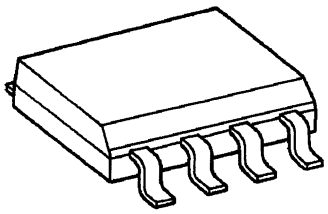
TOSHIBA Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1033F

High-side Power Switch for Motors, Solenoids, and Lamp Drivers

The TPD1033F is a monolithic power IC for high-side switches. The IC has a vertical MOS FET output that can be directly driven from a CMOS or TTL logic circuit (e.g., an MPU). The device is equipped with intelligent self-protection and diagnostic functions.



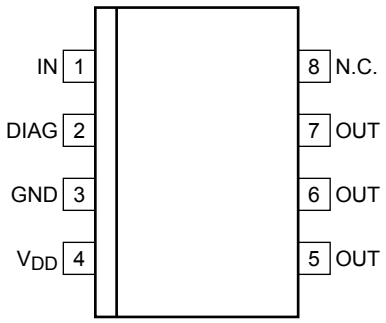
SOP8-P-1.27A

Weight: 0.08 g (typ.)

Features

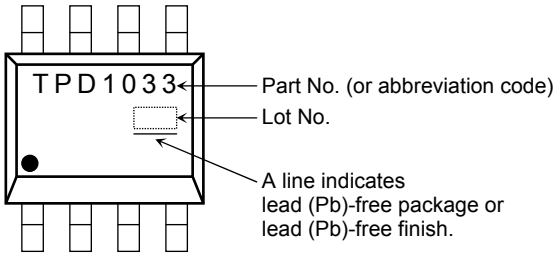
- A monolithic power IC with a new structure combining a control block (Bi-CMOS) and a vertical power MOS FET (π-MOS) on a single chip
- One side of load can be grounded to a high-side switch
- Can directly drive a power load from a microprocessor.
- Built-in protection against thermal shutdown and load short-circuiting.
- Incorporates a diagnosis function that allows diagnosis output to be read externally in the event of load short-circuiting, opening, or overheating.
- Up to -10 V of counterelectromotive force from an L load can be applied.
- Low on-resistance : R_{ON} = 220 mΩ (max)
- Low operating current : I_{DD} = 1 mA (typ.), (@V_{DD} = 12 V, V_{IN} = 0 V)
- 8-pin SOP package for surface mounting can be packed in tape.

Pin Assignment



(top view)

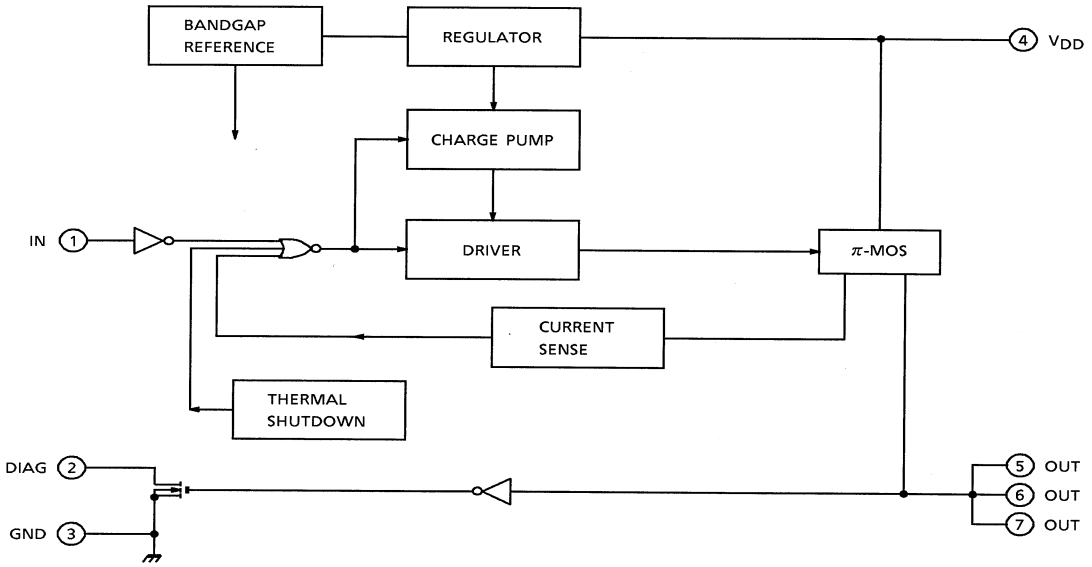
Marking



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

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

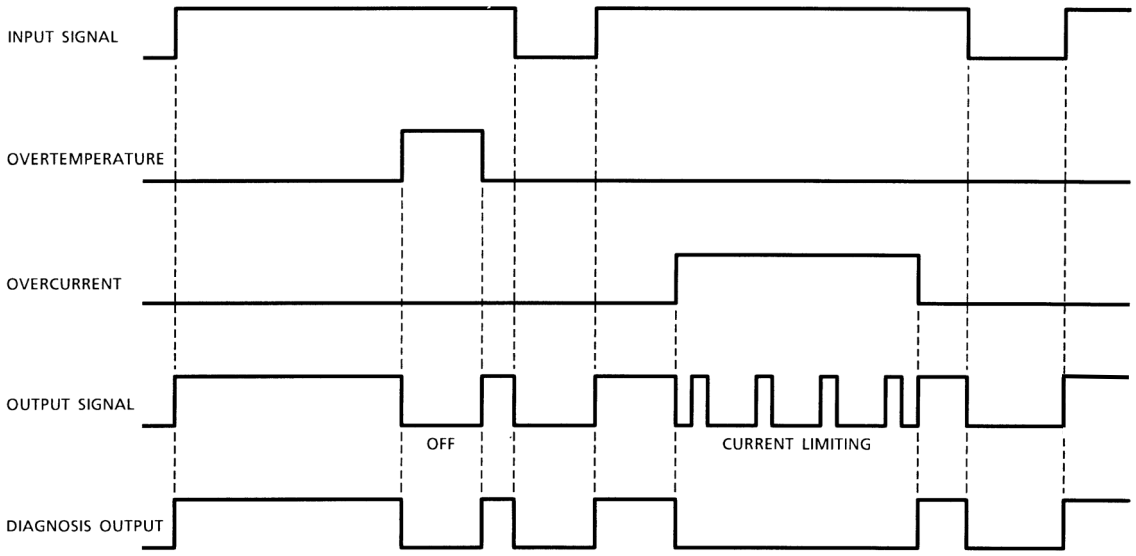
Block Diagram



Pin Description

Pin No.	Symbol	Function
1	IN	Input pin. Input is CMOS-compatible, with pull-down resistor connected. Even if the input is open, output will not accidentally turn on.
2	DIAG	Self-diagnosis detection pin. Goes low when overheating is detected or when output is short-circuited with input on (high). n-channel open drain.
3	GND	Ground pin.
4	V_{DD}	Power pin.
5, 6, 7	OUT	Output pin. When the load is short-circuited and current in excess of the detection current (8 A typ.) flows to the output pin, the output automatically turns on or off.

Timing Chart



Truth Table

Input Signal	Output Signal	Diagnosis Output	State
H	H	H	Normal
L	L	L	
H	L	L	Load short-circuited
L	L	L	
H	H	H	Load open
L	H	H	
H	L	L	Overtemperature
L	L	L	

Absolute Maximum Ratings (Ta = 25°C)

Characteristic		Symbol	Rating	Unite
Drain-source voltage		V_{DS}	60	V
Supply voltage	DC	$V_{DD\ (1)}$	25	V
	Pulse	$V_{DD\ (2)}$	60 (Rs = 1Ω,τ= 250 ms)	V
Input voltage	DC	$V_{IN\ (1)}$	-0.5 ~ 12	V
	Pulse	$V_{IN\ (2)}$	$V_{DD\ (1)}$ + 1.5 (t = 100 ms)	V
Diagnosis output voltage		V_{DIAG}	-0.5 ~ 25	V
Output current		I_O	Internally limited	A
Input current		I_{IN}	± 10	mA
Diagnosis output current		I_{DIAG}	5	mA
Power dissipation (Ta = 25°C)		P_D	1.4 Note 1	W
			2.4 Note 2	
Operating temperature		T_{opr}	- 40 ~ 110	°C
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	- 55 ~ 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	Test Condition	Unit
Thermal resistance	$R_{th\ (ch-a)}$	89.3 (Note 1)	°C/ W
		52.1 (Note 2)	

Note 1: Mounted on glass epoxy board (25.4 mm × 25.4 mm × 0.8 mm) (DC)
Note 2: Mounted on glass epoxy board (25.4 mm × 25.4 mm × 0.8 mm) ($t_W \leq 10$ s)

Electrical Characteristics

(Unless otherwise specified, T_{ch} = - 40 to 110°C, V_{DD} = 8~18 V)

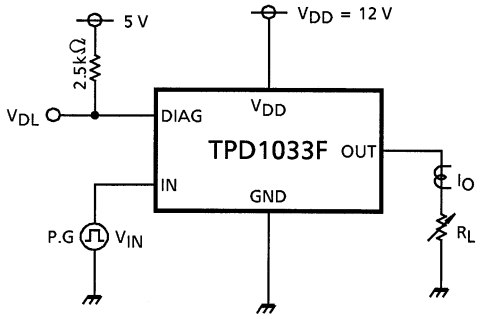
Characteristic		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Operating supply voltage		$V_{DD\ (opr)}$	—	—	5	12	18	V
Supply current		I_{DD}	—	V_{DD} = 12 V, V_{IN} = 0 V	—	1	5	mA
Input voltage		V_{IH}	—	V_{DD} = 12 V, I_O = 2 A	3.5	—	—	V
		V_{IL}	—	V_{DD} = 12 V, I_O = 1.2 mA	—	—	1.5	V
Input current		$I_{IN\ (1)}$	—	V_{DD} = 12 V, V_{IN} = 5 V	—	50	200	μA
		$I_{IN\ (2)}$	—	V_{DD} = 12 V, V_{IN} = 0 V	-0.2	—	0.2	μA
On-voltage		$V_{DS\ (ON)}$	—	V_{DD} = 12 V, I_O = 2 A, T_{ch} = 25°C	—	—	0.44	V
On-resistance		$R_{DS\ (ON)}$	—	V_{DD} = 12 V, I_O = 2 A, T_{ch} = 25°C	—	—	0.22	Ω
Output leakage current		I_{OL}	—	V_{DD} = 18 V, V_{IN} = 0 V	—	—	1.2	mA
Diagnosis output voltage	"L" Level	V_{DL}	—	V_{DD} = 12 V, I_{DL} = 2 mA	—	—	0.4	V
Diagnosis output current	"H" Level	I_{DH}	—	V_{DD} = 18 V, V_{DH} = 18 V	—	—	10	μA
Overcurrent protection		$I_{S\ (1)}$ Note 3	1	V_{DD} = 12 V, T_{ch} = 25°C	4	6	8	A
		$I_{S\ (2)}$ Note 4	2		4	8	12	A
Thermal shutdown	Temperature	Ts	—	—	150	160	200	°C
	Hysteresis	ΔTs	—		—	10	—	°C
Open detection resistance		R_{ops}	—	V_{DD} = 8 V	1	20	100	kΩ
Switching time		t_{ON}	3	V_{DD} = 12 V, R_L = 5Ω, T_{ch} = 25°C	10	100	—	μs
		t_{OFF}	3		10	30	—	μs

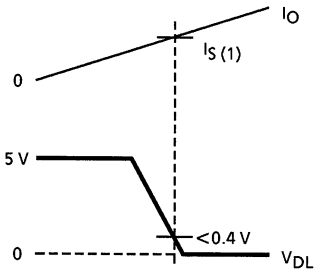
Note 3: Overcurrent detection value when load is short circuited and V_{IN} = "L" → "H"

Note 4: Overcurrent detection value when load current is increased while V_{IN} = "H"

Test Circuit 1

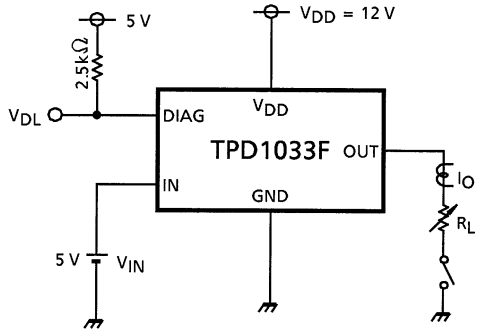
Over-current detection

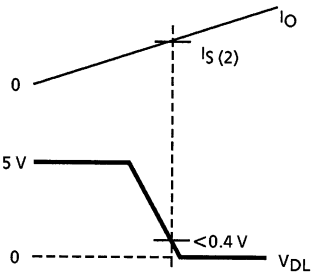




Test Circuit 2

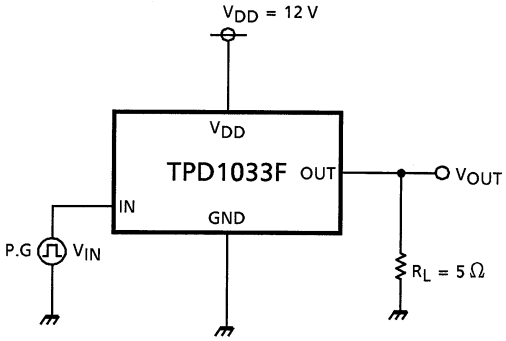
Over-current detection

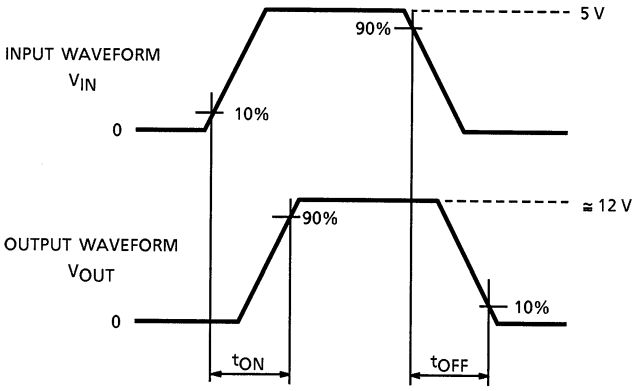




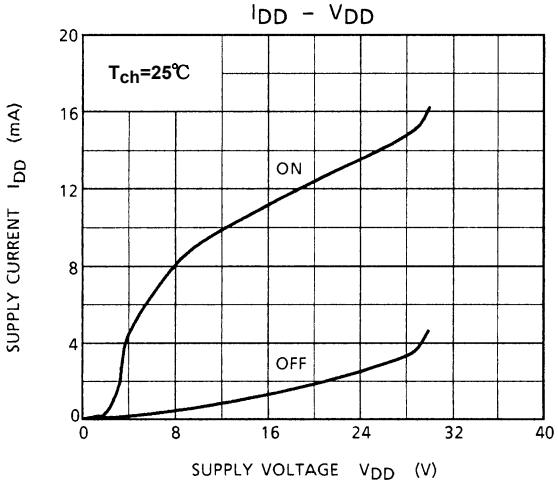
Test Circuit 3

Switching time

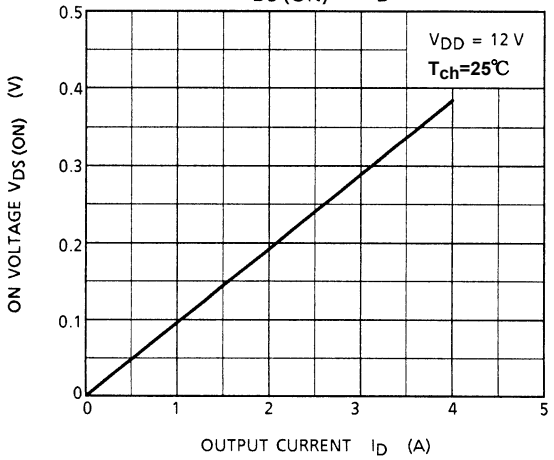




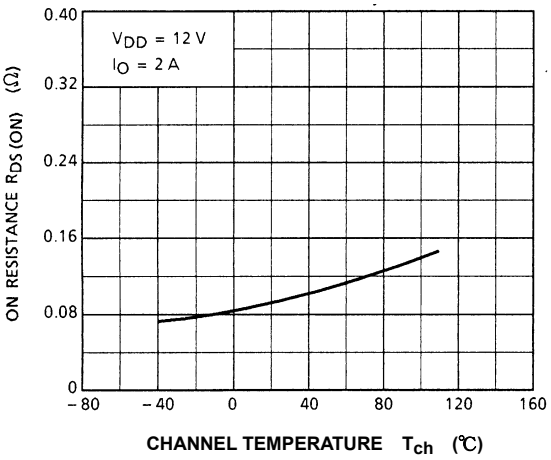
I_{DD} – V_{DD}



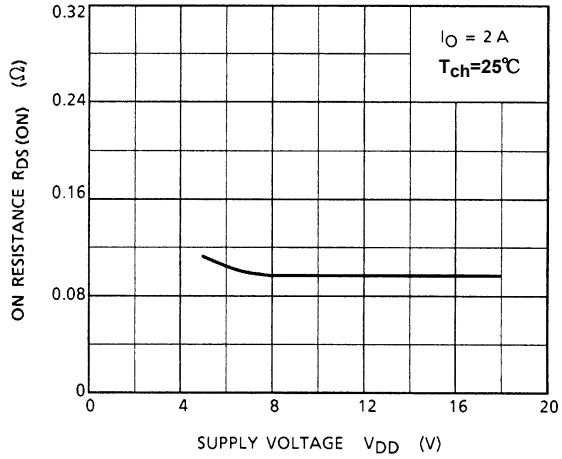
$V_{DS\ (ON)}$ – I_D



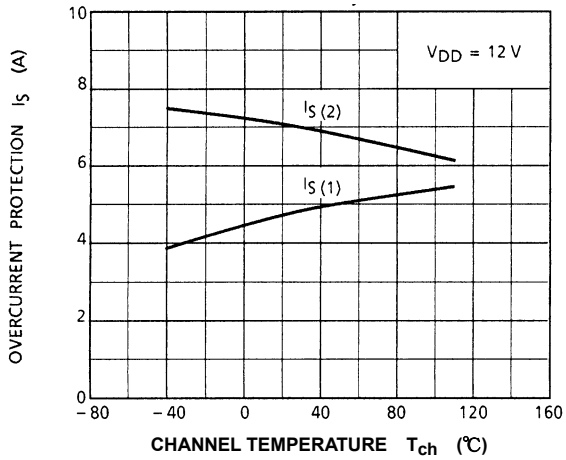
$R_{DS(ON)}$ – T_{ch}



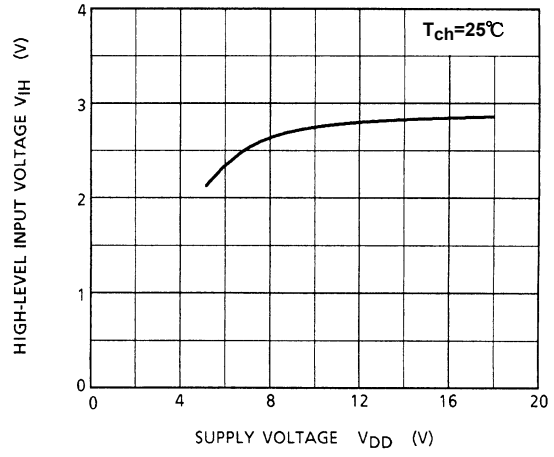
$R_{DS\ (ON)}$ – V_{DD}

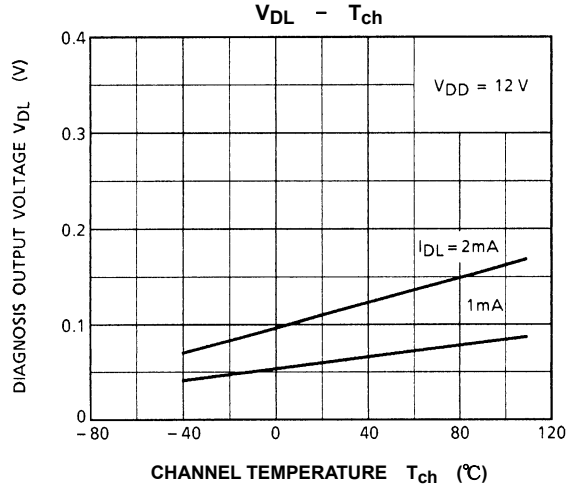


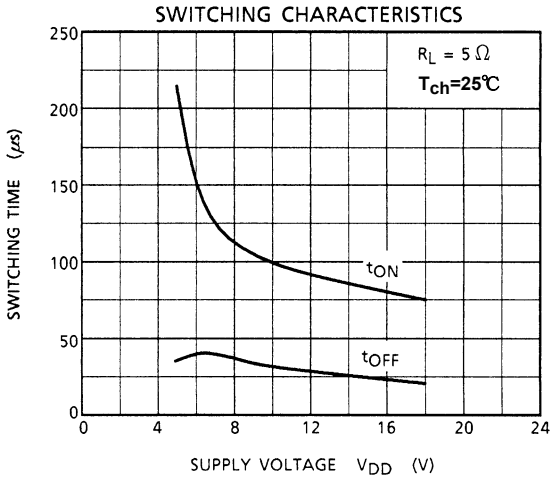
I_S – T_C

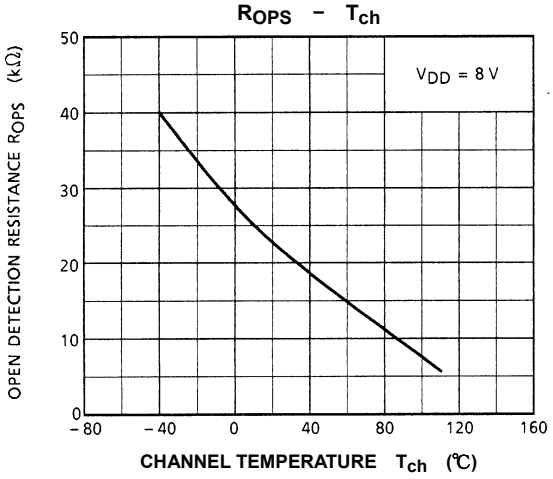


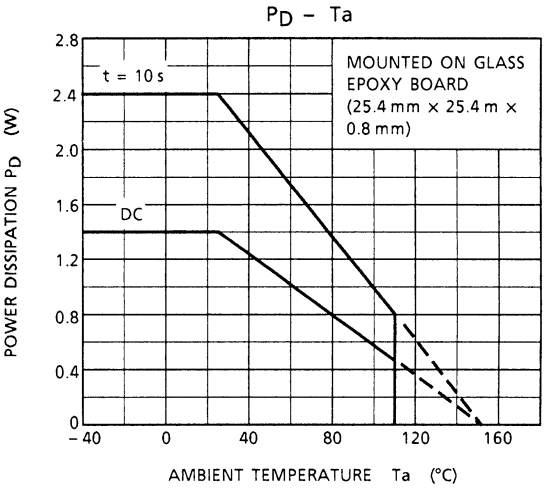
V_{IH} – V_{DD}

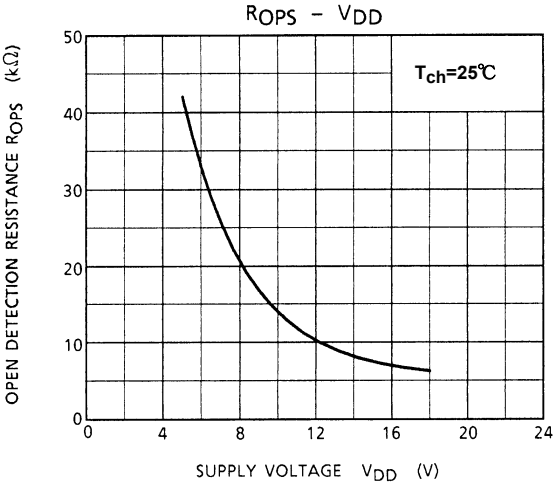






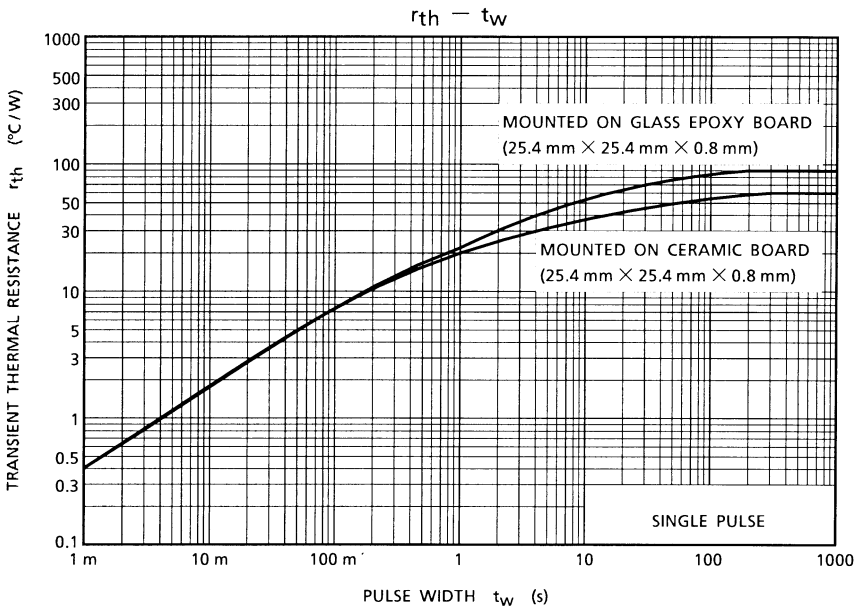






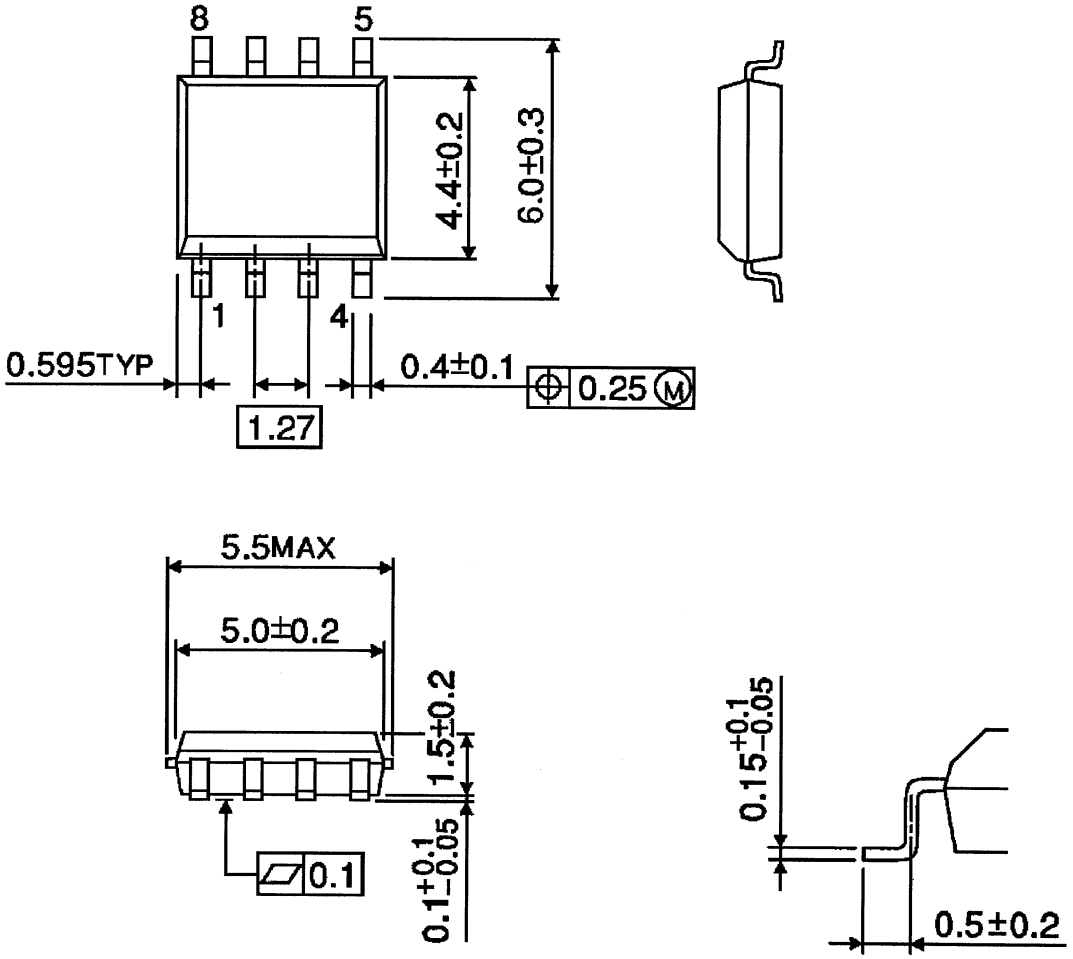
Precaution:

1. Since there is no built-in protection against reverse connection of batteries, etc., provide such protection using external circuits.


r_{th} – t_W
TRANSIENT THERMAL RESISTANCE r_{th} (°C / W)
1000
500
300
100
50
30
10
5
3
1
0.5
0.3
0.1
MOUNTED ON GLASS EPOXY BOARD
(25.4 mm × 25.4 mm × 0.8 mm)
MOUNTED ON CERAMIC BOARD
(25.4 mm × 25.4 mm × 0.8 mm)
SINGLE PULSE
1 m
10 m
100 m
1
10
100
1000
PULSE WIDTH t_W (s)

Package Dimensions

SOP8-P1.27A Unit : mm



Weight: 0.08 g (typ.)

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20070701-EN

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