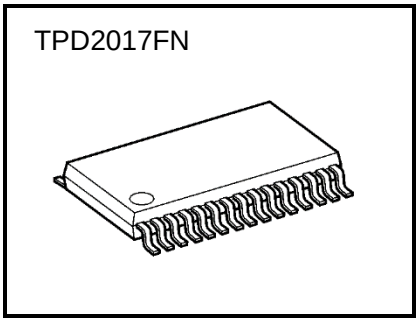
Toshiba Intelligent Power Device Silicon Monolithic MOS Integrated Circuit

TPD2017FN

Low side switch (8-channels) for motors, solenoids, lamp drives

1. Description

TPD2017FN is a low-side switch (8 channels) with MOS FET out. This is the monolithic power IC that can be driven directly from CMOS, TTL logic circuitry (MCUs, etc.) and have overcurrent and thermal protection features.



SSOP30-P-300-0.65

2. Applications

- Programmable logic controller for Industrial Use.
- Driving resistant load and inductive loads.

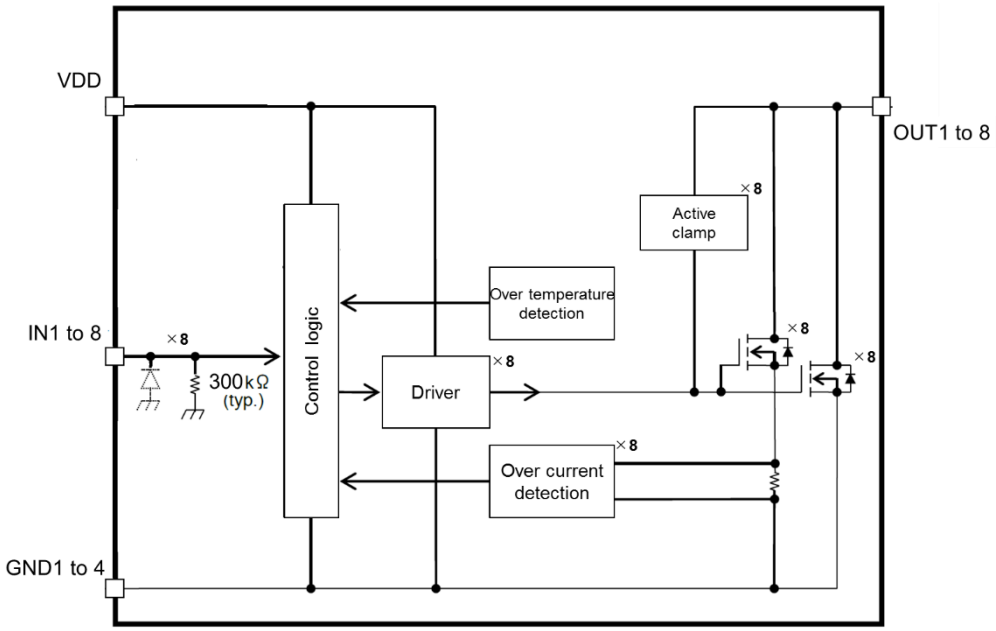
3. Features

- 8-channels of N-channel MOSFET are built-in.
- This IC can drive the power load directly.
- Built-in protection against over temperature and over current.
- 8-channels access enables space-saving design.
- Low voltage operation is possible : 2.7 V
- Low on resistance : 0.55Ω (max) @ V_{IN} = 5V, I_{OUT} = 0.5A, T_j = 25℃ (per channels)
- Parallel operation is possible.
- Built-in active clamp circuit.
- SSOP30 packaging (300 mils) is embossed taping.

Note:This product has a MOS structure. Be careful of static electricity when handling it.

Start of commercial production
2022-05

4. Block Diagram



Note: Some of the functional blocks, circuits, constants, etc. in the block diagram are omitted and simplified.

Figure 4.1 Block Diagram

5. Pin Assignments

(TOP VIEW)

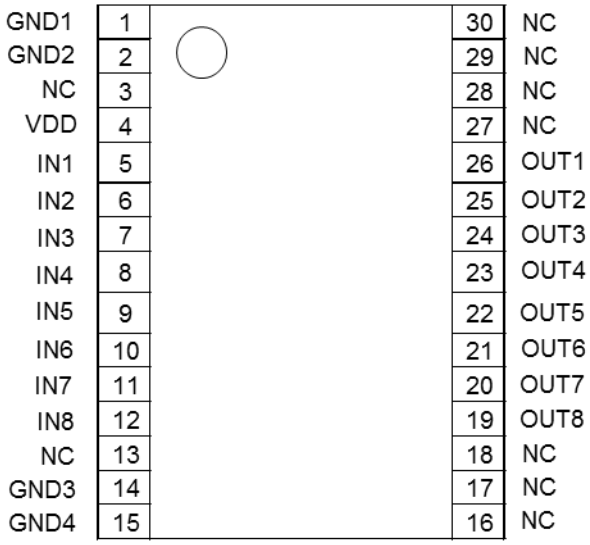


Figure 5.1 Pin Assignments

6. Pin Description

Table 6.1 Pin Description

Pin No.	Symbol	I/O	Pin Description
1	GND1	-	GND pin.
2	GND2	-	GND pin.
3	NC	-	No-Connect pin.
4	VDD	-	Power supply pin.
5	IN1	IN	Input pin for channel 1. Built in pull down resistor (300kΩ typ.).
6	IN2	IN	Input pin for channel 2. Built in pull down resistor (300kΩ typ.).
7	IN3	IN	Input pin for channel 3. Built in pull down resistor (300kΩ typ.).
8	IN4	IN	Input pin for channel 4. Built in pull down resistor (300kΩ typ.).
9	IN5	IN	Input pin for channel 5. Built in pull down resistor (300kΩ typ.).
10	IN6	IN	Input pin for channel 6. Built in pull down resistor (300kΩ typ.).
11	IN7	IN	Input pin for channel 7. Built in pull down resistor (300kΩ typ.).
12	IN8	IN	Input pin for channel 8. Built in pull down resistor (300kΩ typ.).
13	NC	-	No-Connect pin.
14	GND3	-	GND pin.
15	GND4	-	GND pin.
16	NC	-	No-Connect pin.
17	NC	-	No-Connect pin.
18	NC	-	No-Connect pin.
19	OUT8	OUT	Output pin of channel 8.
20	OUT7	OUT	Output pin of channel 7.
21	OUT6	OUT	Output pin of channel 6.
22	OUT5	OUT	Output pin of channel 5.
23	OUT4	OUT	Output pin of channel 4.
24	OUT3	OUT	Output pin of channel 3.
25	OUT2	OUT	Output pin of channel 2.
26	OUT1	OUT	Output pin of channel 1.
27	NC	-	No-Connect pin.
28	NC	-	No-Connect pin.
29	NC	-	No-Connect pin.
30	NC	-	No-Connect pin.

7. Operational Description

7.1. Over temperature protection

To prevent destruction due to temperature rise, the outputs are turned off when the junction temperature of this product exceeds the overheat detection temperature (T_{SD}). When the junction temperature falls below the hysteresis set temperature (T_{SD}-ΔT_{SD}), the unit recovers to normal operation.

7.2. Over current protection

When the output current exceeds the overcurrent detection value (I_{OC}) due to a load short-circuit, etc., the output is turned off for the overcurrent protection operation time ($t_{OFF\text{-}DUTY}$). The output will then recover, but if the overcurrent condition persists, the output will be turned off again for the overcurrent protective operation period ($t_{OFF\text{-}DUTY}$).

7.3. Timing chart

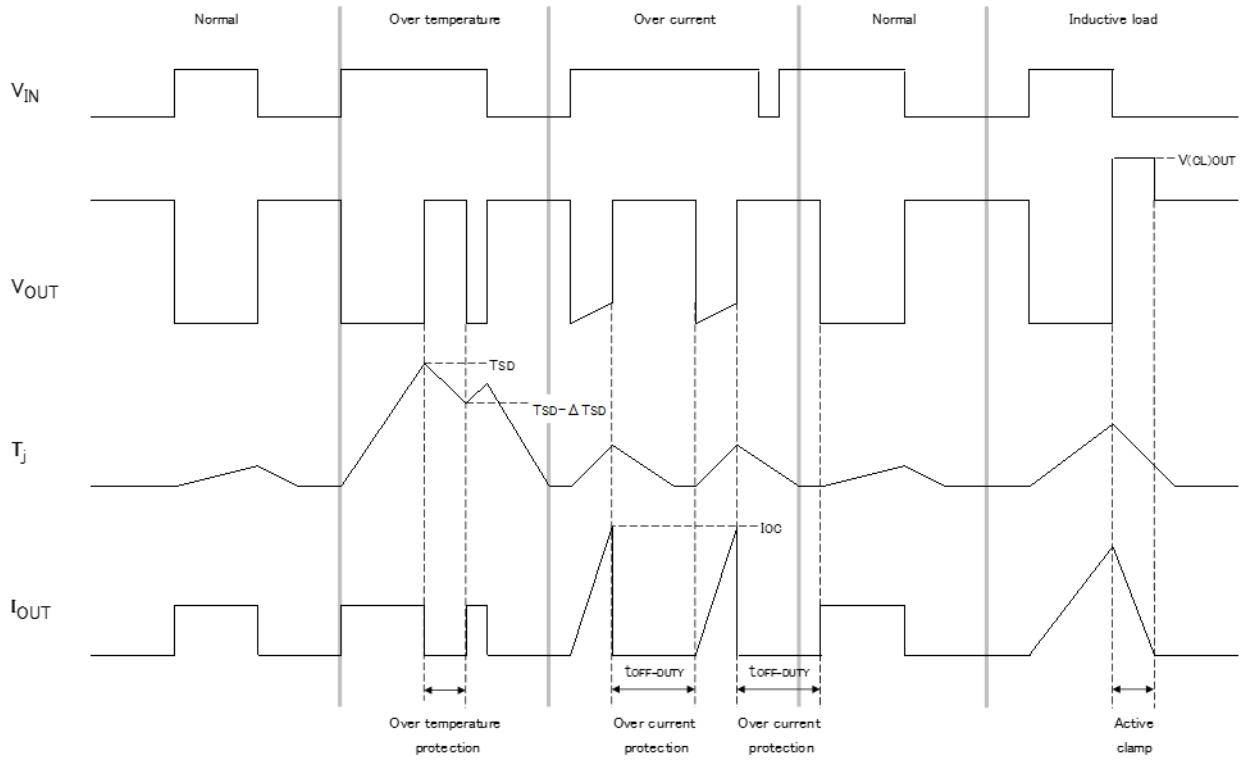


Figure 7.1 Timing chart

7.4. Truth table

Table 7.1 Truth table

Input	Output	Operating state
L	H	Normal
H	L	
L	H	Over current protection (Load short circuit)
H	Switching	
L	H	Over temperature protection
H	H	

8. Absolute Maximum Ratings

Table 8.1 Absolute Maximum Ratings

(T_a = 25℃ unless otherwise specified)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{DD}	−0.3 to 6.0	V
Input voltage	V_{IN}	−0.3 to 6.0	V
Output withstand voltage	V_{OUT}	50.0[1)]	V
Output current	I_{OUT}	Internally limited	A
Power dissipation (operation all channels, Ta=25℃)	P_D	1.8	W
Operating temperature	T_{opr}	−40 to 110	°C
Junction temperature	T_j	150	°C
Storage temperature	T_{stg}	−55 to 150	°C

Note1**:** 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).

1) Not subject to production test

8.1. Thermal Resistance

Table 8.2 Thermal resistance

Characteristics	Symbol	Rating	Unit
Thermal resistance (junction to ambient)	$R_{th\ (j-a)}$	70	°C / W

Note: JEDEC Standard.
Glass epoxy board
Material: FR-4(4 layer)
Board size: 76.2mmx114.3mmx1.6mm

9. Operating Ranges

Table 9.1 Operating supply voltage

Characteristics	Symbol	Condition	Min	Typ.	Max	Unit
Operating supply voltage	$V_{DD(opr)}$	T_j = 25°C	2.7	-	5.5	V

10. Electrical Characteristics

Table 10.1 Electrical Characteristics

(T_j = 25°C, V_{DD} = 2.7 to 5.5V unless otherwise specified)

Characteristics		Symbol	Test condition	Min	Typ.	Max	Unit
Output clamp voltage		$V_{(CL)OUT}$	I_{OUT} = 10mA, V_{IN} = 0V	40	-	50	V
Supply current		$I_{DD(OFF)}$	V_{DD} =5V, V_{IN} = 0V	-	1.8	2.6	mA
		$I_{DD(ON)}$	V_{DD} =5V, V_{IN} = 5V, All outputs open	-	2.2	3.1	mA
Input voltage	**"L" level**	V_{IL}	-	-	-	0.8	V
	"H" level	V_{IH}	-	2.0	-	-	
Input current		I_{IL}	V_{IN} = 0V	−1.0	-	1.0	μA
		I_{IH}	V_{IN} = 5V	-	17	23	
On resistance		$R_{DS(ON)}$	V_{DD} = 5V, V_{IN} = 5V, I_{OUT} = 0.5A	-	0.40	0.55	Ω
Output leakage current		I_{OL}	V_L = 40V, V_{IN} = 0V, Per output	-	-	10	μA
Over current detection		I_{OC}	V_{DD} = 5V	1.0	1.5	2.5	A
Over current protection operation time		$t_{OFF-DUTY}$	V_{DD} = 5V	1.5	3.0	4.8	ms
Over temperature detection	**Temperature**	T_{SD}	V_{DD} = 5V	150	175	200	°C
	Hysteresis	ΔT_{SD}	V_{DD} = 5V	5	15	25	
Switching time		t_{ON}	Refer to test circuit 1	5	10	18	μs
		t_{OFF}		3	8	15	
Single pulse energy		E_S	T_a=25℃, I_{OUT}=0.75A (1-channel operation)	30	150[2)]	-	mJ

2) Not subject to production test

11. Test circuit

11.1. Test circuit 1

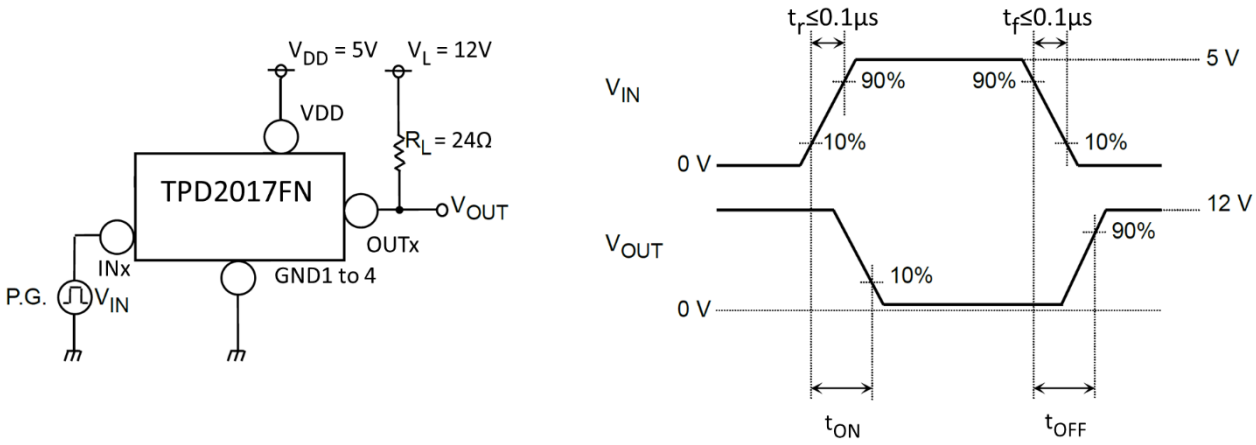
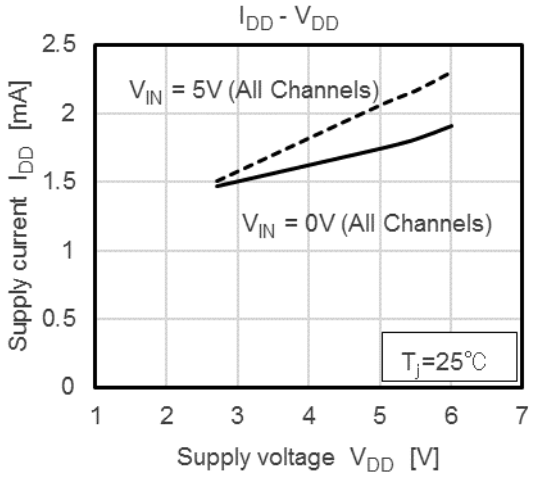
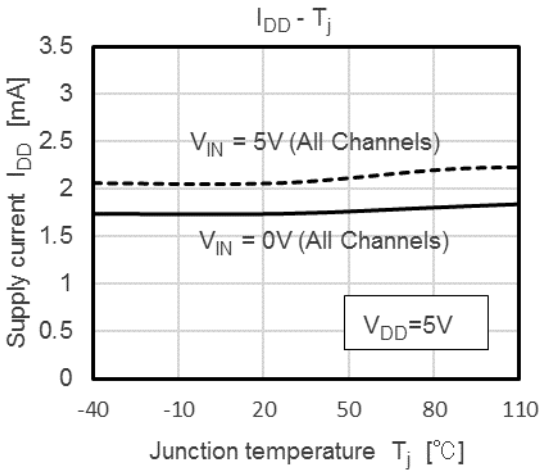


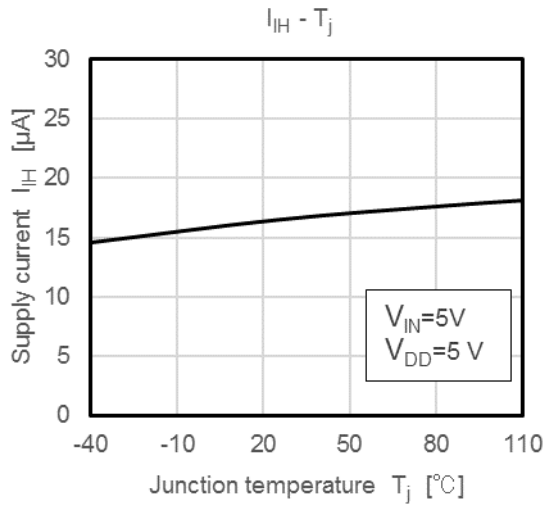
Figure 11.1 Switching time measurement circuit

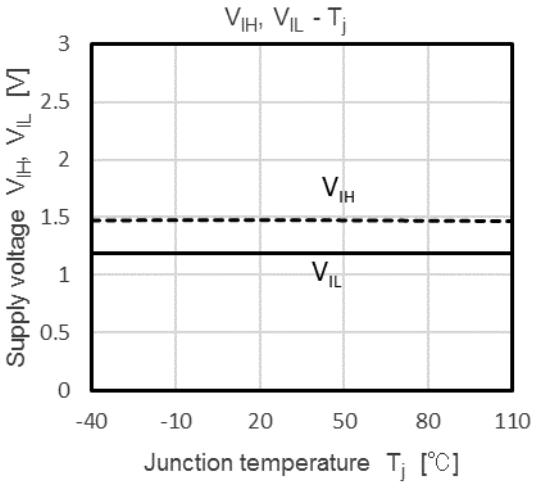
12. Characteristic curves

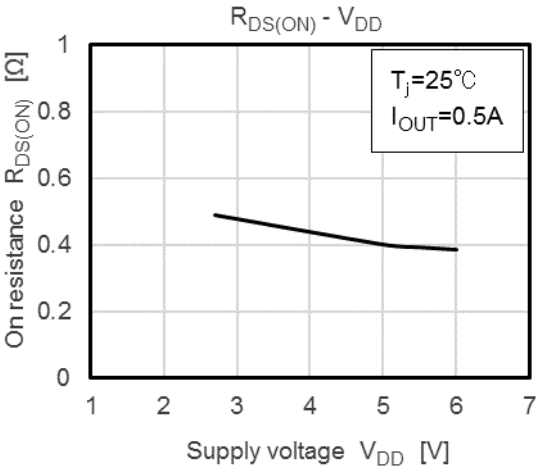
The values in the characteristic diagram are not guaranteed values unless otherwise specified, but reference values.

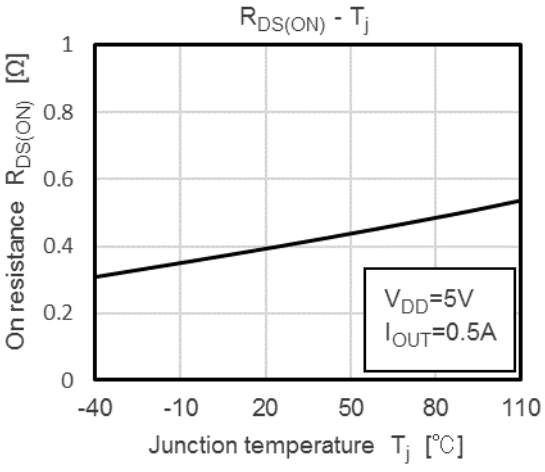


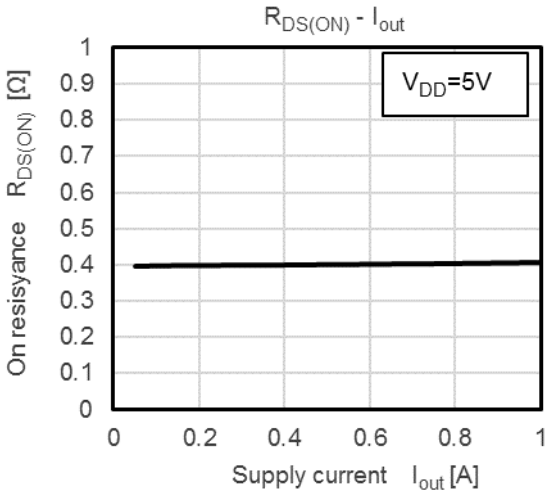


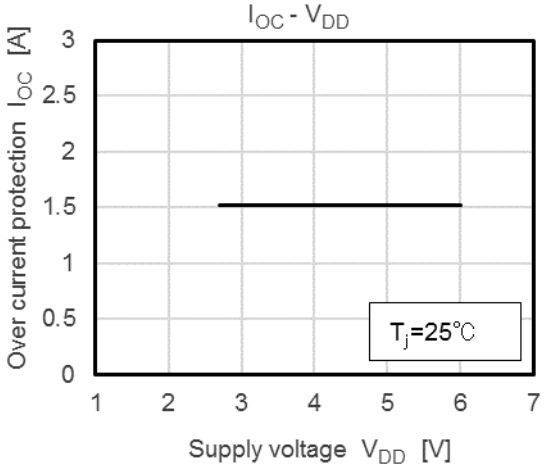


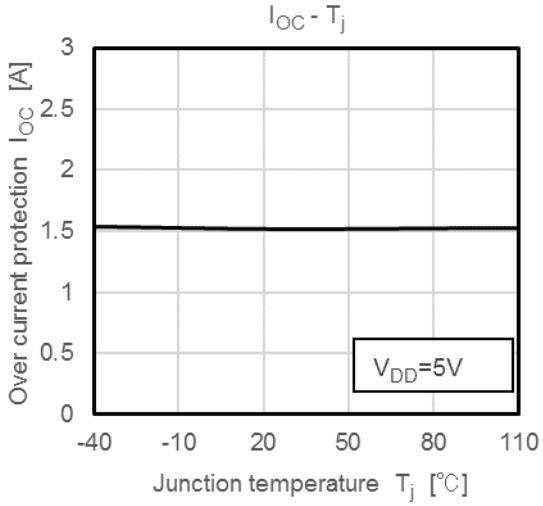


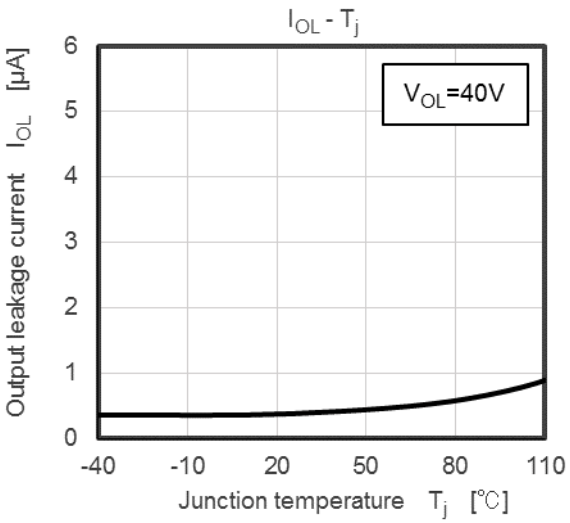


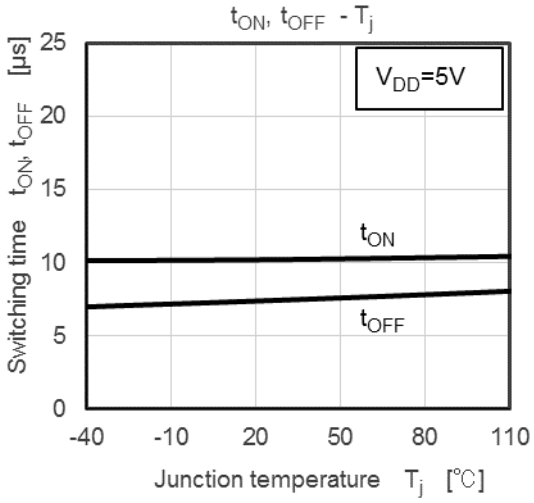


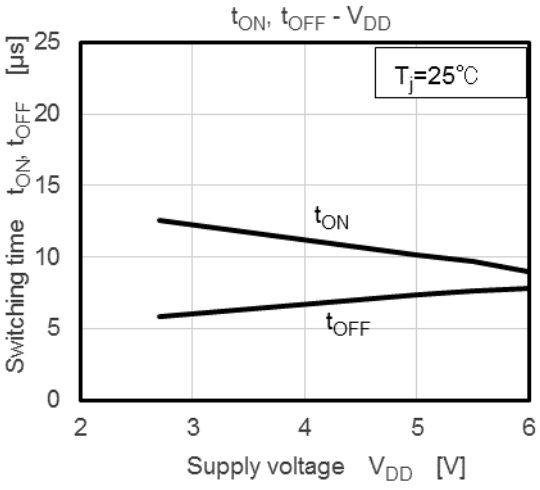


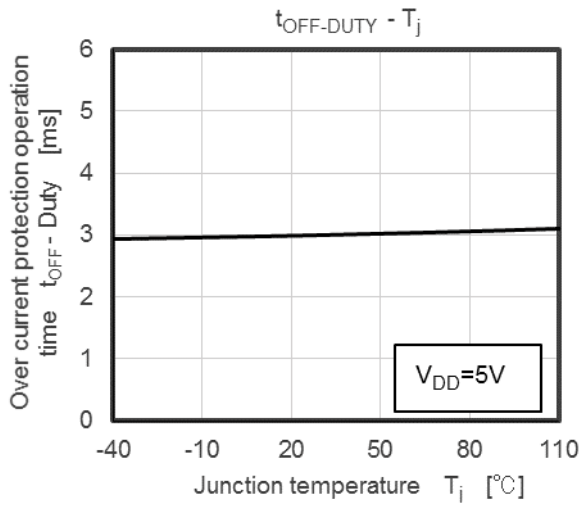


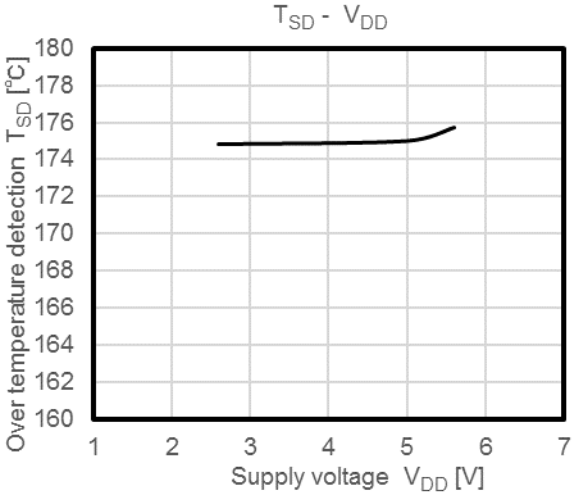


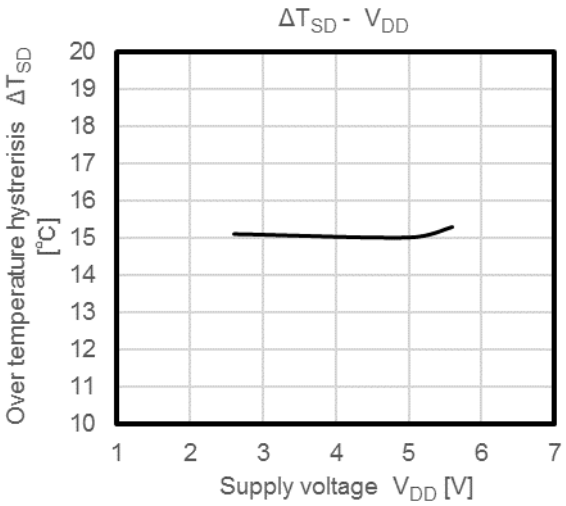




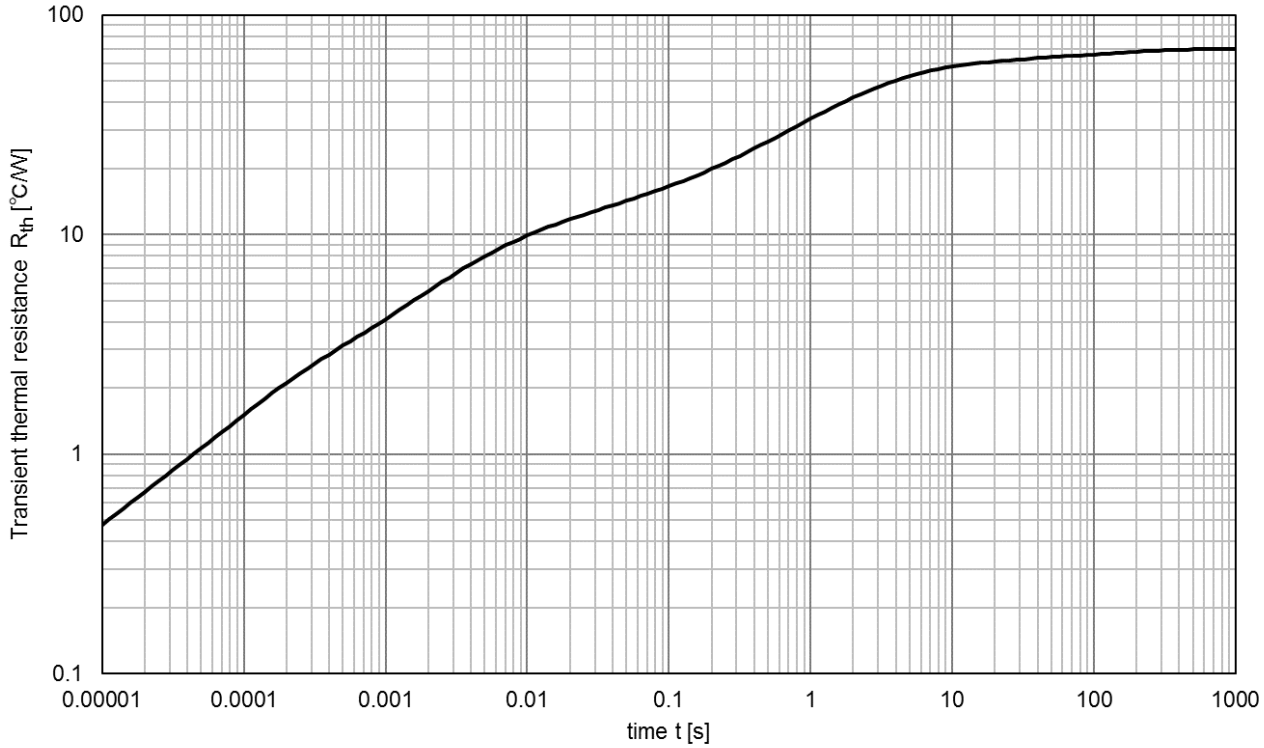



$t_{OFF-DUTY}$ - T_j
Over current protection operation time t_{OFF} - Duty [ms]
6
5
4
3
2
1
0
-40
-10
20
50
80
110
Junction temperature T_j [°C]
V_{DD}=5V


T_{SD} - V_{DD}
Over temperature detection T_{SD} [°C]
180
178
176
174
172
170
168
166
164
162
160
1
2
3
4
5
6
7
Supply voltage V_{DD} [V]


ΔT_{SD} - V_{DD}
Over temperature hystrerisis ΔT_{SD} [°C]
20
19
18
17
16
15
14
13
12
11
10
1
2
3
4
5
6
7
Supply voltage V_{DD} [V]

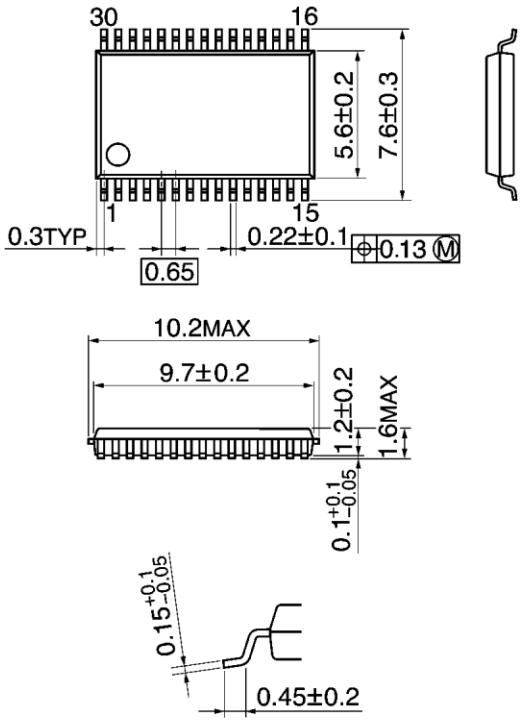
R_{th} - t (1-channel operation)



13. Package Information

13.1. Package Dimensions

Unit : mm



Weight: 0.176 g (Typ.)

Figure 13.1 Package Dimensions

13.2. Marking

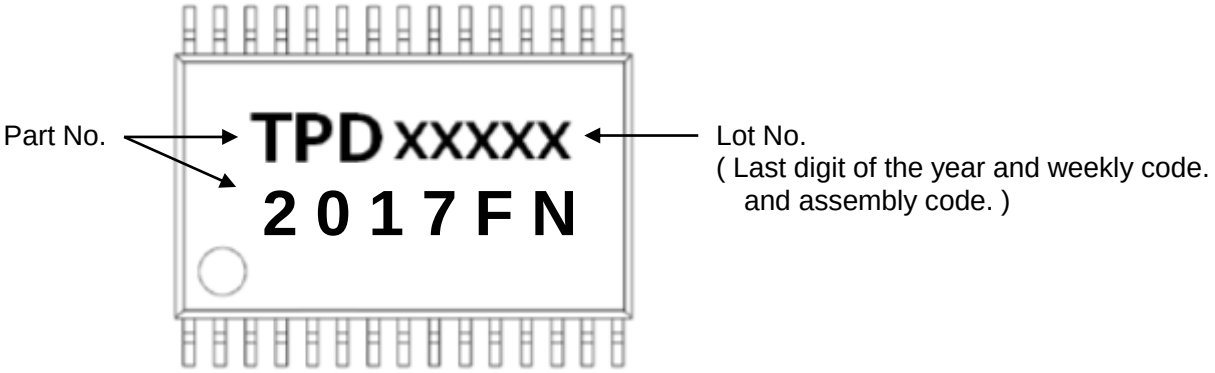


Figure 13.2 Marking

13.3. Land Pattern Dimensions for Reference only

SSOP30-P-300-0.65

"Unit: mm"

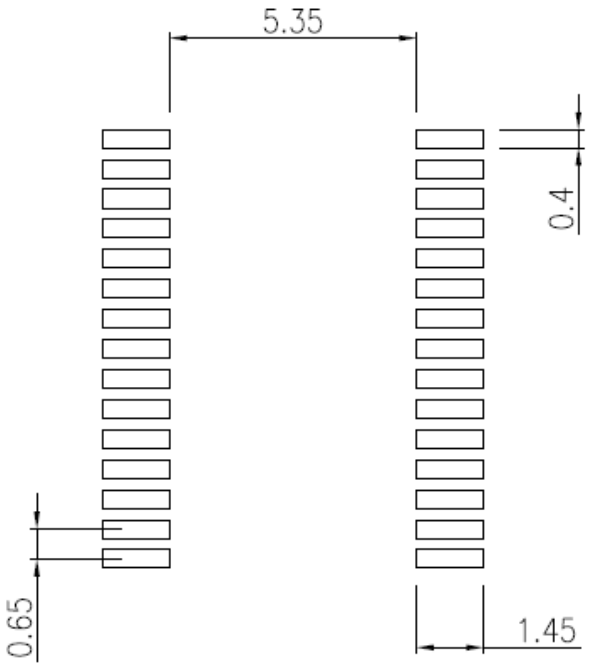


図 13.3 Land Pattern Dimensions for Reference only

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.

Since the power supply reverse connection protection is not built-in, take measures with an external circuit.

Since the negative bias protection circuit of the output terminal is not built-in, when a negative bias is applied to the output terminal, be sure to connect a diode for back electromotive voltage absorption (FWD) between OUT and GND.

14.2. Notes on moisture-proof packaging

After opening the moisture-proof package, mount it within 168 hours in an environment of 30°C and RH 60% or less.
Since it cannot be baked due to embossing, be sure to use it within the permissible range after opening the moisture-proof packaging.
The standard packing quantity for taping is 2000 pieces / reel.

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