

TOSHIBA Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

# TPD1009S

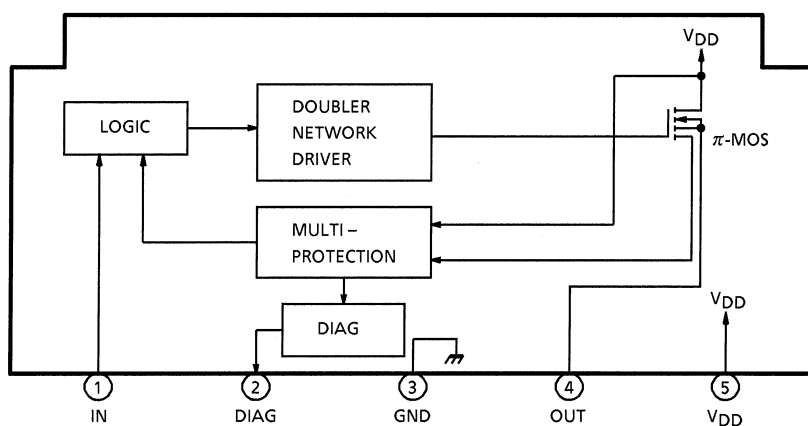
High-side Power Switch for Motors, Solenoids, and Lamp Drivers.

The TPD1009S is a monolithic power IC for high-side switches. The IC has a vertical MOS FET 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.

## Features

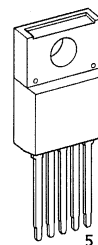
- A monolithic power IC with a new structure combining a control block (Bi-CMOS) and a vertical power MOS FET ( $\pi$ -MOS) on a single chip
- One side of load can be grounded to a high-side switch.
- Can directly drive a power load from a microprocessor.
- Built-in protection against thermal shutdown and load short circuiting.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at load short-circuiting, opening, or overtemperature.
- Up to -10V of counterelectromotive force from an L load can be applied.
- Low on-resistance :  $R_{ON} = 60m\Omega$  (max)
- Low operating current :  $I_{DD} = 1mA$  (typ.) (@ $V_{DD} = 12V$ ,  $V_{IN} = 0V$ )
- 5-pin TO-220 insulated package.
- Three standard lead configurations.

## Pin Assignment



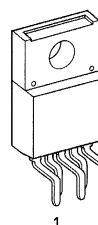
Note: Due to its MOS structure, this product is sensitive to static electricity.

STL



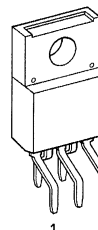
SSIP5-P-1.70C

LBF



ZIP5-P-1.70L

LBS



ZIP5-P-1.70K

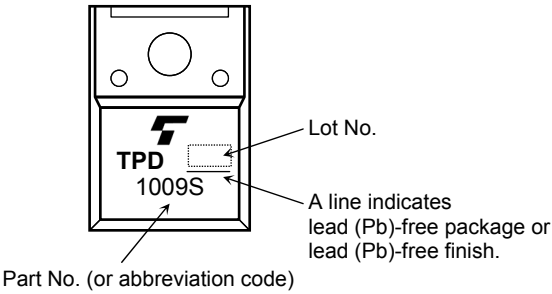
Weight

SSIP5-P-1.70C : 2.1g (typ.)

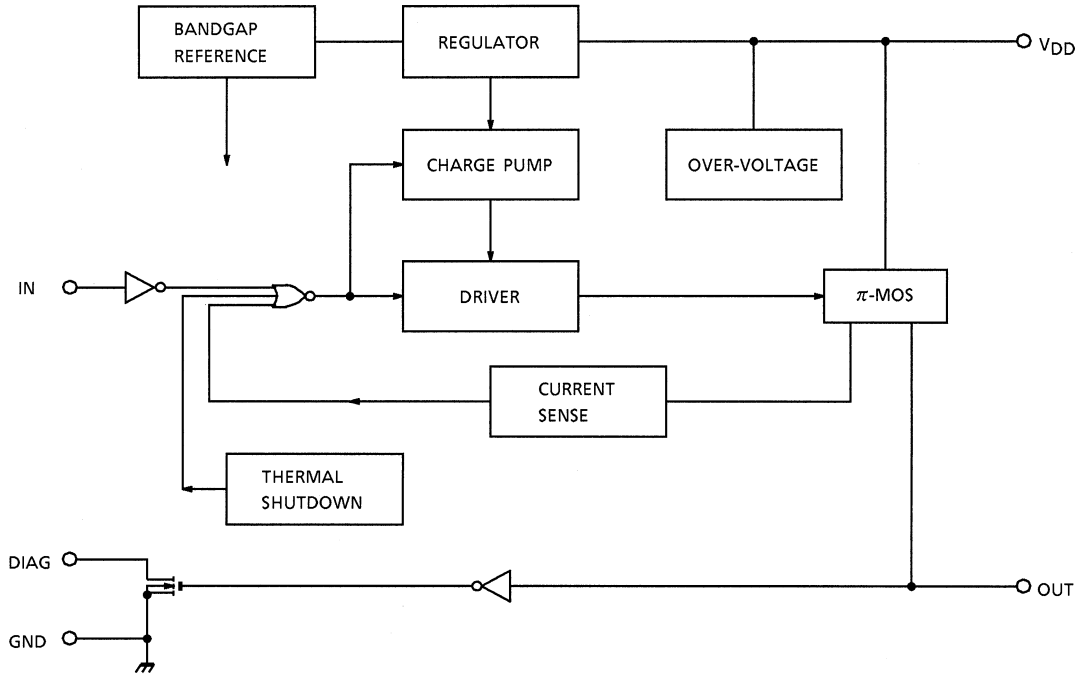
ZIP5-P-1.70L : 2.1g (typ.)

ZIP5-P-1.70K : 2.1g (typ.)

Marking



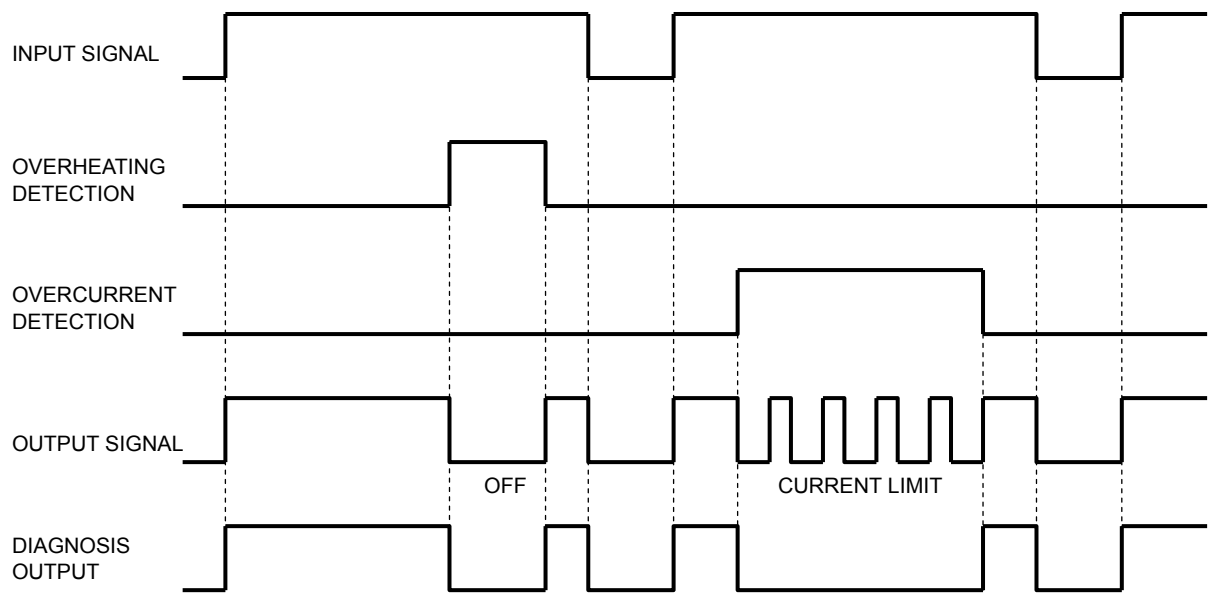
Block Diagram



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	OUT	Output pin. When the load is short-circuited and current in excess of the detection current flows to the output pin, the output automatically turns on or off.
5	V <sub>DD</sub>	Power pin.

Timing Chart



Truth Table

Input Signal	Output Signal	Diagnosis Output	State
H	H	H	Normal
L	L	L	
H	L	L	Overcurrent
L	L	L	
H	H	H	Load open
L	H	H	
H	L	L	Overtemperature
L	L	L	

## Absolute Maximum Ratings (Ta = 25°C)

Characteristics		Symbol	Rating	Unit
Drain-source Voltage		V <sub>DS</sub>	60	V
Supply Voltage	DC	V <sub>DD</sub> (1)	25	V
	Pulse	V <sub>DD</sub> (2)	60 (Rs = 1Ω, τ = 250ms)	V
Input Voltage	DC	V <sub>IN</sub> (1)	-0.5~12	V
	Pulse	V <sub>IN</sub> (2)	V <sub>DD</sub> (1) + 1.5 (t = 100ms)	V
Diagnosis Output Voltage		V <sub>DIAG</sub>	-0.5~25	V
Output Current		I <sub>O</sub>	Internally Limited	A
Input Current		I <sub>IN</sub>	±10	mA
Diagnosis Output Current		I <sub>DIAG</sub>	5	mA
Power Dissipation	Tc = 25°C	P <sub>D</sub> (1)	30	W
	Ta = 25°C	P <sub>D</sub> (2)	2	W
Operating Temperature		T <sub>opr</sub>	-40~110	°C
Junction Temperature		T <sub>j</sub>	150	°C
Storage Temperature		T <sub>stg</sub>	-55~150	°C
Lead Temperature/time		T <sub>SOL</sub>	275 (5s), 260 (10s)	°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).

## Electrical Characteristics (Tc = -40~110°C, V<sub>DD</sub> = 8~18V)

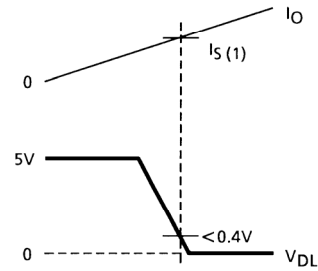
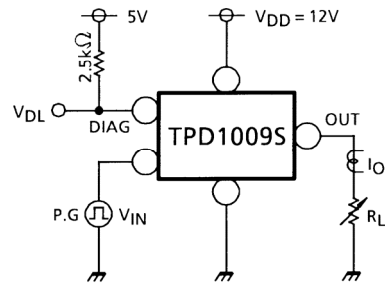
Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Operating Supply Voltage		V <sub>DD</sub> (opr)	—	—	5	12	18	V
Supply Current		I <sub>DD</sub>	—	V <sub>DD</sub> = 12V, V <sub>IN</sub> = 0V	—	1	5	mA
Input Voltage		V <sub>IH</sub>	—	V <sub>DD</sub> = 12V, I <sub>O</sub> = 8A	3.5	—	—	V
		V <sub>IL</sub>	—	V <sub>DD</sub> = 12V, I <sub>O</sub> = 1.2mA	—	—	1.5	V
Input Current		I <sub>IN</sub> (1)	—	V <sub>DD</sub> = 12V, V <sub>IN</sub> = 5V	—	50	200	μA
		I <sub>IN</sub> (2)	—	V <sub>DD</sub> = 12V, V <sub>IN</sub> = 0V	-0.2	—	0.2	μA
On Voltage		V <sub>DS</sub> (ON)	—	V <sub>DD</sub> = 12V, I <sub>O</sub> = 8A, T <sub>C</sub> = 25°C	—	—	0.48	V
On Resistance		R <sub>DS</sub> (ON)	—	V <sub>DD</sub> = 12V, I <sub>O</sub> = 8A, T <sub>C</sub> = 25°C	—	—	0.06	Ω
Output Leakage Current		I <sub>OL</sub>	—	V <sub>DD</sub> = 18V, V <sub>IN</sub> = 0V	—	—	1.2	mA
Diagnosis Output Voltage	"L" Level	V <sub>DL</sub>	—	V <sub>DD</sub> = 12V, I <sub>DL</sub> = 2mA	—	—	0.4	V
Diagnosis Output Current	"H" Level	I <sub>DH</sub>	—	V <sub>DD</sub> = 18V, V <sub>DH</sub> = 18V	—	—	10	μA
Overcurrent Protection		I <sub>S</sub> (1) (Note 1)	1	V <sub>DD</sub> = 12V, T <sub>C</sub> = 25°C	8	12	—	A
		I <sub>S</sub> (2) (Note 2)	2		15	24	—	A
Thermal Shutdown	Temperature	T <sub>s</sub>	—	—	150	160	200	°C
	Hysteresis	ΔT <sub>s</sub>			—	10	—	°C
Open Detection Resistance		R <sub>Ops</sub>	—	V <sub>DD</sub> = 8V	1	50	100	kΩ
Switching Time		t <sub>ON</sub>	3	V <sub>DD</sub> = 12V, R <sub>L</sub> = 5Ω, T <sub>C</sub> = 25°C	10	200	—	μs
		t <sub>OFF</sub>	3		10	30	—	μs

Note 1: I<sub>S</sub> (1) Overcurrent detection value when load is short-circuited and V<sub>IN</sub> = "L" → "H"

Note 2: I<sub>S</sub> (2) Overcurrent detection value when load current is increased while V<sub>IN</sub> = "H"

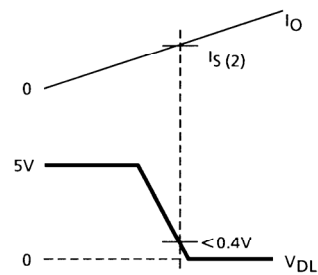
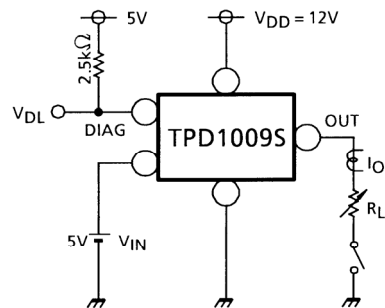
Test Circuit 1

Over-current detection



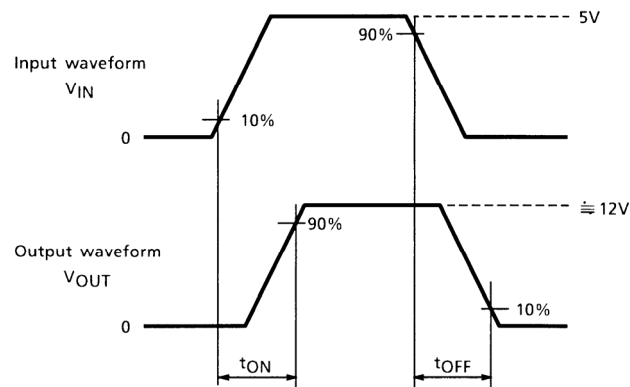
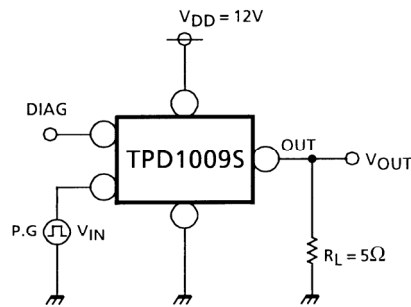
Test Circuit 2

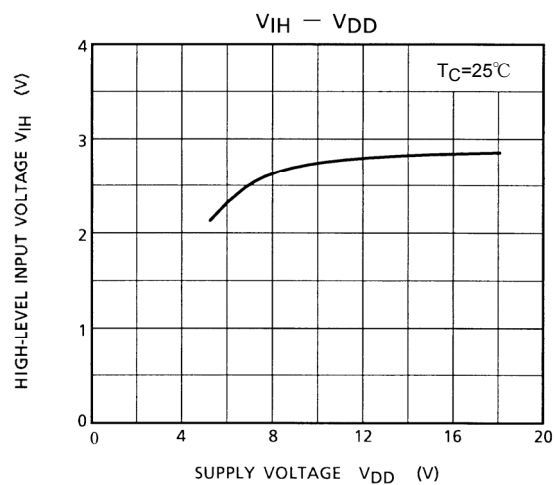
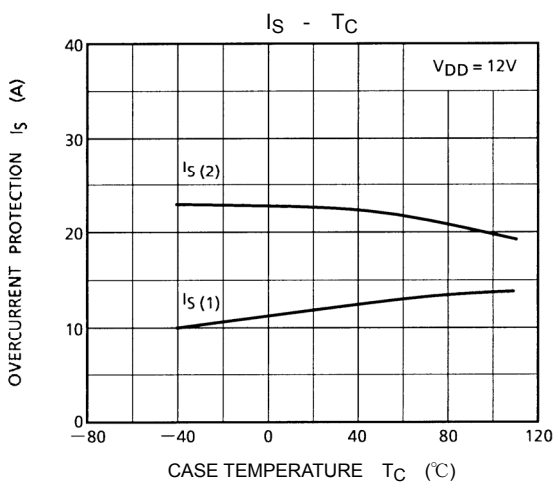
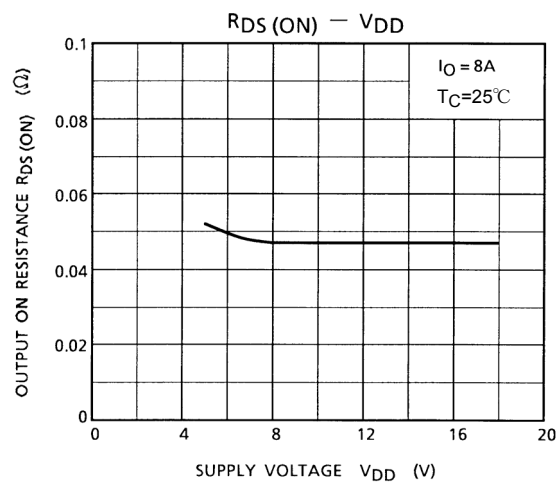
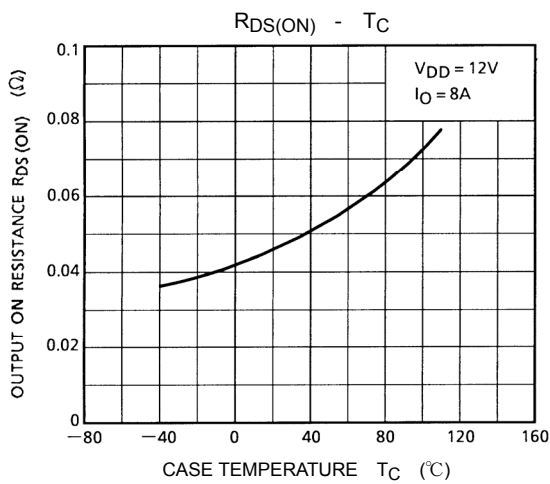
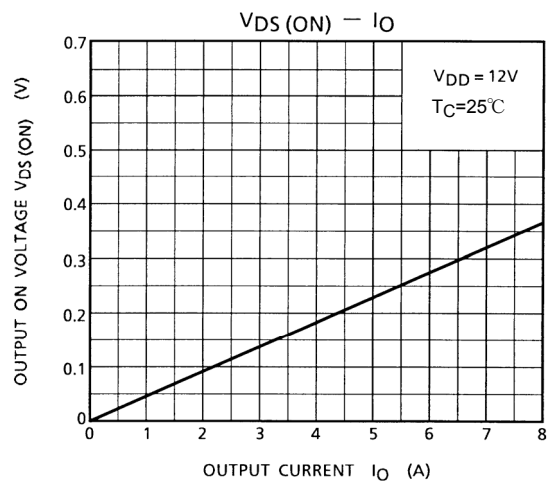
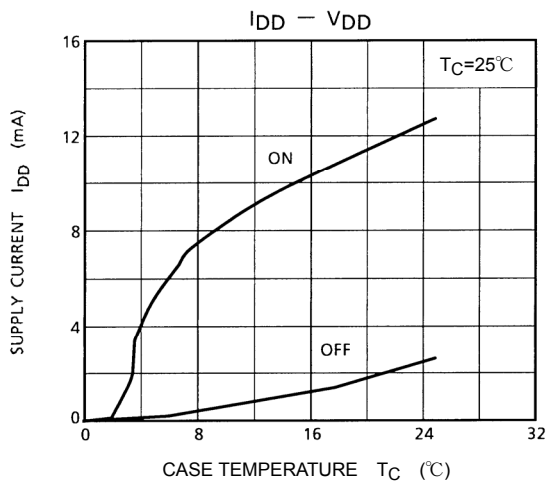
Over-current detection

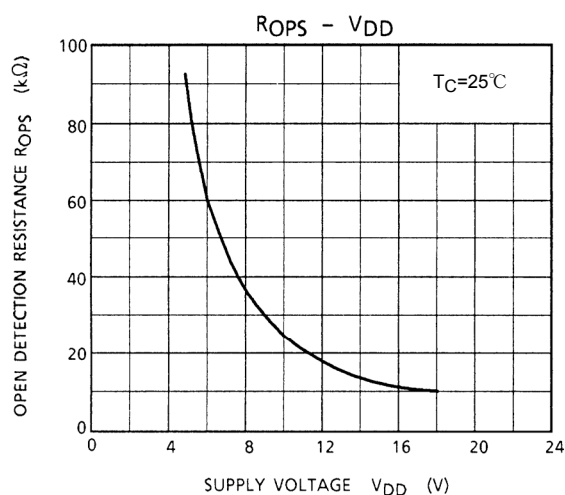
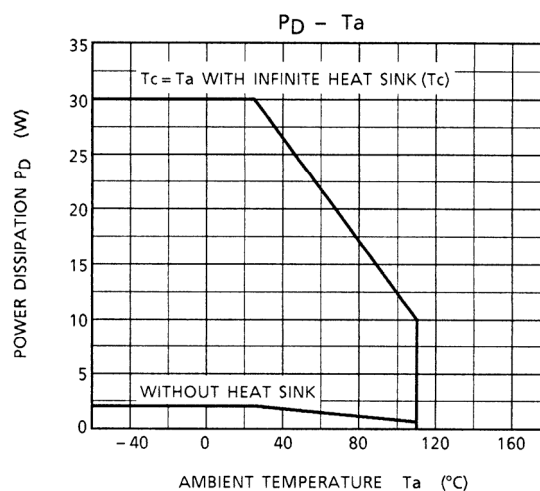
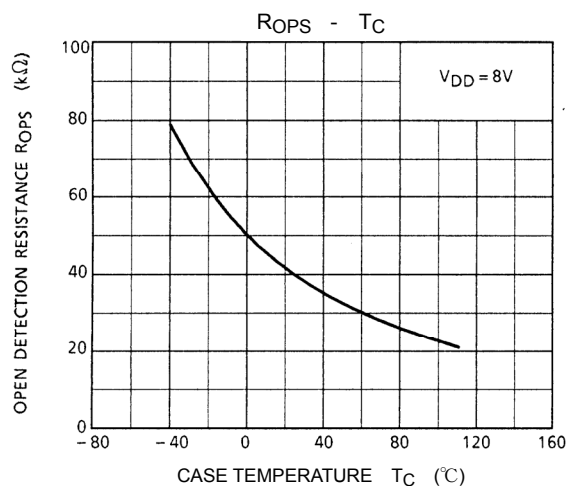
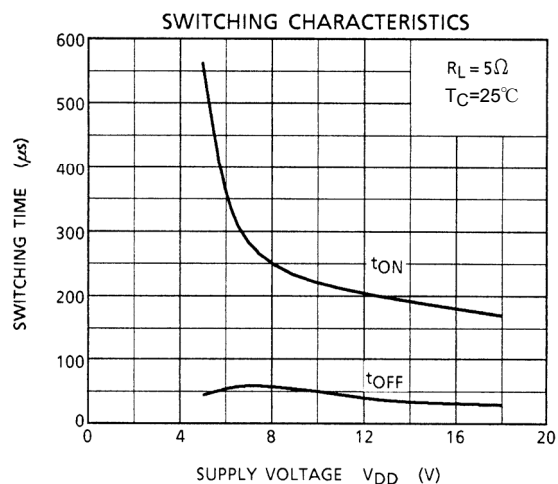
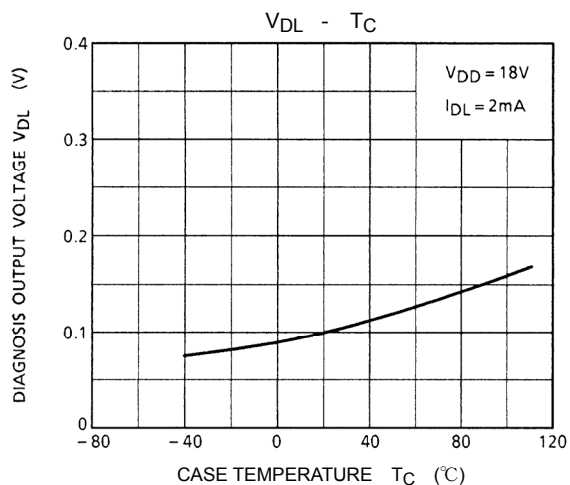


Test Circuit 3

Switching time







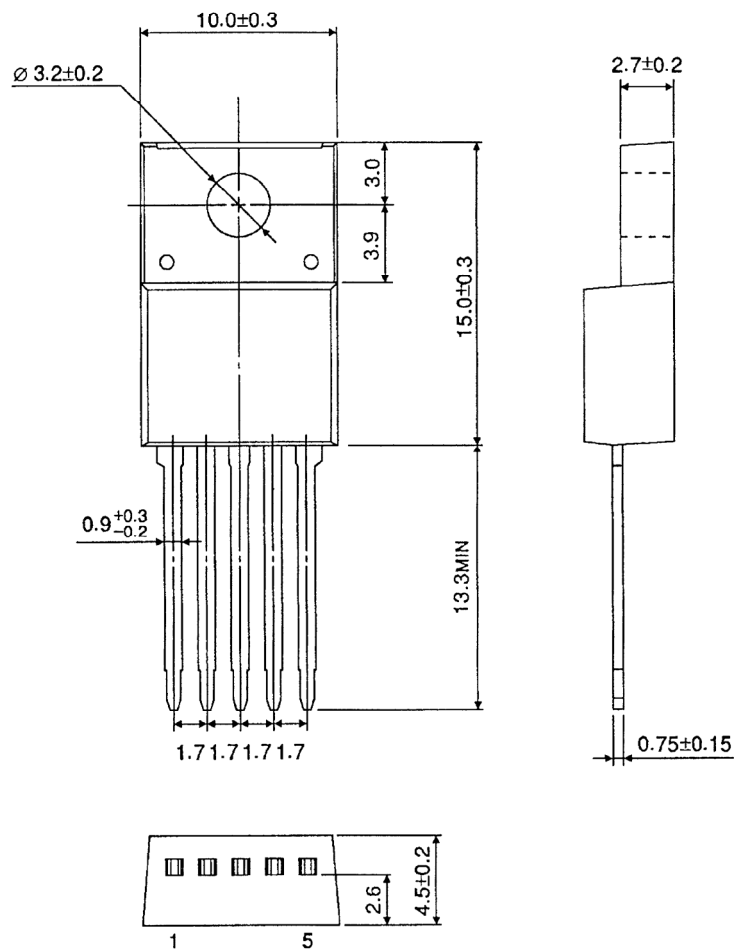
## Precaution:

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

Package Dimensions

SSIP5-P-1.70C (STL)

Unit : mm



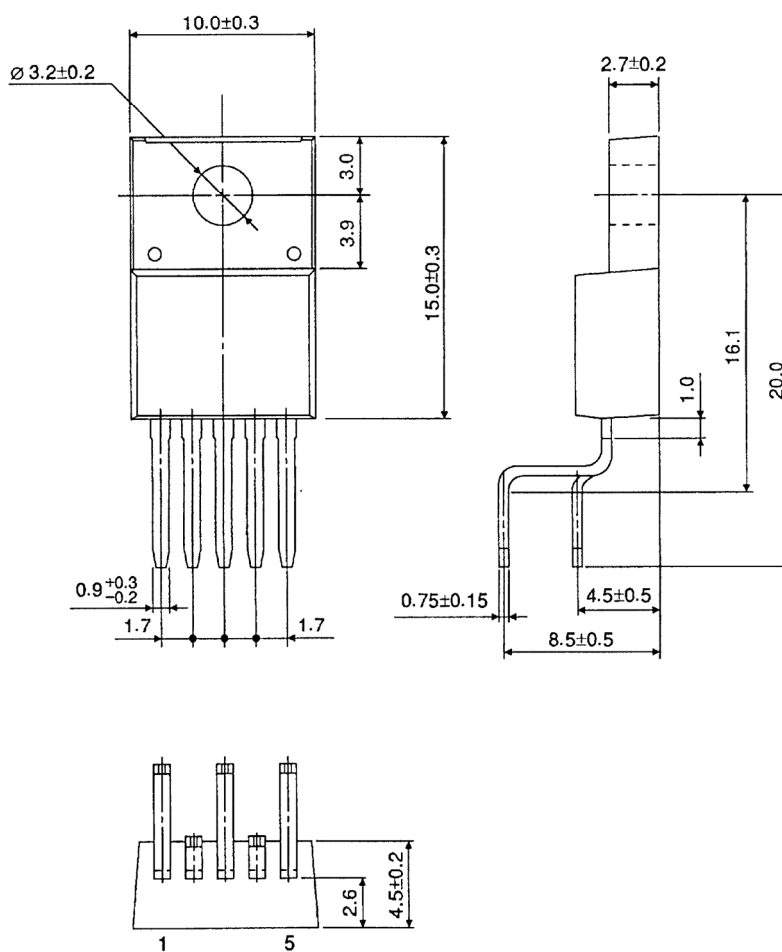
Weight: 2.1g (typ.)



## Package Dimensions

ZIP5-P-1.70L (LBF)

Unit : mm

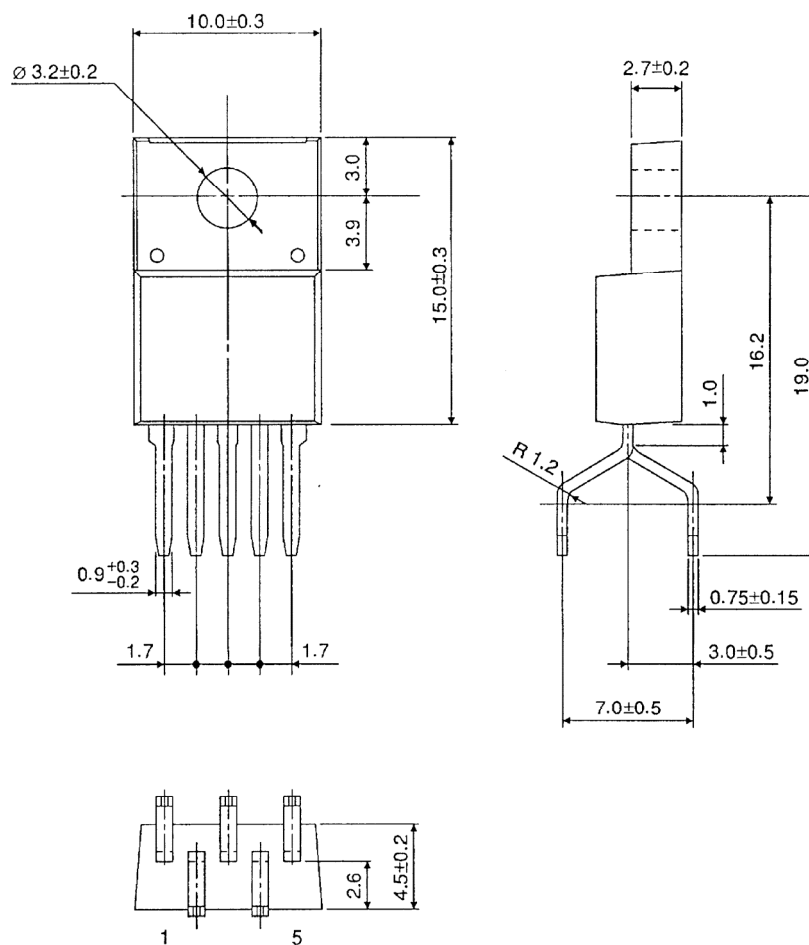


Weight: 2.1g (typ.)

## Package Dimensions

ZIP5-P-1.70K (LBS)

Unit : mm



Weight: 2.1g (typ.)

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