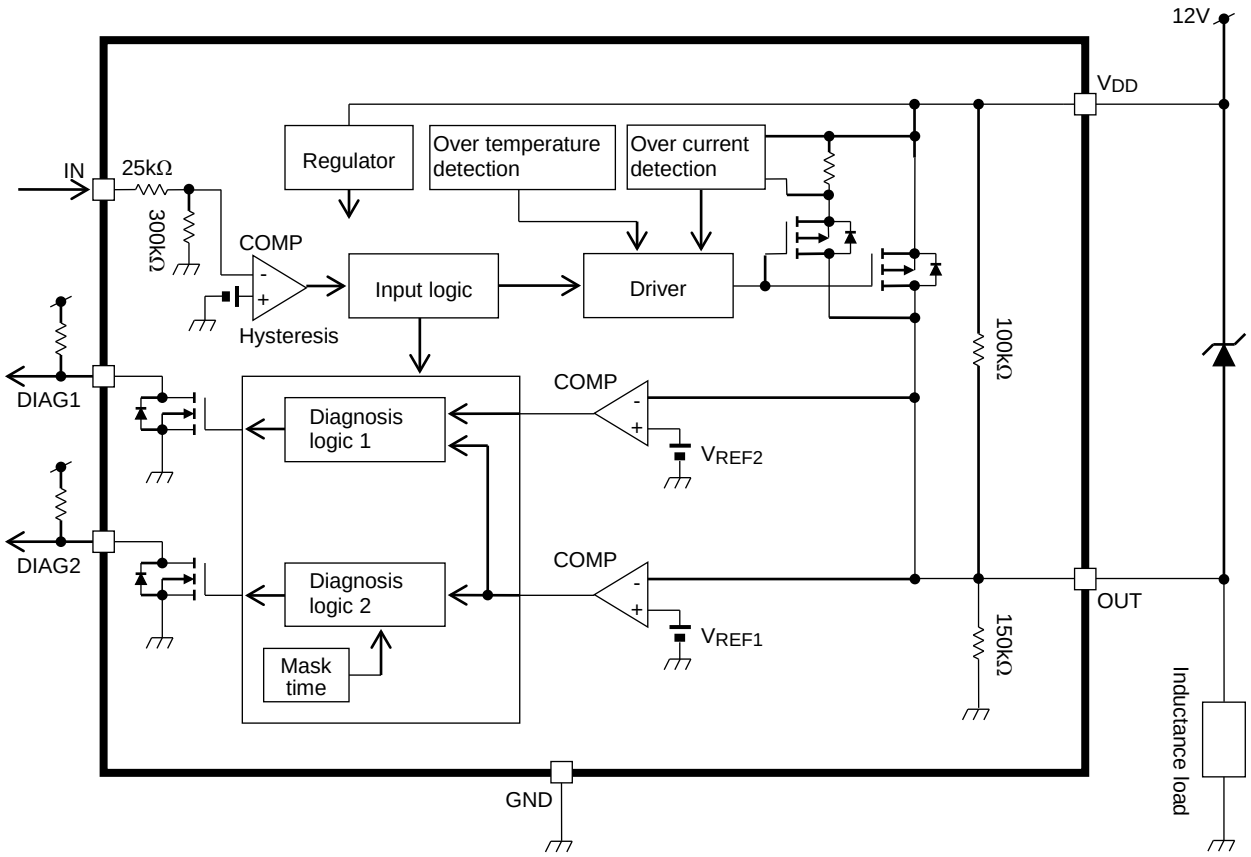
Marking



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

Start of commercial production
2013-12

Block Diagram



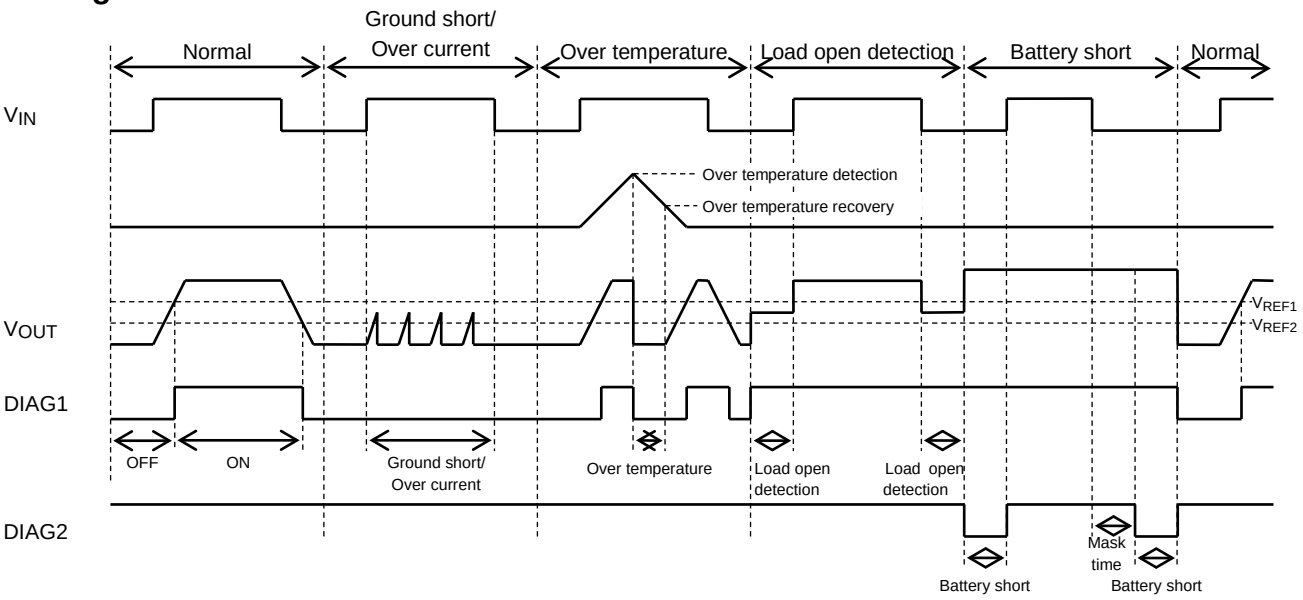
Pin Description

Pin No	Symbol	Function
1,2	V_{DD}	Power pin.
4	IN	Input pin. Input is connected to GND pin with pull down resistor. Even if the input is open, output will not accidentally turn on.
5	GND	Ground pin.
6	DIAG2	Self-diagnosis detection pin. It detect battery short. N-channel open drain.
7	DIAG1	Self-diagnosis detection pin. It detect load open, overcurrent, overtemperature. N-channel open drain.
9,10	OUT	Output pin. When the load is short-circuited and current in excess of the detection current (3A min) flows to the output pin, the output automatically turns on or off.
3,8	N.C	No-Connect pin.

*Exposed Pad has to connect GND pattern because of stability operation and heat radiation.

*Please use N.C pin in opening or GND connection.

Timing Chart



Truth Table

Input signal V_{IN}	Output voltage V_{OUT}	Output state	Operating state
L	L	Off	Normal
H	H	On	
L	H(Note 1)	Off	Load open detection
H	H	On	
L	H	Off	Battery short
H	H	On	
L	L	Off	Ground short / Over current
H	L	Current limit (Switching)	
L	L	Off	Over temperature
H	L	Off	

Note 1: Internal voltage in TPD1055F and external voltage decide this output voltage.

Input signal V_{IN}	Output voltage V_{OUT}	Diagnosis state			
		V_{DIAG1}		V_{DIAG2}	
			State		state
L	$V_{OUT}<V_{REF2}$	L	Normally off	H	-
	$V_{REF2}\leq V_{OUT}<V_{REF1}$	H	Load open detection	H	-
	$V_{REF1}\leq V_{OUT}$	H	-	L	Battery short
H	$V_{REF1}\leq V_{OUT}$	H	Normally on	H	-
	$V_{OUT}<V_{REF1}$	L	Over current(Load short)/ Over temperature	H	-

V_{REF2}: V_{IH}=1.8V(Typ.) / V_{IL}=1.6V(Typ.) * Hysteresis 0.2V

V_{REF1}: $V_{IH}=V_{DD}$-1V(Typ.) / $V_{IL}=V_{DD}$-1.5V(Typ.) * Hysteresis 0.5V

Absolute Maximum Ratings (T_a = 25°C)

Characteristics		Symbol	Rating	Unit	Note
Drain-source voltage		V_{DS}	40	V	P channel
Supply voltage	DC	$V_{DD(1)}$	-0.3 to 25	V	
	Pulse	$V_{DD(2)}$	40	V	Range exceeding 25V is within 0.3s.
Input voltage		V_{IN}	-0.3 to 6	V	
Diagnosis output voltage		V_{DIAG}	-0.3 to 6	V	
Output voltage		V_{OUT}	(V_{DD}-40) to (V_{DD}+0.3)	V	
Output current		I_O	Internally Limited	A	
Diagnosis current		I_{DIAG}	5	mA	
Power dissipation		P_D	1.84	W	Note2
Operating temperature		Topr	-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

Characteristic		Symbol	Rating	Unit
Channel to ambient thermal resistance	TPD1055FA	$R_{th(ch-a)}$	67.6	°C /W

Test conditions

Note 2:
Glass epoxy board
Material: FR-4(4 layer)
Size: 76.2mm * 114.3mm * 1.6mm
Via: φ0.3mm (2 points)

Electrical Characteristics

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

Characteristics		Symbol	Test circuit	Test condition	Min	Typ.	Max	Unit
Operating supply voltage		$V_{DD(opr)}$	-	-	5	-	18	V
Negative output voltage that can be applied to output		$V_{OUT(neg)}$	-	V_{IN}=0V	VDD-40	-	-	V
Supply current		$I_{DD(off)}$	-	V_{IN}=0V, Output open	-	1.0	2.5	mA
		$I_{DD(on)}$	-	V_{IN}=5V, Output open	-	1.2	3	mA
Input voltage		V_{IH}	-	-	2.0	-	-	V
		V_{IL}	-	-	-	-	0.8	V
Input current		$I_{IN(1)}$	-	V_{IN}=5V	-	15	50	μA
		$I_{IN(2)}$	-	V_{IN}=0V	-1	-	1	μA
On resistance		$R_{DS(ON)}$	-	V_{DD}=8 to 18V, I_O=-2A, T_{ch}=25°C	-	0.08	0.12	Ω
Output leakage current		I_{OL}	-	V_{IN}=0V, V_{OUT}=0V	-500	-120	-	μA
Diagnosis output voltage	"L"-level	V_{DL}	-	I_{DIAG}=1mA	-	0.15	0.4	V
Diagnosis output current	"H"-level	I_{DH}	-	V_{DIAG}=5V	-	-	10	μA
Over current detection		I_{OC}	-	-	-9	-5	-3	A
Over current off time		Short-Toff	-	V_{DD}=12V, R_L=0.1Ω, T_{ch}=25°C	3.3	8	15	ms
Over temperature detection	Temperature	T_{OT}	-	-	150	170	200	°C
	Hysteresis	ΔT_{OT}	-	-	-	5	-	°C
Load open detection resistance		R_{OP}	-	V_{IN}=0V	1	20	200	kΩ
Load open detection voltage		$V_{OUT(OP)}$		V_{IN}=0V	-	0.6*V_{DD}	0.7*V_{DD}	V
Battery short detection voltage	Temperature	V_{REF1}	-	V_{IN}=0V, V_{OUT}=L to H	V_{DD}-1.5	V_{DD}-1.0	V_{DD}-0.7	V
	Hysteresis	ΔV_{REF1}	-		-	0.5	-	V
Battery short detection mask time		Tmask	-	V_{OUT}=V_{DD}, V_{IN} ↓⇒DIAG2 ↓	50	110	200	μs
Switching time		ton	1	V_{DD}=12V, R_L=10Ω, T_{ch}=25°C	-	20	50	μs
		toff			-	20	50	μs

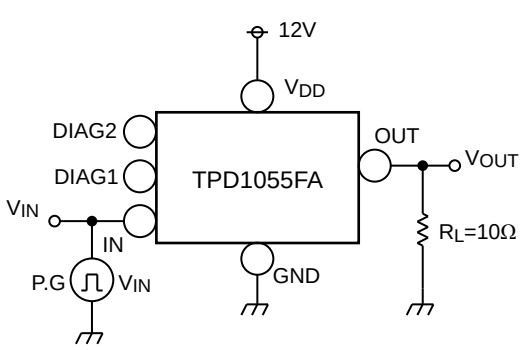
*Typical characteristic conditions are V_{DD}=12V, T_{ch}=25°C.

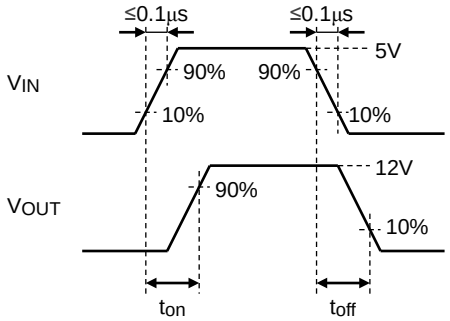
*Sink current to this IC is expressed by "+", source current from this IC is expressed by "-".

*The voltage range that can detect difference between Load open and battery short is V_{DD}≥7V.

Test Circuit 1

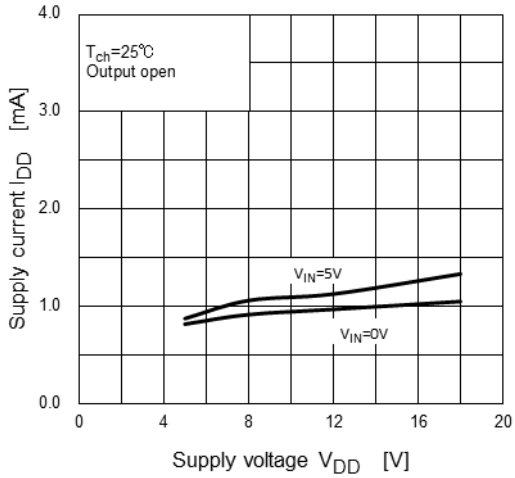
Switching times t_{on}, t_{off}



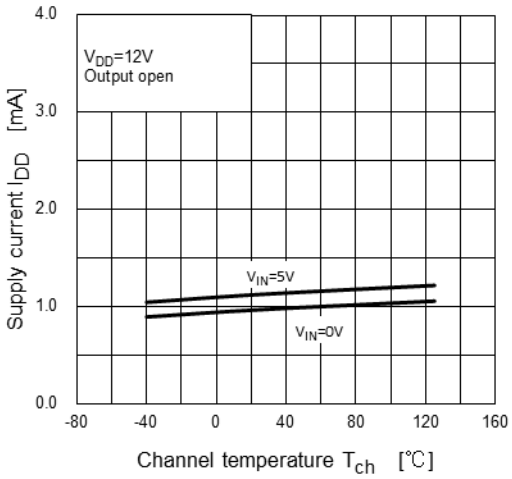


*Because TPD1055FA does not have output clamp circuit, in the case of inductance load, connect flywheel diode.

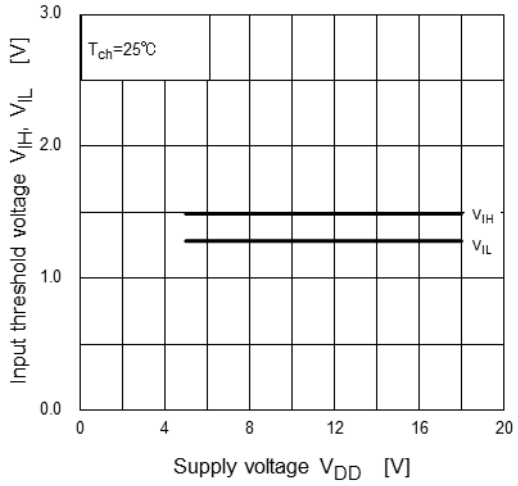
I_{DD} – V_{DD}



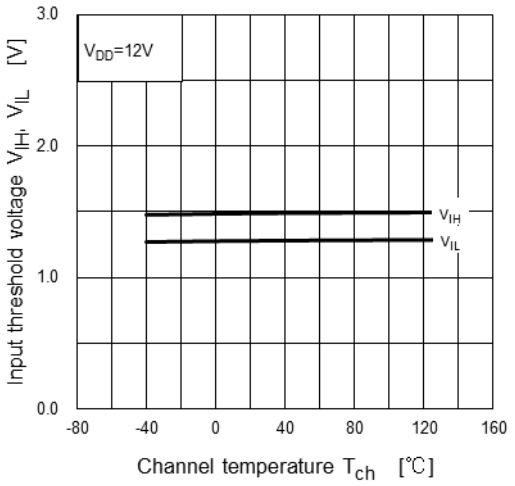
I_{DD} – T_{ch}



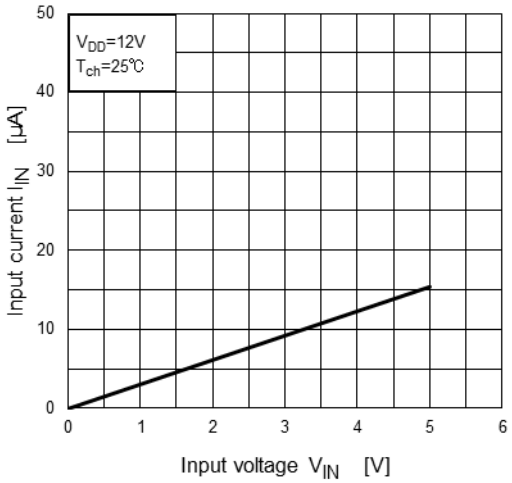
V_{IH}, V_{IL} – V_{DD}



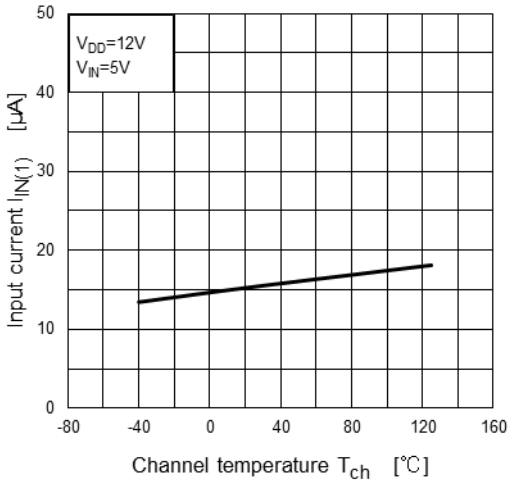
V_{IH}, V_{IL} – T_{ch}



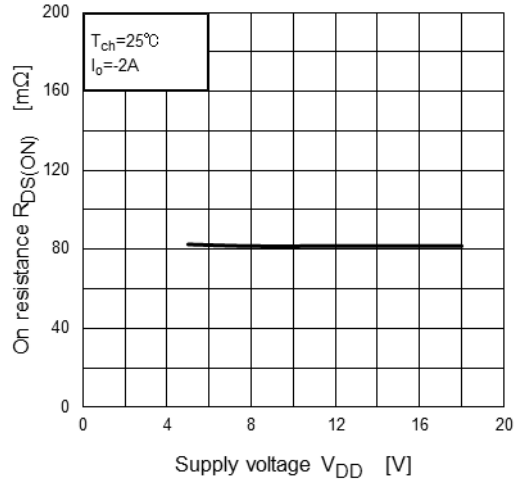
I_{IN} – V_{IN}



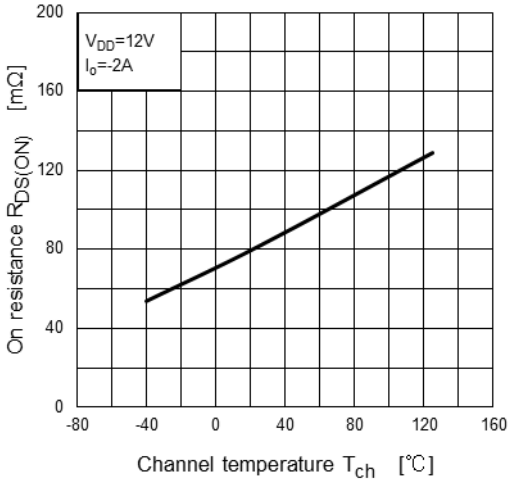
$I_{IN(1)}$ – T_{ch}



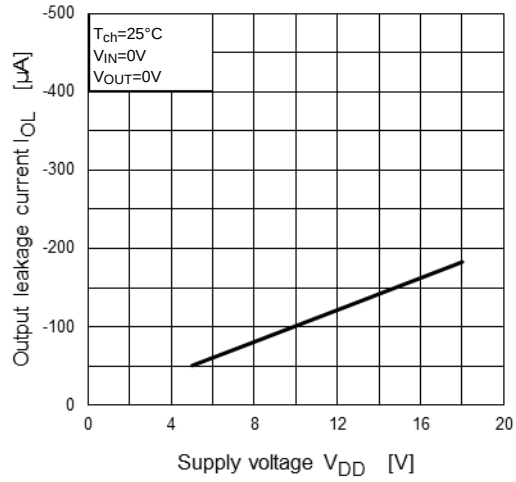
$R_{DS(ON)}$ – V_{DD}



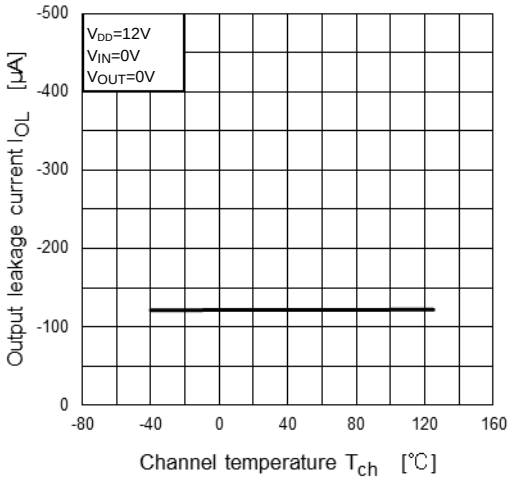
$R_{DS(ON)}$ – T_{ch}



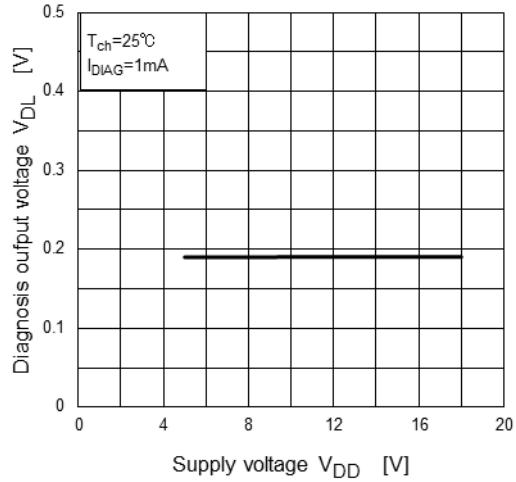
I_{OL} – V_{DD}



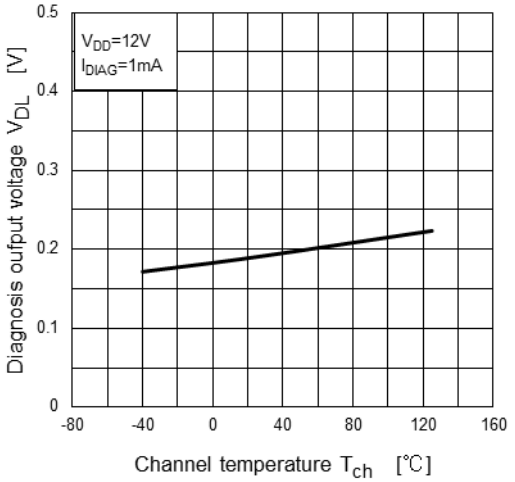
I_{OL} – T_{ch}



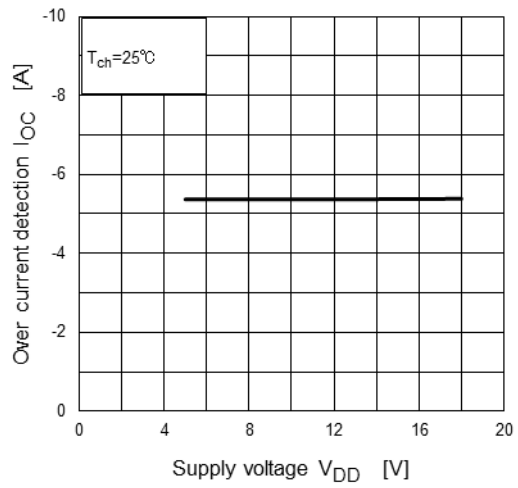
V_{DL} – V_{DD}



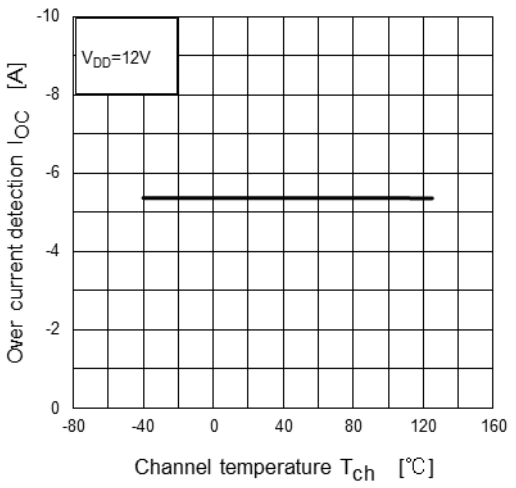
V_{DL} – T_{ch}



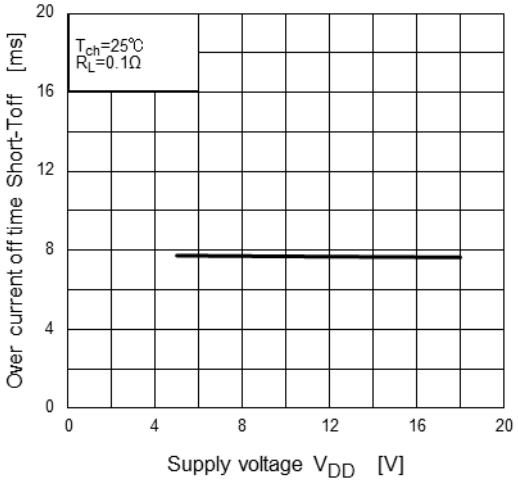
I_{OC} – V_{DD}



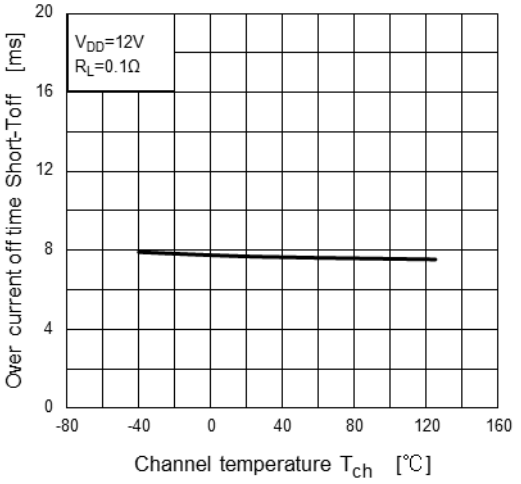
I_{OC} – T_{ch}



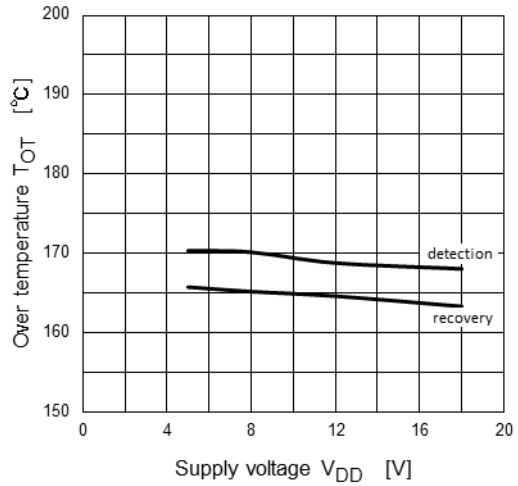
Short-Toff – V_{DD}



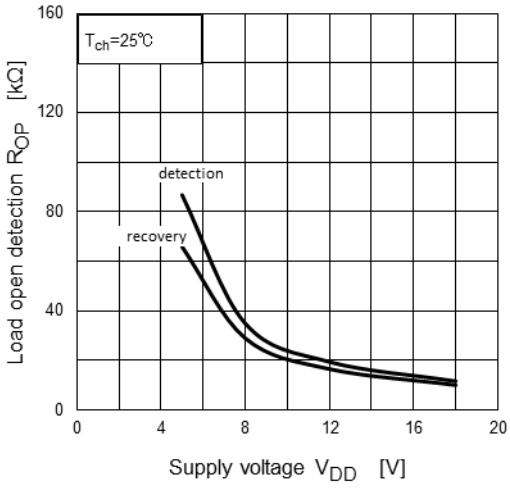
Short-Toff – T_{ch}



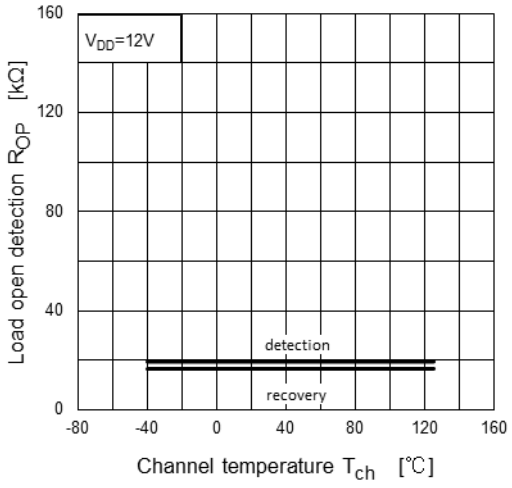
T_{OT} – V_{DD}



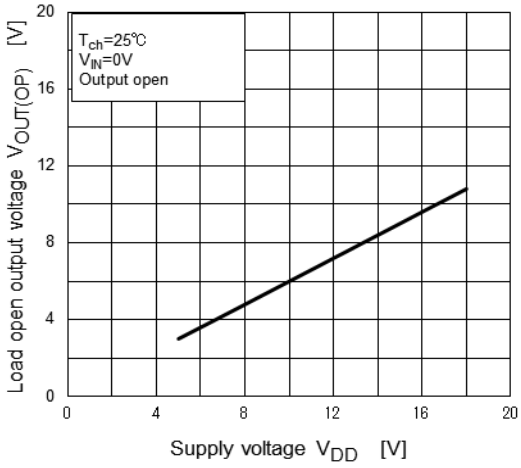
R_{OP} – V_{DD}



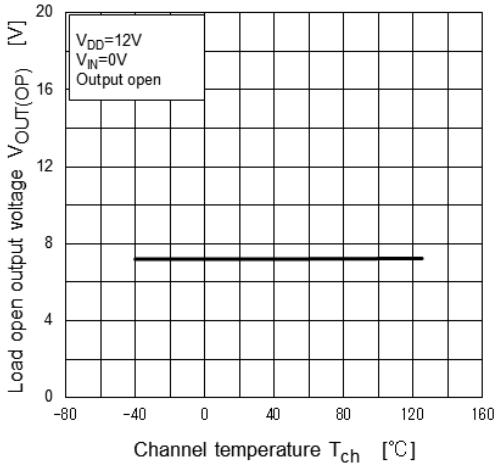
R_{OP} – T_{ch}



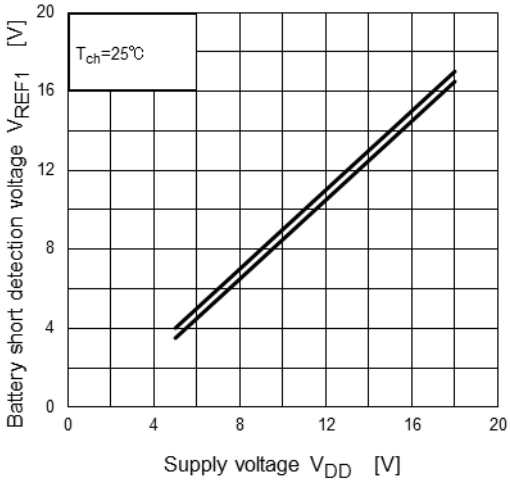
$V_{OUT(OP)}$ – V_{DD}



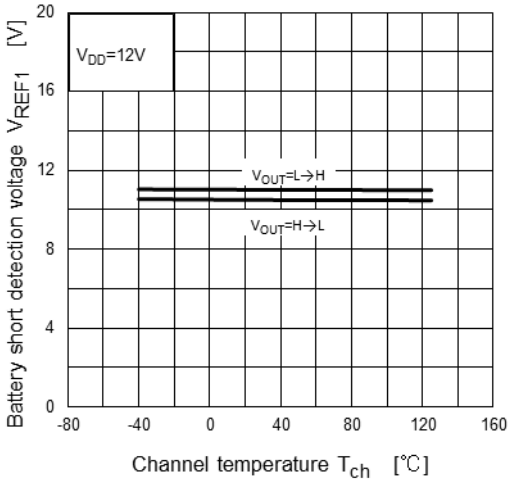
$V_{OUT(OP)}$ – T_{ch}



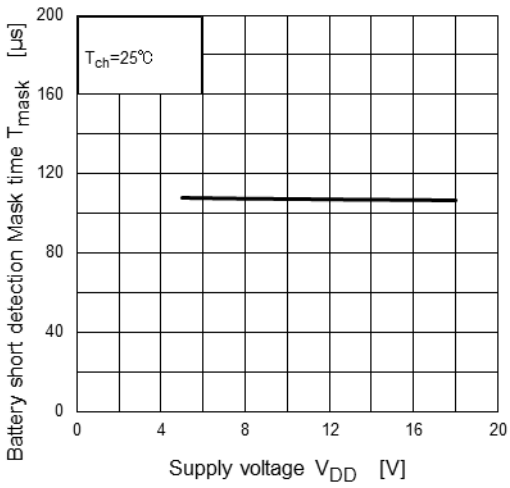
V_{REF1} – V_{DD}



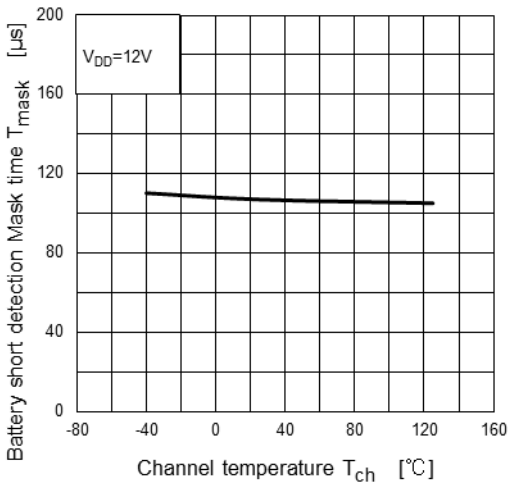
V_{REF1} – T_{ch}



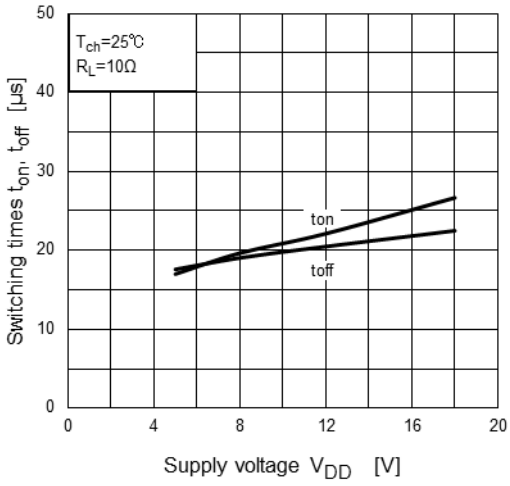
T_{mask} – V_{DD}



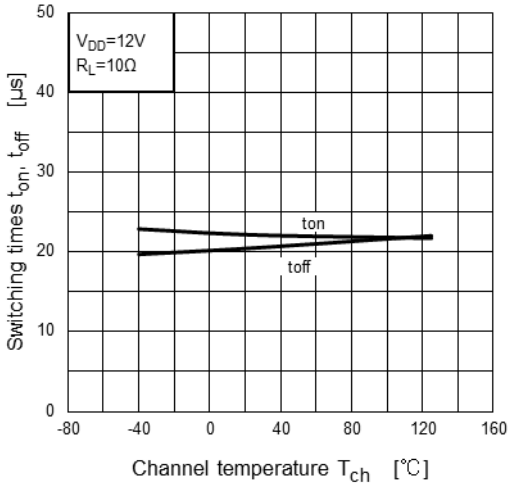
T_{mask} – T_{ch}



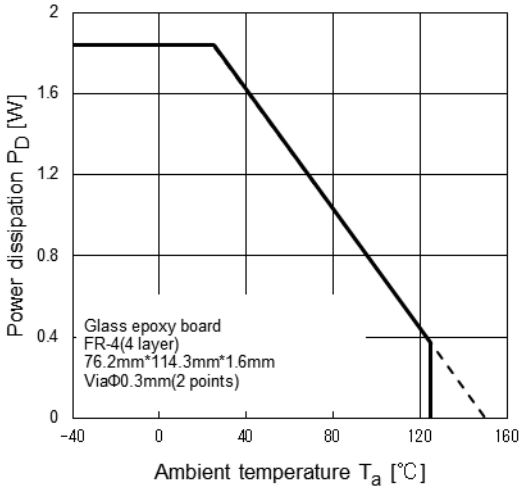
Swtching Times – V_{DD}



Switching Times – T_{ch}

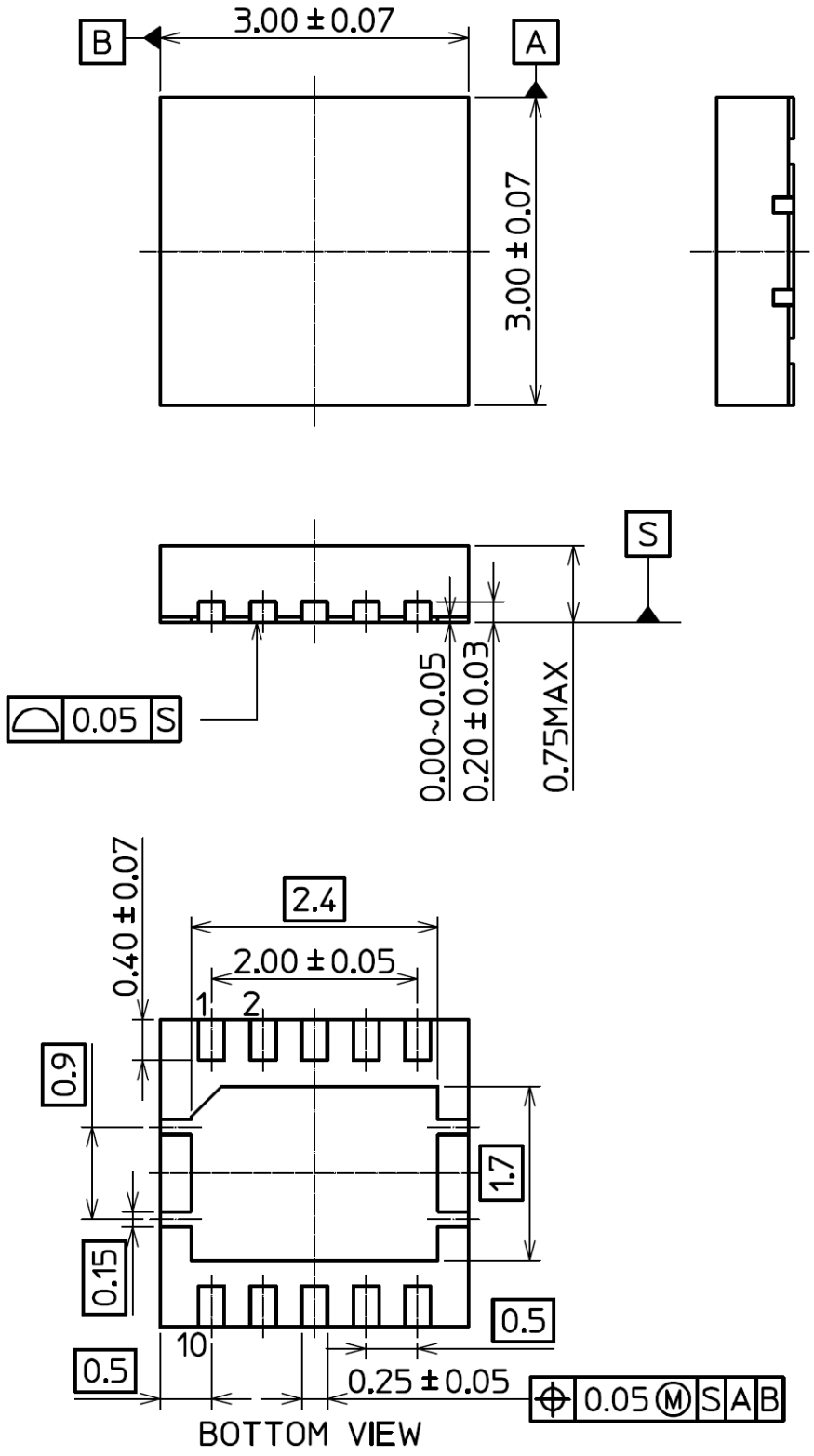


P_D – T_a



Package Dimensions

Unit: mm



Weight: 0.02g(typ.)

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