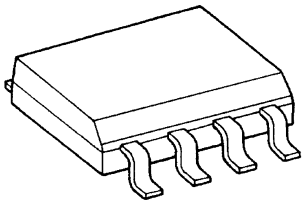
Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1053F

Motor, Solenoid, Lamp Drivers

High-side Power Switch

The TPD1053F is a monolithic power IC for high-side switches. The IC has a vertical MOSFET output which can be directly driven from a CMOS or TTL logic circuit (e.g., an MPU). The device offers intelligent self-protection and diagnostic functions.



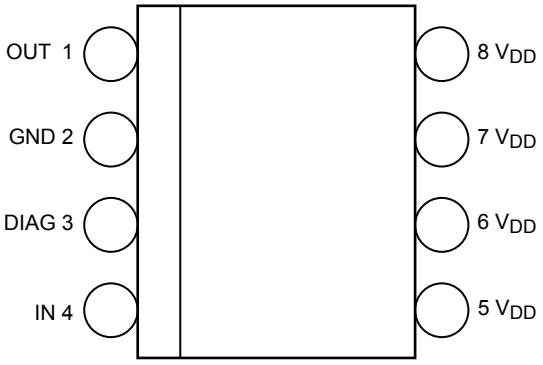
SOP8-P-1.27A

Weight: 0.08 g (Typ.)

Features

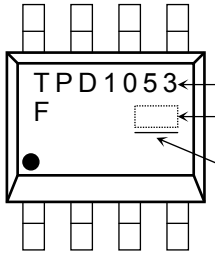
- A monolithic power IC with a structure combining a control block (Bi-CMOS) and a vertical power MOSFET on a single chip.
- One side of load can be grounded to a high-side switch.
- Can directly drive a power load from a microprocessor.
- Built-in protection against over temperature and load short-circuiting.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short-circuiting, opening, or over temperature.
- Up to -16(Typ.) 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)
- 8-pin SOP package for surface mounting that can be packed in tape.

Pin Assignment



(TOP VIEW)

Marking



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

* Weekly code : (Three digits)

Week of manufacture
(01 for first week of year, continuing up to 52 or 53)

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

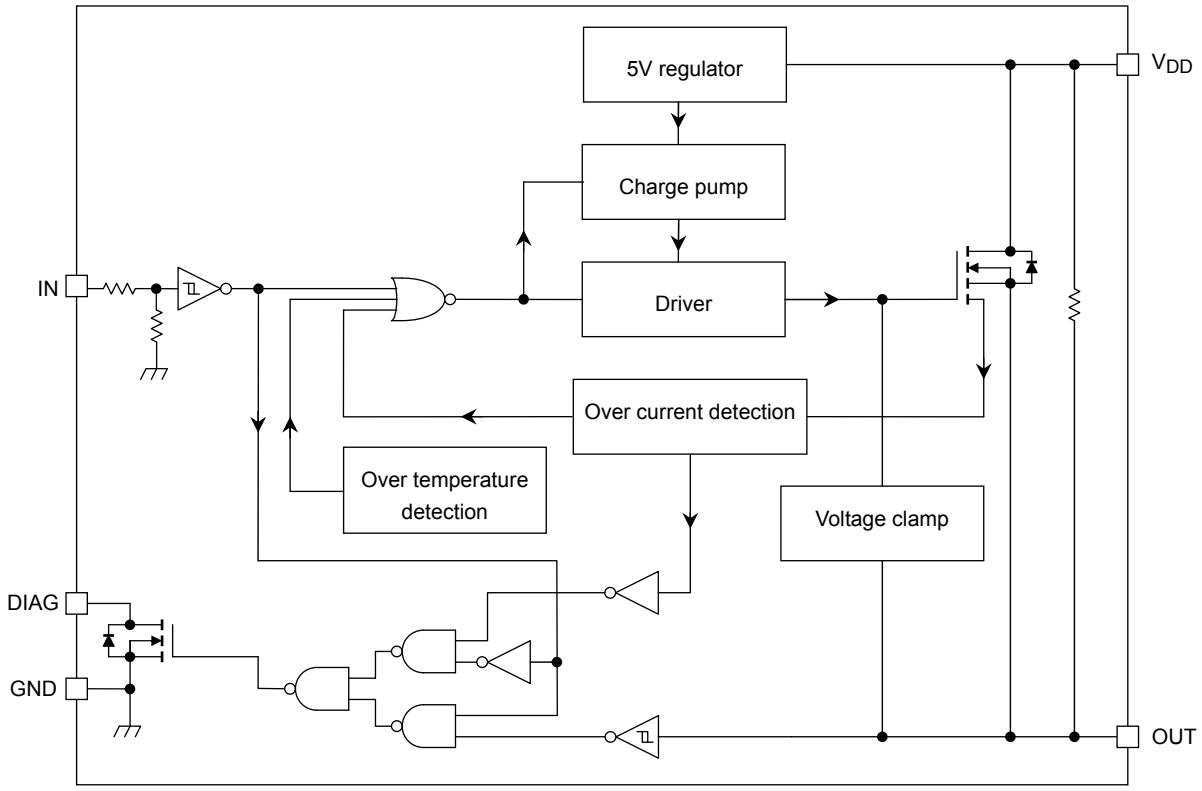
Note 1 : A line under a Lot No. indentifies the indication of product Labels.
Not underlined : [[Pb]]/INCLUDES > MCV
Underlined : [[G]]/RoHS COMPATIBLE or [[G]]/RoHS[[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.
The RoHS is 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 hazardous substances in electrical and electronic equipment.

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

Start of commercial production
2011-05

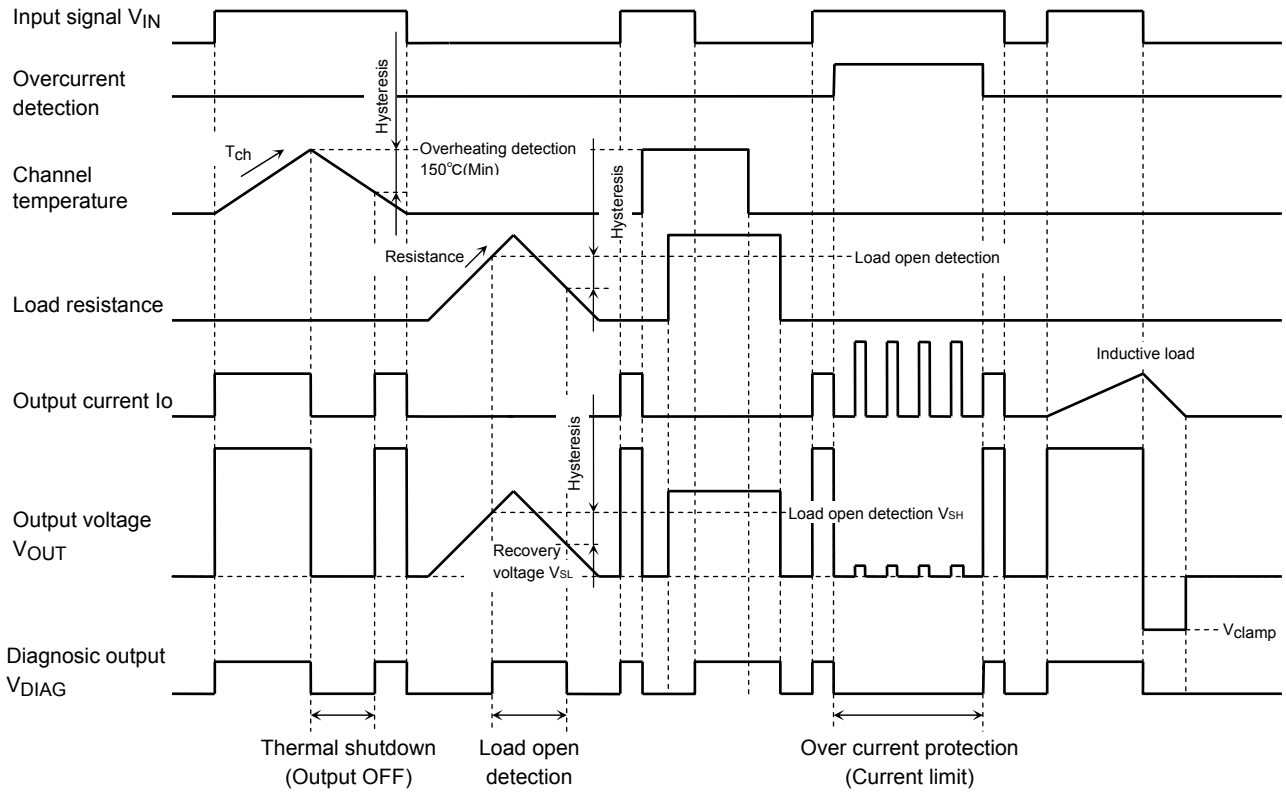
Block Diagram



Pin Description

Pin No	Symbol	Function
1	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.
2	GND	Ground pin.
3	DIAG	Self-diagnosis detection pin. Goes low when over temperature is detected or when output is short circuit with input on (high). N-channel open drain.
4	IN	Input pin. Input is CMOS compatible, with pull down resistor connected. Even if the input is open, output will not accidentally turn on.
5,6,7,8	V_{DD}	Power pin.

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 2)	off	Load open
H	H	on	
L	L	off	Load short
H	L	Current limit (Switching)	
L	L	off	Over temperature
H	L	off	

Note 2: Internal voltage in TPD1053F and external voltage decide this output voltage.

Input signal V_{IN}	Output voltage V_{OUT}	Diagnosis V_{DIAG}	Diagnosis state
L	$V_{OUT} < V_{SL}$	L	Normally off
	$V_{OUT} \geq V_{SH}$	H	Load open
H	$V_{OUT} \geq V_{DD}$-V_{OC}	H	Normally on
	$V_{OUT} < V_{DD}$-V_{OC}	L	Over current(Load short), Over temperature

V_{SH},V_{SL} : Schmitt inverter threshold voltage(V_{SH}=2.2V(Typ.), V_{SL}=1.8V(Typ.) @V_{DD}=12V, T_{ch}=25°C)
V_{OC} : Over current detection threshold voltage

Absolute Maximum Ratings (T_a = 25°C)

Characteristics		Symbol	Rating	Unit
Drain-source voltage		V_{DS}	60	V
Supply voltage	DC	$V_{DD(1)}$	-0.5 to 25	V
	Pulse	$V_{DD(2)}$	60(R_S=1Ω,τ=250ms)	V
Input voltage	DC	$V_{IN(1)}$	-0.5 to 12	V
	Pulse	$V_{IN(2)}$	$V_{DD(1)}$+1.5(t=100ms)	V
Diagnosis output voltage		V_{DIAG}	-0.5 to 25	V
Output current		I_O	Internally Limited	A
Input current		I_{IN}	±10	mA
Diagnosis current		I_{DIAG}	5	mA
Power dissipation (Note 3-a)		$P_{D(1)}$	1.1	W
Power dissipation (Note 3-b)		$P_{D(2)}$	0.425	W
Operating temperature		Topr	-40 to 125	°C
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	-55 to 150	°C

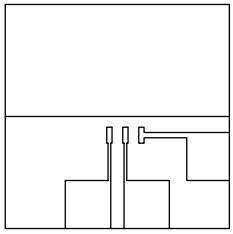
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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
Thermal resistance	$R_{th(ch-a)}$	113.5 (Note 3a)	°C /W
		294.0 (Note 3b)	

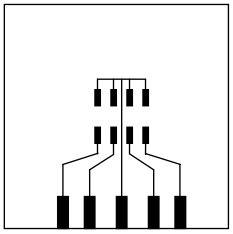
Note 3:

3-a : Glass epoxy board (a)



FR-4
25.4 × 25.4 × 0.8
(Unit : mm)

3-b : Glass epoxy board (b)



FR-4
25.4 × 25.4 × 0.8
(Unit : mm)

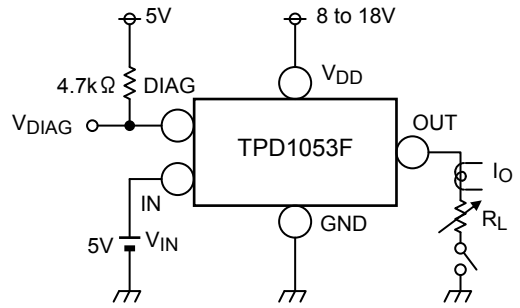
Electrical Characteristics (Unless otherwise specified, T_{ch} = -40 to 125 °C, V_{DD} = 5 to 18 V)

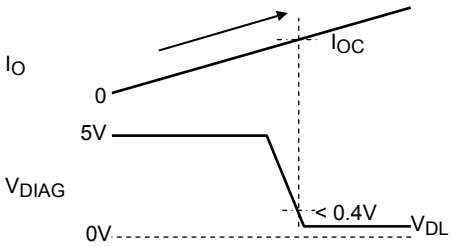
Characteristics		Symbol	Test circuit	Test condition	Min	Typ.	Max	Unit
Operating supply voltage		$V_{DD(opr)}$	-	-	5	12	18	V
Supply current		$I_{DD(off)}$	-	V_{IN}=0V, Output open	-	0.8	4.5	mA
		$I_{DD(on)}$	-	V_{IN}=5V, Output open	-	1.4	5	mA
Input voltage		V_{IH}	-	V_{DD}=8 to 18V	3.5	-	-	V
		V_{IL}	-	V_{DD}=8 to 18V	-	-	1.5	V
Input current		$I_{IN(1)}$	-	V_{IN}=5V	-	25	200	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	-	0.09	0.12	Ω
Output leakage current		I_{OL}	-	V_{IN}=0V, V_{OUT}=0V	-	0.2	2	mA
Diagnosis output voltage	"L"-level	V_{DL}	-	I_{DIAG}=1mA	-	-	0.4	V
Diagnosis output current	"H"-level	I_{DH}	-	V_{DIAG}=18V	-	-	10	μA
Over current detection		I_{OC}	1, 2	V_{DD}=8 to 18V	3	6	9	A
Over temperature detection	Temperature	T_{OT}	-	-	150	170	200	°C
	Hysteresis	ΔT_{OT}	-	-	-	10	-	°C
Load open detection		R_{OP}	3	V_{DD}=8 to 18V, V_{IN}=0V	0.5	15	250	kΩ
Switching time		t_{on}	4	V_{DD}=12V, R_L=10Ω, T_{ch}=25°C	-	50	100	μs
		t_{off}			-	40	80	μs
Diagnosis delay time		t_{DLH}	5	V_{DD}=12V, R_L=10Ω, T_{ch}=25°C	-	40	-	μs
		t_{DHL}			-	40	-	μs
Output clamp voltage		V_{clamp}	-	V_{IN}=0V, I_O=1A, T_{ch}=25°C	-25	-16	-10	V

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

Test Circuit 1

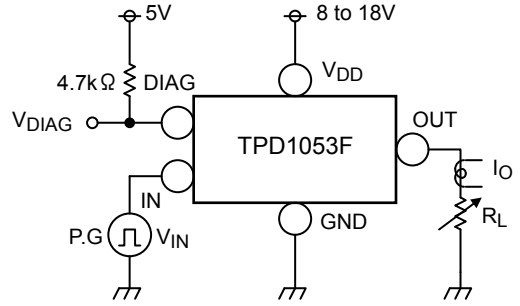
Over current detection I_{OC} : Over current detection when load current is increased while V_{IN} = “H”.

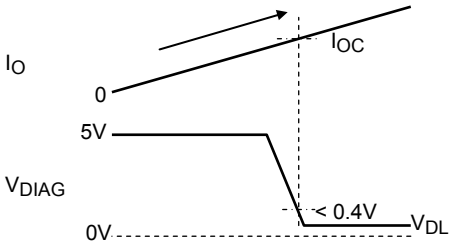




Test Circuit 2

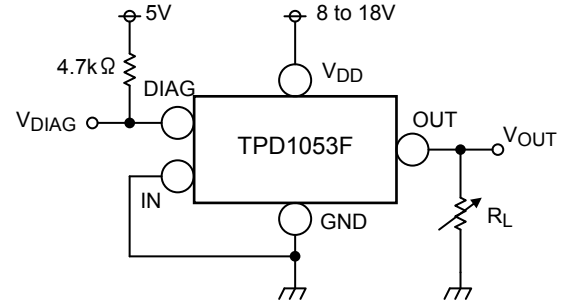
Over current detection I_{OC} : Over current detection when load is short circuit and V_{IN} = “L” → ”H”

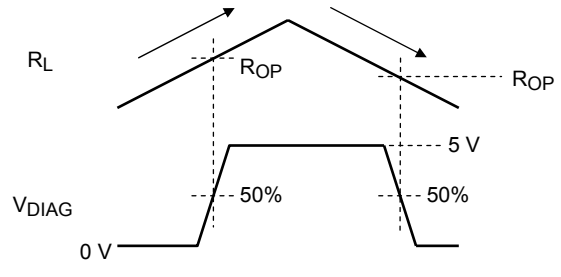




Test Circuit 3

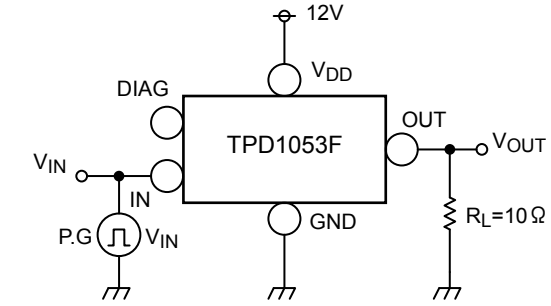
Load open detection R_{OP}

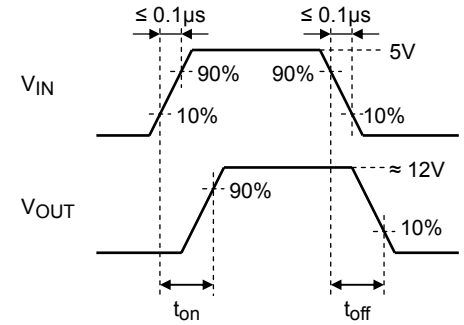




Test Circuit 4

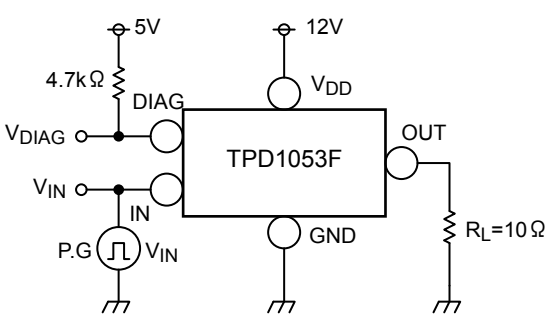
Switching times t_{on}, t_{off}

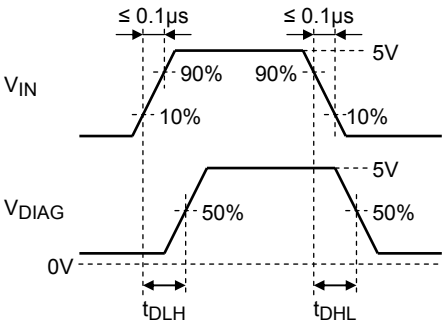




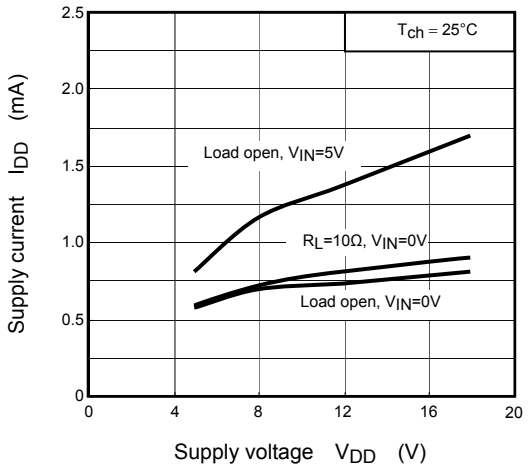
Test Circuit 5

Diagnosis delay time t_{DLH}, t_{DHL}

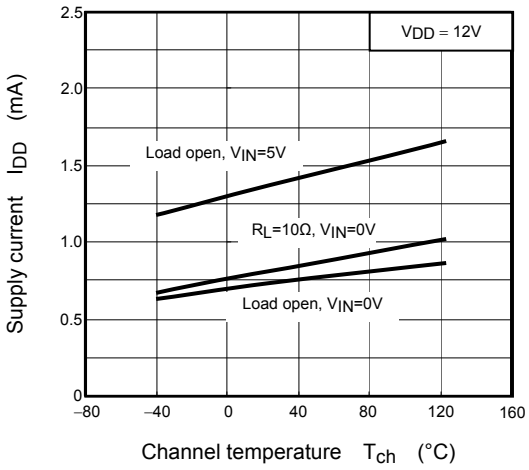




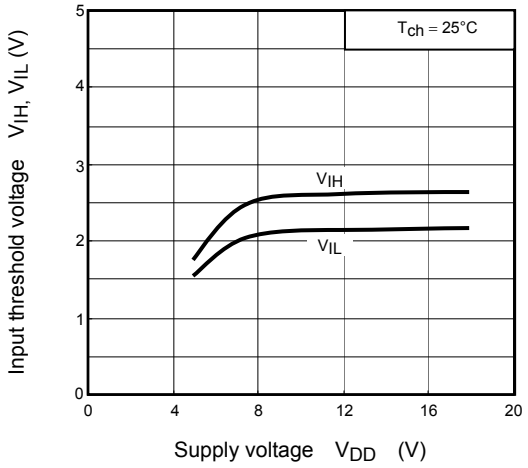
$I_{DD} - V_{DD}$



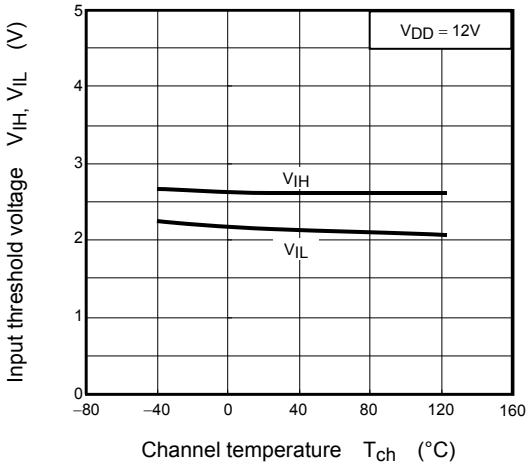
$I_{DD} - T_{ch}$



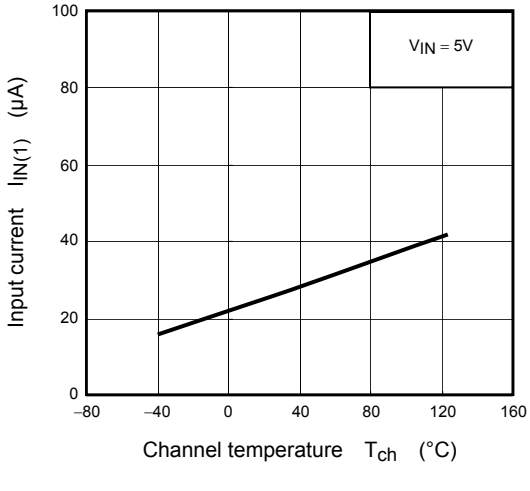
$V_{IH}, V_{IL} - V_{DD}$



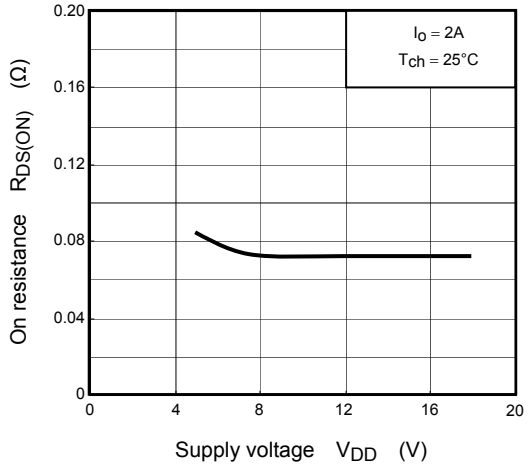
$V_{IH}, V_{IL} - T_{ch}$



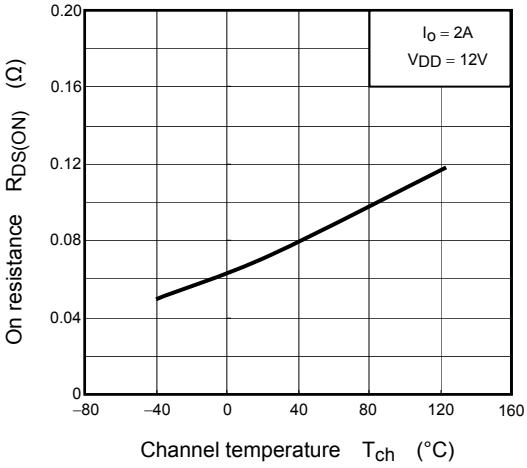
$I_{IN(1)} - T_{ch}$



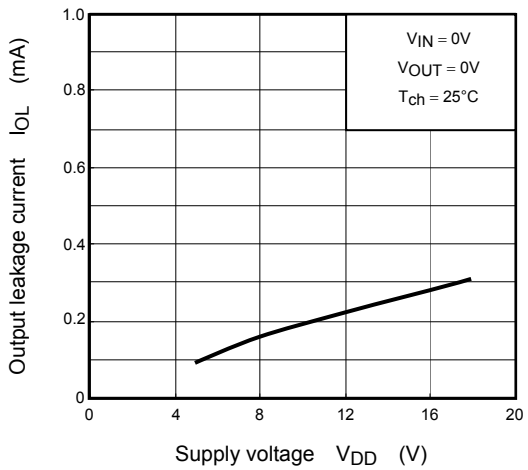
$R_{DS(ON)} - V_{DD}$



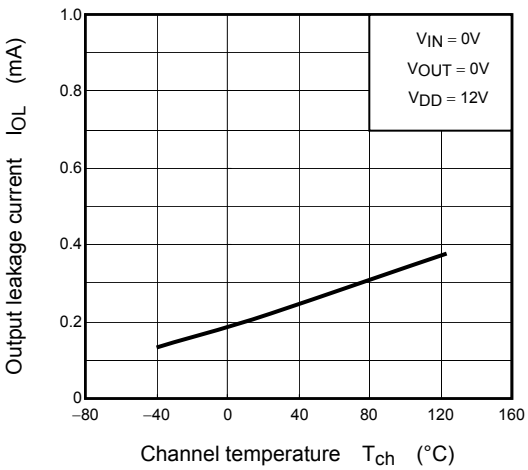
$R_{DS(ON)} - T_{ch}$



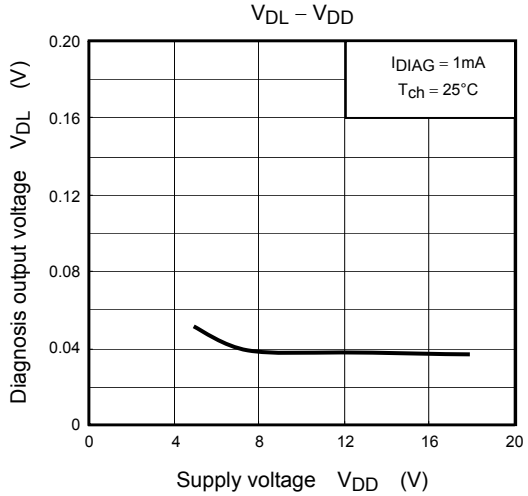
$I_{OL} - V_{DD}$



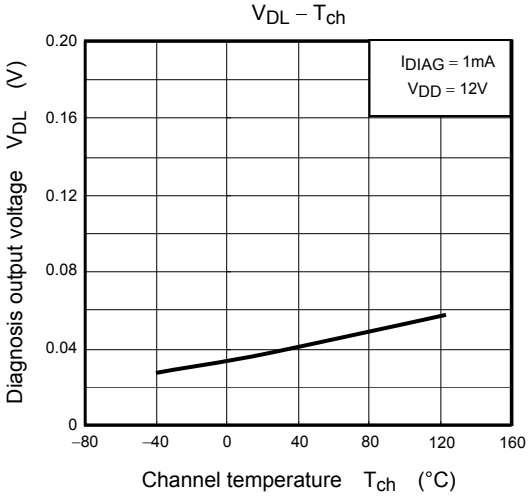
$I_{OL} - T_{ch}$



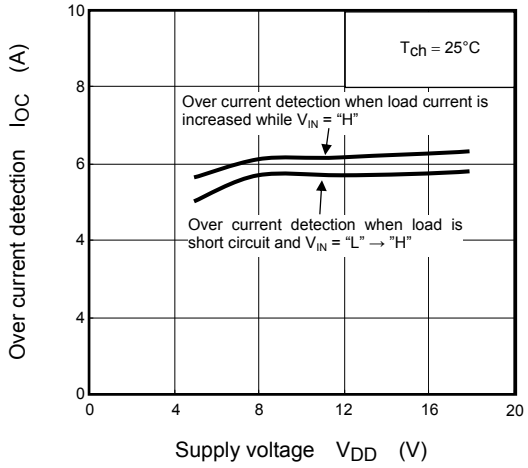
$V_{DL} - V_{DD}$



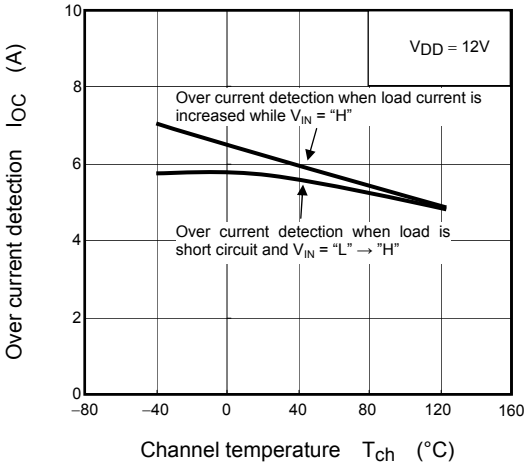
$V_{DL} - T_{ch}$



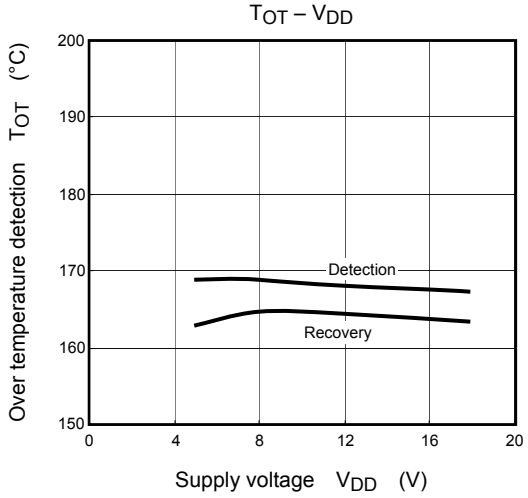
$I_{OC} - V_{DD}$



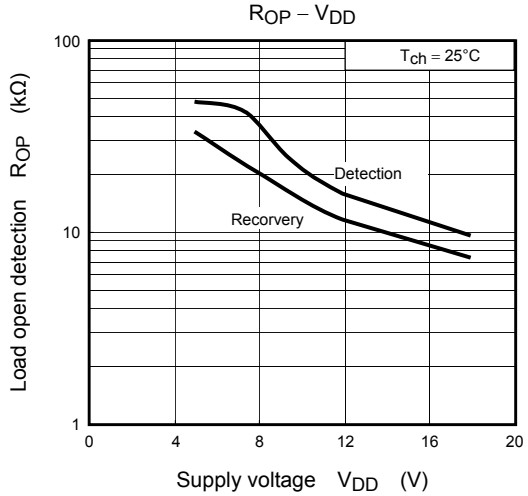
$I_{OC} - T_{ch}$



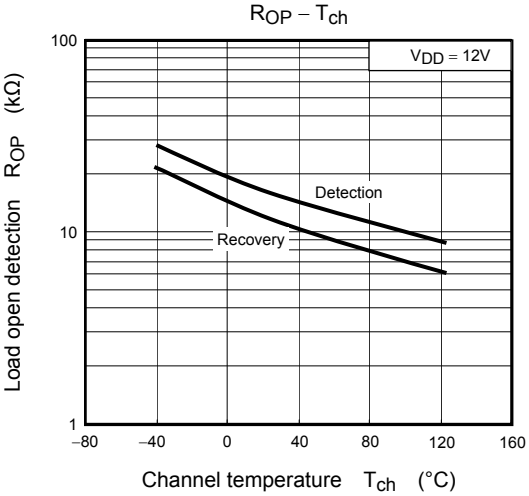
$T_{OT} - V_{DD}$



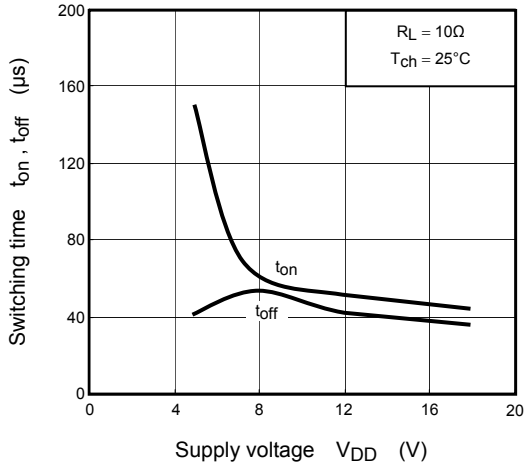
$R_{OP} - V_{DD}$



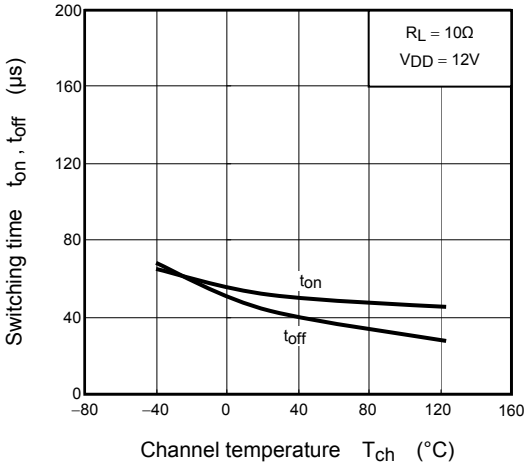
$R_{OP} - T_{ch}$



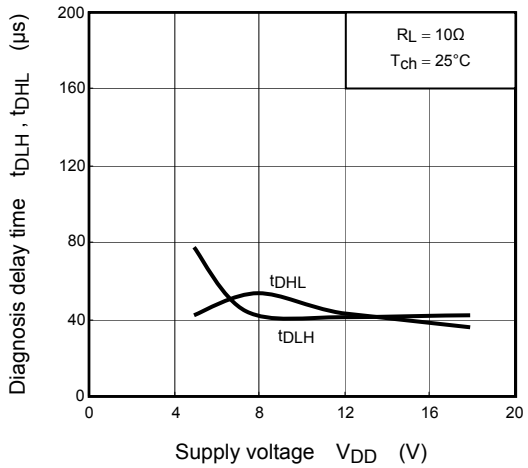
t_{on} , t_{off} – V_{DD}



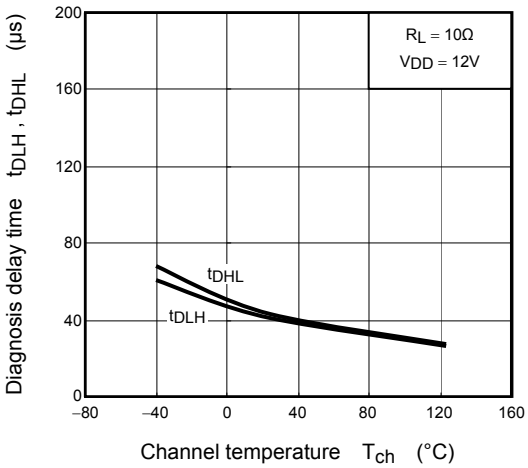
t_{on} , t_{off} – T_{ch}



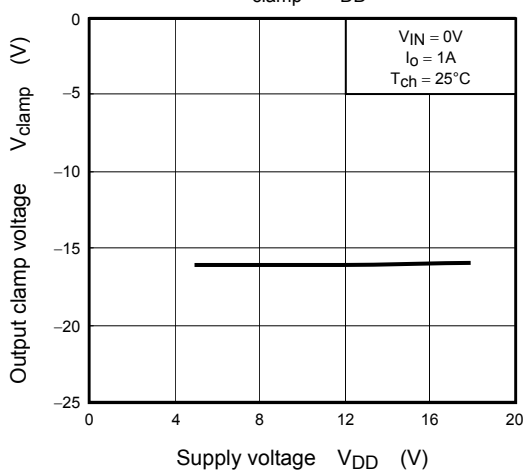
t_{DLH} , t_{DHL} – V_{DD}



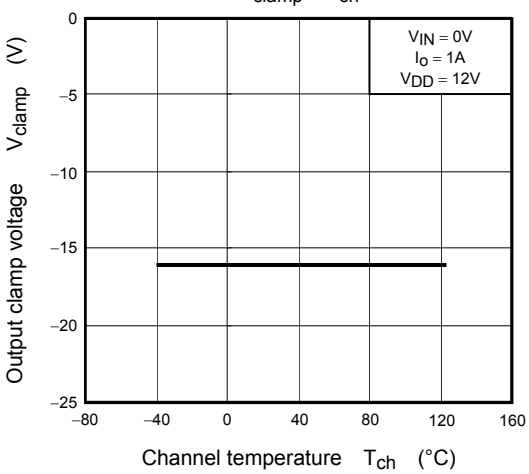
t_{DLH} , t_{DHL} – T_{ch}

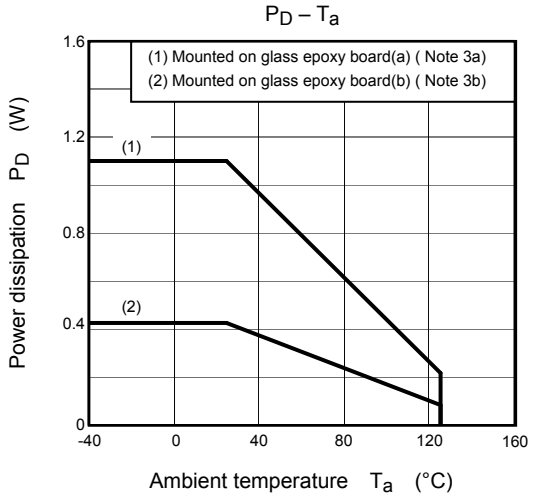


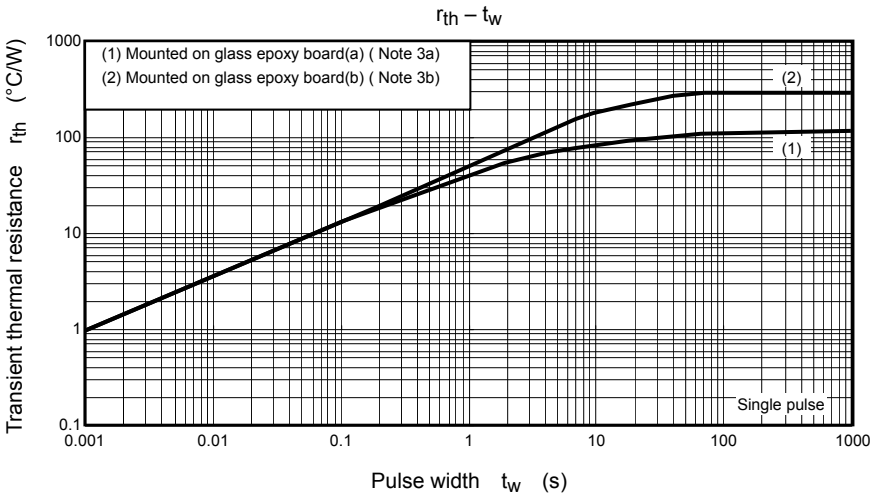
V_{clamp} – V_{DD}



V_{clamp} – T_{ch}

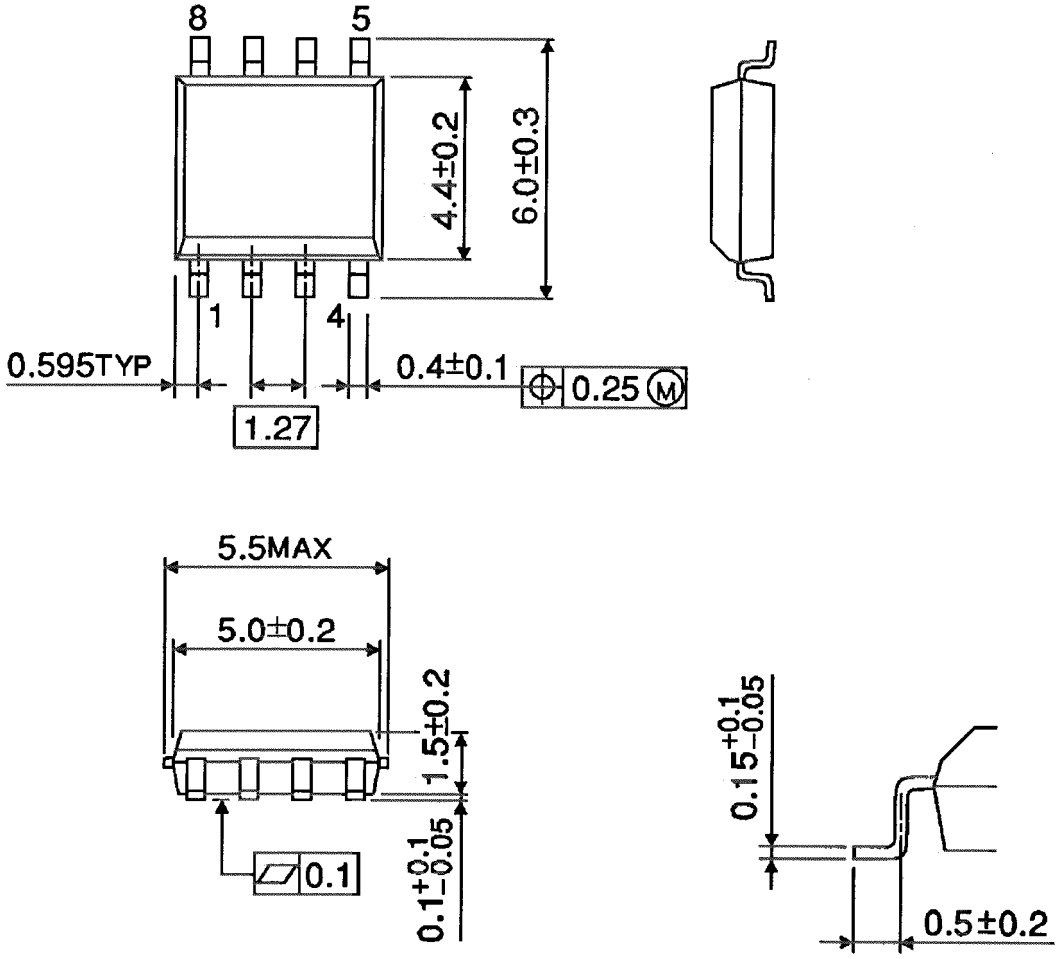



$P_D - T_a$
(1) Mounted on glass epoxy board(a) (Note 3a)
(2) Mounted on glass epoxy board(b) (Note 3b)
(1)
(2)
Power dissipation P_D (W)
1.6
1.2
0.8
0.4
0
-40
0
40
80
120
160
Ambient temperature T_a (°C)


$r_{th} - t_w$
(1) Mounted on glass epoxy board(a) (Note 3a)
(2) Mounted on glass epoxy board(b) (Note 3b)
(2)
(1)
Single pulse
Transient thermal resistance r_{th} (°C/W)
1000
100
10
1
0.1
0.001
0.01
0.1
1
10
100
1000
Pulse width t_w (s)

Package Dimensions

SOP8-P-1.27A Unit : mm



Weight: 0.08 g (Typ.)

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