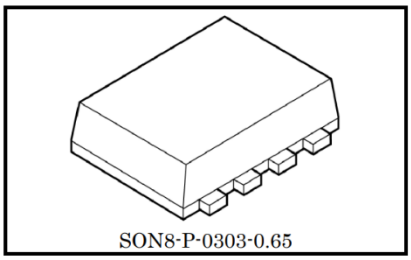
Toshiba Intelligent Power Device Silicon Monolithic MOS Integrated Circuit

TPD1044F

Low-Side Switch for Motor, Solenoid and Lamp Drive

1. Description

The TPD1044F is a low-side switch. The IC has a vertical MOSFET output which can be directly driven from a CMOS or TTL logic circuit (e.g., an MPU). The IC is equipped with intelligent self-protection functions.



Weight: 0.017 g (typ.)

2. Applications

Motor drive, solenoid drive, lamp drive.

3. Features

- A monolithic IC with a new structure combining a control block and a vertical MOSFET on single chip.
- Can directly drive a power load from a CMOS or TTL logic IC.
- Built-in protection circuits against overvoltage (active clamp), overtemperature (thermal shutdown), and overcurrent (current limiter).
- Low Drain-Source ON-resistance: $R_{DS\ (ON)}$ = 0.6 Ω (max) (@V_{IN} = 5 V, I_D = 0.5 A, T_{ch} = 25 °C)
- Low Drain cut-off Current: I_{DSS} = 10 μA (max) (@V_{IN} = 0 V, V_{DS} = 30 V, T_{ch} = 25 °C)
- Low Input Current: I_{IN} = 300 μA (max) (@V_{IN} = 5 V, T_{ch} = 25°C)
- AEC-Q100 qualified.
- It is a surface-mounted package “PS-8” (named by Toshiba), and the packing is embossed-tape packing.

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

Start of commercial production
2003-09

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4. Block Diagram

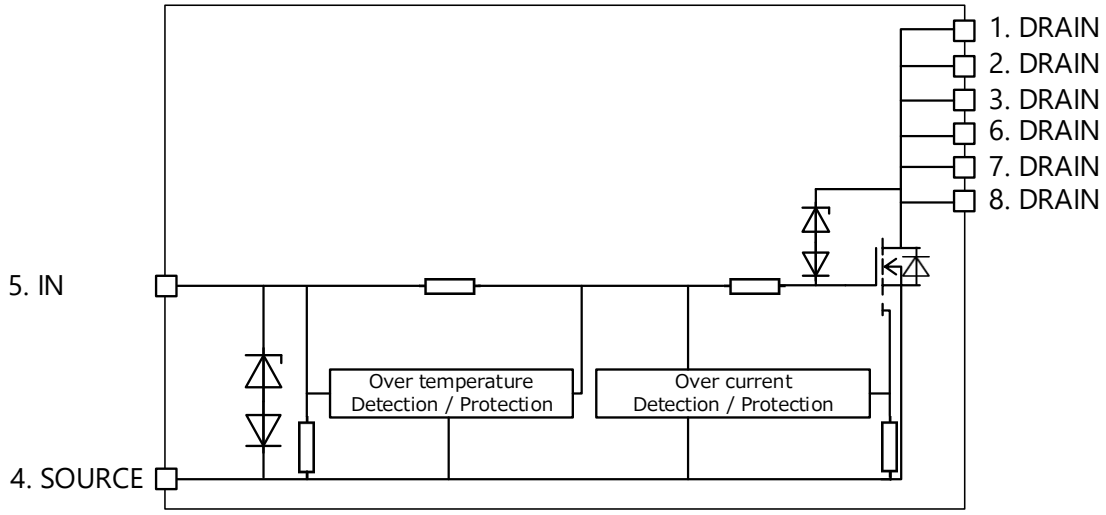

Figure 4.1 Block Diagram

5. Pin Assignments (Top view)

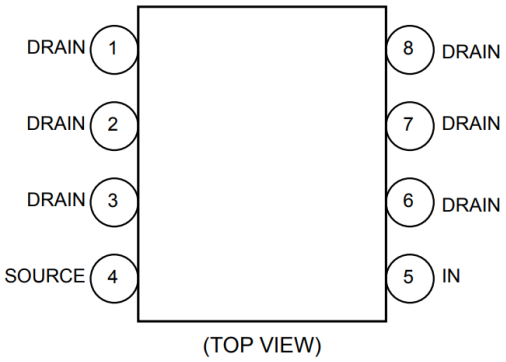

Figure 5.1 Pin Assignments (Top view)

6. Pin Description

Table 6.1 Pin Description

Pin No.	Symbol	Description
1,2,3,6,7,8	DRAIN	Drain current is limited (by current limiter) if it exceeds 1 A (min) in order to protect the IC.
4	SOURCE	Source pin.
5	IN	Input pin. This pin is connected to a pull-down resistor internally, so that even when input wiring is open-circuited, output can never be turned on inadvertently.

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7. Timing chart

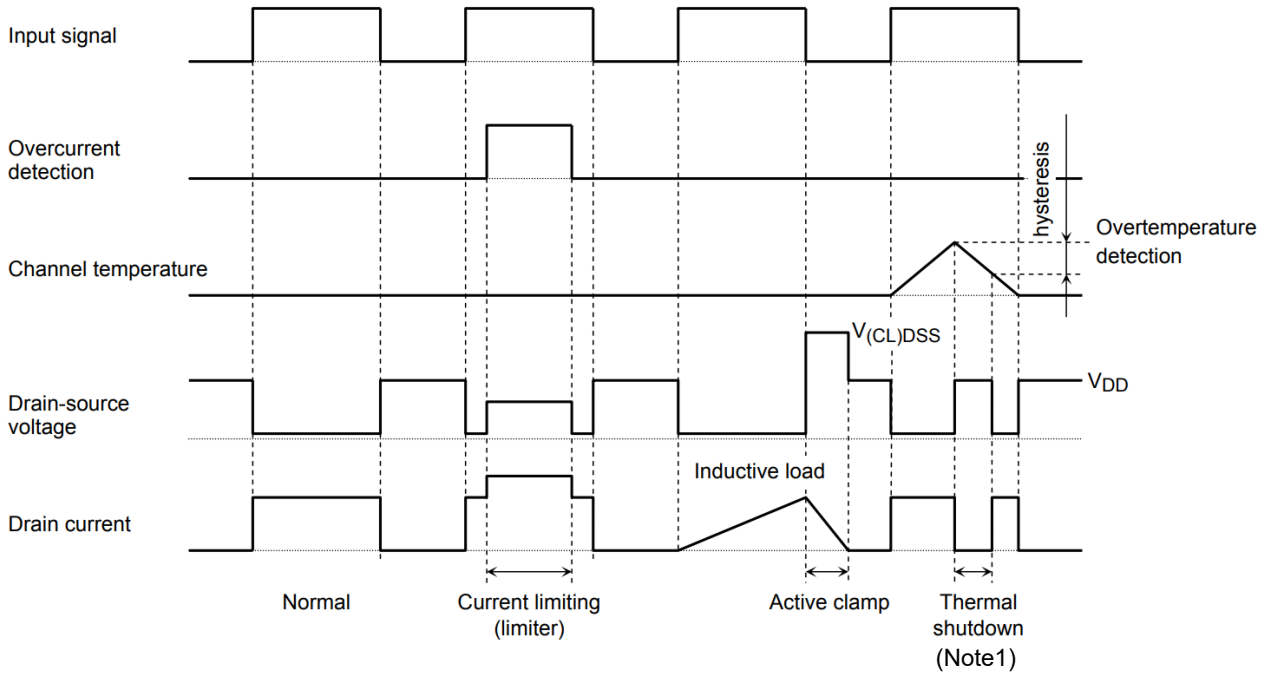

Figure 7.1 Timing chart

Note 1: The overtemperature detection is self-recovery. The detection and recovery hysteresis is 5 °C (typ.).

8. Truth table

Table 8.1 Truth table

IN	V_{DS}	Output state	Operation state
L	H	OFF	Normal
H	L	ON	
L	H	OFF	Overcurrent (load short)
H	H	current limiting (limiter)	
L	H	OFF	Overtemperature
H	H	OFF	

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9. Absolute Maximum Ratings

Table 9.1 Absolute Maximum Ratings (Ta = 25 °C) (Note)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DS\ (DC)}$	41	V
Drain current	I_D	Internally limited	A
Input voltage	V_{IN}	-0.3 to 7.0	V
Power dissipation (T_a = 25 °C) (Note 1)	P_D	0.9	W
Single pulse active clamp capability (Note 2)	E_{AS}	125	mJ
Active clamp current	I_{AR}	1	A
Repetitive active clamp capability (Note 3)	E_{AR}	0.09	mJ
Operating temperature	T_{opr}	-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.).

Note 1: Refer to 10. Thermal Characteristics.

Note 2: Active clamp capability (single pulse) test condition V_{DS} = 40 V, T_{ch} = 25°C(initial), L = 50 mH, I_{AR} = 1 A, R_G = 25 Ω

Note 3: Repetitive rating, pulse width limited by maximum channel temperature.

10. Thermal Characteristics

Table 10.1 Thermal characteristics

Characteristics	Symbol	Max	Unit
Thermal resistance, channel to ambient (Note 4)	$R_{th\ (ch\text{-}a)}$	138.9	°C/W

$P_D = (T_{ch} - T_a) / R_{th\ (ch\text{-}a)}$

Note 4: Thermal resistance measurement conditions.
Mounted on glass epoxy board (FR-4) [25.4 mm × 25.4 mm × 0.8 mm]

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11. Electrical Characteristics

Table 11.1 Electrical Characteristics (Ta = 25 °C)

Characteristics	Symbol	Test circuit	Test Condition	Min	Typ.	Max	Unit
Drain-source clamp voltage	$V_{(CL)\ DSS}$	-	V_{IN} = 0 V, I_D = 1 mA	41	-	60	V
Input threshold voltage	V_{th}	-	V_{DS} = 13 V, I_D = 10 mA	1.0	-	2.8	V
Protective circuit operation input voltage range	$V_{IN\ (opr)}$	-	-	3	-	6	V
Drain cut-off current	I_{DSS}	-	V_{IN} = 0 V, V_{DS} = 30 V	-	-	10	μA
Input current	$I_{IH\ (1)}$	-	V_{IN} = 5 V, at normal operation	-	-	300	μA
	$I_{IH\ (2)}$	-	V_{IN} = 5 V, when overcurrent protective circuit is actuated	-	-	350	
Drain-source on resistance	$R_{DS\ (ON)}$	-	V_{IN} = 5 V, I_D = 0.5 A	-	0.44	0.60	Ω
Overtemperature detection	T_{OT}	-	V_{IN} = 5 V	150	160	-	°C
Overcurrent detection	I_{OC}	1	V_{IN} = 5 V	1.0	1.8	-	A
Switching time	t_{on}	2	V_{DD} = 13 V, V_{IN} = 0 V / 5 V, I_D = 0.5 A	-	10	-	μs
	t_{off}			-	15	-	

Test circuit 1: Overcurrent measuring circuit

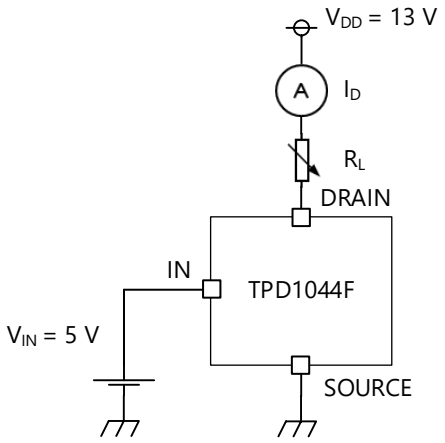

Figure 11.1 Test circuit 1

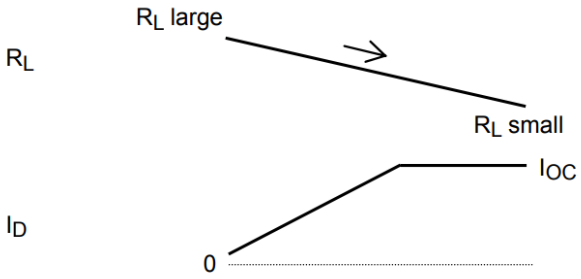

Figure 11.2 Measured waveforms 1

Test circuit 2: Switching time measuring circuit

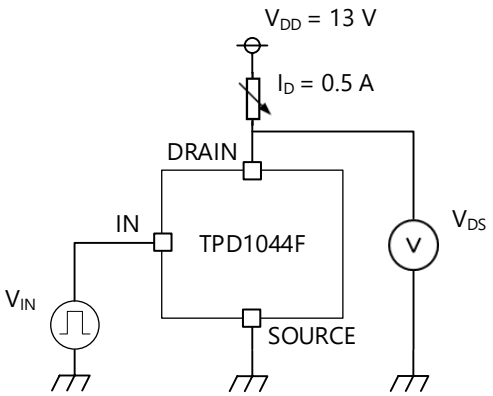

Figure 11.3 Test circuit 2

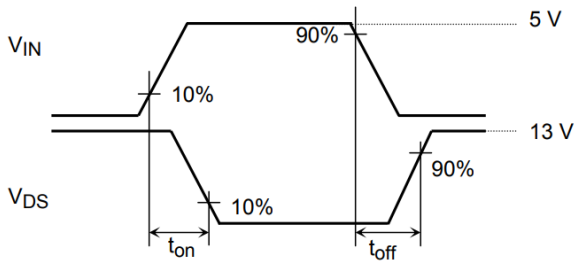

Figure 11.4 Measured waveforms 2

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12. Characteristic curves

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

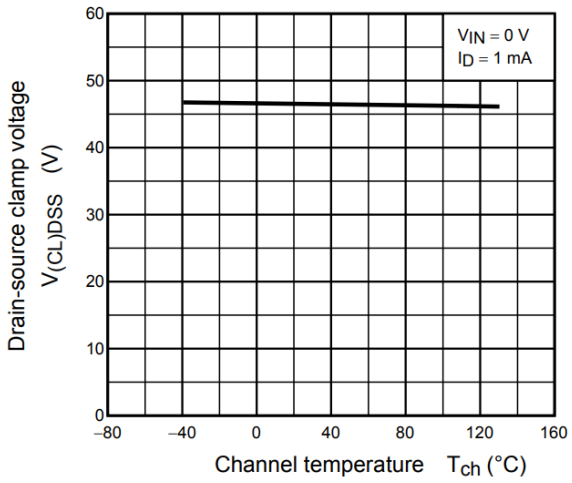

Figure 12.1 $V_{(CL)DSS}$ - T_{ch}

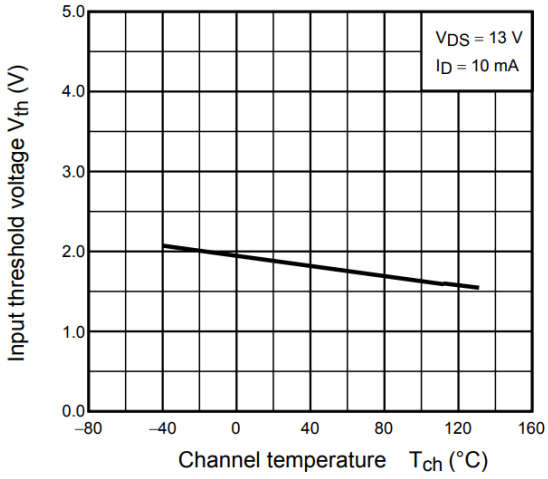

Figure 12.2 V_{th} - T_{ch}

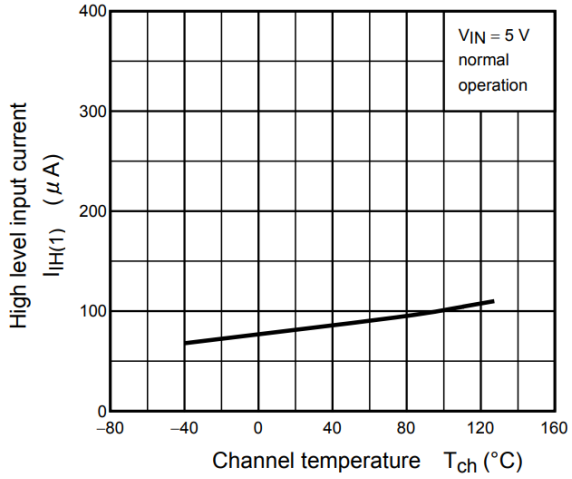

Figure 12.3 $I_{IH\ (1)}$ - T_{ch}

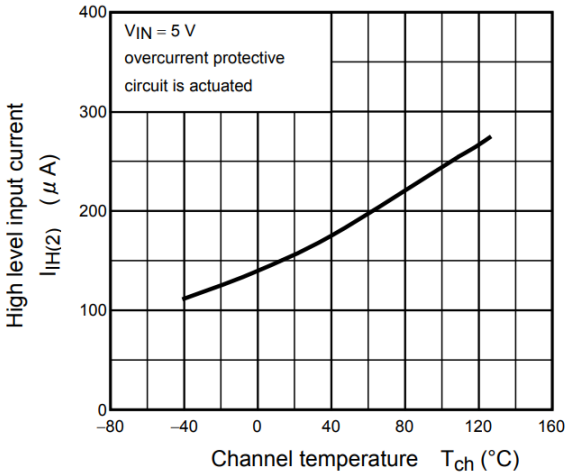

Figure 12.4 $I_{IH\ (2)}$ - T_{ch}

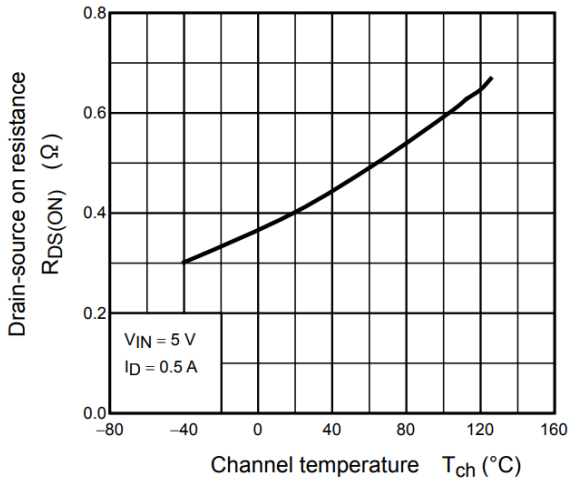

Figure 12.5 $R_{DS\ (ON)}$ - T_{ch}

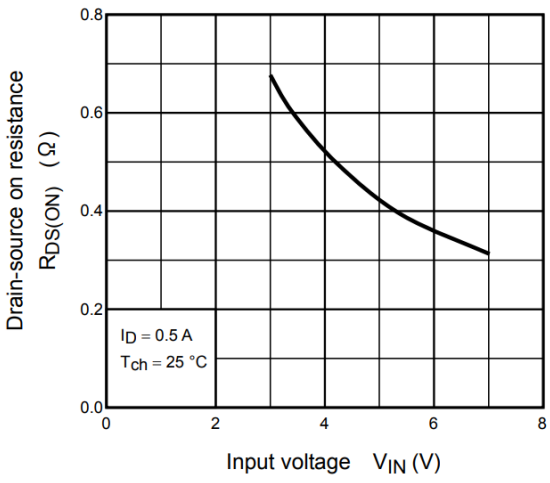

Figure 12.6 $R_{DS\ (ON)}$ - V_{IN}

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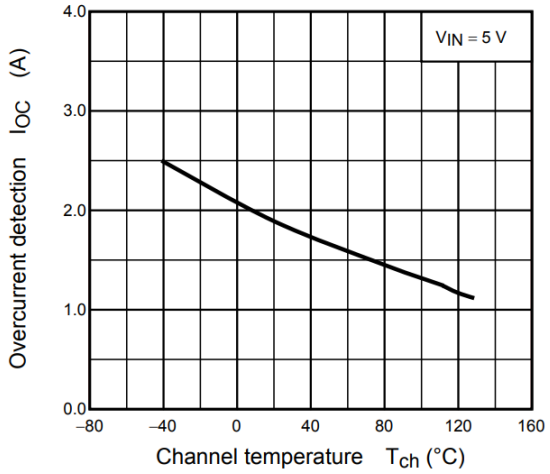


Figure 12.7 I_{OC} - T_{ch}

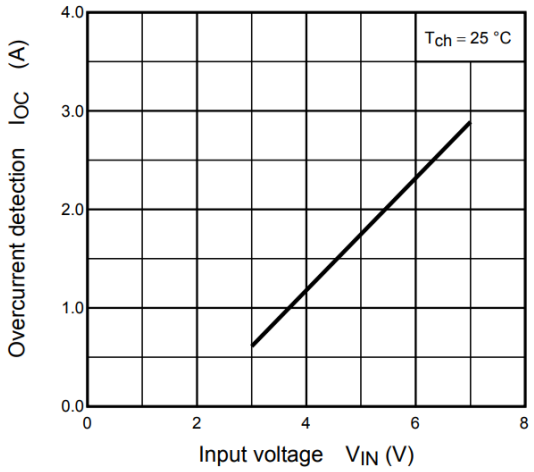


Figure 12.8 I_{OC} - V_{IN}

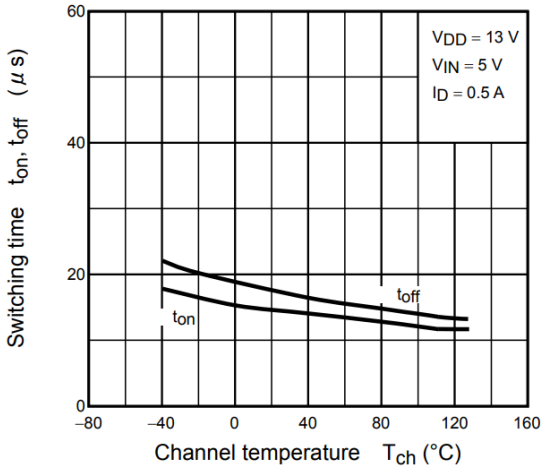


Figure 12.9 t_{on}, t_{off} - T_{ch}

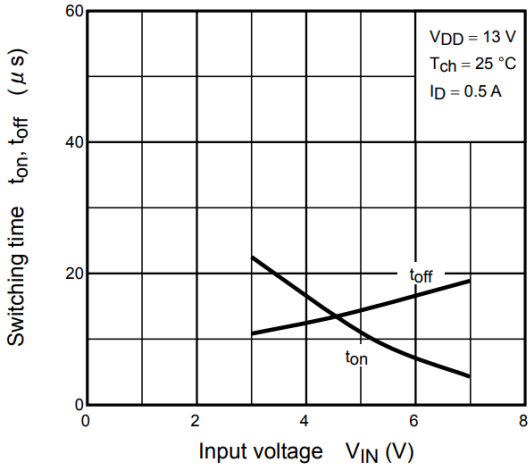


Figure 12.10 t_{on}, t_{off} - V_{IN}

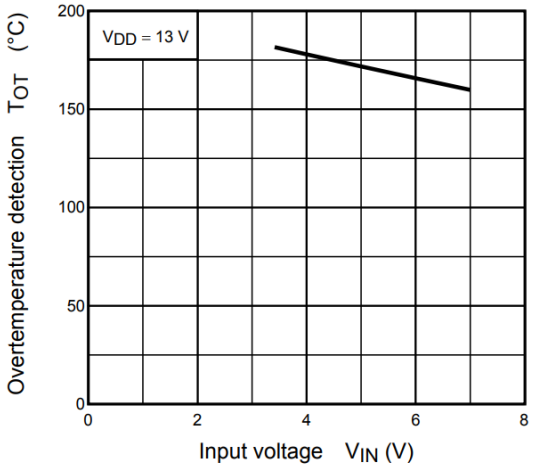


Figure 12.11 T_{OT} - V_{IN}

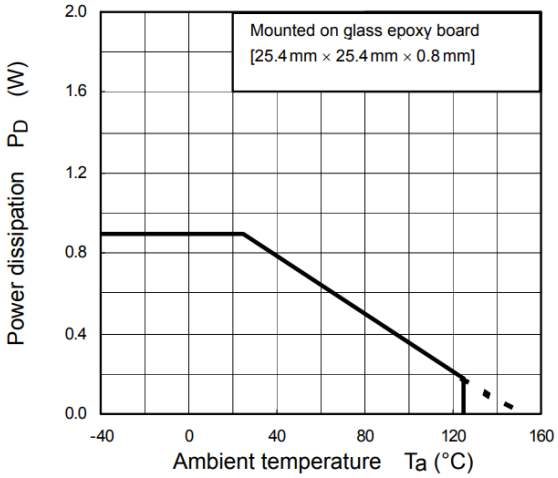


Figure 12.12 P_D - T_a

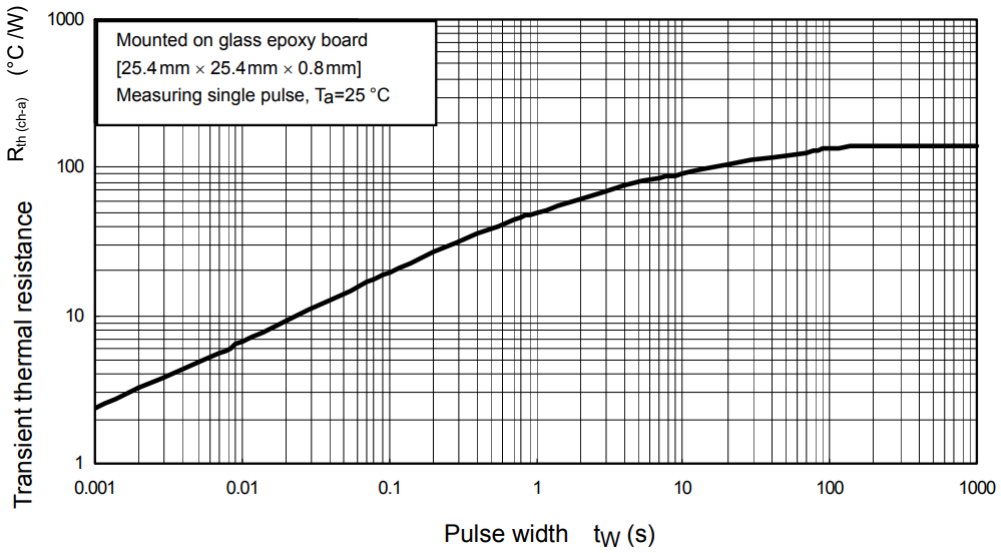
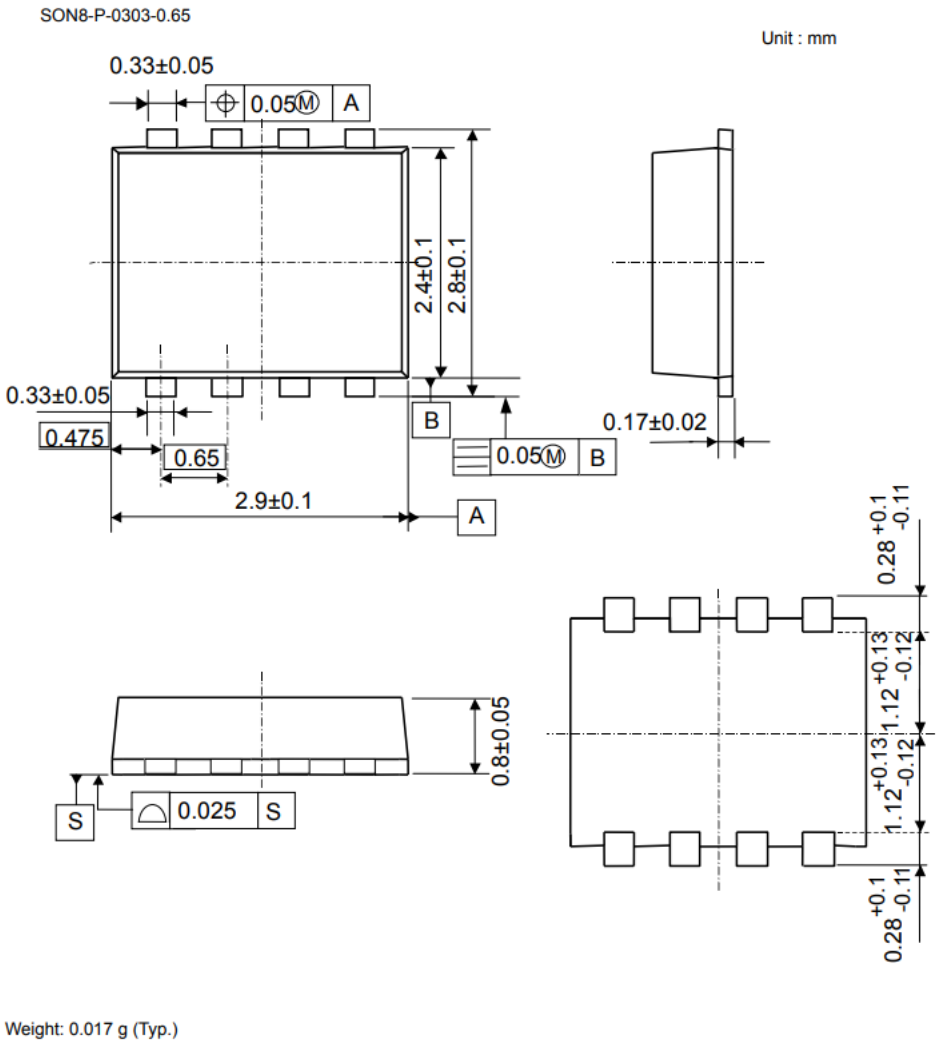


Figure 12.13 $R_{th\ (ch\text{-}a)}$ - t_W

13. Package Information

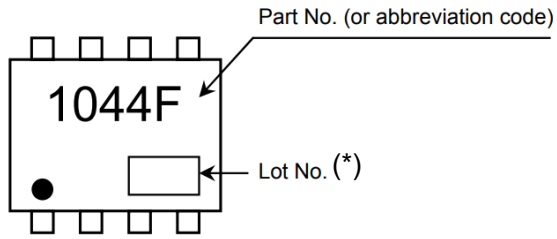
13.1. Package Dimensions



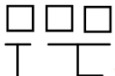
Weight: 0.017 g (Typ.)

Figure 13.1 Package Dimensions

13.2. Marking



* 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)

Figure 13.2 Marking

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

13.3. Land Pattern Dimensions for Reference only

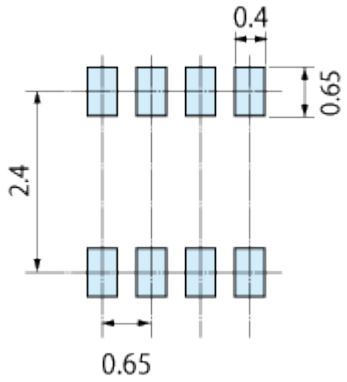


Figure 13.3 Land Pattern Dimensions for Reference only

14. IC Usage Considerations

14.1. Notes on Handling of ICs

The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. None of the multiple ratings can be exceeded. Exceeding the absolute maximum ratings may cause destruction, damage and deterioration, and may result in injury due to explosion or burning.

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