# μPA2375T1P

R07DS0573EJ0100
Rev.1.00
Dec 05, 2011

## N-CHANNEL MOSFET FOR SWITCHING

## DESCRIPTION

The μPA2375T1P is a switching device, which can be driven directly by a 2.5 V power source.

The μPA2375T1P features a low on-state resistance and excellent switching characteristics, and is suitable for single cell LiB application.

## FEATURES

- 2.5 V drive available
- Ultra low on-state resistance
  $R_{SS(on)1}$ = 11.4 mΩ MAX. ($V_{GS}$ = 4.5 V, $I_S$ = 5 A)
  $R_{SS(on)2}$ = 12.4 mΩ MAX. ($V_{GS}$ = 4.0 V, $I_S$ = 5 A)
  $R_{SS(on)3}$ = 13.0 mΩ MAX. ($V_{GS}$ = 3.8 V, $I_S$ = 5 A)
  $R_{SS(on)4}$ = 17.0 mΩ MAX. ($V_{GS}$ = 3.1 V, $I_S$ = 5 A)
  $R_{SS(on)5}$ = 23.0 mΩ MAX. ($V_{GS}$ = 2.5 V, $I_S$ = 5 A)
- Built-in G-S protection diode against ESD

## ORDERING INFORMATION

| Part No. | Lead Plating | Packing | Package |
|---|---|---|---|
| μPA2375T1P-E1- A *1 | Ni/Au | Reel 5000 p/reel | 6-pin EFLIP-LGA |

Note: *1. Pb-free (This product does not contain Pb in the external electrode and other parts.)

## ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25°C)

| Item | Symbol | Ratings | Unit |
|---|---|---|---|
| Source to Source Voltage ($V_{GS}$ = 0 V) | $V_{SSS}$ | 24.0 | V |
| Gate to Source Voltage ($V_{DS}$ = 0 V) | $V_{GSS}$ | ±12.0 | V |
| Source Current (DC) *1 | $I_{S(DC)}$ | ±10 | A |
| Source Current (pulse) *2 | $I_{S(pulse)}$ | ±100 | A |
| Total Power Dissipation (2 units) *1 | $P_{T1}$ | 1.75 | W |
| Channel Temperature | $T_{ch}$ | 150 | °C |
| Storage Temperature | $T_{stg}$ | –55 to +150 | °C |

Note: *1. Mounted on ceramic board (50 $cm^2$ × 1.0 mmt)
*2. PW ≤ 10 μs, Duty Cycle ≤ 1%

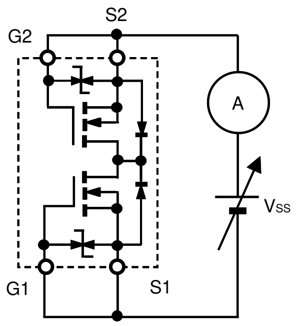
## ELECTRICAL CHARACTERISTICS ($T_A$ = 25°C)

| Characteristics | Symbol | MIN. | TYP. | MAX. | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Zero Gate Voltage Source Current | $I_{SSS}$ | | | 1 | μA | $V_{SS}$ = 24 V, $V_{GS}$ = 0 V, TEST CIRCUIT 1 |
| Gate Leakage Current | $I_{GSS}$ | | | ±10 | μA | $V_{GS}$ = ±12 V, $V_{SS}$ = 0 V, TEST CIRCUIT 2 |
| Gate to Source Cut-off Voltage | $V_{GS(off)}$ | 0.5 | 0.9 | 1.5 | V | $V_{SS}$ = 10 V, $I_S$ = 1.0 mA, TEST CIRCUIT 3 |
| Forward Transfer Admittance *1 | $\lvert y_{fs} \rvert$ | 7.0 | | | S | $V_{SS}$ = 5 V, $I_S$ = 5 A, TEST CIRCUIT 4 |
| Source to Source On-state Resistance *1 | $R_{SS(on)1}$ | 6.5 | 9.0 | 11.4 | mΩ | $V_{GS}$ = 4.5 V, $I_S$ = 5 A, TEST CIRCUIT 5 |
| | $R_{SS(on)2}$ | 6.5 | 9.6 | 12.4 | mΩ | $V_{GS}$ = 4.0 V, $I_S$ = 5 A, TEST CIRCUIT 5 |
| | $R_{SS(on)3}$ | 6.5 | 9.8 | 13.0 | mΩ | $V_{GS}$ = 3.8 V, $I_S$ = 5 A, TEST CIRCUIT 5 |
| | $R_{SS(on)4}$ | 7.0 | 11.5 | 17.0 | mΩ | $V_{GS}$ = 3.1 V, $I_S$ = 5 A, TEST CIRCUIT 5 |
| | $R_{SS(on)5}$ | 9.0 | 15.0 | 23.0 | mΩ | $V_{GS}$ = 2.5 V, $I_S$ = 5 A, TEST CIRCUIT 5 |
| Input Capacitance | $C_{iss}$ | | 2250 | | pF | $V_{SS}$ = 10 V, |
| Output Capacitance | $C_{oss}$ | | 670 | | pF | $V_{GS}$ = 0 V, |
| Reverse Transfer Capacitance | $C_{rss}$ | | 510 | | pF | f = 1.0 MHz, TEST CIRCUIT 7 |
| Turn-on Delay Time | $t_{d(on)}$ | | 6.6 | | μs | $V_{DD}$ = 20 V, $I_S$ = 10 A, |
| Rise Time | $t_r$ | | 44 | | μs | $V_{GS}$ = 4.0 V, |
| Turn-off Delay Time | $t_{d(off)}$ | | 72 | | μs | $R_G$ = 6.0 Ω, |
| Fall Time | $t_f$ | | 133 | | μs | TEST CIRCUIT 8 |
| Total Gate Charge | $Q_G$ | | 40 | | nC | $V_{DD}$ = 19.2 V, $V_{G1S1}$ = 4.0 V, $I_S$ = 3 A, TEST CIRCUIT 9 |
| Body Diode Forward Voltage *1 | $V_{F(S-S)}$ | | 0.9 | | V | $I_F$ = 10 A, $V_{GS}$ = 0 V, TEST CIRCUIT 6 |

Note: *1. Pulsed test

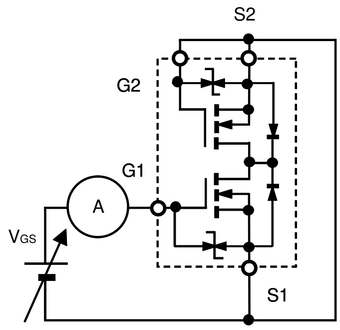
Both the FET1 and the FET2 are measured. Test circuits are example of measuring the FET1 side.

**TEST CIRCUIT 1 $I_{SSS}$**



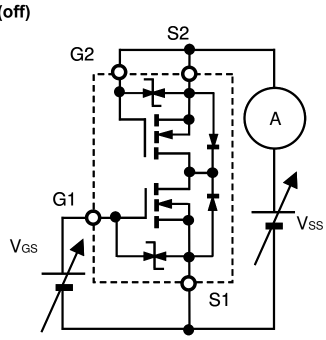

**TEST CIRCUIT 2 $I_{GSS}$**

When FET1 is measured, between GATE and SOURCE of FET2 are shorted.



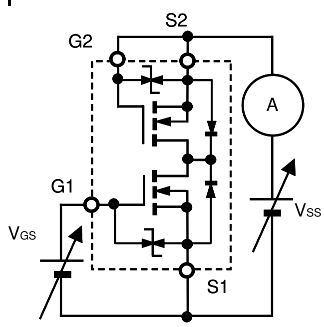

**TEST CIRCUIT 3 $V_{GS(off)}$**

When FET1 is measured, between GATE and SOURCE of FET2 are shorted.



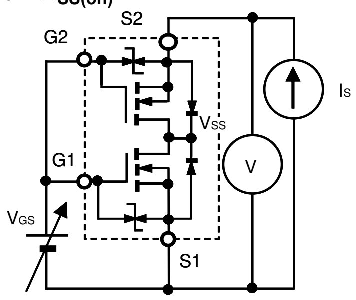

**TEST CIRCUIT 4 $\lvert y_{fs} \rvert$**

$\Delta I_S/\Delta V_{GS}$



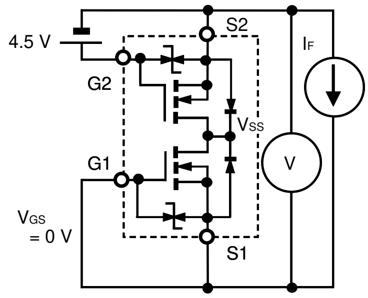
## TEST CIRCUIT 5 $R_{SS(on)}$

$V_{SS}/I_S$

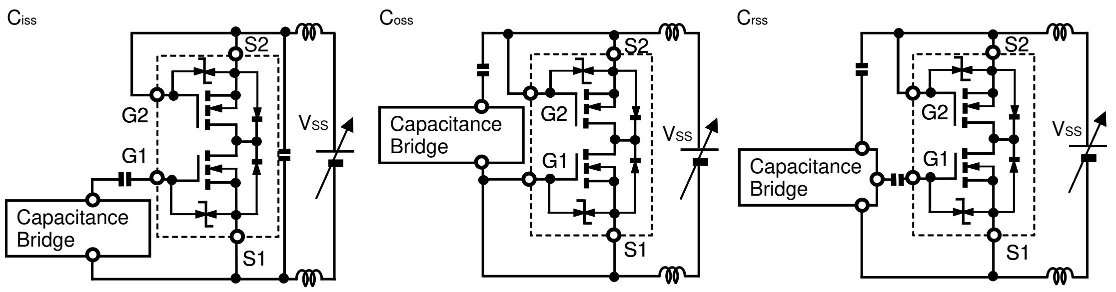



## TEST CIRCUIT 6 $V_{F(S-S)}$

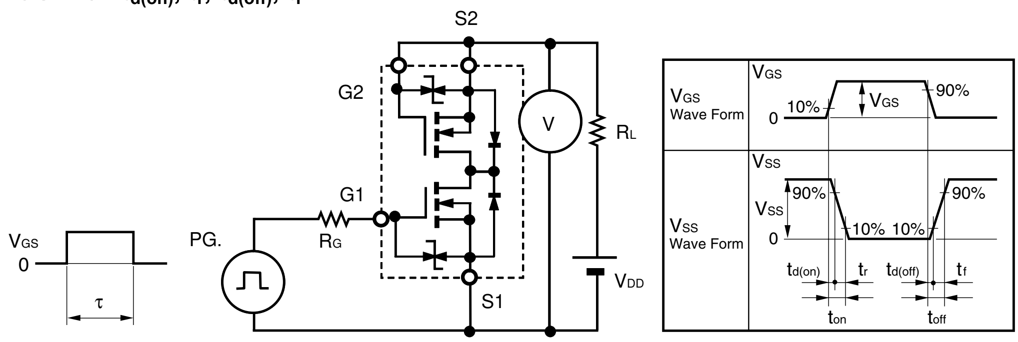
When FET1 is measured, FET2 is added $V_{GS}$ + 4.5 V.




## TEST CIRCUIT 7

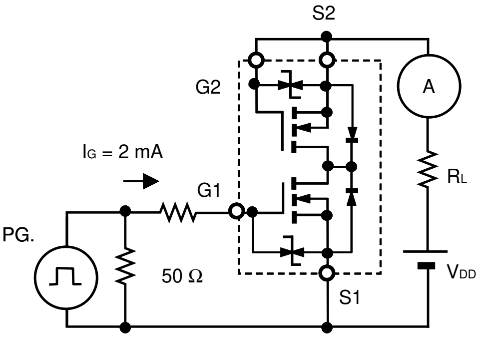



## TEST CIRCUIT 8 $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

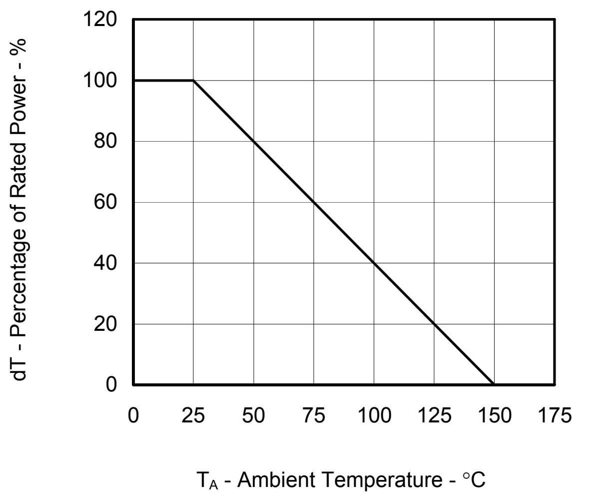



τ = 1 μs
Duty Cycle ≤ 1%

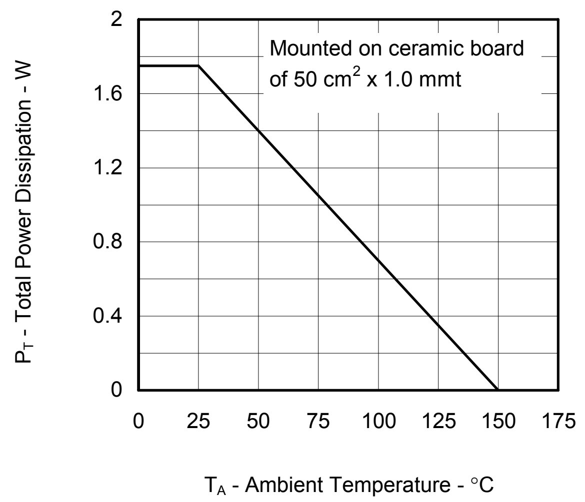
## TEST CIRCUIT 9 $Q_G$



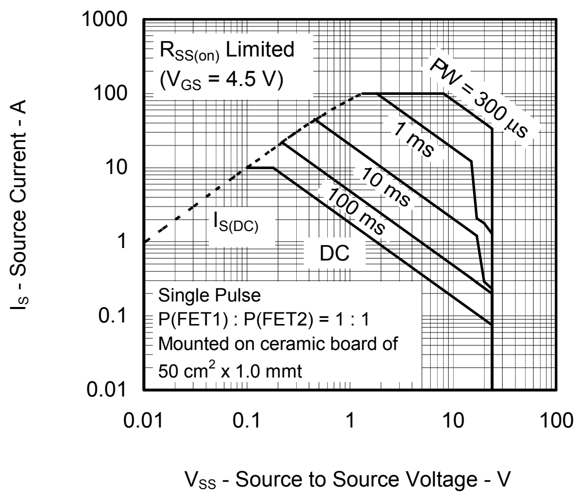
DERATING FACTOR OF FORWARD BIAS SAFE OPERATING AREA



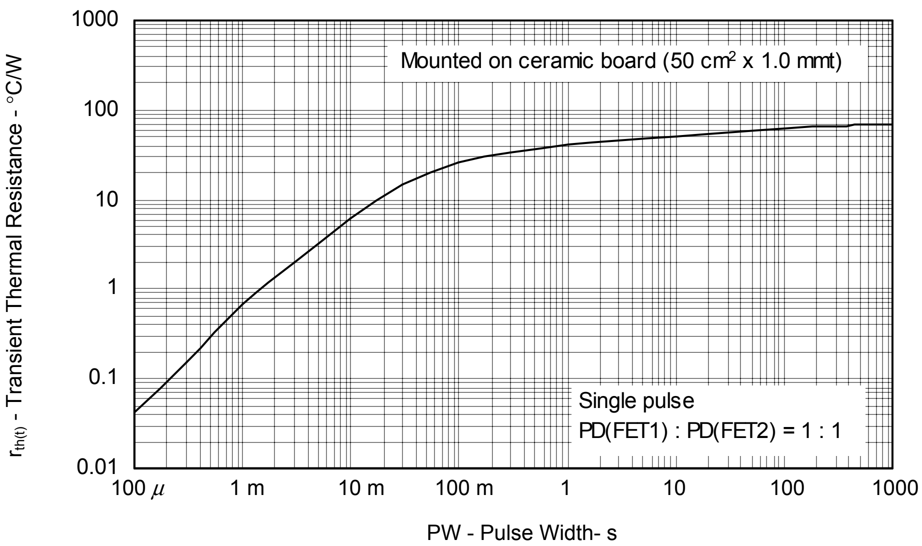

TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



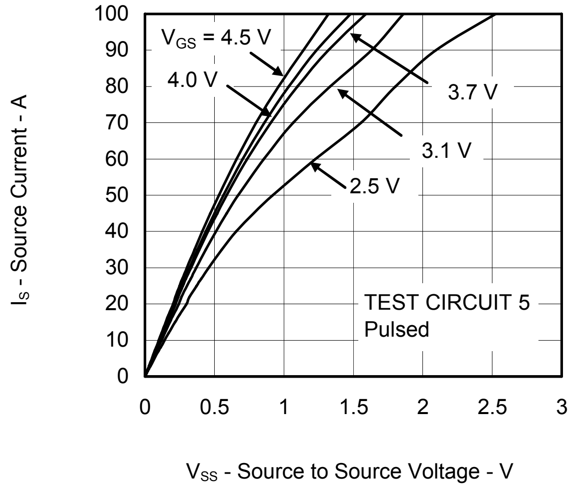

FORWARD BIAS SAFE OPERATING AREA



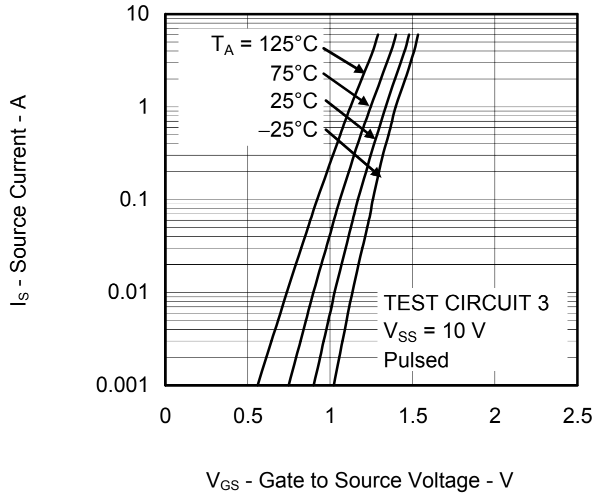

TRANSIENT THERMAL RESISTANCE vs. PULSE WIDTH



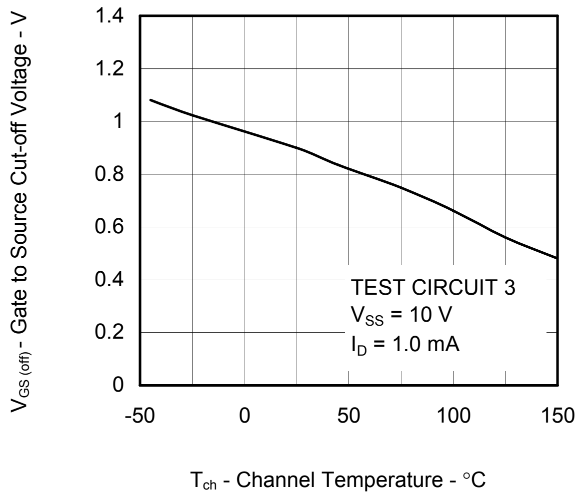
SOURCE CURRENT vs.
SOURCE TO SOURCE VOLTAGE



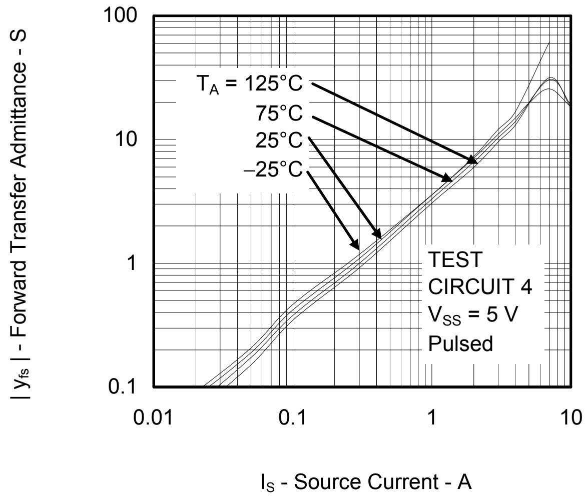

FORWARD TRANSFER CHARACTERISTICS



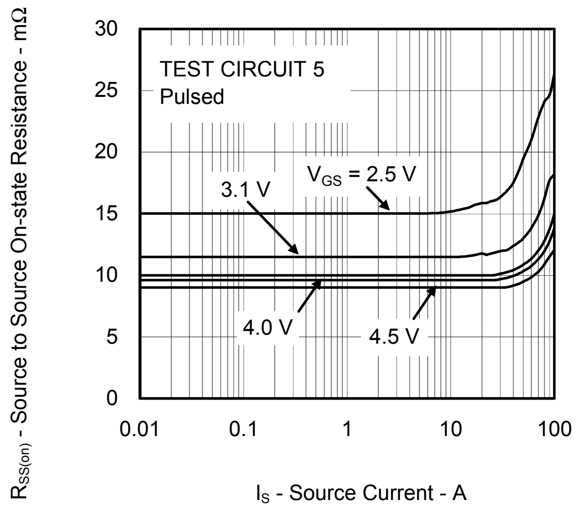

GATE TO SOURCE CUT-OFF VOLTAGE
vs. CHANNEL TEMPERATURE



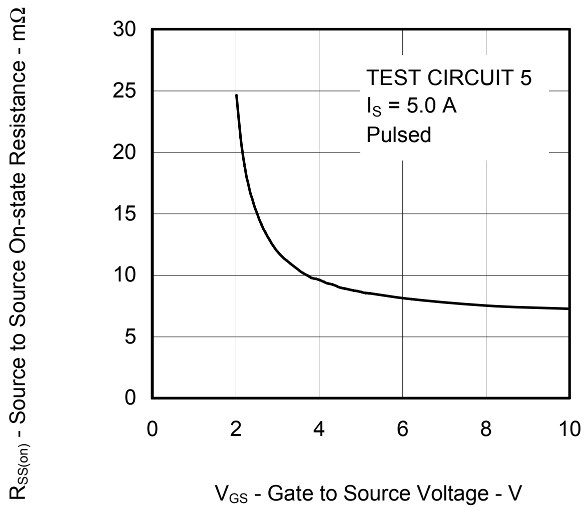

FORWARD TRANSFER ADMITTANCE vs.
SOURCE CURRENT

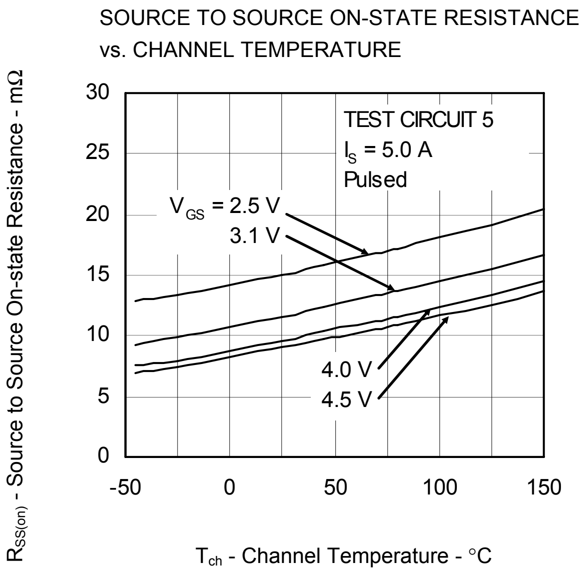


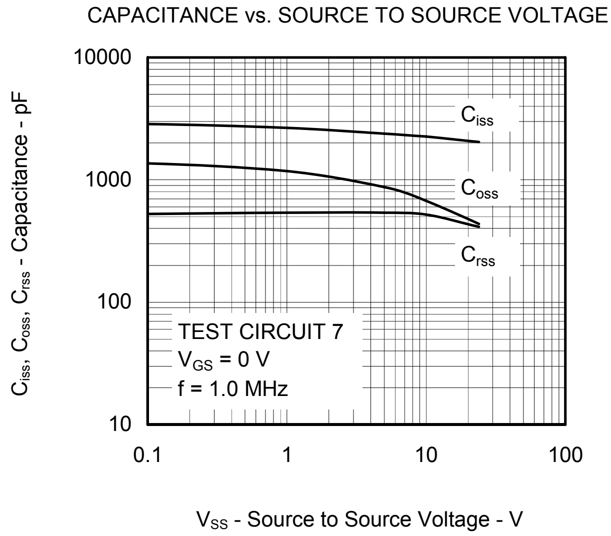

SOURCE TO SOURCE ON-STATE RESISTANCE
vs. SOURCE CURRENT

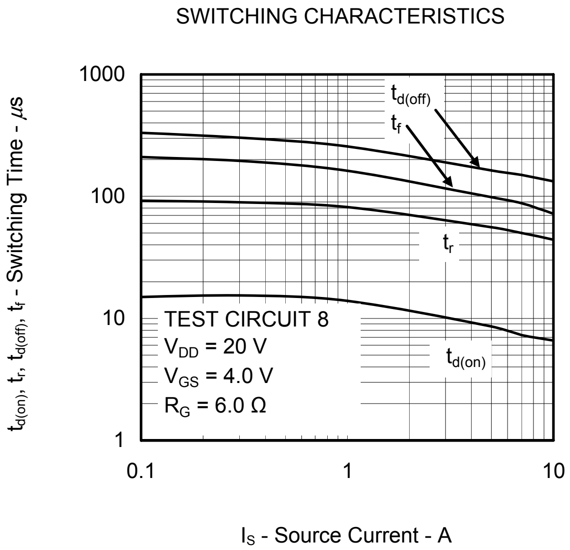


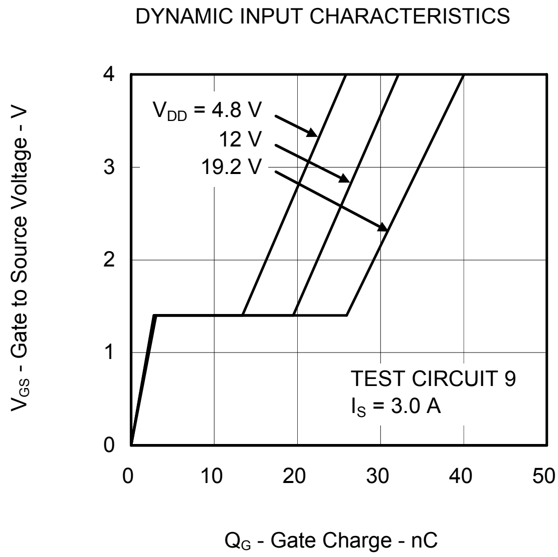

SOURCE TO SOURCE ON-STATE RESISTANCE vs.
GATE TO SOURCE VOLTAGE

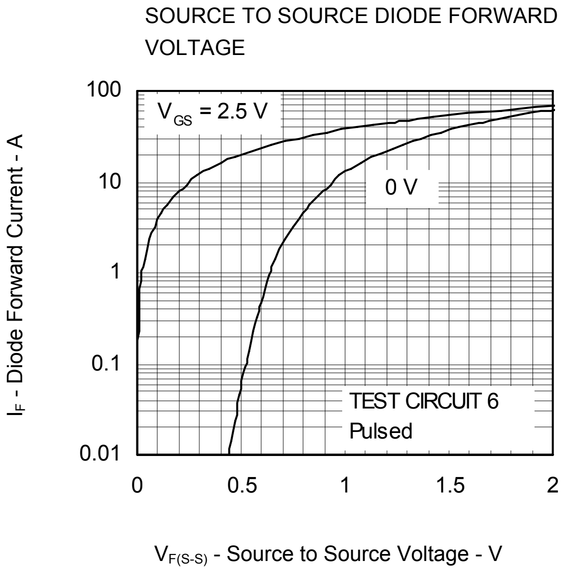



SOURCE TO SOURCE ON-STATE RESISTANCE
vs. CHANNEL TEMPERATURE
TEST CIRCUIT 5
IS = 5.0 A
Pulsed
VGS = 2.5 V
3.1 V
4.0 V
4.5 V
RSS(on) - Source to Source On-state Resistance - mΩ
Tch - Channel Temperature - °C


CAPACITANCE vs. SOURCE TO SOURCE VOLTAGE
Ciss
Coss
Crss
TEST CIRCUIT 7
VGS = 0 V
f = 1.0 MHz
Ciss, Coss, Crss - Capacitance - pF
VSS - Source to Source Voltage - V

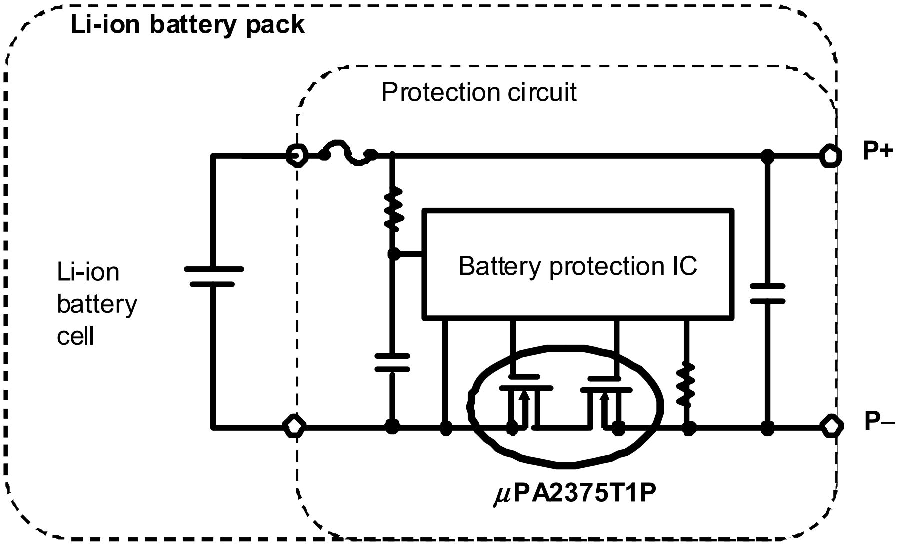

SWITCHING CHARACTERISTICS
td(off)
tf
tr
td(on)
TEST CIRCUIT 8
VDD = 20 V
VGS = 4.0 V
RG = 6.0 Ω
td(on), tr, td(off), tf - Switching Time - μs
IS - Source Current - A


DYNAMIC INPUT CHARACTERISTICS
VDD = 4.8 V
12 V
19.2 V
TEST CIRCUIT 9
IS = 3.0 A
VGS - Gate to Source Voltage - V
QG - Gate Charge - nC


SOURCE TO SOURCE DIODE FORWARD
VOLTAGE
VGS = 2.5 V
0 V
TEST CIRCUIT 6
Pulsed
IF - Diode Forward Current - A
VF(S-S) - Source to Source Voltage - V

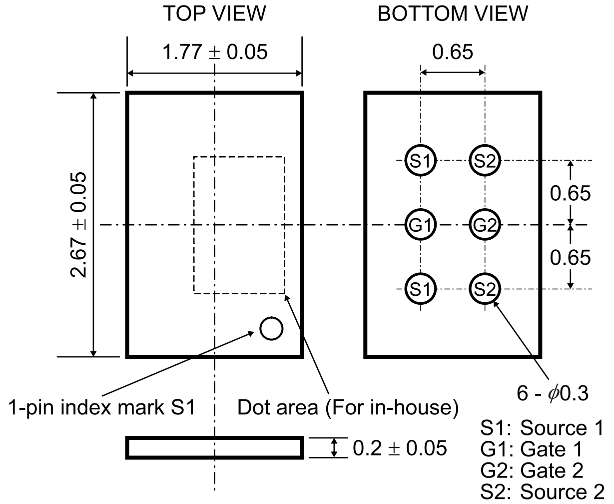
## Example of application circuit

### Li-ion battery (1 cell) protection circuit

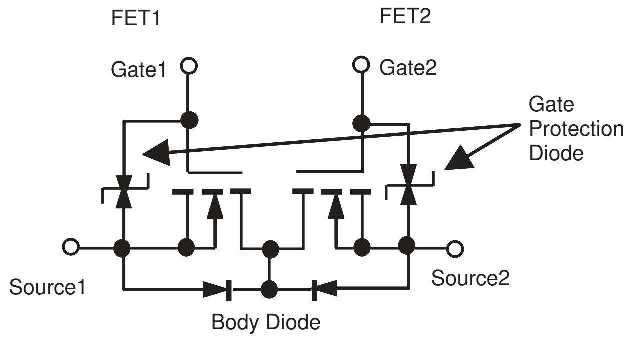


## PACKAGE DRAWINGS (UNIT: mm)

### 6-pin EFLIP-LGA




## Equivalent Circuit




**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.

## USAGE CAUTIONS

When you use this device, in order to prevent a customer's hazard and damage, use it with understanding the following contents. If used exceeding recommended conditions, there is a possibility of causing the device and characteristic degradation.

1. This device is very thin device and should be handled with caution for mechanical stress. The distortion applied to the device should become below 2000 × $10^{-6}$. If the distortion exceeds 2000 × $10^{-6}$, the characteristic of a device may be degraded and it may result in failure.

2. Please do not damage the device when you handle it. The use of metallic tweezers has the possibility of giving the wound. Mounting with the nozzle with clean point is recommended.

3. When you mount the device on a substrate, carry out within our recommended soldering conditions of infrared reflow. If mounted exceeding the conditions, the characteristic of a device may be degraded and it may result failure.

4. When you wash the device mounted the board, carry out within our recommended conditions. If washed exceeding the conditions, the characteristic of a device may be degraded and it may result in failure.

5. When you use ultrasonic wave to substrate after the device mounting, prevent from touching a resonance directly. If it touches, the characteristic of a device may be degraded and it may result in failure.

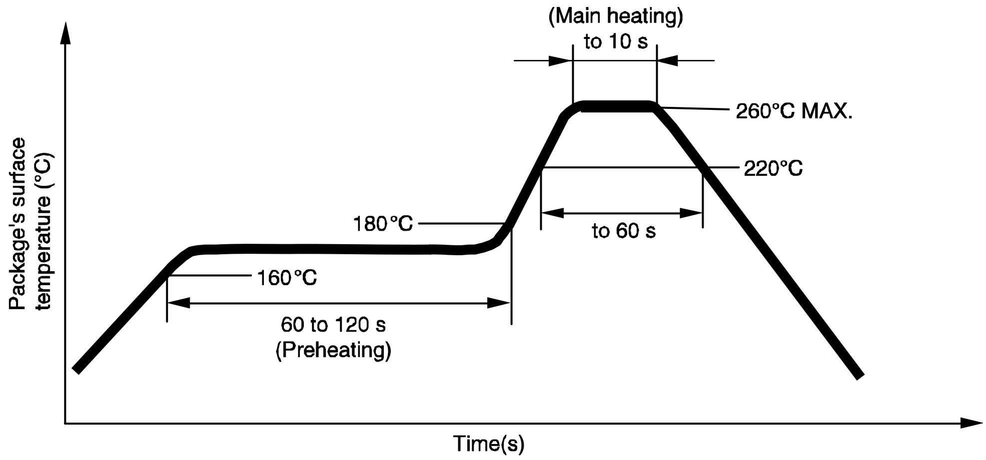
6. Only the epoxy resin of the semiconductor grade is recommended as coating material.

7. Please refer to Figure 2 as an example of the Mounting Pad. Optimize the land pattern in consideration of density, appearance of solder fillets, common difference, etc in an actual design.

8. The marking side of this device is an internal electrode. Please neither contact with terminals of other parts nor take out the electrode.

**Figure 1 Recommended soldering conditions of INFRARED REFLOW**

| | |
|---|---|
| Maximum temperature (Package's surface temperature) | : 260°C or below |
| Time at maximum temperature | : 10 s or less |
| Time of temperature higher than 220°C | : 60 s or less |
| Preheating time at 160 to 180°C | : 60 to 120 s |
| Maximum number of reflow processes | : 3 times |
| Maximum chlorine content of rosin flux (Mass percentage) | : 0.2% or less |




Infrared Reflow Temperature Profile

**Figure 2 The example of the Mounting Pad (Unit : mm)**

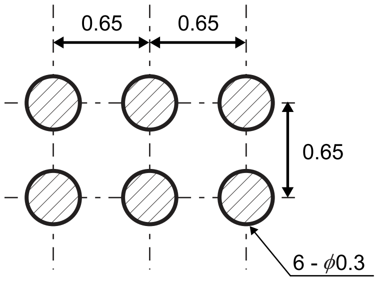
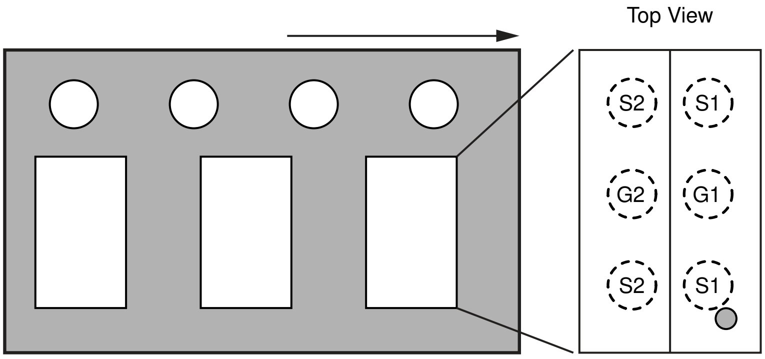



**Figure 3 The unit orientation**



| Revision History | $\mu$PA2375T1P Data Sheet |
|---|---|

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 1.00 | Dec 05, 2011 | – | First Edition Issued |

**SALES OFFICES** Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.


**Renesas Electronics America Inc.**
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

**Renesas Electronics Canada Limited**
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

**Renesas Electronics Europe Limited**
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

**Renesas Electronics Europe GmbH**
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

**Renesas Electronics (China) Co., Ltd.**
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

**Renesas Electronics (Shanghai) Co., Ltd.**
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

**Renesas Electronics Hong Kong Limited**
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

**Renesas Electronics Taiwan Co., Ltd.**
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

**Renesas Electronics Singapore Pte. Ltd.**
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

**Renesas Electronics Malaysia Sdn.Bhd.**
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

**Renesas Electronics Korea Co., Ltd.**
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141





Colophon 1.1