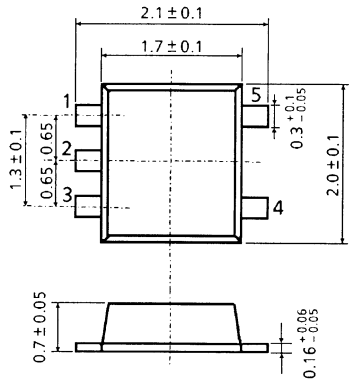
Silicon N Channel MOS Type (U-MOSⅢ)/Silicon Epitaxial Schottky Barrier Diode

# SSM5H05TU

DC-DC Converter

- Combined Nch MOSFET and Schottky Diode in one package.
- Low $R_{DS\ (ON)}$ and low $V_F$

Unit: mm




1 : GATE 4 : CATHODE
2 : SOURCE 5 : DRAIN
3 : ANODE

**UFV**

| | |
|---|---|
| JEDEC | ― |
| JEITA | ― |
| TOSHIBA | 2-2R1A |

Weight: 7 mg (typ.)

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

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-Source voltage | | $V_{DS}$ | 20 | V |
| Gate-Source voltage | | $V_{GSS}$ | ±12 | V |
| Drain current | DC | $I_D$ | 1.5 | A |
| | Pulse | $I_{DP}$ (Note 2) | 6.0 | |
| Drain power dissipation | | $P_D$ (Note 1) | 0.5 | W |
| | | t = 10s | 0.8 | |
| Channel temperature | | $T_{ch}$ | 150 | °C |

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

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Maximum (peak) reverse voltage | $V_{RM}$ | 15 | V |
| Reverse voltage | $V_R$ | 12 | V |
| Average forward current | $I_O$ | 0.5 | A |
| Peak one cycle surge forward current (non-repetitive) | $I_{FSM}$ | 2 (50 Hz) | A |
| Junction temperature | $T_j$ | 125 | °C |

## Absolute Maximum Ratings (Ta = 25°C) MOSFET, DIODE COMMON

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Storage temperature | $T_{stg}$ | −55~125 | °C |
| Operating temperature | $T_{opr}$ (Note 3) | −40~85 | °C |

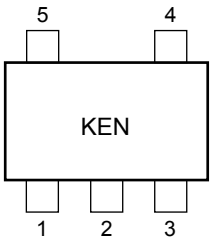
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.
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).

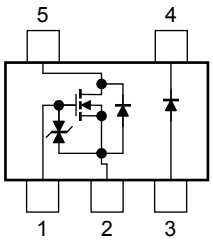
Note 1: Mounted on FR4 board
(25.4 mm × 25.4 mm × 1.6 t, Cu pad: 645 $mm^2$)

Note 2: The pulse width is limited by max channel temperature.

Note 3: The operating temperature is limited by max channel temperature and max junction temperature.

**Marking** **Equivalent Circuit**




## Handling Precaution

When handling individual devices (which are not yet mounted on a circuit board), ensure that the environment is protected against static discharge. Operators should wear anti-static clothing and use containers and other objects that are made of anti-static materials.

The Channel-to-Ambient thermal resistance $R_{th\ (ch\text{-}a)}$ 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.

## MOSFET

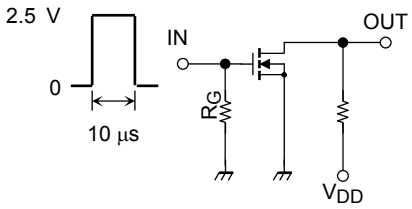
## Electrical Characteristics (Ta = 25°C)

| Characteristic | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Gate leakage current | | $I_{GSS}$ | $V_{GS}$ = ±12 V, $V_{DS}$ = 0 | — | — | ±1 | μA |
| Drain-Source breakdown voltage | | $V_{(BR)\ DSS}$ | $I_D$ = 1 mA, $V_{GS}$ = 0 | 20 | — | — | V |
| | | $V_{(BR)\ DSX}$ | $I_D$ = 1 mA, $V_{GS}$ = -12 V | 12 | — | — | |
| Drain Cut-off current | | $I_{DSS}$ | $V_{DS}$ = 20 V, $V_{GS}$ = 0 | — | — | 1 | μA |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = 3 V, $I_D$ = 0.1 mA | 0.4 | — | 1.1 | V |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = 3 V, $I_D$ = 0.75 A (Note 4) | 1.4 | 2.8 | — | S |
| Drain-Source on-resistance | | $R_{DS\ (ON)}$ | $I_D$ = 0.75 A, $V_{GS}$ = 4 V (Note 4) | — | 140 | 160 | mΩ |
| | | | $I_D$ = 0.75 A, $V_{GS}$ = 2.5 V (Note 4) | — | 180 | 220 | |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = 10 V, $V_{GS}$ = 0, f = 1 MHz | — | 125 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | $V_{DS}$ = 10 V, $V_{GS}$ = 0, f = 1 MHz | — | 17 | — | pF |
| Output capacitance | | $C_{oss}$ | $V_{DS}$ = 10 V, $V_{GS}$ = 0, f = 1 MHz | — | 42 | — | pF |
| Switching time | Turn-on time | $t_{on}$ | $V_{DD}$ = 10 V, $I_D$ = 0.75 A | — | 15.5 | — | ns |
| | Turn-off time | $t_{off}$ | $V_{GS}$ = 0~2.5 V, $R_G$ = 4.7 Ω | — | 8.5 | — | |

Note 4: Pulse measurement

## Switching Time Test Circuit

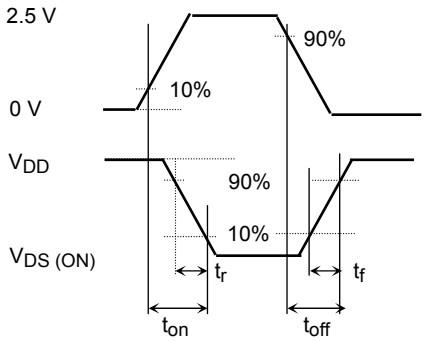
### (a) Test circuit




$V_{DD}$ = 10 V
$R_G$ = 4.7 Ω
Duty ≦ 1%
$V_{IN}$: $t_r$, $t_f$ < 5 ns
Common source
Ta = 25°C

### (b) $V_{IN}$

### (c) $V_{OUT}$




## Precaution

$V_{th}$ can be expressed as the voltage between the gate and source when the low operating current value is $I_D$ = 100 μA for this product. For normal switching operation, $V_{GS\ (on)}$ requires a higher voltage than $V_{th}$ and $V_{GS\ (off)}$ requires a lower voltage than $V_{th}$. (The relationship can be established as follows: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

Be sure to take this into consideration when using the device.

## Schottky Diode

## Electrical Characteristics (Ta = 25°C)

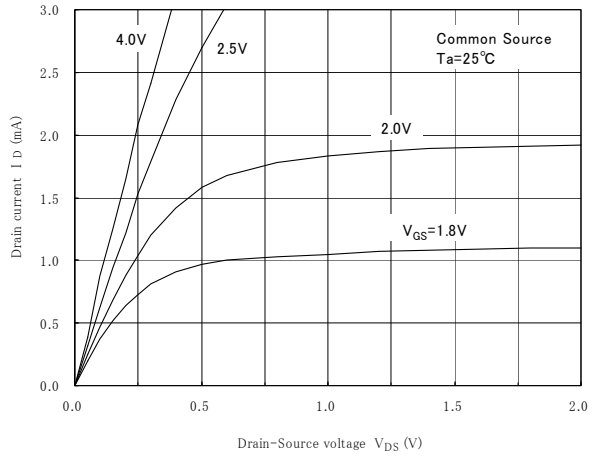
| Characteristic | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Forward voltage | $V_{F\ (1)}$ | $I_F$ = 0.3 A | — | 0.33 | 0.39 | V |
| | $V_{F\ (2)}$ | $I_F$ = 0.5 A | — | 0.37 | 0.43 | V |
| Reverse current | $I_R$ | $V_R$ = 12 V | — | — | 100 | μA |
| Total capacitance | $C_T$ | $V_R$ = 0 V, f = 1 MHz | — | 80 | — | pF |

## Precaution

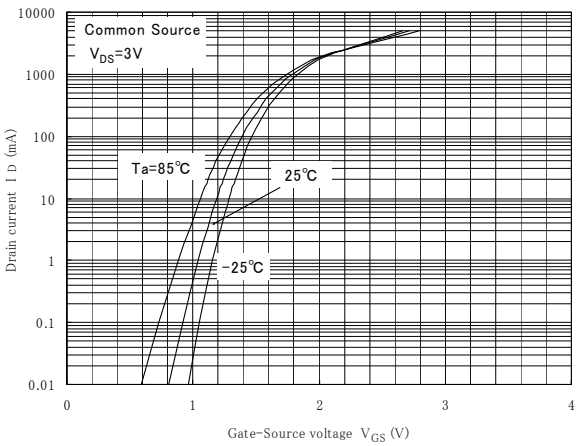
The schottky barrier diode of this product has large reverse current leakage characteristics compared to other switching diodes. This current leakage, combined with improper operating temperature or voltage, may cause thermal runaway. Be sure to take forward and reverse loss into consideration during you design.

## MOSFET Electrical Characteristics

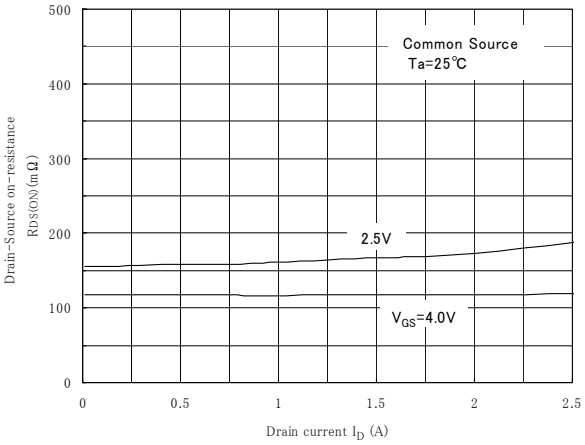
$I_D$ – $V_{DS}$ (MOSFET)



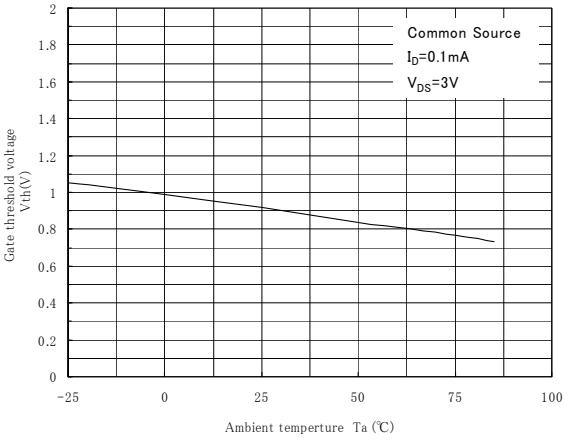

$I_D$ – $V_{GS}$ (MOSFET)



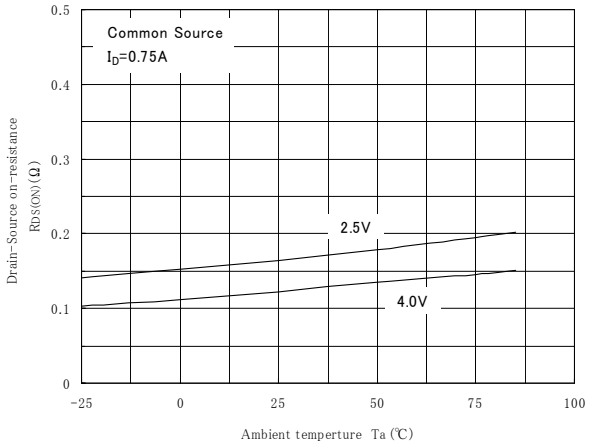

$R_{DS(ON)}$ – ID (MOSFET)



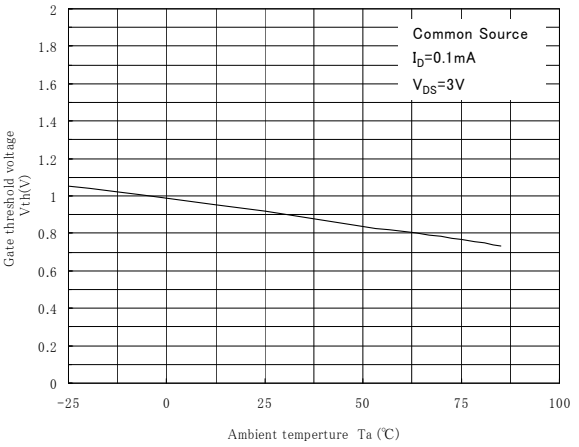

Vth – Ta (MOSFET)



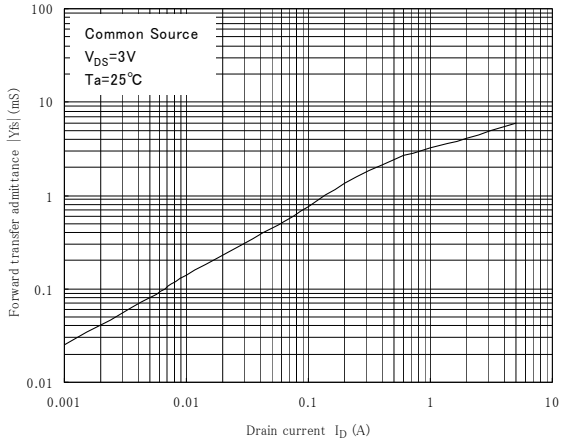

$R_{DS(ON)}$ – Ta (MOSFET)



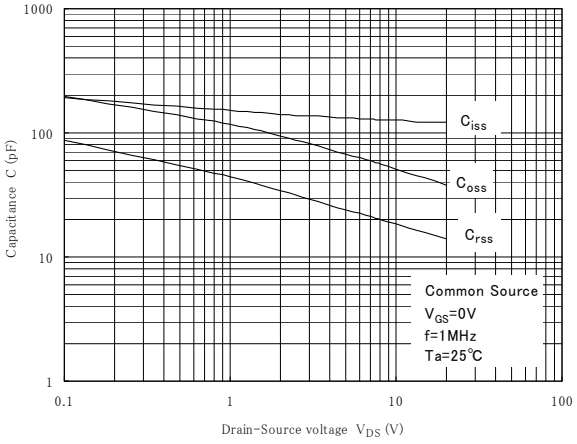

Vth – Ta (MOSFET)



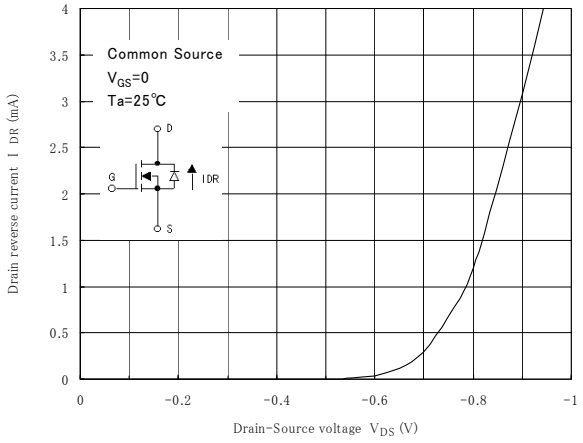
|Yfs| – $I_D$ (MOSFET)



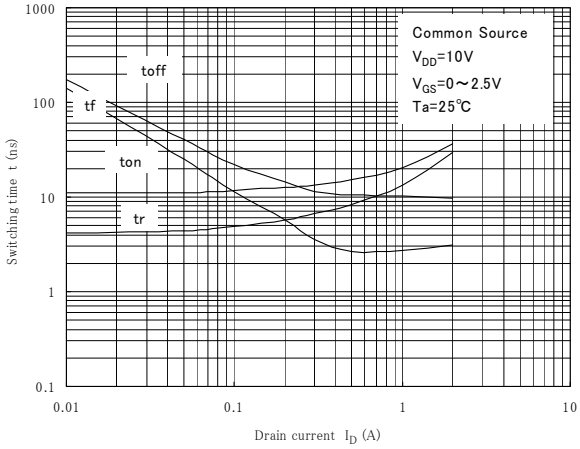

C – $V_{DS}$ (MOSFET)



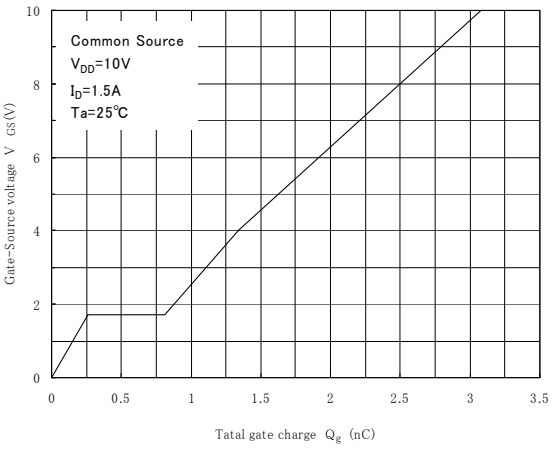

$I_{DR}$ – $V_{DS}$ (MOSFET)



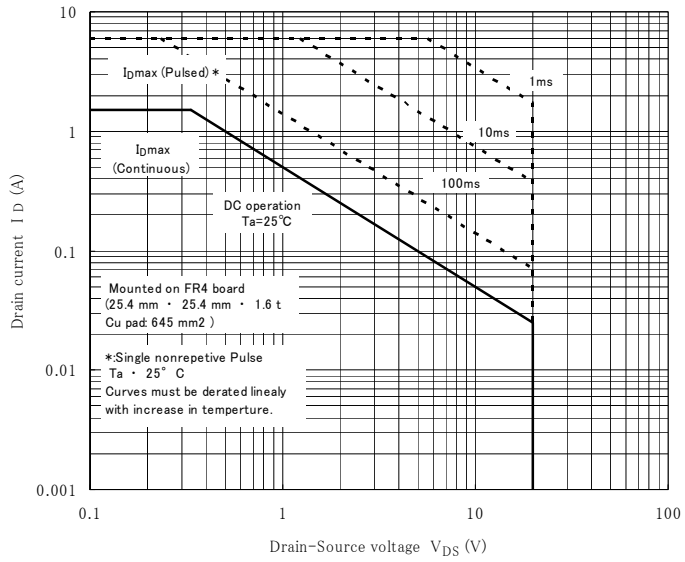

t – $I_D$ (MOSFET)



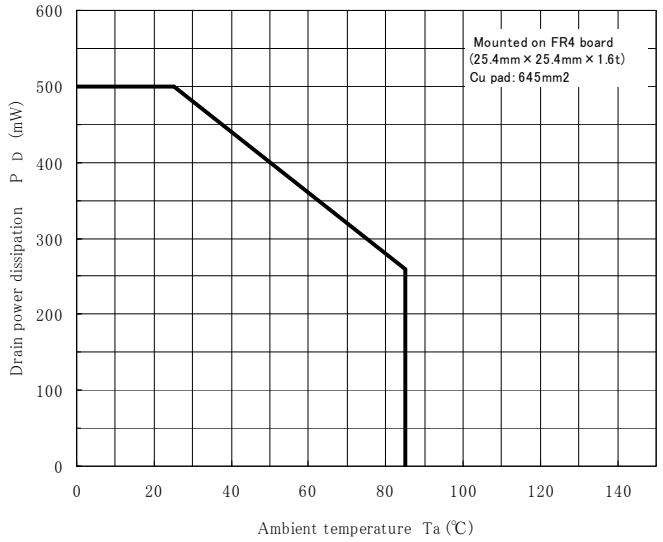

Dynamic Input Characteristic (MOSFET)



Safe operating area (MOSFET)

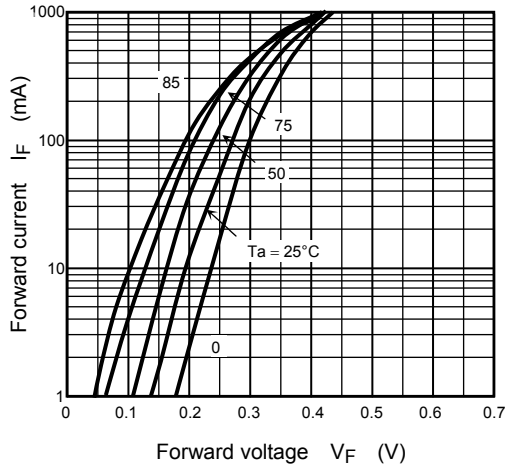



$P_D$ - Ta (MOSFET)

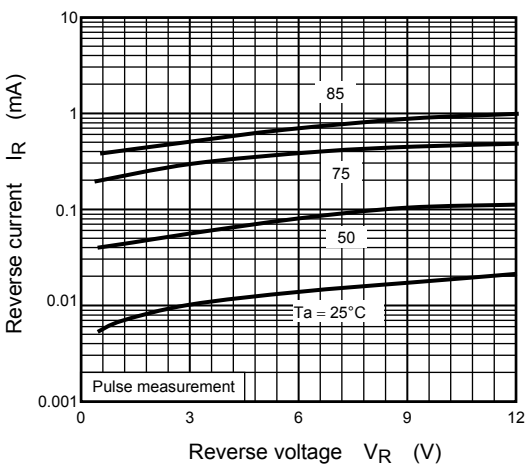


## SBD Electrical Characteristics

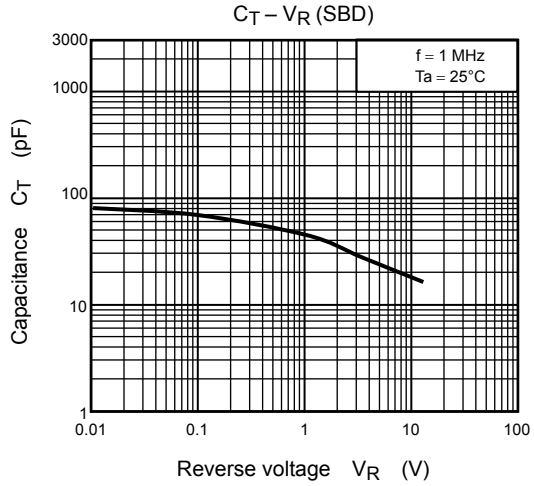
$I_F – V_F$ (SBD)



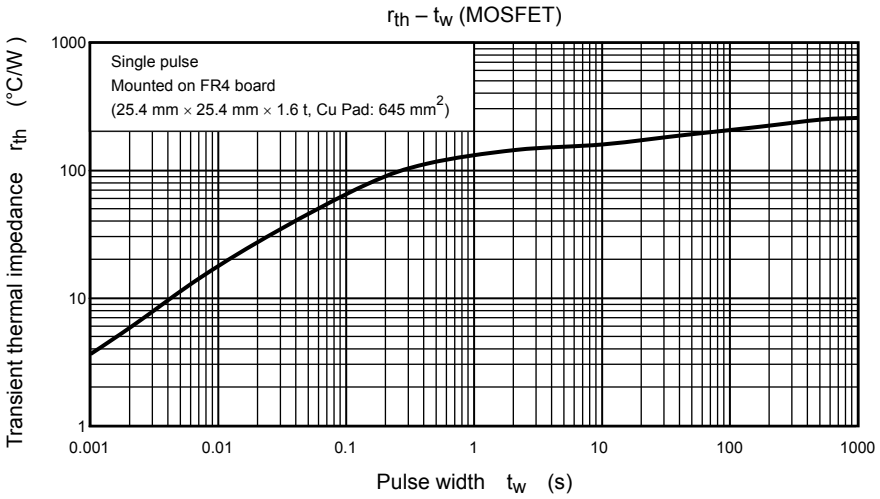

$I_R – V_R$ (SBD)

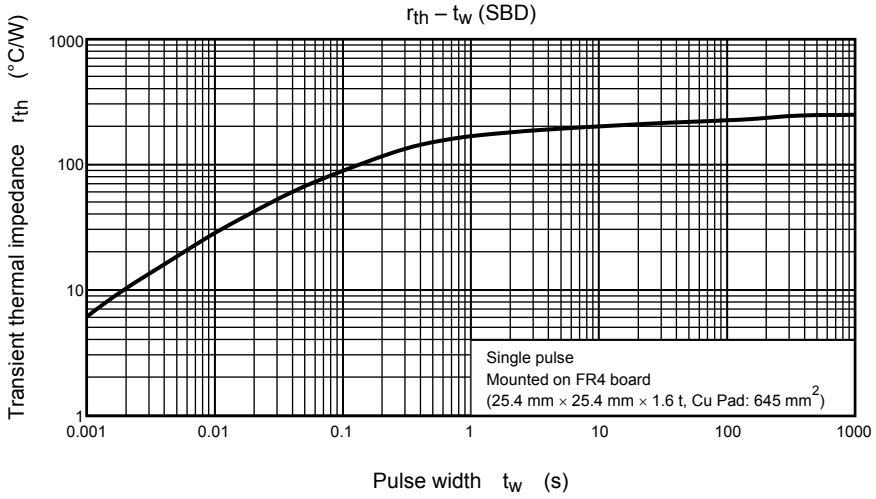



$C_T – V_R$ (SBD)



## Transient Thermal Impedance



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20070701-EN GENERAL

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