

# MOSFET – Power, Dual N-Channel, for 1-2 Cells Lithium-ion Battery Protection

24 V, 45 mΩ, 6 A

## EFC4612R-S

This Power MOSFET features a low on-state resistance. This device is suitable for applications such as power switches of portable machines. Best suited for 1–2 cells lithium-ion battery applications.

### Features

- 2.5 V Drive
- Common-Drain Type
- ESD Diode-Protected Gate
- Pb-Free, Halide Free and RoHS Compliant

### Applications

- 1–2 Cells Lithium-ion Battery Charging and Discharging Switch

### SPECIFICATIONS

#### ABSOLUTE MAXIMUM RATINGS at T<sub>A</sub> = 25°C

| Parameter   | Symbol           | Value       | Unit |
|---|------------------|-------------|------|
| Source to Source Voltage                              | V <sub>SSS</sub> | 24          | V    |
| Gate to Source Voltage                                | V <sub>GSS</sub> | ±12         | V    |
| Source Current (DC)                                   | I <sub>S</sub>   | 6           | A    |
| Source Current (Pulse)<br>PW ≤ 10 μs, duty cycle ≤ 1% | I <sub>SP</sub>  | 60          | A    |
| Total Dissipation (Note 2)                            | P <sub>T</sub>   | 1.6         | W    |
| Junction Temperature                                  | T <sub>J</sub>   | 150         | °C   |
| Storage Temperature                                   | T <sub>stg</sub> | -55 to +150 | °C   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

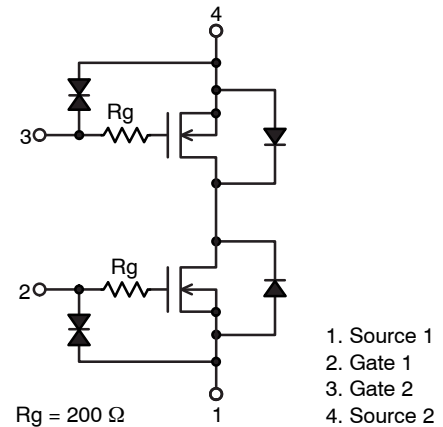
#### THERMAL RESISTANCE RATINGS

| Parameter                    | Symbol           | Value | Unit |
|------------------------------|------------------|-------|------|
| Junction to Ambient (Note 1) | R <sub>θJA</sub> | 78.1  | °C/W |

1. Surface mounted on ceramic substrate (5000 mm<sup>2</sup> × 0.8 mm).

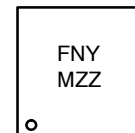
| V <sub>SSS</sub> | R <sub>SS(on)</sub> Max | I <sub>S</sub> Max |
|------------------|-------------------------|--------------------|
| 24 V             | 45 mΩ @ 4.5 V           | 6 A                |
|                  | 48 mΩ @ 4.0 V           |                    |
|                  | 50 mΩ @ 3.7 V           |                    |
|                  | 57 mΩ @ 3.1 V           |                    |
|                  | 72 mΩ @ 2.5 V           |                    |

### ELECTRICAL CONNECTION N-Channel



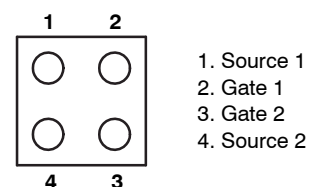
WLCSP4, 1.3 × 1.3 /  
EFCP1313-4CC-037  
CASE 567DP

### MARKING DIAGRAM



FN = Specific Device Code  
Y = Year  
M = Month  
ZZ = Assembly Lot Number

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# EFC4612R-S

## ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$

| Parameter                                   | Symbol        | Conditions   | Value |     |          | Unit             |
|---|---------------|--|-------|-----|----------|------------------|
|   |               |  | Min   | Typ | Max      |                  |
| Source to Source Breakdown Voltage          | $V_{(BR)SSS}$ | $I_S = 1\text{ mA}, V_{GS} = 0\text{ V}$ (Figure 1)                        | 24    | -   | -        | V                |
| Zero-Gate Voltage Source Current            | $I_{SSS}$     | $V_{SS} = 20\text{ V}, V_{GS} = 0\text{ V}$ (Figure 1)                     | -     | -   | 1        | $\mu\text{A}$    |
| Gate to Source Leakage Current              | $I_{GSS}$     | $V_{GS} = \pm 8\text{ V}, V_{SS} = 0\text{ V}$ (Figure 2)                  | -     | -   | $\pm 10$ | $\mu\text{A}$    |
| Gate Threshold Voltage                      | $V_{GS(th)}$  | $V_{SS} = 10\text{ V}, I_S = 1\text{ mA}$ (Figure 3)                       | 0.5   | -   | 1.3      | V                |
| Forward Transconductance                    | $g_{FS}$      | $V_{SS} = 10\text{ V}, I_S = 3\text{ A}$ (Figure 4)                        | -     | 3.1 | -        | S                |
| Static Source to Source On-State Resistance | $R_{SS(on)1}$ | $V_{GS} = 4.5\text{ V}, I_S = 3\text{ A}$ (Figure 5)                       | 24    | 39  | 45       | $\text{m}\Omega$ |
|   | $R_{SS(on)2}$ | $V_{GS} = 4.0\text{ V}, I_S = 3\text{ A}$ (Figure 5)                       | 25    | 41  | 48       | $\text{m}\Omega$ |
|   | $R_{SS(on)3}$ | $V_{GS} = 3.7\text{ V}, I_S = 3\text{ A}$ (Figure 5)                       | 27.5  | 43  | 50       | $\text{m}\Omega$ |
|   | $R_{SS(on)4}$ | $V_{GS} = 3.1\text{ V}, I_S = 3\text{ A}$ (Figure 5)                       | 31.5  | 48  | 57       | $\text{m}\Omega$ |
|   | $R_{SS(on)5}$ | $V_{GS} = 2.5\text{ V}, I_S = 3\text{ A}$ (Figure 5)                       | 33.5  | 58  | 72       | $\text{m}\Omega$ |
| Turn-ON Delay Time                          | $t_d(on)$     | $V_{SS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_S = 3\text{ A}$ (Figure 6) | -     | 20  | -        | ns               |
| Rise Time                                   | $t_r$         |  | -     | 230 | -        | ns               |
| Turn-OFF Delay Time                         | $t_d(off)$    |  | -     | 130 | -        | ns               |
| Fall Time                                   | $t_f$         |  | -     | 210 | -        | ns               |
| Total Gate Charge                           | $Q_g$         | $V_{SS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_S = 6\text{ A}$ (Figure 7) | -     | 7   | -        | nC               |
| Forward Source to Source Voltage            | $V_{F(S-S)}$  | $I_S = 3\text{ A}, V_{GS} = 0\text{ V}$ (Figure 8)                         | -     | 0.8 | 1.2      | V                |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

Test Circuit are Example of Measuring FET1 Side

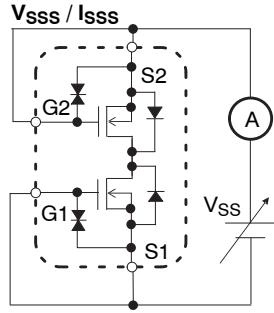


Figure 1. Test Circuit 1

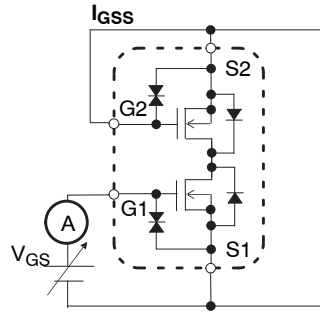


Figure 2. Test Circuit 2

When FET1 is measured, Gate and Source of FET2 are short-circuited.

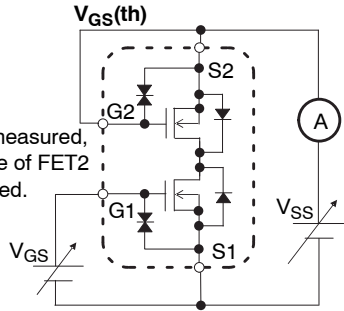


Figure 3. Test Circuit 3

When FET1 is measured, Gate and Source of FET2 are short-circuited.

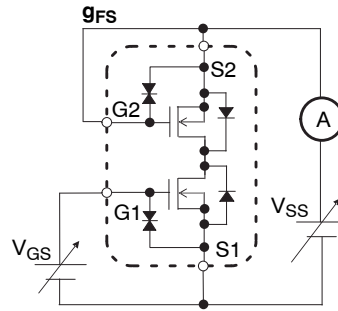


Figure 4. Test Circuit 4

When FET1 is measured, Gate and Source of FET2 are short-circuited.

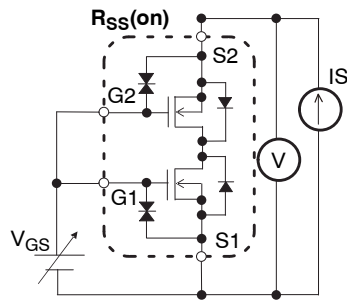


Figure 5. Test Circuit 5

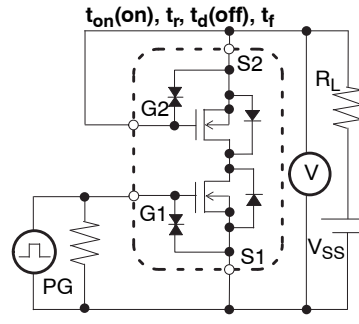


Figure 6. Test Circuit 6

When FET1 is measured, Gate and Source of FET2 are short-circuited.

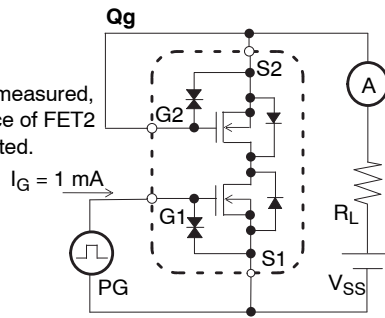


Figure 7. Test Circuit 7

When FET1 is measured, Gate and Source of FET2 are short-circuited.

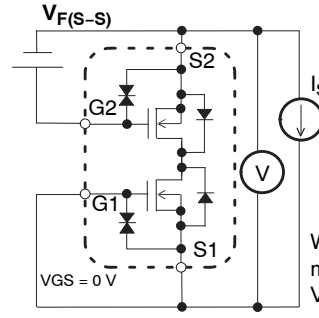


Figure 8. Test Circuit 8

When FET1 is measured, +4.5 V is added to VGS of FET2.

NOTE: When FET2 is measured, the position of FET1 and FET2 is switched.

TYPICAL CHARACTERISTICS

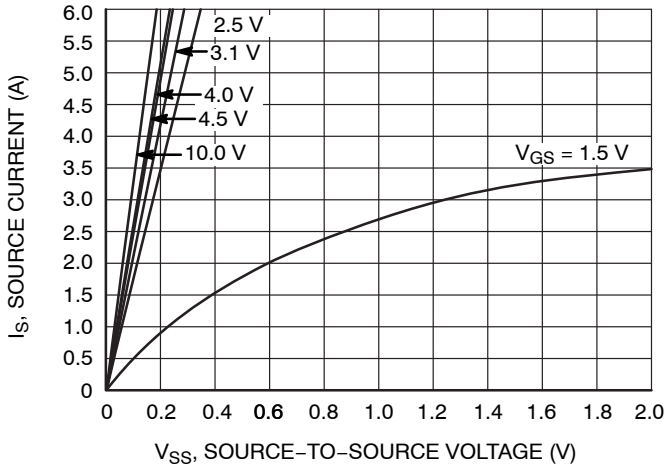


Figure 9.  $I_S - V_{SS}$

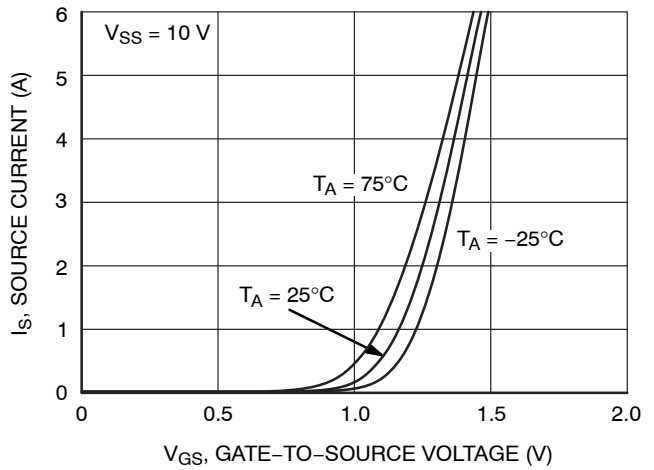


Figure 10.  $I_S - V_{GS}$

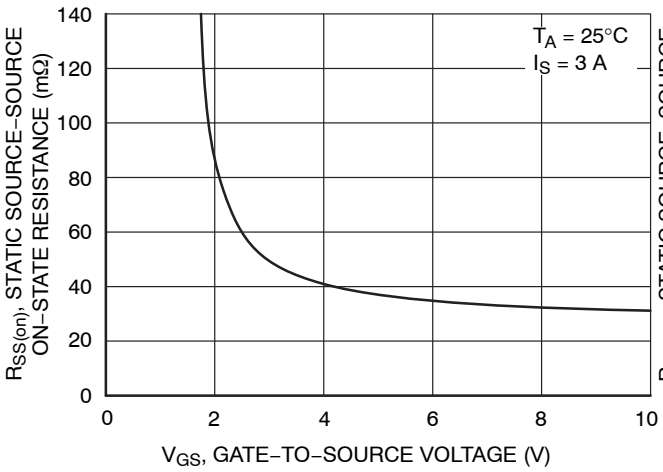


Figure 11.  $R_{SS(on)} - V_{GS}$

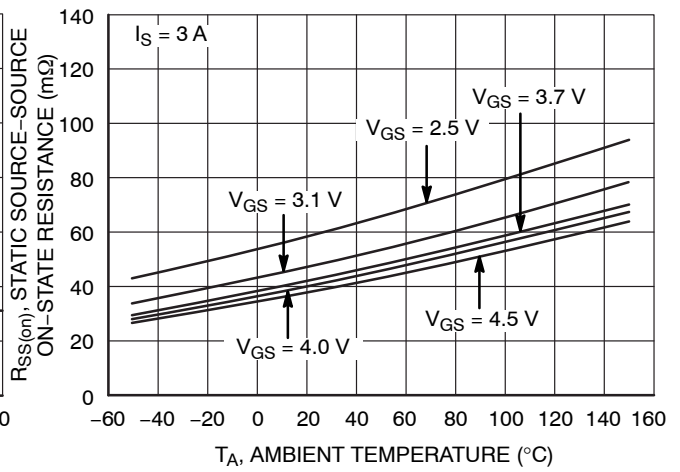


Figure 12.  $R_{SS(on)} - T_A$

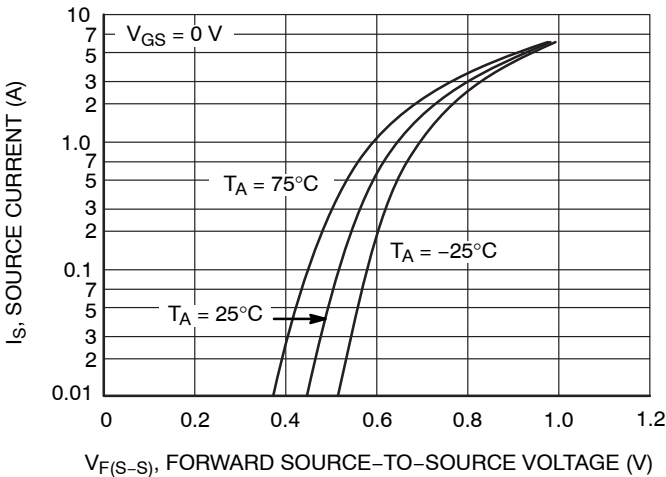


Figure 13.  $I_S - V_{F(S-S)}$

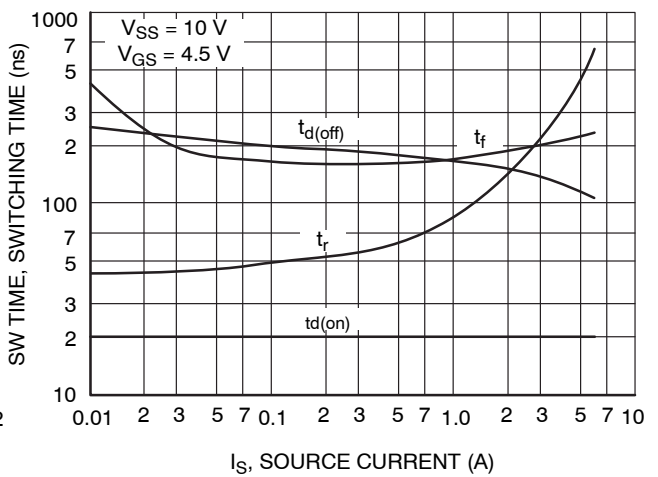


Figure 14. SW Time -  $I_S$

# EFC4612R-S

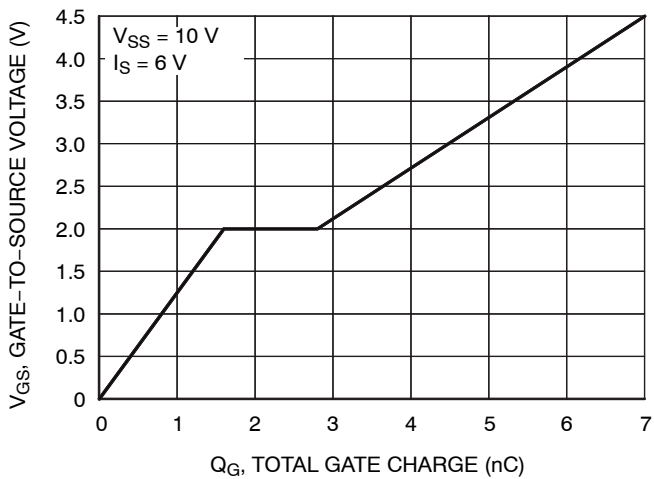


Figure 15.  $V_{GS} - Q_g$

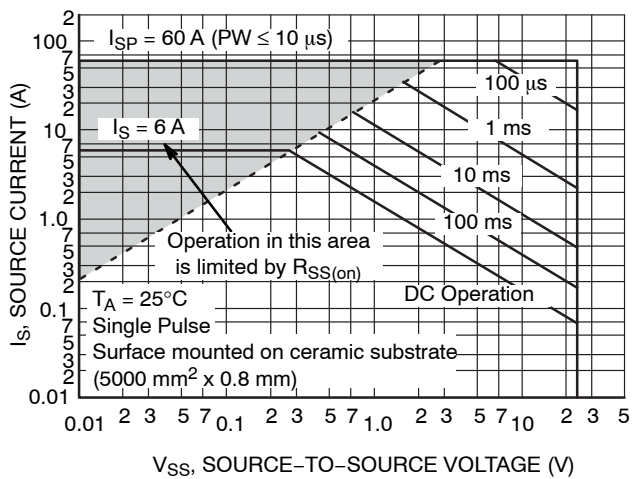


Figure 16. SOA

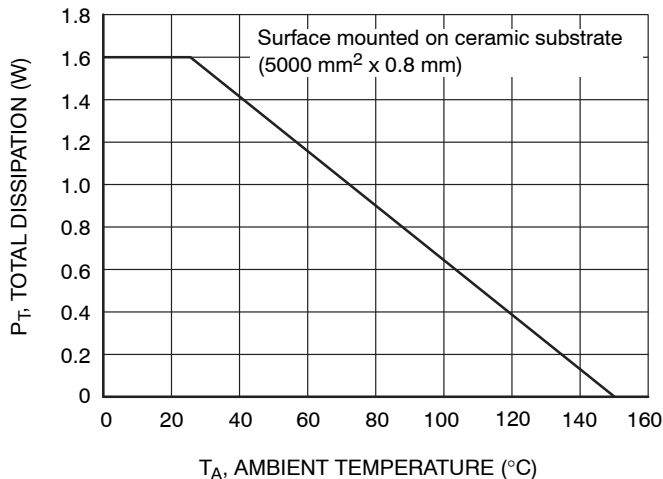


Figure 17.  $P_T - T_A$

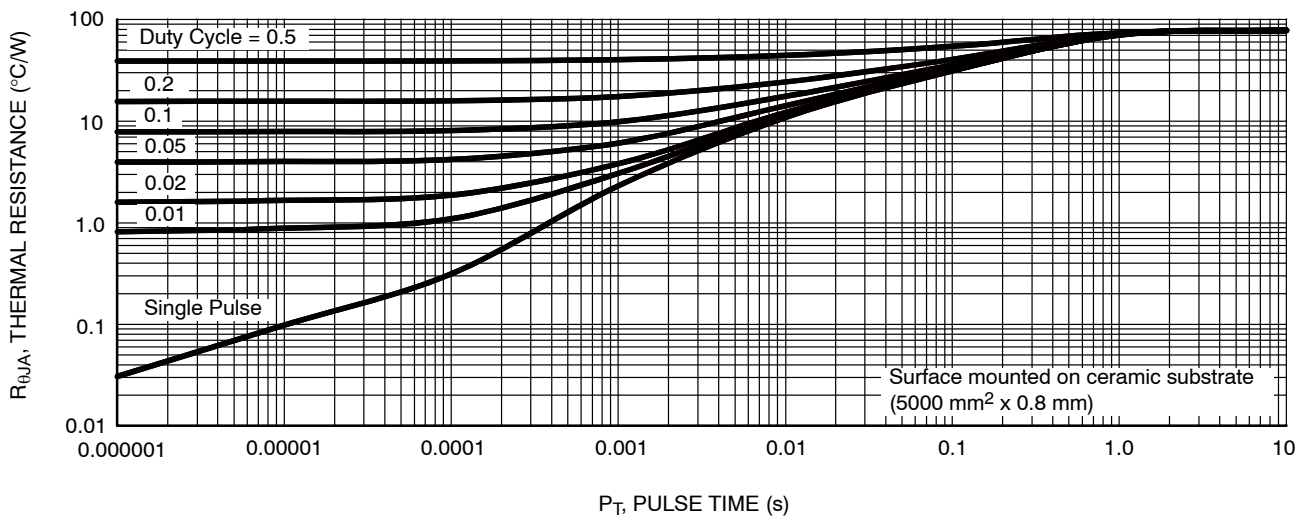


Figure 18.  $R_{\theta JA} - \text{Pulse Time}$

# EFC4612R-S

## ORDERING INFORMATION

| Device        | Marking | Package  | Shipping <sup>†</sup> (Qty / Packing) |
|---------------|---------|--|---------------------------------------|
| EFC4612R-S-TR | FN      | WLCSP4, 1.3 × 1.3 /<br>EFCP1313-4CC-037<br>(Pb-Free and Halide Free) | 5000 / Tape & Reel                    |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, [BRD8011/D](#).

## PACKAGE DIMENSION

(Unit: mm)

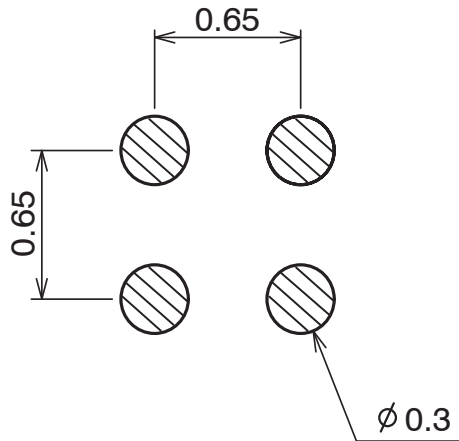
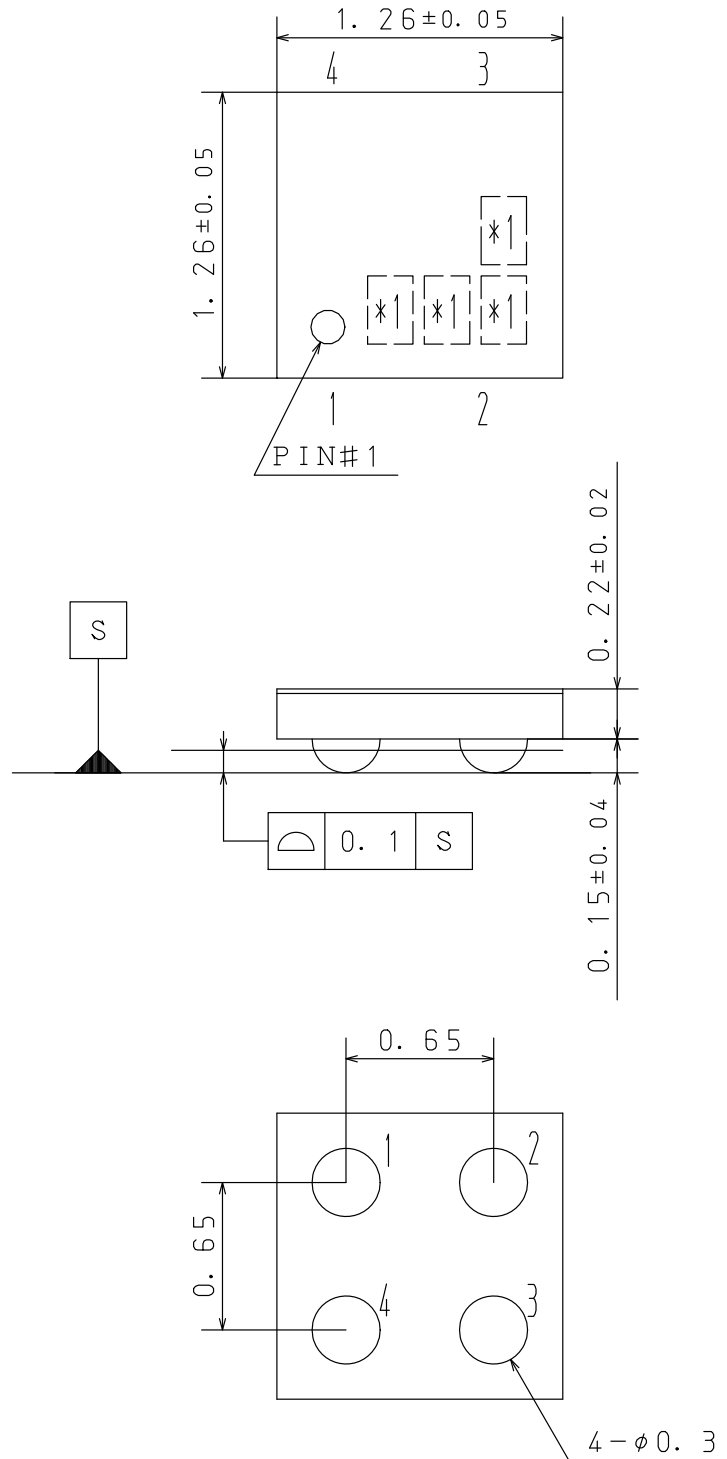


Figure 19. Recommended Soldering Footprint

**WLCSP4, 1.3x1.3 / EFCP1313-4CC-037**  
CASE 567DP  
ISSUE 0

DATE 29 FEB 2012



|                         |  |   |
|-------------------------|--|---|
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