

# μPA2378T1P

## N-CHANNEL MOSFET FOR SWITCHING

R07DS0702EJ0100

Rev.1.00

Mar 19, 2012

### DESCRIPTION

The μPA2378T1P is a switching device, which can be driven directly by a 2.5 V power source.

The μPA2378T1P 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
  - $R_{SS(on)1} = 11.9 \text{ m}\Omega \text{ MAX.}$  ( $V_{GS} = 4.5 \text{ V}$ ,  $I_S = 4.0 \text{ A}$ )
  - $R_{SS(on)2} = 12.8 \text{ m}\Omega \text{ MAX.}$  ( $V_{GS} = 4.0 \text{ V}$ ,  $I_S = 4.0 \text{ A}$ )
  - $R_{SS(on)3} = 13.0 \text{ m}\Omega \text{ MAX.}$  ( $V_{GS} = 3.8 \text{ V}$ ,  $I_S = 4.0 \text{ A}$ )
  - $R_{SS(on)4} = 17.6 \text{ m}\Omega \text{ MAX.}$  ( $V_{GS} = 3.1 \text{ V}$ ,  $I_S = 4.0 \text{ A}$ )
  - $R_{SS(on)5} = 26.0 \text{ m}\Omega \text{ MAX.}$  ( $V_{GS} = 2.5 \text{ V}$ ,  $I_S = 4.0 \text{ A}$ )
- Built-in G-S protection diode against ESD

### ORDERING INFORMATION

Part No.	Lead Plating	Packing	Package
μPA2378T1P-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 ( $T_A = 25^\circ\text{C}$ )

Item	Symbol	Ratings	Unit
Source to Source Voltage ( $V_{GS} = 0 \text{ V}$ )	$V_{SSS}$	12.0	V
Gate to Source Voltage ( $V_{DS} = 0 \text{ V}$ )	$V_{GSS}$	$\pm 8.0$	V
Source Current (DC) *1	$I_{S(DC)}$	$\pm 8.0$	A
Source Current (pulse) *2	$I_{S(pulse)}$	$\pm 80$	A
Total Power Dissipation (2 units) *1	$P_{T1}$	1.8	W
Channel Temperature	$T_{ch}$	150	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-55 to +150	$^\circ\text{C}$

Note: \*1. Mounted on ceramic board of  $50 \text{ cm}^2 \times 1.0 \text{ mm}$

\*2.  $PW \leq 10 \text{ }\mu\text{s}$ , Duty Cycle  $\leq 1\%$

# ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C)

Characteristics	Symbol	MIN.	TYP.	MAX.	Unit	Test Conditions
Zero Gate Voltage Source Current	I <sub>SSS</sub>			1	μA	V <sub>SS</sub> = 12 V, V <sub>GS</sub> = 0 V, TEST CIRCUIT 1
Gate Leakage Current	I <sub>GSS</sub>			±10	μA	V <sub>GS</sub> = ±8 V, V <sub>SS</sub> = 0 V, TEST CIRCUIT 2
Gate to Source Cut-off Voltage	V <sub>GS(off)</sub>	0.5	0.85	1.5	V	V <sub>SS</sub> = 10 V, I <sub>S</sub> = 1.0 mA, TEST CIRCUIT 3
Forward Transfer Admittance *1	y <sub>fs</sub>	6.0			S	V <sub>SS</sub> = 5 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 4
Source to Source On-state Resistance *1	R <sub>SS(on)1</sub>	6.6	9.4	11.9	mΩ	V <sub>GS</sub> = 4.5 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 5
	R <sub>SS(on)2</sub>	6.6	9.9	12.8	mΩ	V <sub>GS</sub> = 4.0 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 5
	R <sub>SS(on)3</sub>	6.6	10.0	13.0	mΩ	V <sub>GS</sub> = 3.8 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 5
	R <sub>SS(on)4</sub>	7.3	12.0	17.6	mΩ	V <sub>GS</sub> = 3.1 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 5
	R <sub>SS(on)5</sub>	9.0	16.0	26.0	mΩ	V <sub>GS</sub> = 2.5 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 5
Input Capacitance	C <sub>iSS</sub>		1480		pF	V <sub>SS</sub> = 10 V,
Output Capacitance	C <sub>oss</sub>		590		pF	V <sub>GS</sub> = 0 V,
Reverse Transfer Capacitance	C <sub>rss</sub>		520		pF	f = 1.0 MHz, TEST CIRCUIT 7
Turn-on Delay Time	t <sub>d(on)</sub>		11.1		μs	V <sub>DD</sub> = 12 V, I <sub>S</sub> = 8.0 A,
Rise Time	t <sub>r</sub>		41		μs	V <sub>GS</sub> = 4.0 V,
Turn-off Delay Time	t <sub>d(off)</sub>		30		μs	R <sub>G</sub> = 6.0 Ω,
Fall Time	t <sub>f</sub>		74		μs	TEST CIRCUIT 8
Total Gate Charge	Q <sub>G</sub>		20		nC	V <sub>DD</sub> = 9.6 V, V <sub>G1S1</sub> = 4.0 V, I <sub>S</sub> = 4.0 A, TEST CIRCUIT 9
Body Diode Forward Voltage *1	V <sub>F(S-S)</sub>		0.8		V	I <sub>F</sub> = 8.0 A, V <sub>GS</sub> = 0 V, TEST CIRCUIT 6

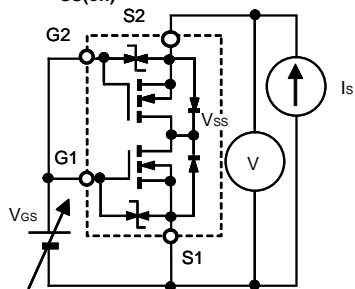
Note: \*1. Pulsed test

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

<b>TEST CIRCUIT 1</b> I <sub>SSS</sub> 	<b>TEST CIRCUIT 2</b> I <sub>GSS</sub> When FET1 is measured, between GATE and SOURCE of FET2 are shorted. 
<b>TEST CIRCUIT 3</b> V <sub>GS(off)</sub> When FET1 is measured, between GATE and SOURCE of FET2 are shorted. 	<b>TEST CIRCUIT 4</b>  y <sub>fs</sub>   ΔI <sub>S</sub> /ΔV <sub>GS</sub> 

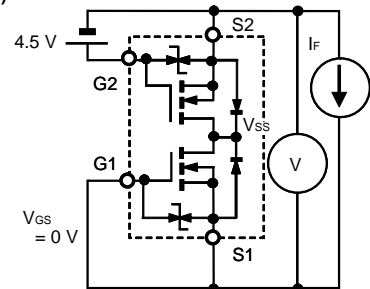
### TEST CIRCUIT 5 $R_{SS(on)}$

$V_{SS}/I_S$

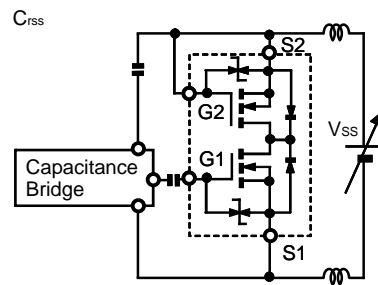
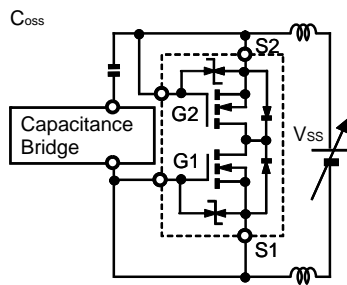
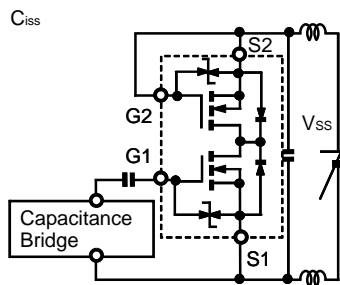


### TEST CIRCUIT 6 $V_{F(S-S)}$

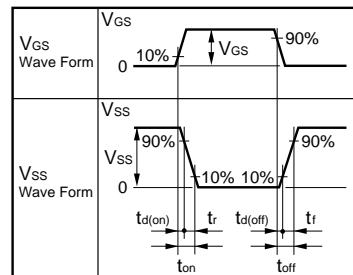
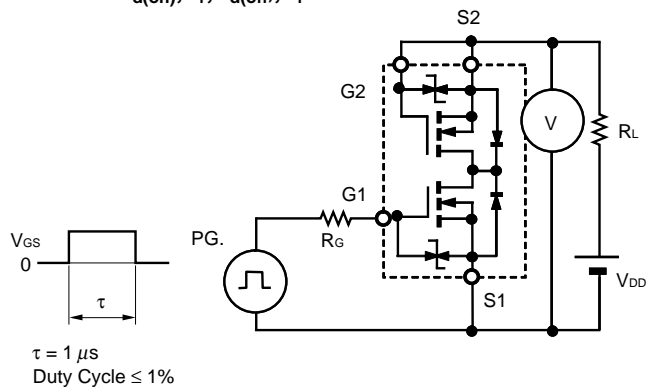
When FET1 is measured, FET2 is added  $V_{GS} + 4.5$  V.



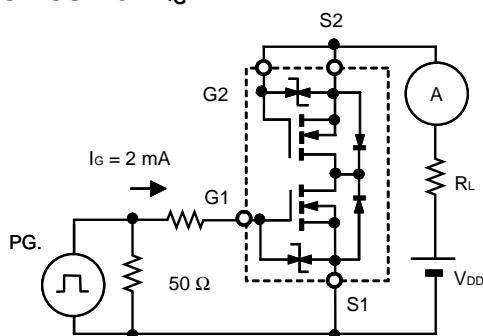
### TEST CIRCUIT 7



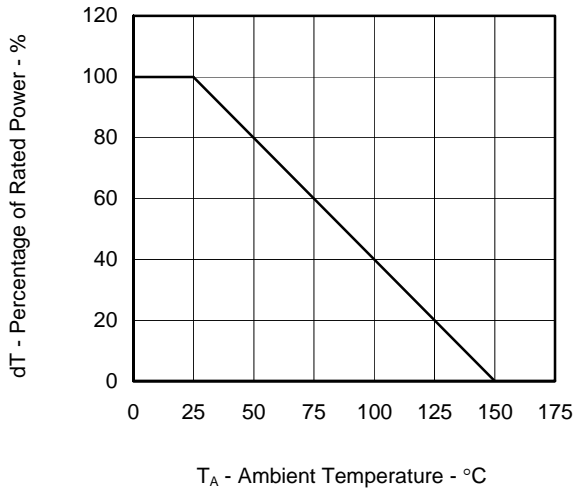
### TEST CIRCUIT 8 $t_{d(on)}$ , $t_r$ , $t_{d(off)}$ , $t_f$



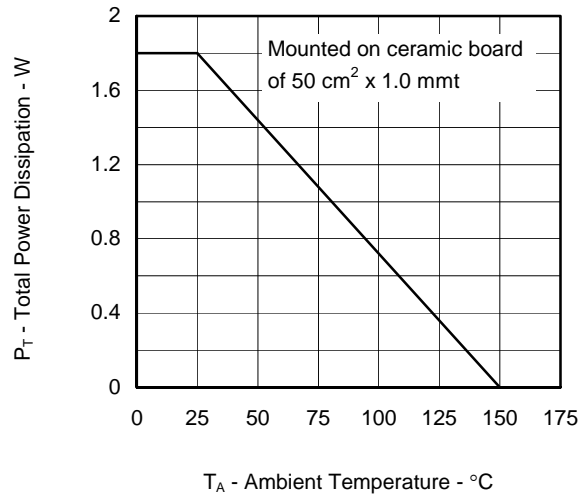
### TEST CIRCUIT 9 $Q_G$



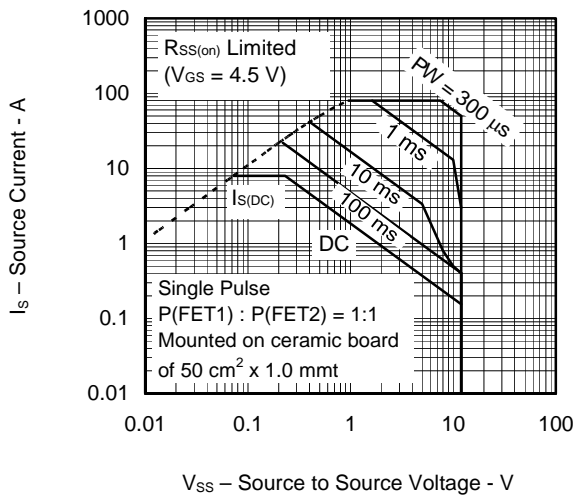
DERATING FACTOR OF FORWARD BIAS SAFE OPERATING AREA



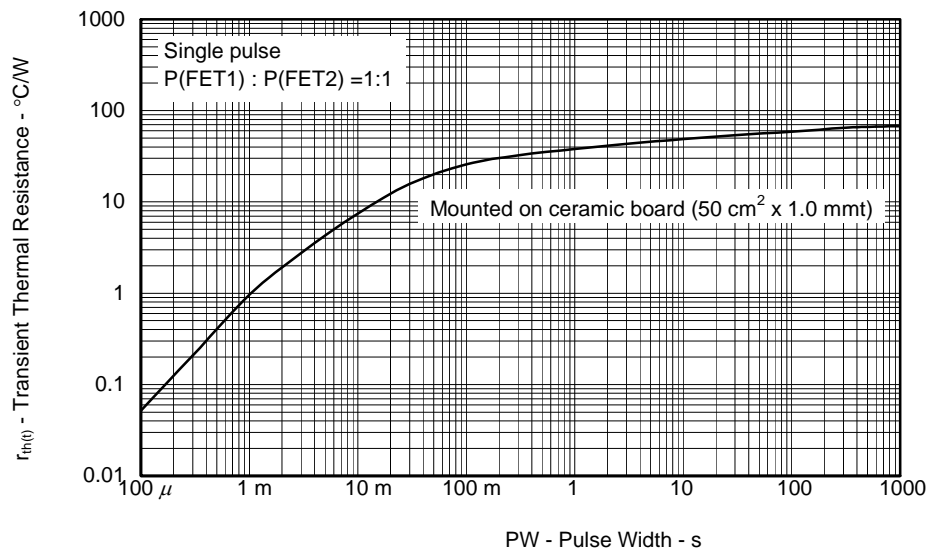
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



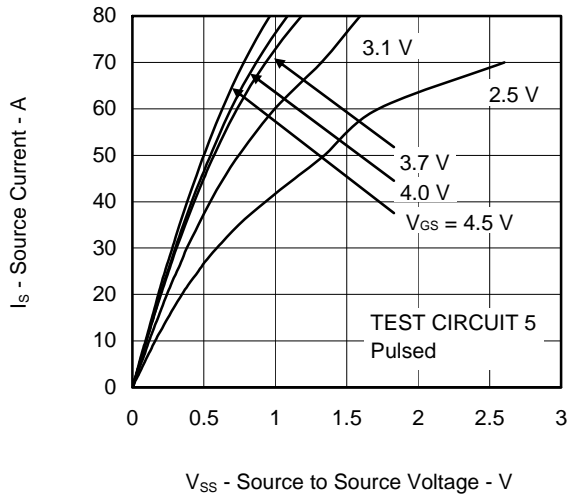
FORWARD BIAS SAFE OPERATING AREA



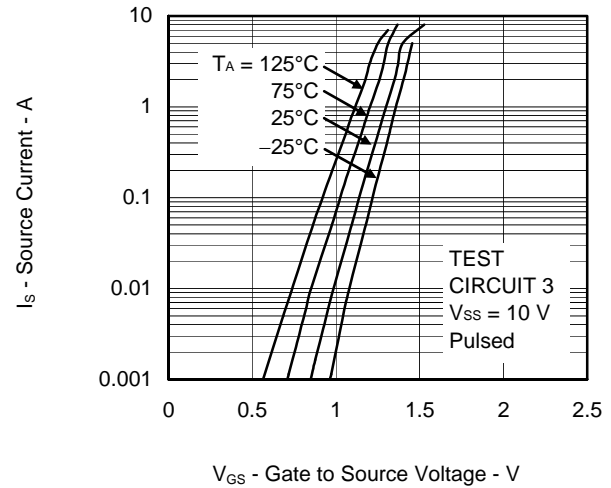
TRANSIENT THERMAL RESISTANCE vs. PULSE WIDTH



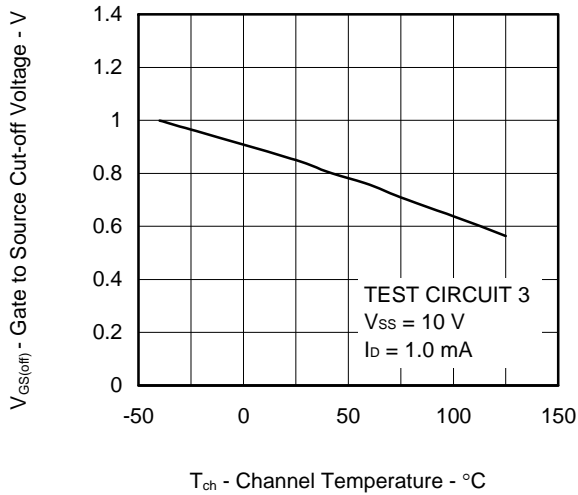
SOURCE CURRENT vs.  
SOURCE TO SOURCE VOLTAGE



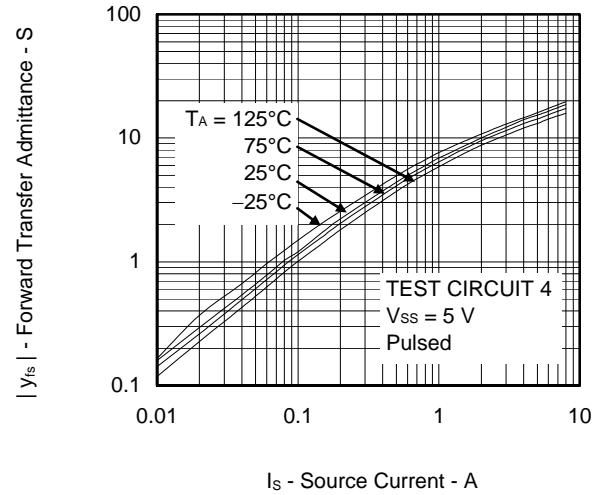
FORWARD TRANSFER CHARACTERISTICS



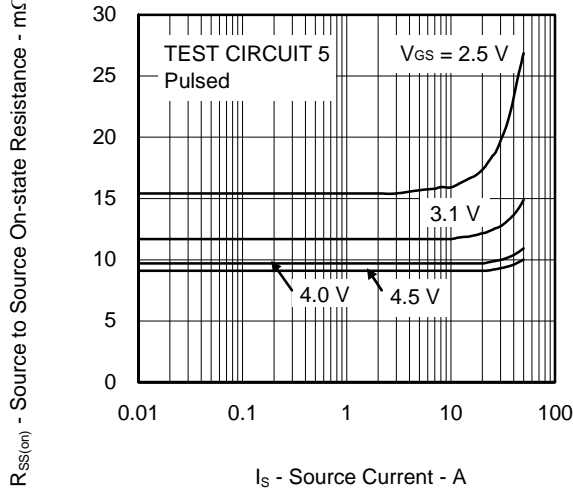
GATE TO SOURCE CUT-OFF VOLTAGE  
vs. CHANNEL TEMPERATURE



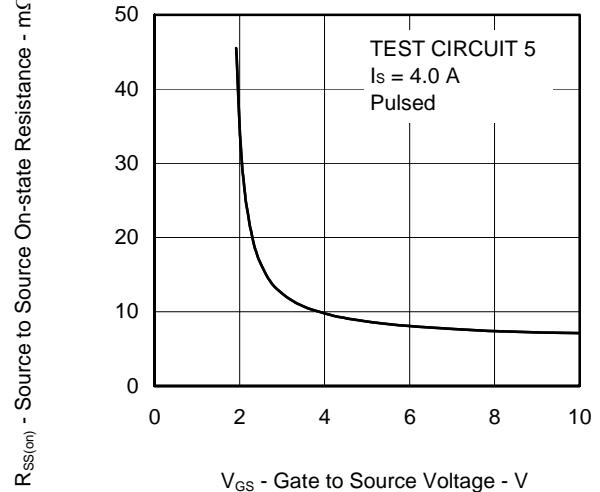
FORWARD TRANSFER ADMITTANCE vs.  
SOURCE CURRENT



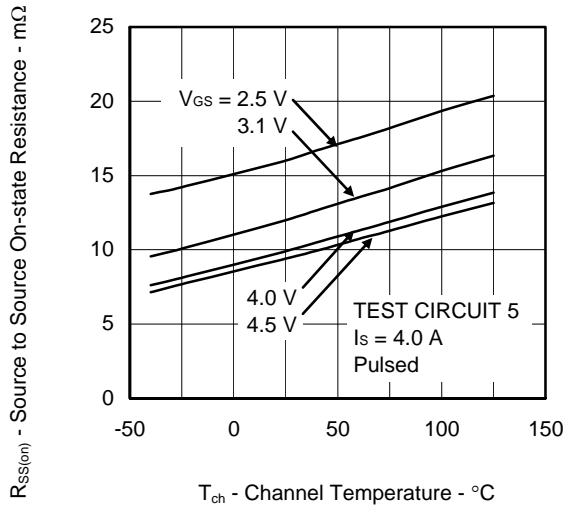
SOURCE TO SOURCE ON-STATE RESISTANCE  
vs. SOURCE CURRENT



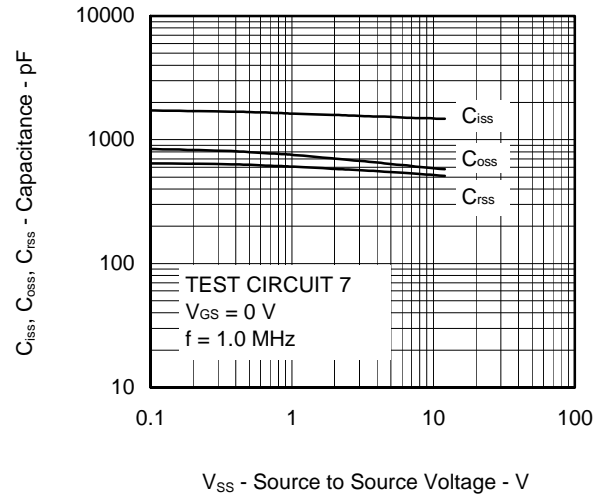
SOURCE TO SOURCE ON-STATE RESISTANCE  
vs. GATE TO SOURCE VOLTAGE



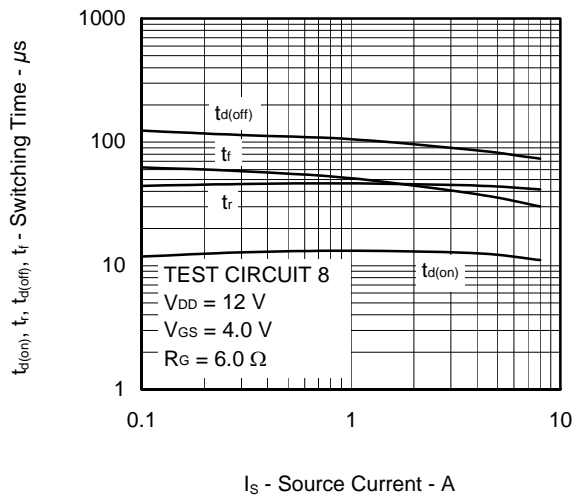
SOURCE TO SOURCE ON-STATE RESISTANCE  
vs. CHANNEL TEMPERATURE



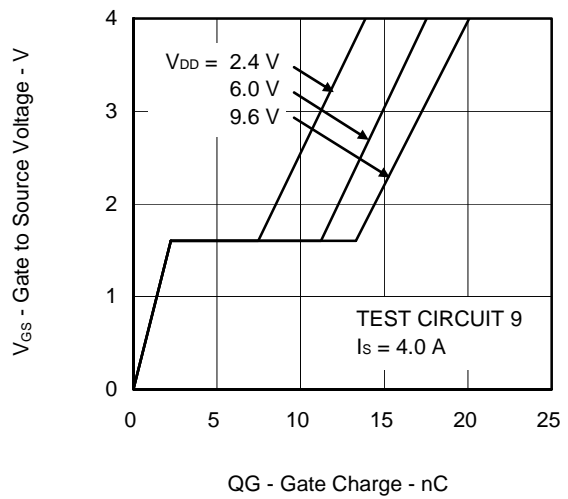
CAPACITANCE vs. SOURCE TO SOURCE VOLTAGE



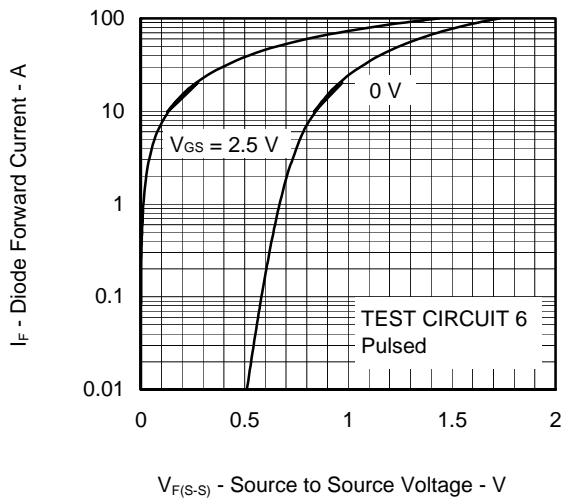
SWITCHING CHARACTERISTICS



DYNAMIC INPUT CHARACTERISTICS

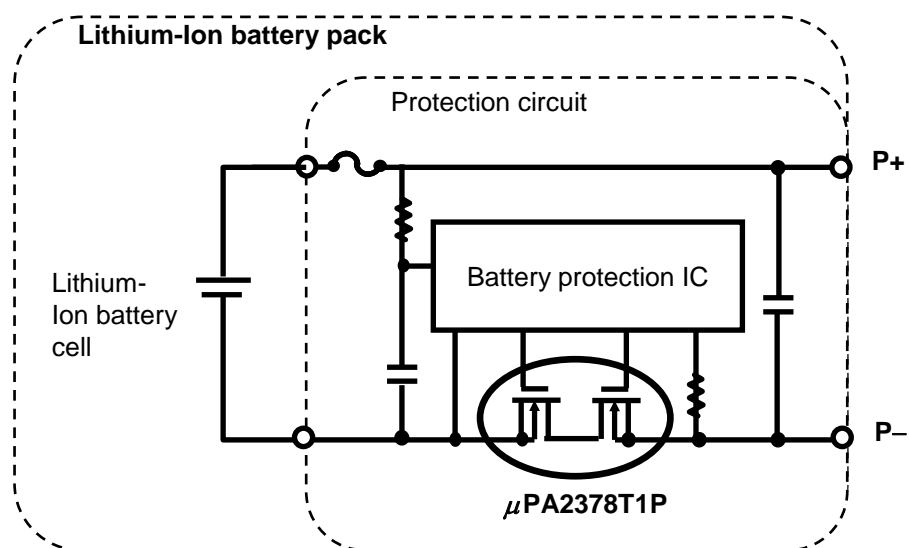


SOURCE TO SOURCE DIODE FORWARD VOLTAGE



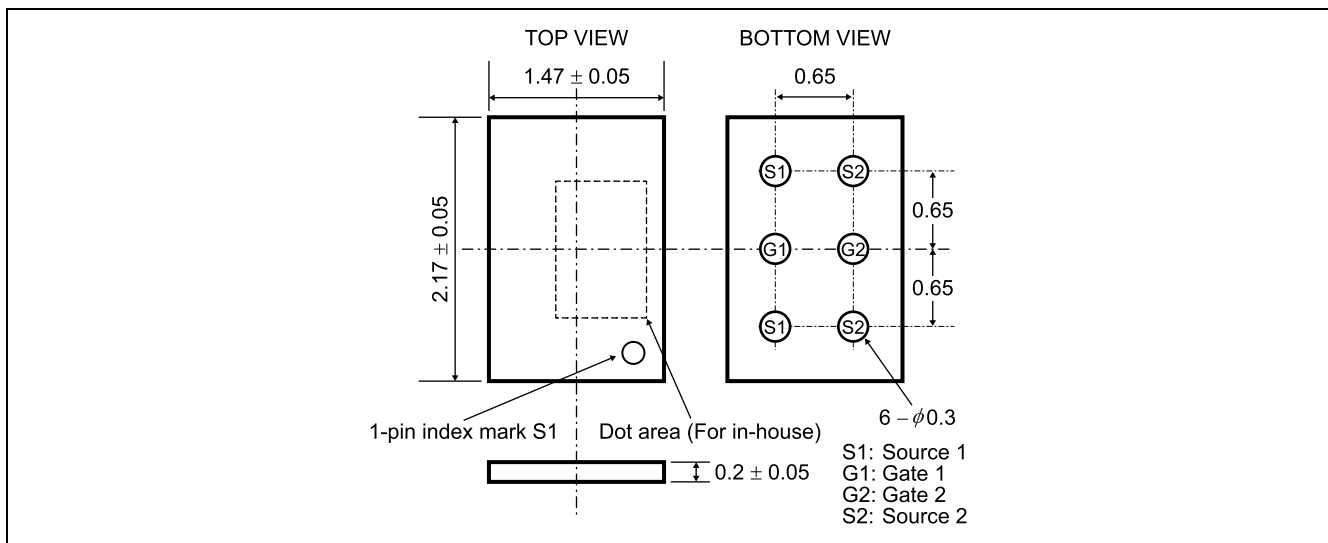
## Example of application circuit

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

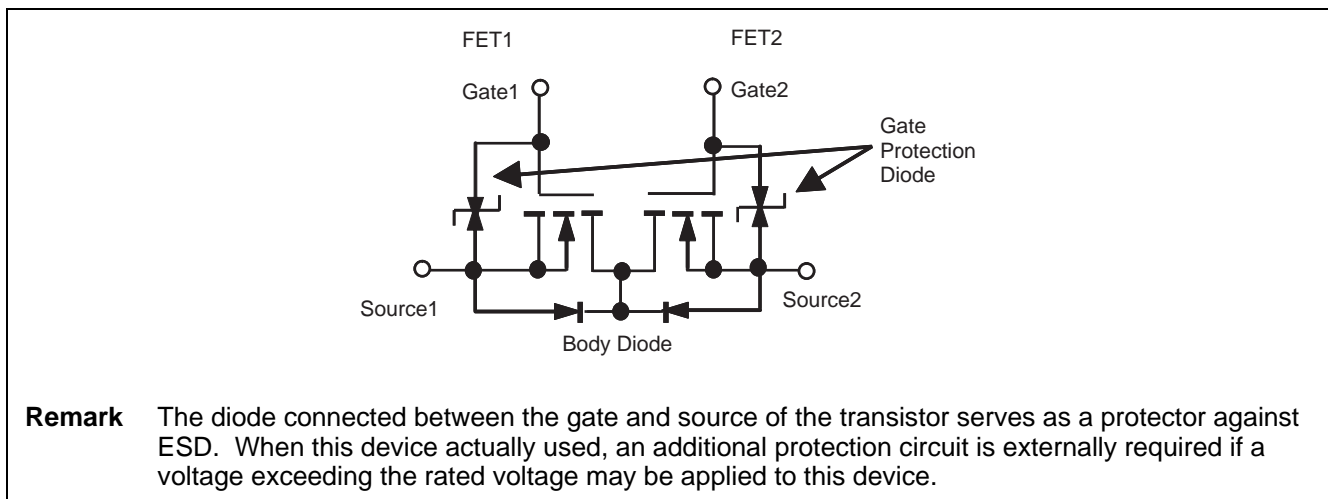


## PACKAGE DRAWINGS (UNIT: mm)

### 6-pin EFLIP-LGA



### Equivalent Circuit





## 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  $2000 \times 10^{-6}$ . If the distortion exceeds  $2000 \times 10^{-6}$ , 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**

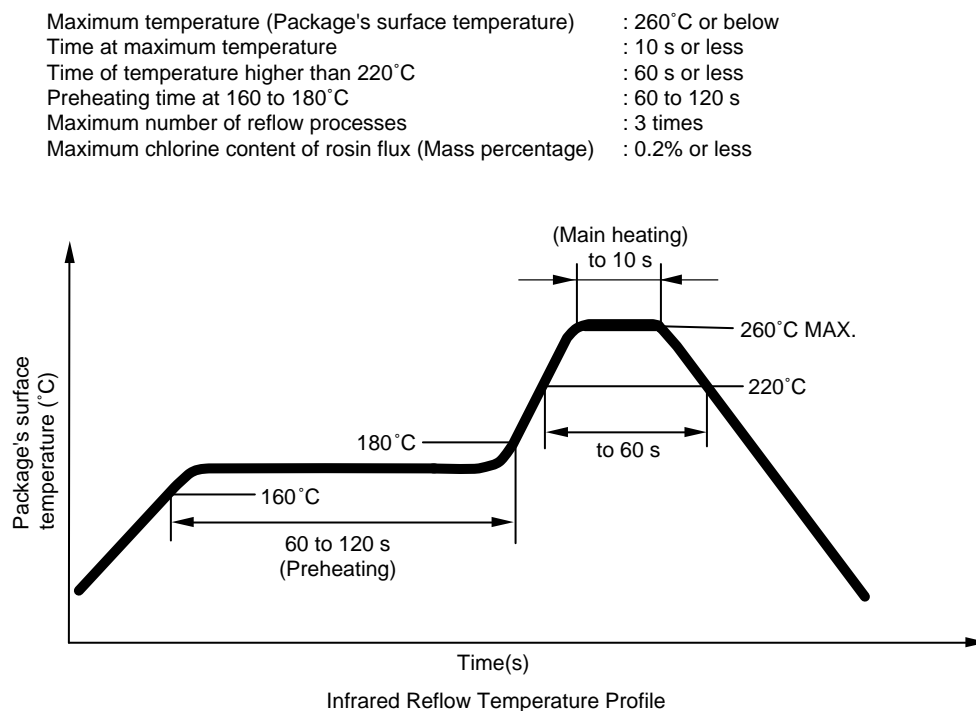


Figure 2 The example of the Mounting Pad (Unit : mm)

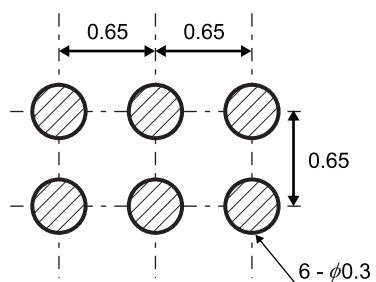
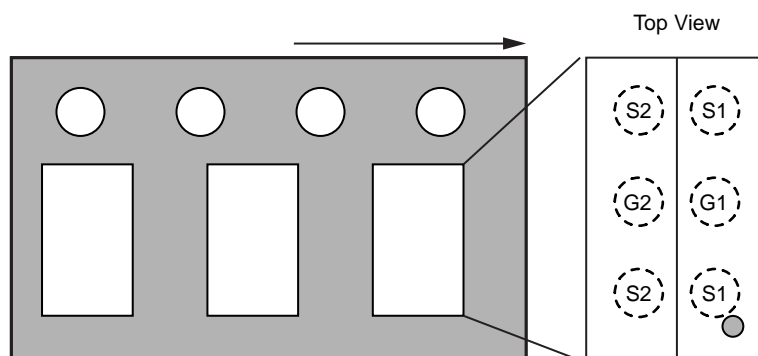


Figure 3 The unit orientation



<b>Revision History</b>	<b>μPA2378T1P Data Sheet</b>
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Rev.	Date	Description	
		Page	Summary
1.00	Mar 19, 2012	–	First Edition Issued

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