To our customers,

## Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation



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DATA SHEET

# MOSFET WITH SCHOTTKY BARRIER DIODE

# μPA2680T1E

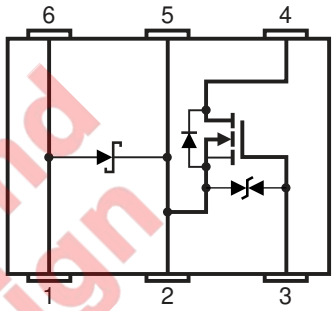
## N-CHANNEL MOSFET WITH SCHOTTKY BARRIER DIODE FOR SWITCHING

### DESCRIPTION

The μPA2680T1E is a switching device, which can be driven directly by a 4.5 V power source.

The μPA2680T1E incorporates a MOSFET which features a low on-state resistance and excellent switching characteristics and a low forward voltage Schottky Barrier Diode, and is suitable for applications such as DC/DC converter of portable machine and so on.

### PIN CONNECTION (Top View)




1: Anode
2: Source/Cathode **(Heat sink 2)**
3: Gate
4: Drain **(Heat sink 1)**
5: Source/Cathode **(Heat sink 2)**
6: Anode

### FEATURES

- 4.5 V drive available MOSFET
- Low on-state resistance MOSFET
  $R_{DS(on)1}$ = 38 mΩ TYP. ($V_{GS}$ = 10 V, $I_D$ = 3.0 A)
  $R_{DS(on)2}$ = 44 mΩ TYP. ($V_{GS}$ = 4.5 V, $I_D$ = 3.0 A)
- Low forward voltage Schottky Barrier Diode
  $V_F$ = 0.36 V TYP. ($I_F$ = 1.0 A)

### ORDERING INFORMATION

| PART NUMBER | PACKAGE |
|---|---|
| μPA2680T1E | 6LD3x3MLP |

**Marking: A2680**



**Remark** The diode connected between the gate and source of the transistor serves as a protector against ESD. When this device actually used, an additional protection circuit is externally required if a voltage exceeding the rated voltage may be applied to this device.

**Caution This product is electrostatic-sensitive device due to low ESD capability and should be handled with caution for electrostatic discharge.**
**$V_{ESD}$ = ±150 V TYP. (C = 200 pF, R = 0 Ω, Single Pulse)**



Document No. G17661EJ2V0DS00 (2nd edition)
Date Published May 2007 NS CP(K)
Printed in Japan



**The mark <R> shows major revised points.**
**The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.**

## ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25°C, unless otherwise specified)

**MOSFET**

| | | | |
|---|---|---|---|
| Drain to Source Voltage ($V_{GS}$ = 0 V) | $V_{DSS}$ | 20 | V |
| Gate to Source Voltage ($V_{DS}$ = 0 V) | $V_{GSS}$ | ±12 | V |
| Drain Current (DC) Note1 | $I_{D(DC)}$ | ±3.0 | A |
| Drain Current (pulse) Note2 | $I_{D(pulse)}$ | ±12.0 | A |
| Total Power Dissipation Note1 | $P_T$ | 1.3 | W |
| Channel Temperature | $T_{ch}$ | 150 | °C |
| Storage Temperature | $T_{stg}$ | –55 to +150 | °C |

**Notes 1.** Mounted on a 1 $in^2$ pad of 2 oz copper, 1.5" x 1.5" x 0.062" thick FR-4 board
(Cu pad: 322 $mm^2$ x 70 μm, FR-4: 1452 $mm^2$ x 1.6 mmt)

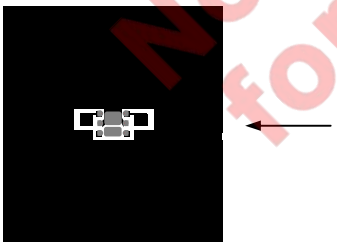
**2.** PW ≤ 10 μs, Duty Cycle ≤ 1%

**Schottky Barrier Diode**

| | | | |
|---|---|---|---|
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | 20 | V |
| Average Forward Current Note | $I_F$ | 1.8 | A |
| Total Power Dissipation Note | $P_T$ | 1.2 | W |
| Junction Temperature | $T_J$ | 125 | °C |
| Storage Temperature | $T_{stg}$ | –55 to +150 | °C |

**Note** Square wave, Duty Cycle = 50%
Mounted on a 1 $in^2$ pad of 2 oz copper, 1.5" x 1.5" x 0.062" thick FR-4 board
(Cu pad: 322 $mm^2$ x 70 μm, FR-4: 1452 $mm^2$ x 1.6 mmt)





SBD side: 85°C/W when mounted on a 1 $in^2$ pad of 2 oz copper

FET side: 97°C/W when mounted on a 1 $in^2$ pad of 2 oz copper

## ELECTRICAL CHARACTERISTICS ($T_A$ = 25°C, unless otherwise specified)

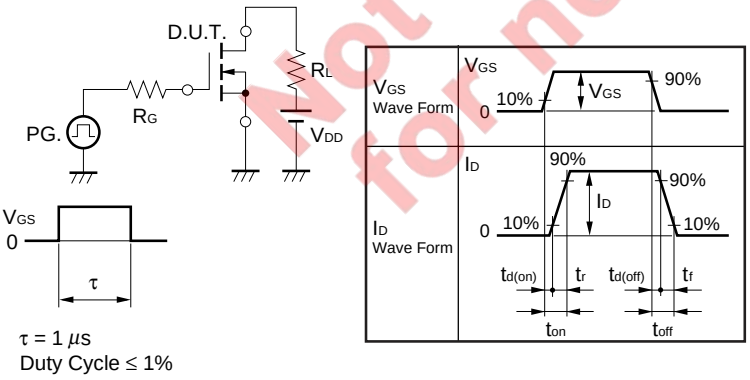
### MOSFET

| CHARACTERISTICS | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 20 V, $V_{GS}$ = 0 V | | | 1 | μA |
| Gate Leakage Current | $I_{GSS}$ | $V_{GS}$ = ±12 V, $V_{DS}$ = 0 V | | | ±10 | μA |
| Gate to Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 0.25 mA | 0.6 | | 2.0 | V |
| Forward Transfer Admittance Note | $\|y_{fs}\|$ | $V_{DS}$ = 10 V, $I_D$ = 1.5 A | 1.0 | 3.6 | | S |
| Drain to Source On-state Resistance Note | $R_{DS(on)1}$ | $V_{GS}$ = 10 V, $I_D$ = 3.0 A | | 38 | 50 | mΩ |
| | $R_{DS(on)2}$ | $V_{GS}$ = 4.5 V, $I_D$ = 3.0 A | | 44 | 60 | mΩ |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = 10 V, | | 190 | | pF |
| Output Capacitance | $C_{oss}$ | $V_{GS}$ = 0 V, | | 90 | | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | f = 1.0 MHz | | 33 | | pF |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$ = 10 V, $I_D$ = 1.5 A, | | 9.0 | | ns |
| Rise Time | $t_r$ | $V_{GS}$ = 4.5 V, | | 7.0 | | ns |
| Turn-off Delay Time | $t_{d(off)}$ | $R_G$ = 10 Ω | | 16 | | ns |
| Fall Time | $t_f$ | | | 4.0 | | ns |
| Total Gate Charge | $Q_G$ | $V_{DD}$ = 16 V, | | 3.1 | | nC |
| Gate to Source Charge | $Q_{GS}$ | $V_{GS}$ = 4.5 V, | | 0.6 | | nC |
| Gate to Drain Charge | $Q_{GD}$ | $I_D$ = 2.0 A | | 1.1 | | nC |
| Body Diode Forward Voltage Note | $V_{F(S-D)}$ | $I_F$ = 3.0 A, $V_{GS}$ = 0 V | | 0.85 | | V |

**Note** Pulsed: PW ≤ 350 μs, Duty Cycle ≤ 2%

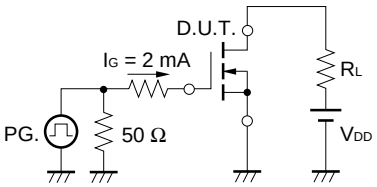


**TEST CIRCUIT 1 SWITCHING TIME**




τ = 1 μs
Duty Cycle ≤ 1%

**TEST CIRCUIT 2 GATE CHARGE**

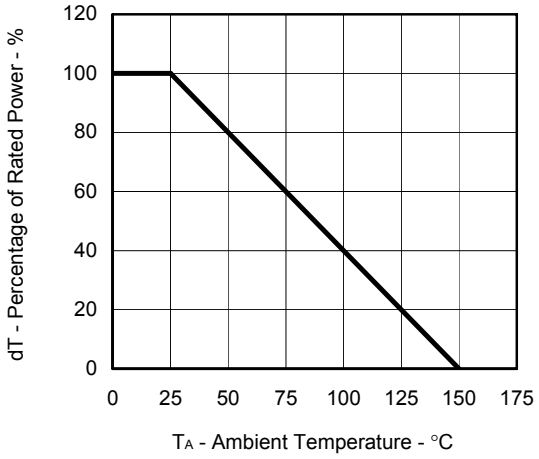



### Schottky Barrier Diode

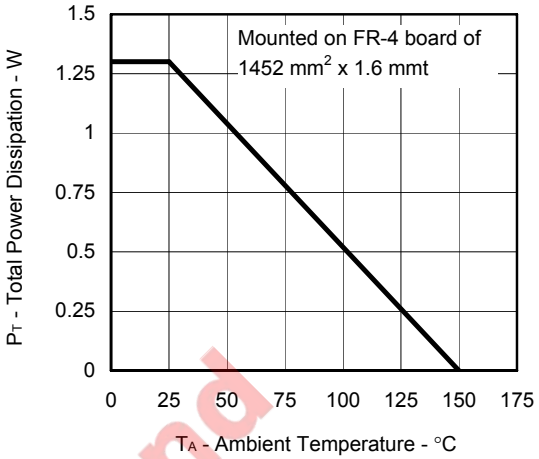
| CHARACTERISTICS | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | $I_F$ = 1.0 A | | 0.36 | 0.39 | V |
| Reverse Current | $I_R$ | $V_R$ = 5 V, $T_A$ = 100°C | | | 15 | mA |
| Terminal Capacitance | $C_T$ | f = 1.0 MHz, $V_R$ = 10 V | | 36 | | pF |

## MOSFET TYPICAL CHARACTERISTICS ($T_A$ = 25°C, unless otherwise specified)

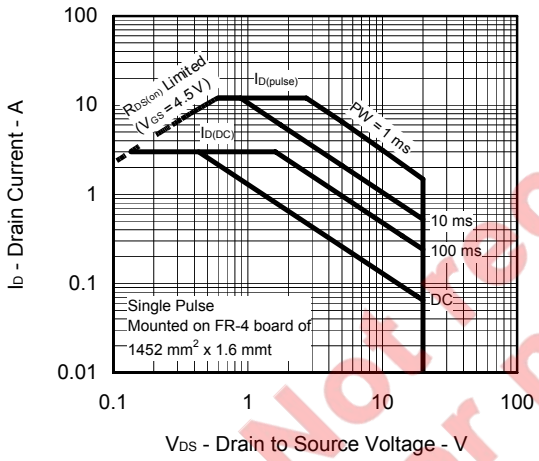
DERATING FACTOR OF FORWARD BIAS SAFE OPERATING AREA




TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE

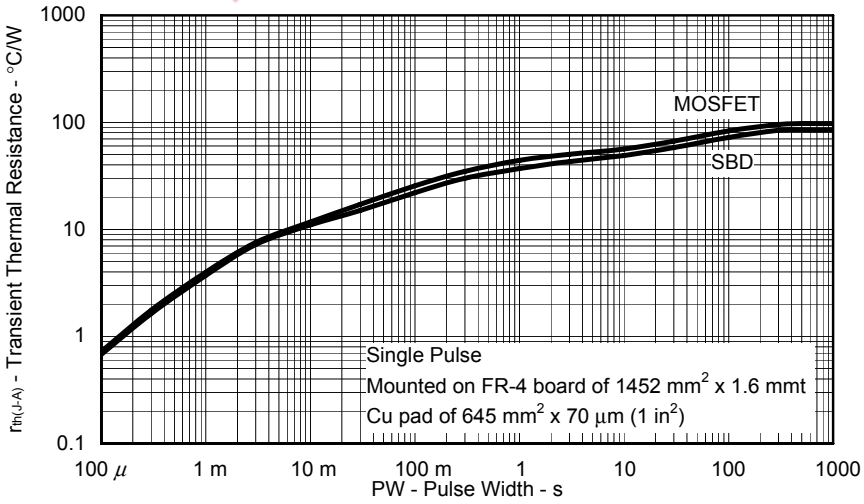



FORWARD BIAS SAFE OPERATING AREA

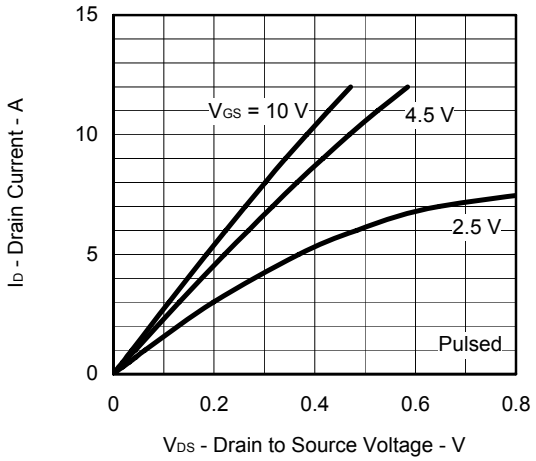




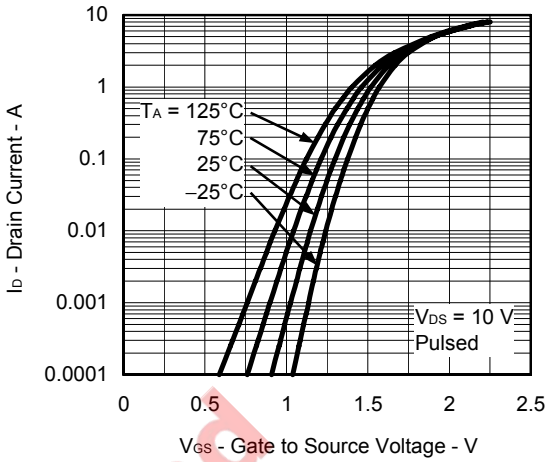

TRANSIENT THERMAL RESISTANCE vs. PULSE WIDTH



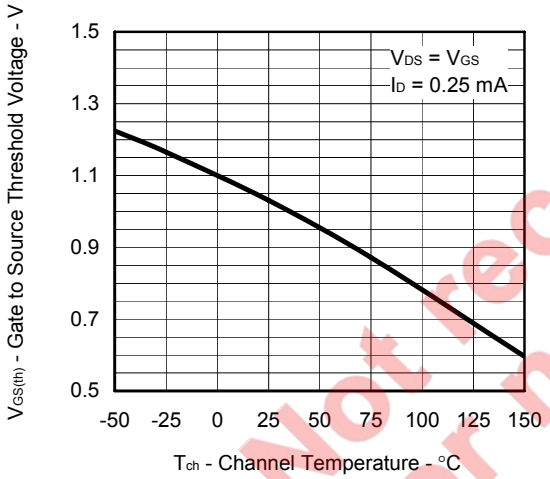
DRAIN CURRENT vs.
DRAIN TO SOURCE VOLTAGE



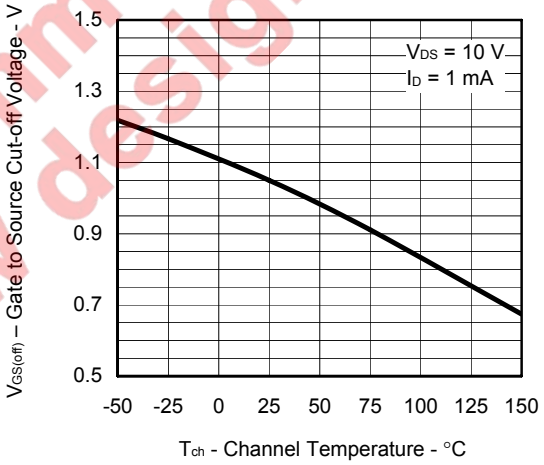

FORWARD TRANSFER CHARACTERISTICS



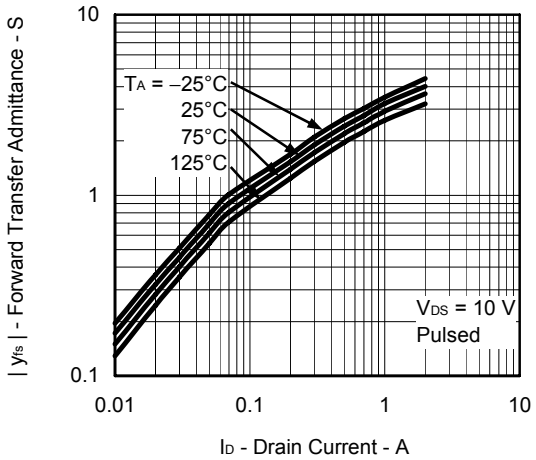

GATE TO SOURCE THRESHOLD VOLTAGE vs.
CHANNEL TEMPERATURE



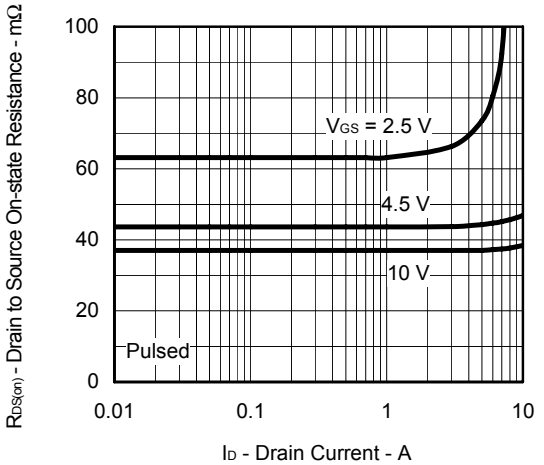

GATE TO SOURCE CUT-OFF VOLTAGE vs.
CHANNEL TEMPERATURE



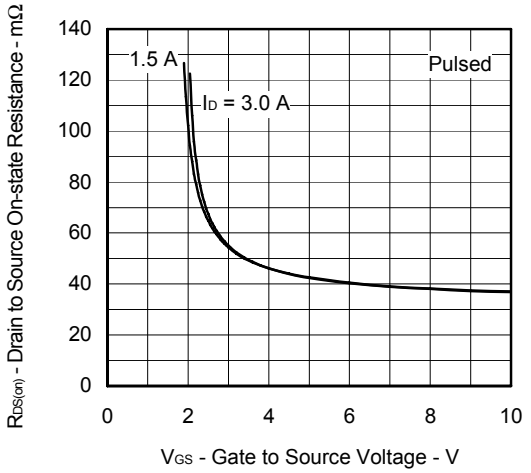

FORWARD TRANSFER ADMITTANCE vs.
DRAIN CURRENT



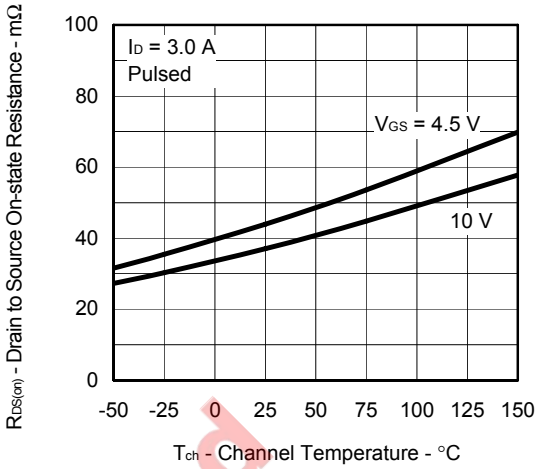

DRAIN TO SOURCE ON-STATE RESISTANCE vs.
DRAIN CURRENT



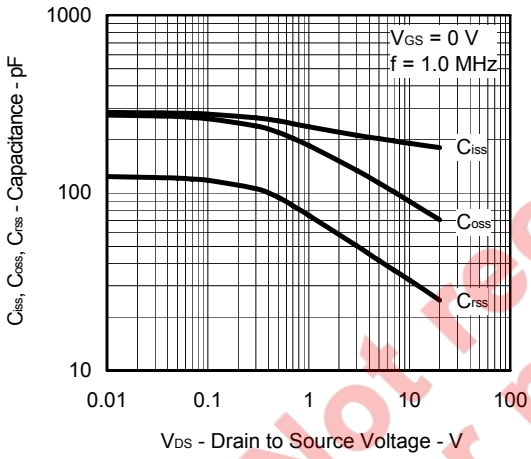
DRAIN TO SOURCE ON-STATE RESISTANCE vs. GATE TO SOURCE VOLTAGE



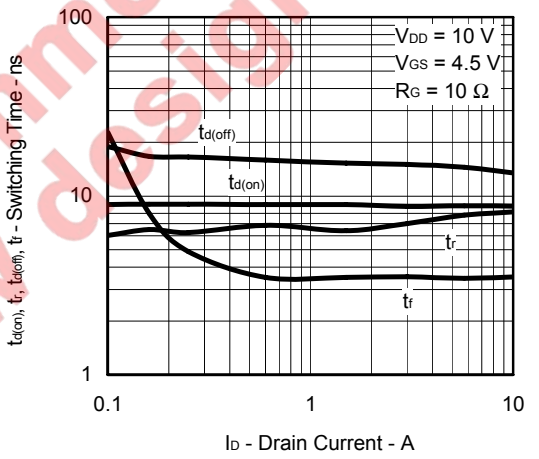

DRAIN TO SOURCE ON-STATE RESISTANCE vs. CHANNEL TEMPERATURE



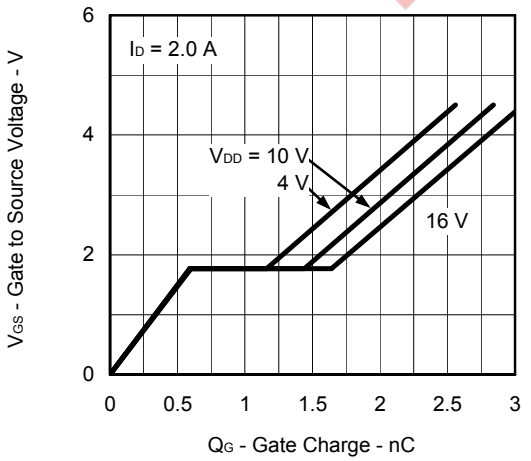

CAPACITANCE vs. DRAIN TO SOURCE VOLTAGE



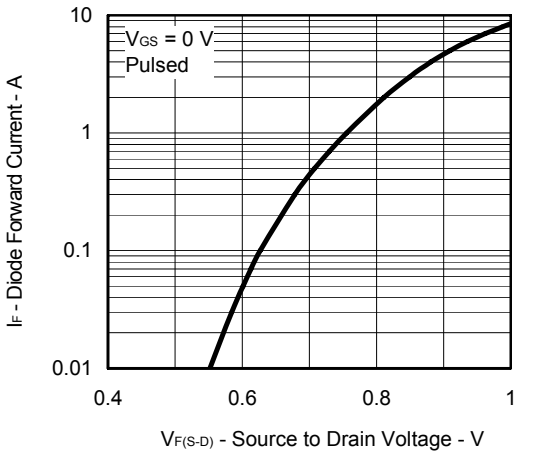

SWITCHING CHARACTERISTICS




DYNAMIC INPUT CHARACTERISTICS

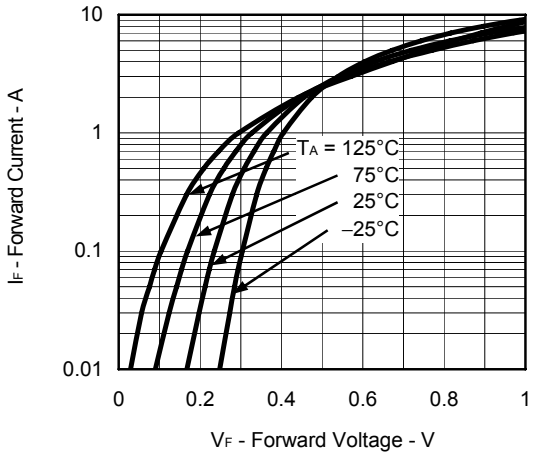



SOURCE TO DRAIN DIODE FORWARD VOLTAGE

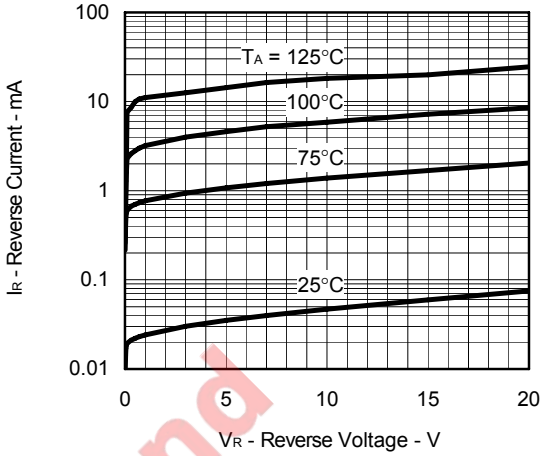


## SCHOTTKY BARRIER DIODE TYPICAL CHARACTERISTICS ($T_A$ = 25°C, unless otherwise specified)

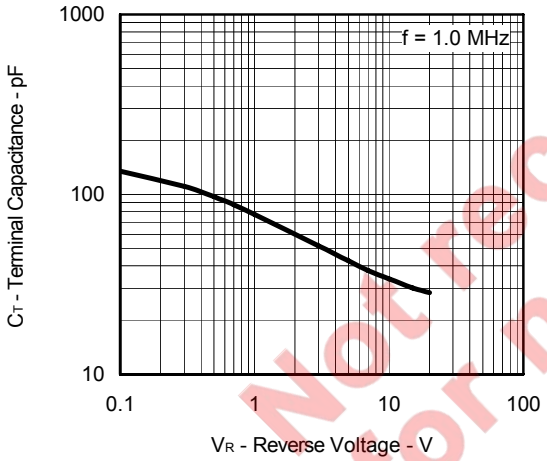
FORWARD CURRENT vs. FORWARD VOLTAGE



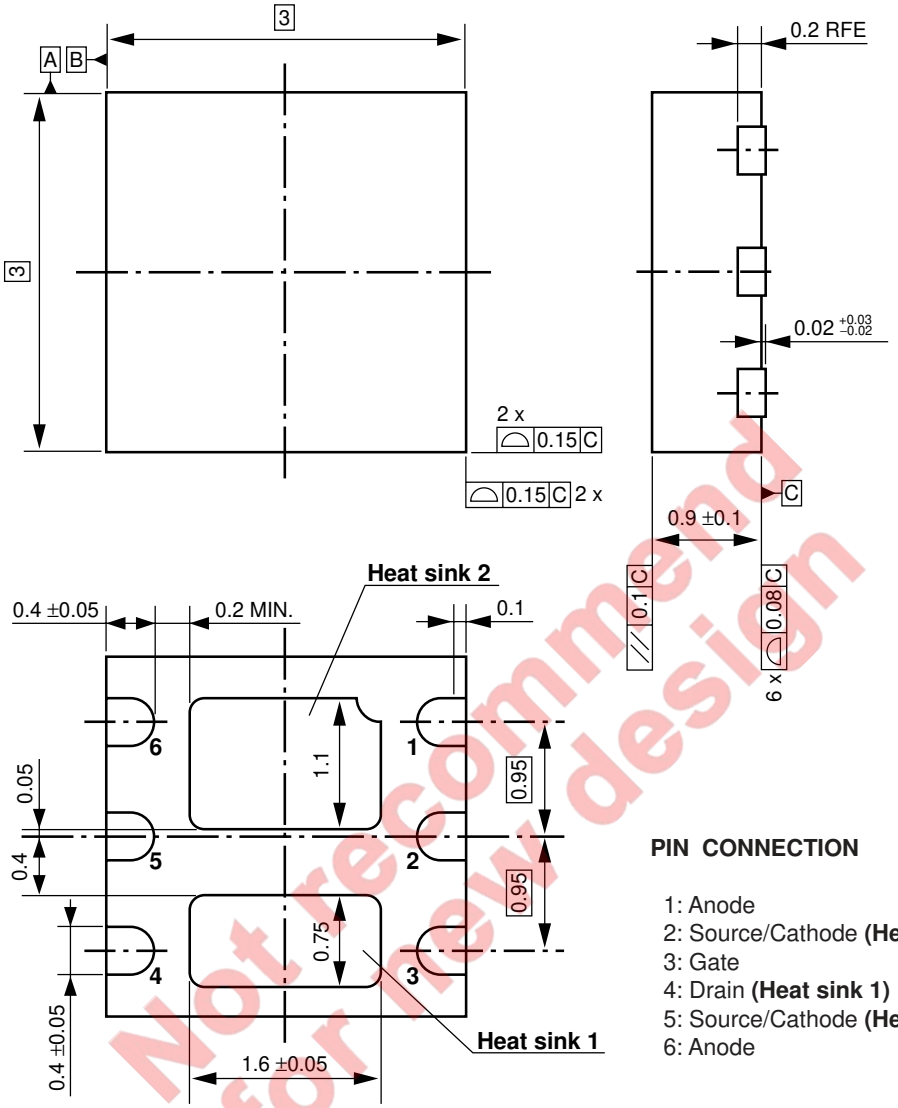

<R> REVERSE CURRENT vs. REVERSE VOLTAGE




TERMINAL CAPACITANCE vs. REVERSE VOLTAGE



**PACKAGE DRAWING (Unit: mm)**




**PIN CONNECTION**

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2: Source/Cathode **(Heat sink 2)**
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