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# TPD1033F

## Toshiba Semiconductor and Storage

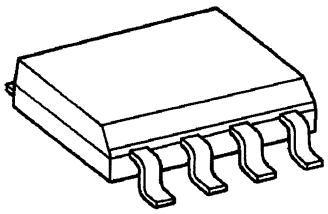
HIGH SIDE POWER SWITCH FOR MOTORS, SOLENOIDS AND LAMP DRIVERS

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.



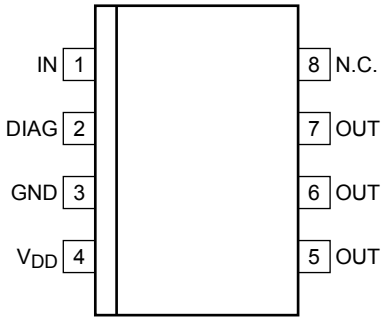
SOP8-P-1.27A

Weight: 0.08 g (typ.)

## Features

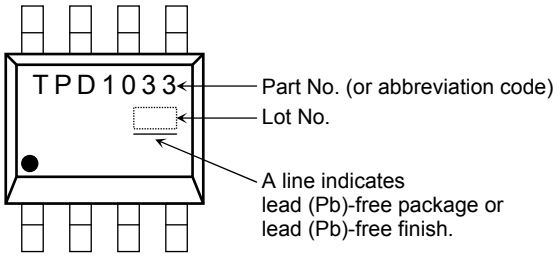
- A monolithic power IC with a new structure combining a control block (Bi-CMOS) and a vertical power MOS FET (π-MOS) on a single chip
- One side of load can be grounded to a high-side switch
- Can directly drive a power load from a microprocessor.
- Built-in protection against thermal shutdown and load 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)

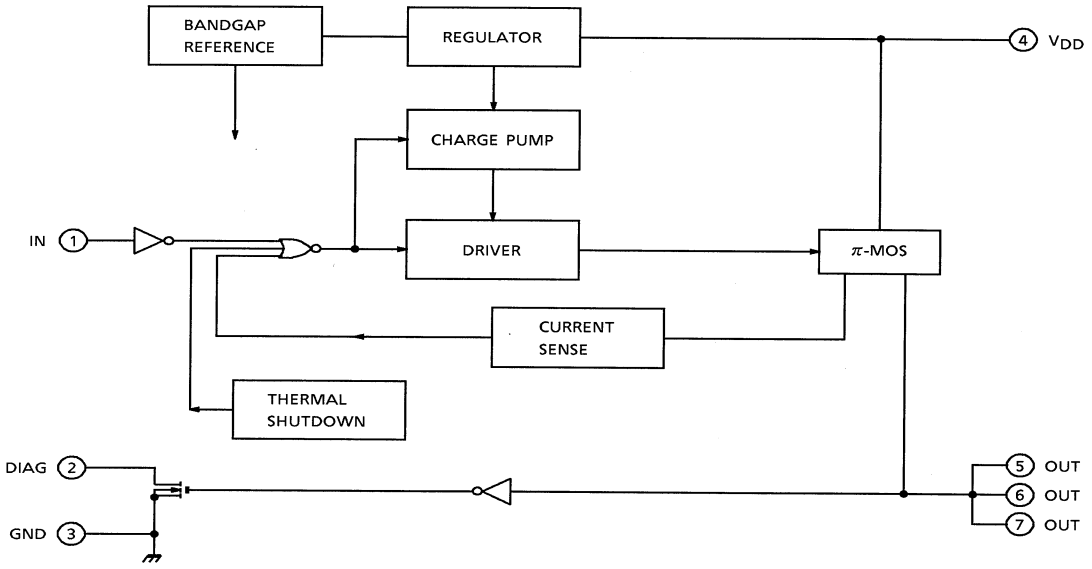
## Marking




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

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

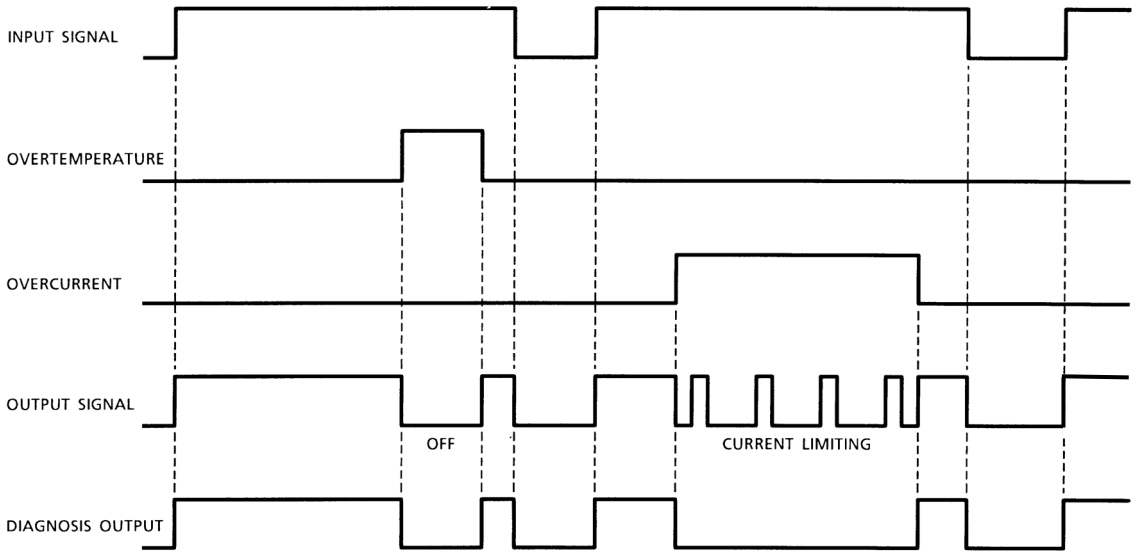
## Block Diagram




## Pin Description

| Pin No. | Symbol | Function |
|---|---|---|
| 1 | IN | Input pin.<br>Input is CMOS-compatible, with pull-down resistor connected.<br>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).<br>n-channel open drain. |
| 3 | GND | Ground pin. |
| 4 | $V_{DD}$ | Power pin. |
| 5, 6, 7 | OUT | Output pin.<br>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)**

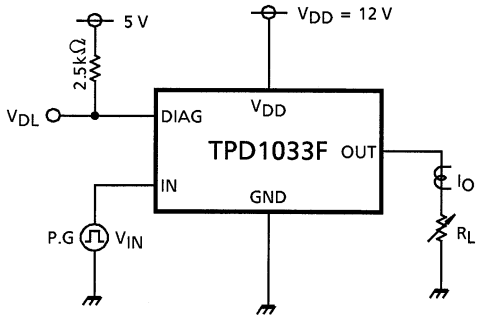
| Characteristic | | Symbol | Test Cir-cuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Operating supply voltage | | $V_{DD\ (opr)}$ | — | — | 5 | 12 | 18 | V |
| Supply current | | $I_{DD}$ | — | $V_{DD}$ = 12 V, $V_{IN}$ = 0 V | — | 1 | 5 | mA |
| Input voltage | | $V_{IH}$ | — | $V_{DD}$ = 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 |

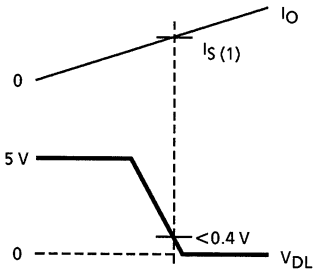
Note 3: Overcurrent detection value when load is short circuited and $V_{IN}$ = "L" → "H"

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

## Test Circuit 1

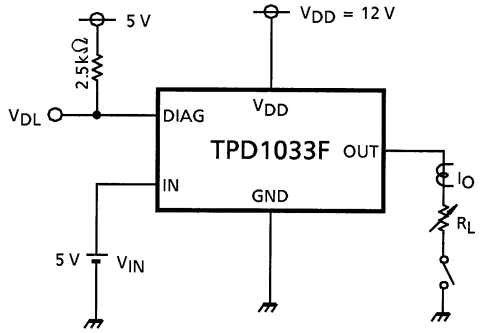
### Over-current detection

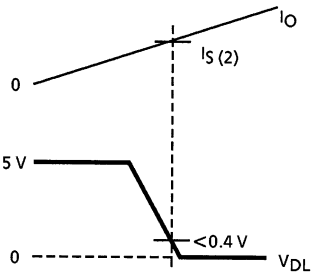



## Test Circuit 2

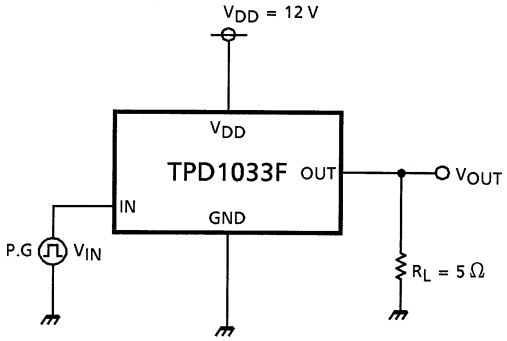
### Over-current detection

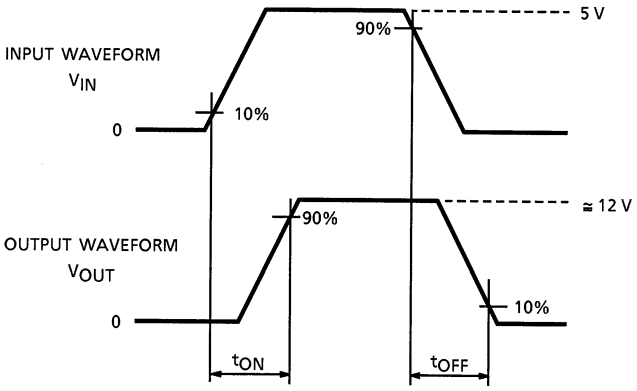


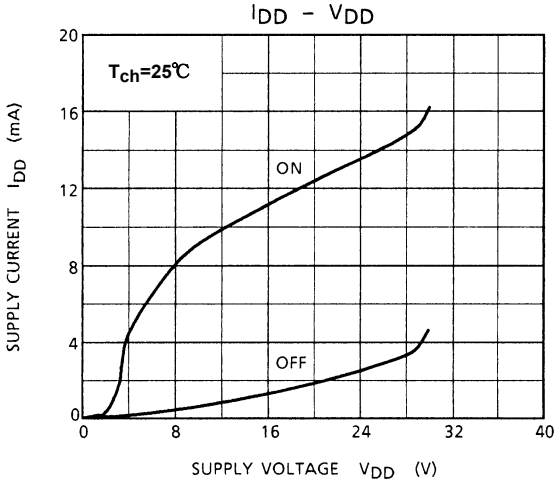

## Test Circuit 3

Switching time

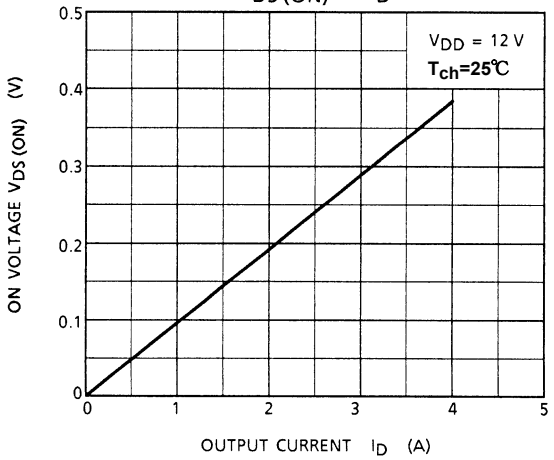


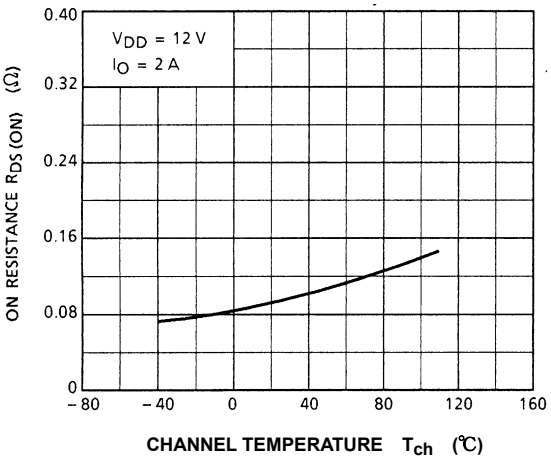
$I_{DD}$ – $V_{DD}$



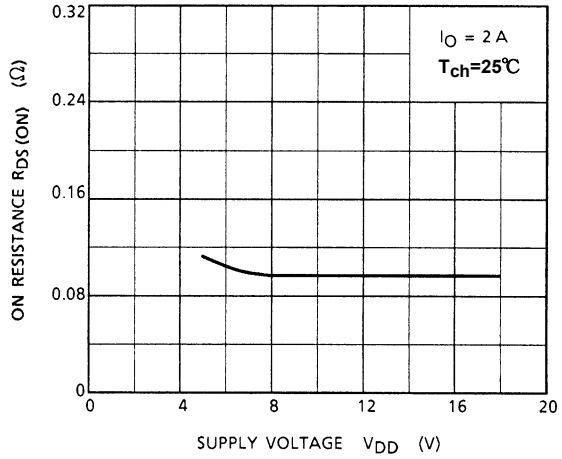

$V_{DS\ (ON)}$ – $I_D$



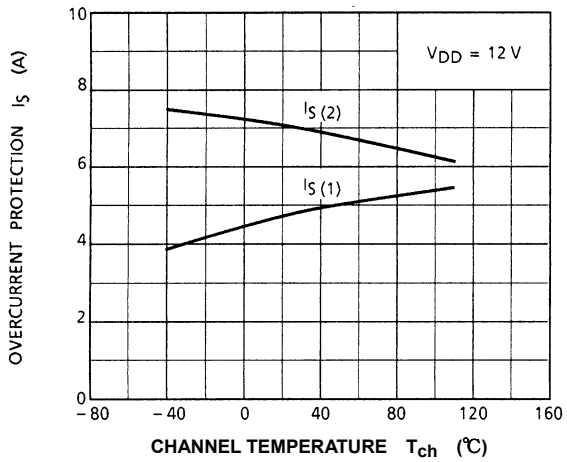

$R_{DS(ON)}$ – $T_{ch}$



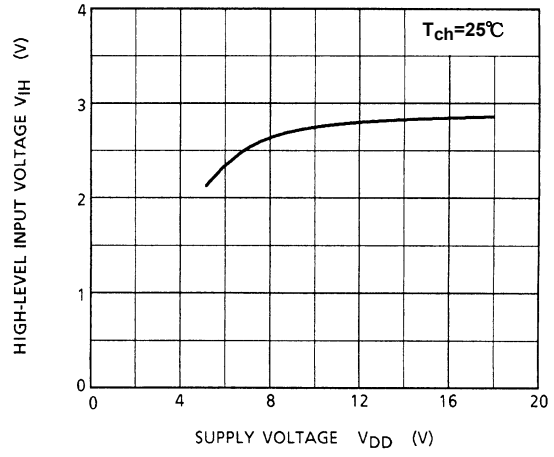

$R_{DS\ (ON)}$ – $V_{DD}$

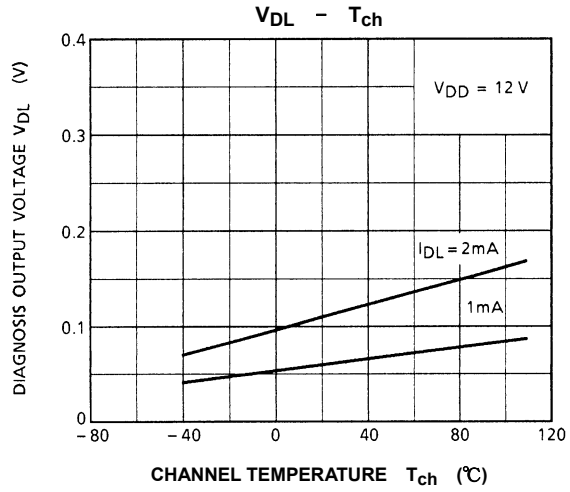


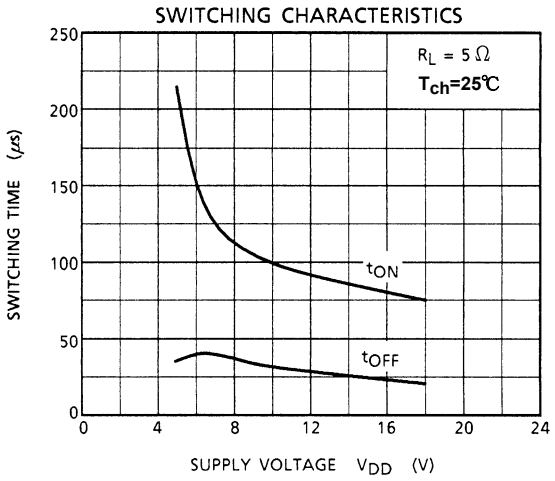

$I_S$ – $T_C$

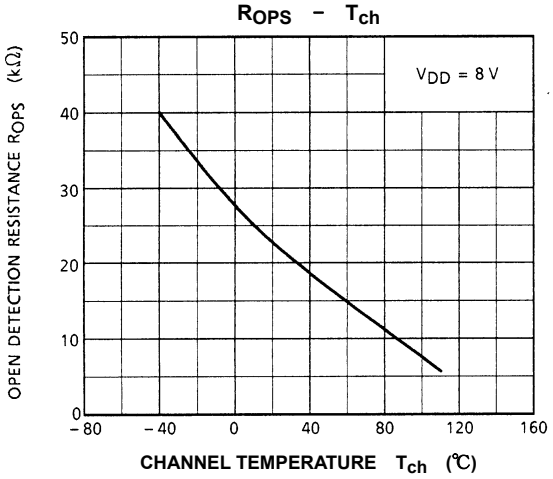


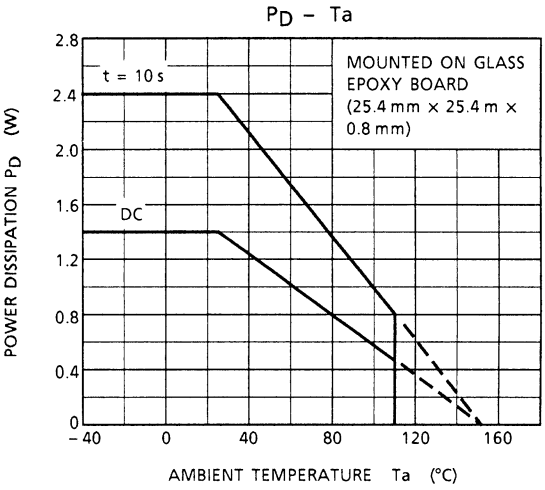

$V_{IH}$ – $V_{DD}$

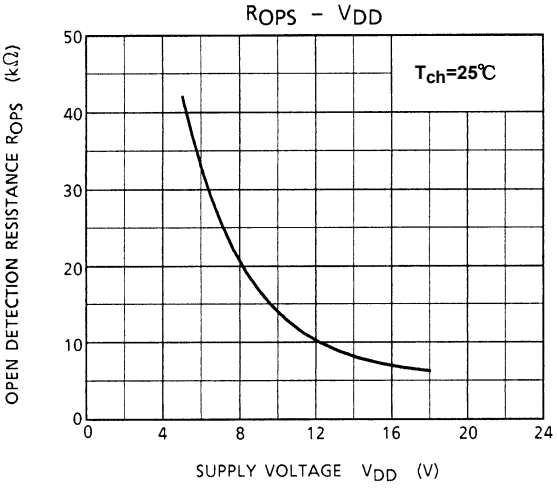




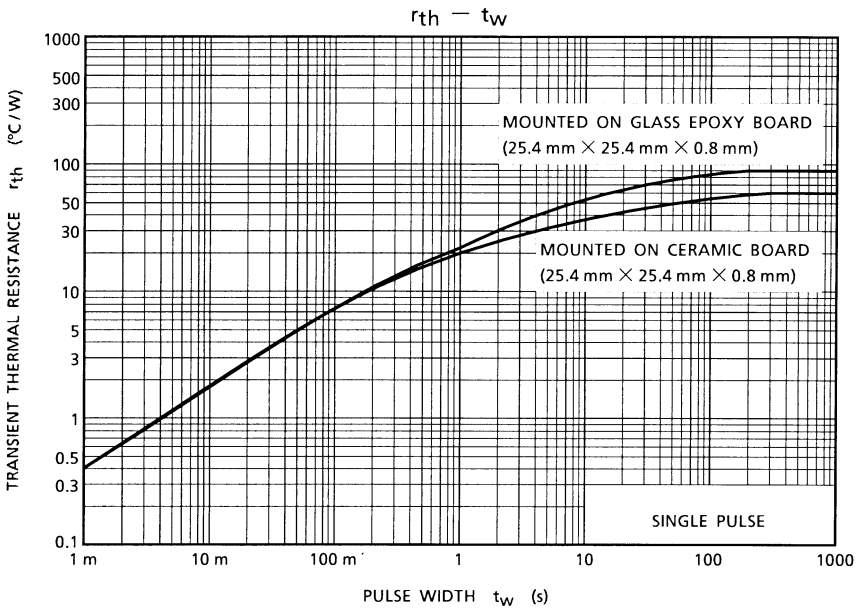



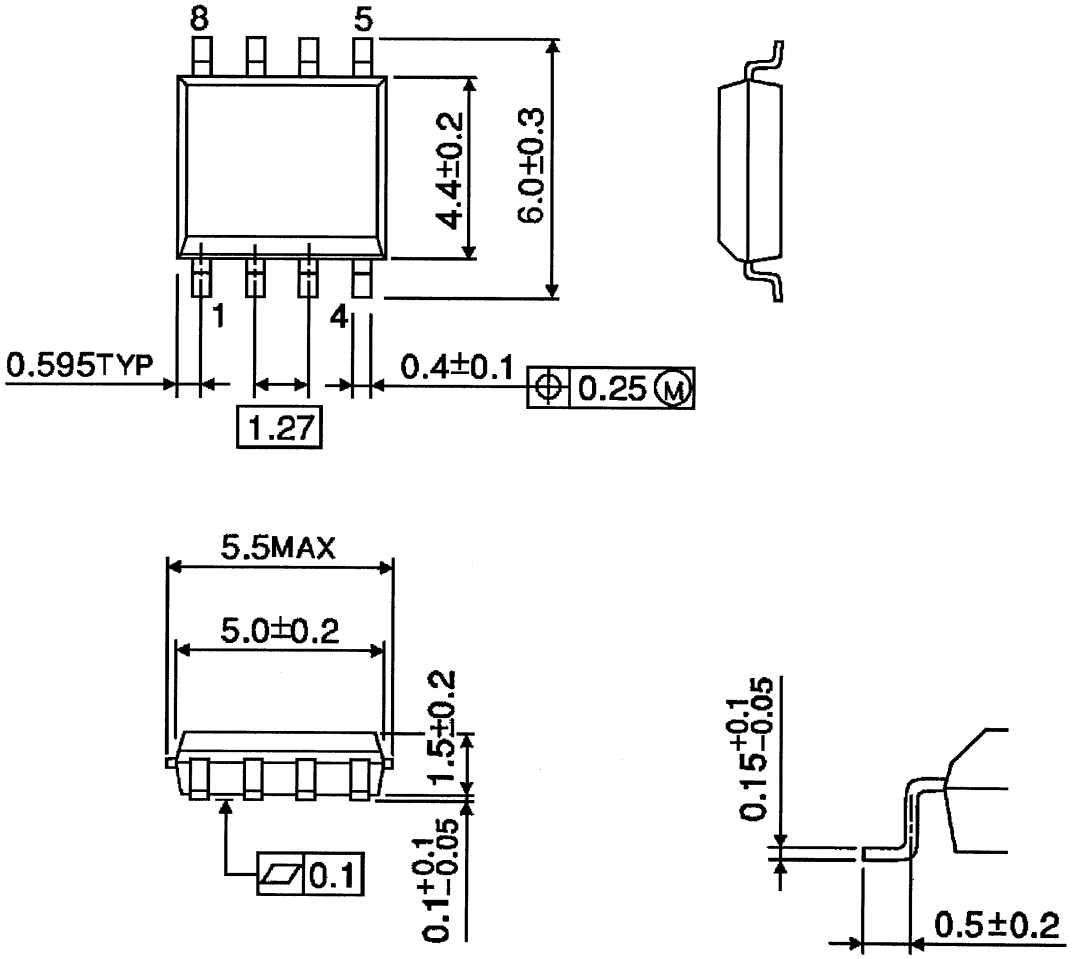

## Precaution:

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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