

SSM5G09TU

1. Applications

- DC-DC Converters

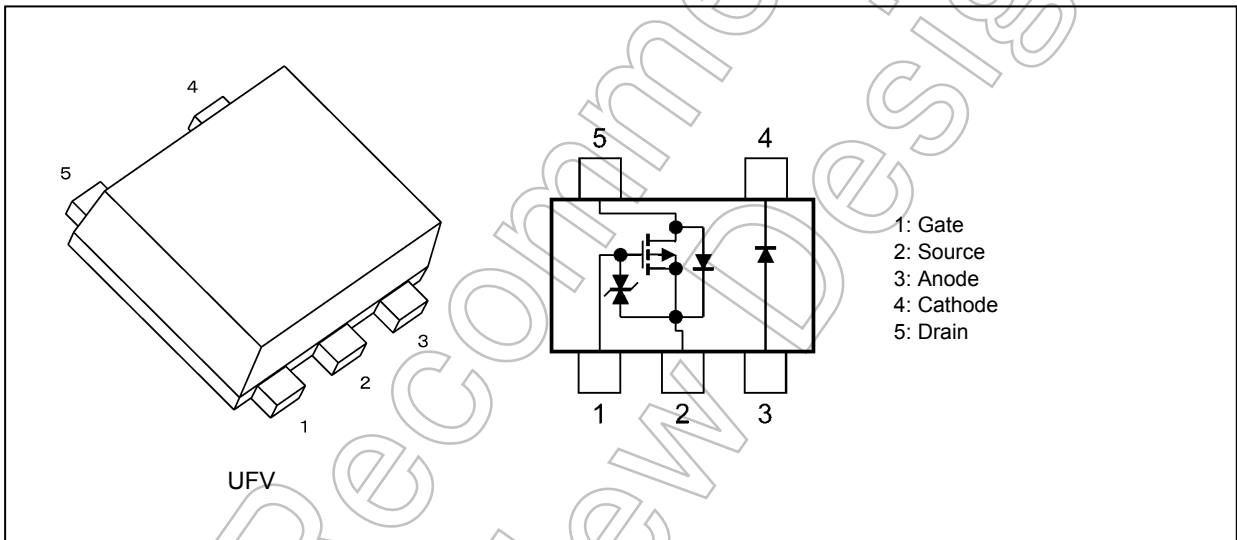
2. Features

- (1) Combined an P-channel MOSFET and a diode in one package.
- (2) Low $R_{DS(ON)}$ and Low V_F

2.1. MOSFET Features

- (1) Low drain-source on-resistance
 $R_{DS(ON)} = 130 \text{ m}\Omega$ (max) (@ $V_{GS} = -4.0 \text{ V}$)
 $R_{DS(ON)} = 200 \text{ m}\Omega$ (max) (@ $V_{GS} = -2.5 \text{ V}$)

3. Packaging and Internal Circuit



4. Absolute Maximum Ratings (Note)

4.1. Absolute Maximum Ratings of the MOSFET (Unless otherwise specified, $T_a = 25 \text{ }^\circ\text{C}$)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	-12	V
Gate-source voltage	V_{GSS}	± 8	
Drain current	I_D	-1.5	A
Drain current (pulsed) (Note 1)	I_{DP}	-6.0	
Power dissipation (Note 2)	P_D	0.5	W
Power dissipation (t = 10 s) (Note 2)		0.8	
Channel temperature	T_{ch}	150	$^\circ\text{C}$

Note 1: The pulse width limited by maximum channel temperature.

Note 2: P_D for the entire IC

Device mounted on a 25.4 mm × 25.4 mm × 1.6 mm FR4 glass epoxy board (Cu pad: 645 mm²)

Start of commercial production

2003-09

4.2. Absolute Maximum Ratings of the Schottky Barrier Diode (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Rating	Unit
Peak reverse voltage	V_{RM}	15	V
Reverse voltage	V_R	12	
Average rectified current	I_O	0.5	A
Non-repetitive peak forward surge current (f = 50 Hz)	I_{FSM}	2	
Junction temperature	T_j	125	$^\circ\text{C}$

4.3. Absolute Maximum Ratings of the Common Section (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Rating	Unit
Storage temperature	T_{stg}	-55 to 125	$^\circ\text{C}$
Operating temperature (Note 1)	T_{opr}	-40 to 85	

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.

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: Maximum operating temperature limited by junction and channel temperatures.

Note: The MOSFETs in this device are sensitive to electrostatic discharge. When handling this device, the worktables, operators, soldering irons and other objects should be protected against anti-static discharge.

Note: The channel-to-ambient thermal resistance, $R_{th(ch-a)}$, and the drain power dissipation, P_D , vary according to the board material, board area, board thickness and pad area. When using this device, be sure to take heat dissipation fully into account.

Not Recommended for New Design

5. Electrical Characteristics

5.1. Static Characteristics of the MOSFET (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	$V_{DS} = 0\text{ V}, V_{GS} = \pm 8\text{ V}$	—	—	± 1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = -12\text{ V}, V_{GS} = 0\text{ V}$	—	—	-1	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = -1\text{ mA}, V_{GS} = 0\text{ V}$	-12	—	—	V
Drain-source breakdown voltage (Note 1)	$V_{(BR)DSX}$	$I_D = -1\text{ mA}, V_{GS} = 8\text{ V}$	-4	—	—	
Gate threshold voltage (Note 2)	V_{th}	$V_{DS} = -3\text{ V}, I_D = -0.1\text{ mA}$	-0.5	—	-1.1	
Drain-source on-resistance (Note 3)	$R_{DS(ON)}$	$I_D = -0.75\text{ A}, V_{GS} = -4.0\text{ V}$	—	100	130	$\text{m}\Omega$
		$I_D = -0.75\text{ A}, V_{GS} = -2.5\text{ V}$	—	130	200	
Forward transfer admittance (Note 3)	$ Y_{fs} $	$V_{DS} = -3\text{ V}, I_D = -0.75\text{ A}$	1.75	3.5	—	S

Note 1: If a reverse bias is applied between gate and source, this device enters $V_{(BR)DSX}$ mode. Note that the drain-source breakdown voltage is lowered in this mode.

Note 2: Let V_{th} be the voltage applied between gate and source that causes the drain current (I_D) to below ($100\text{ }\mu\text{A}$ for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than V_{th} , and $V_{GS(OFF)}$ must be lower than V_{th} . This relationship can be expressed as: $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$. Take this into consideration when using the device.

Note 3: Pulse measurement.

5.2. Dynamic Characteristics of the MOSFET (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$	—	550	—	pF
Reverse transfer capacitance	C_{riss}		—	155	—	
Output capacitance	C_{oss}		—	170	—	
Switching time (turn-on time)	t_{on}	$V_{DD} = -10\text{ V}, I_D = -0.75\text{ A},$ $V_{GS} = 0\text{ to }-2.5\text{ V}, R_G = 4.7\text{ }\Omega$ Duty $\leq 1\%$, Input: $t_r, t_f < 5\text{ ns}$, Common source, See Chapter 5.3.	—	34	—	ns
Switching time (turn-off time)	t_{off}		—	28	—	

5.3. Switching Time Test Circuit

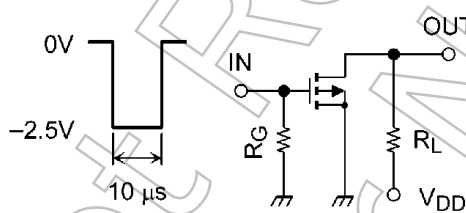


Fig. 5.3.1 Test Circuit of Switching Time

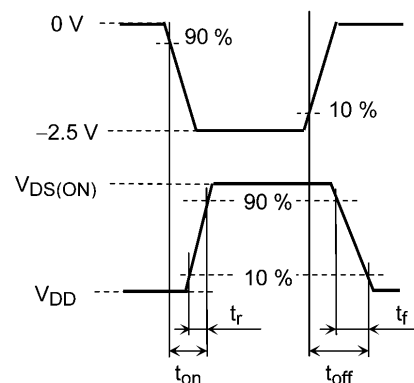


Fig. 5.3.2 Input Waveform/Output Waveform

5.4. Characteristics of the Diode (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Forward voltage	$V_{F(1)}$	$I_F = 300\text{ mA}$	—	0.33	0.39	V
	$V_{F(2)}$	$I_F = 500\text{ mA}$	—	0.37	0.43	
Reverse current	I_R	$V_R = 12\text{ V}$	—	—	100	μA
Total capacitance	C_t	$V_R = 0\text{ V}, f = 1\text{ MHz}$	—	80	—	pF

6. Marking

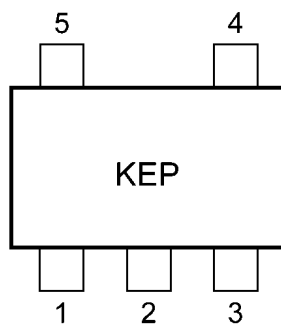


Fig. 6.1 Marking

Note: The schottky barrier diode of this product are having large-reverse-current-leakage characteristic compare to the other switching diodes. This current leakage and not proper operating temperature or voltage may cause thermal runaway. Be sure to take forward and reverse loss into consideration when you design.

Not Recommended
for New Design

7. Characteristics Curves (Note)

7.1. Characteristics Curves of the MOSFET

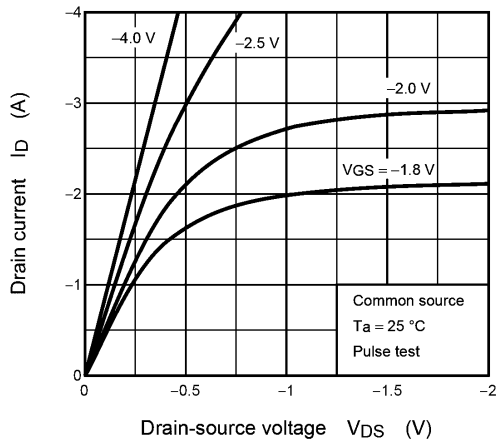


Fig. 7.1.1 $I_D - V_{DS}$

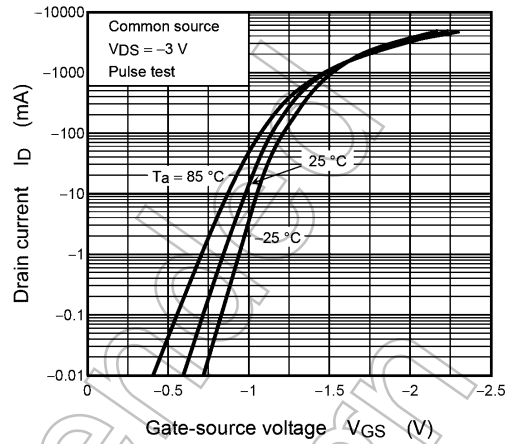


Fig. 7.1.2 $I_D - V_{GS}$

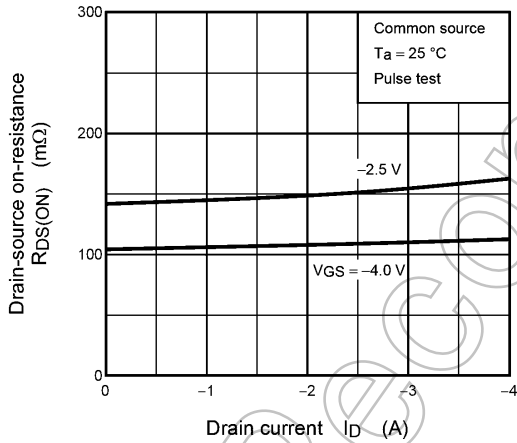


Fig. 7.1.3 $R_{DS(ON)} - I_D$

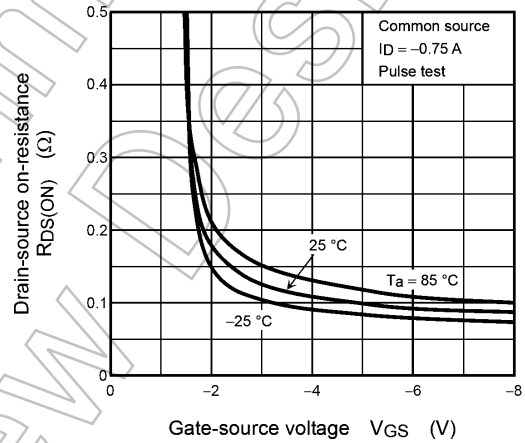


Fig. 7.1.4 $R_{DS(ON)} - V_{GS}$

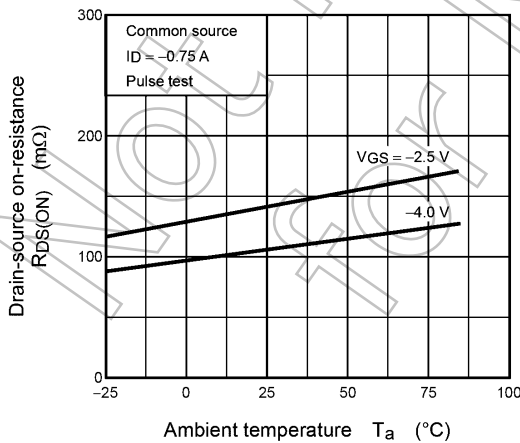


Fig. 7.1.5 $R_{DS(ON)} - T_a$

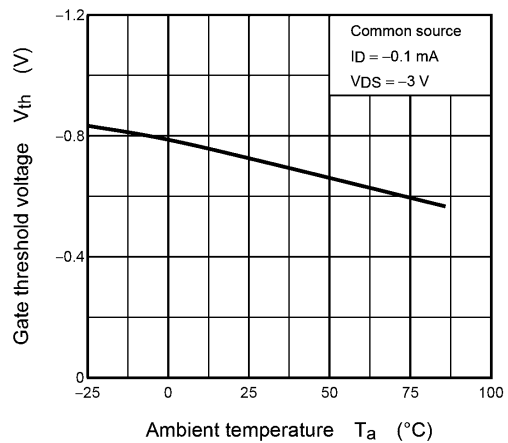


Fig. 7.1.6 $V_{th} - T_a$

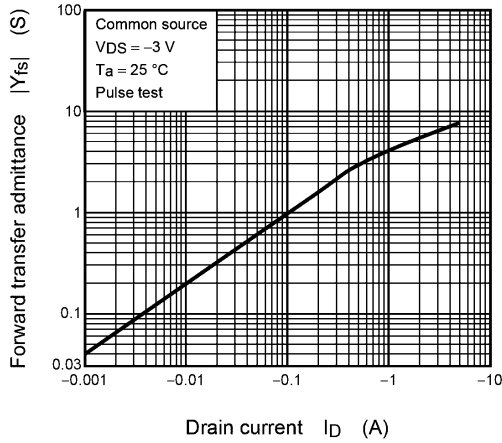


Fig. 7.1.7 $|Y_{fs}| - I_D$

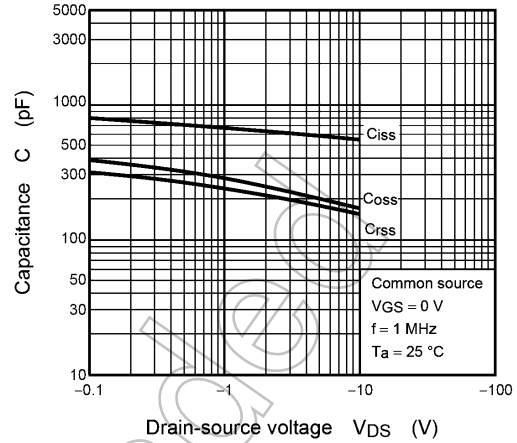


Fig. 7.1.8 $C - V_{DS}$

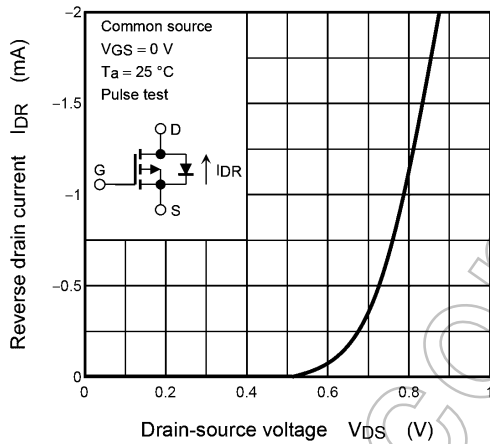


Fig. 7.1.9 $I_{DR} - V_{DS}$

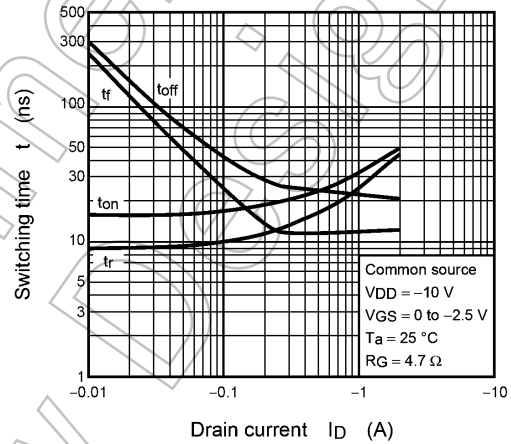


Fig. 7.1.10 $t - I_D$

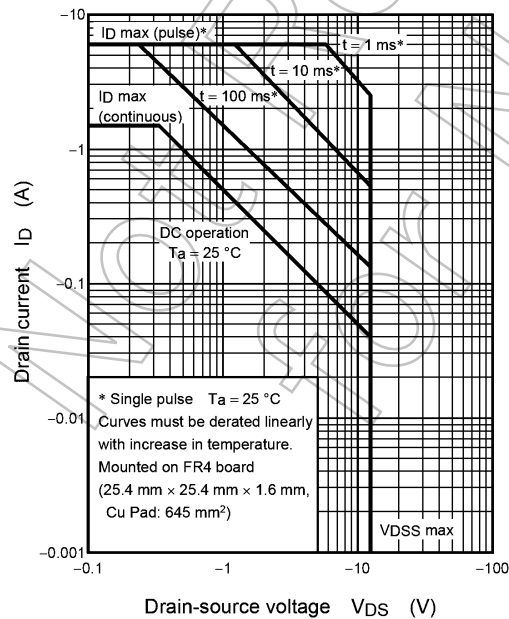


Fig. 7.1.11 Safe Operating Area

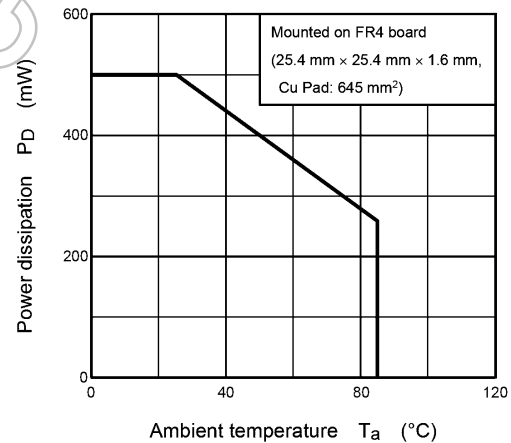


Fig. 7.1.12 $P_D - T_a$

7.2. Characteristics Curves of the Diode

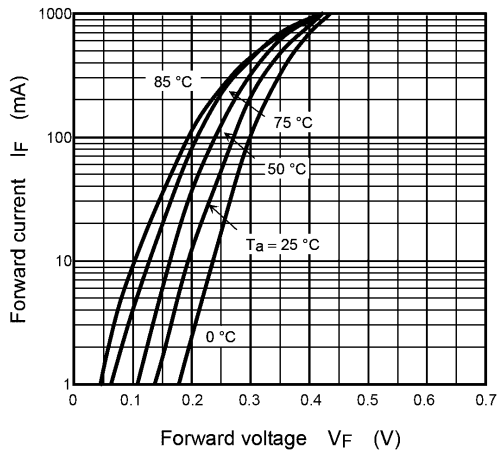


Fig. 7.2.1 $I_F - V_F$

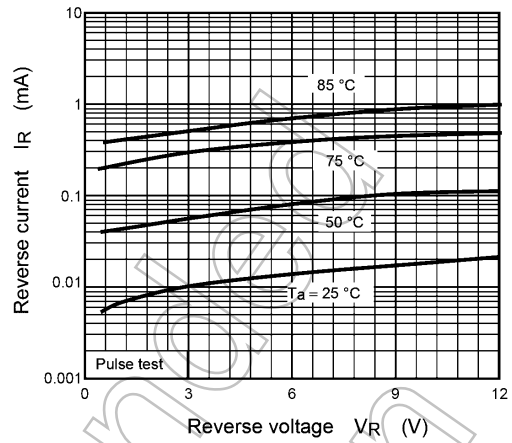


Fig. 7.2.2 $I_R - V_R$

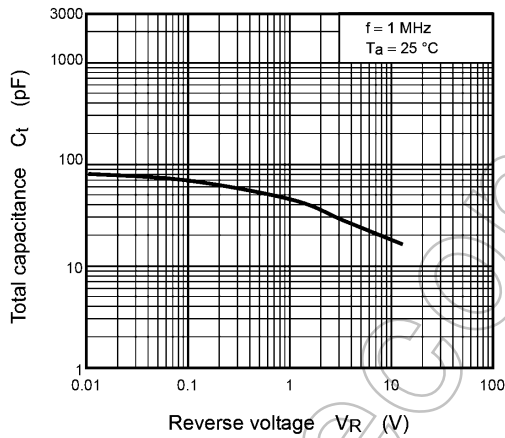


Fig. 7.2.3 $C_t - V_R$

7.3. Transient thermal impedance Graph

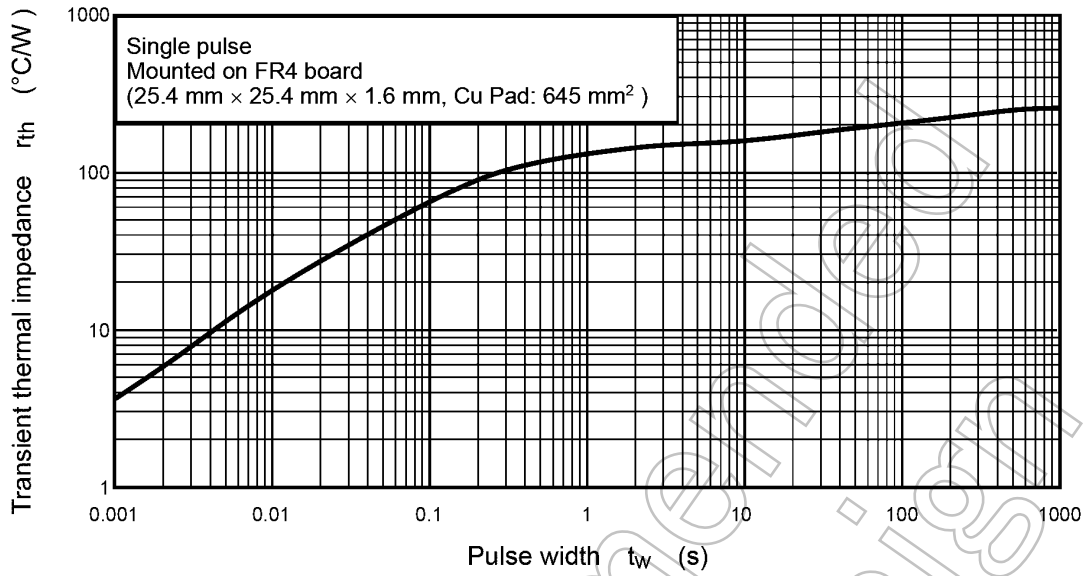


Fig. 7.3.1 $r_{th} - t_w$ (MOSFET)

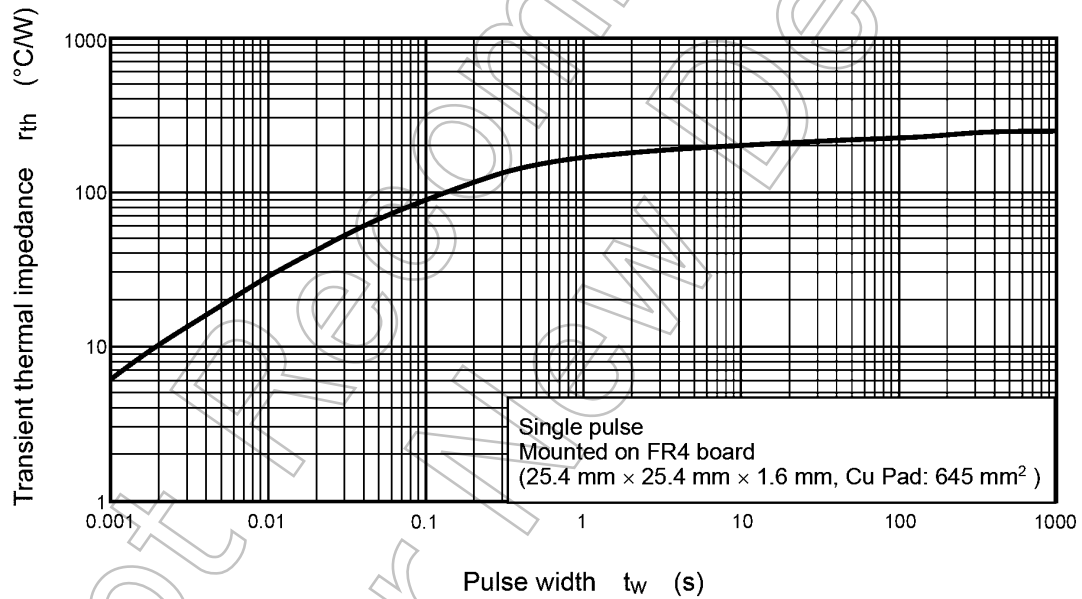


Fig. 7.3.2 $r_{th} - t_w$ (SBD)

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

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