

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK2292xG, TCK2297xG

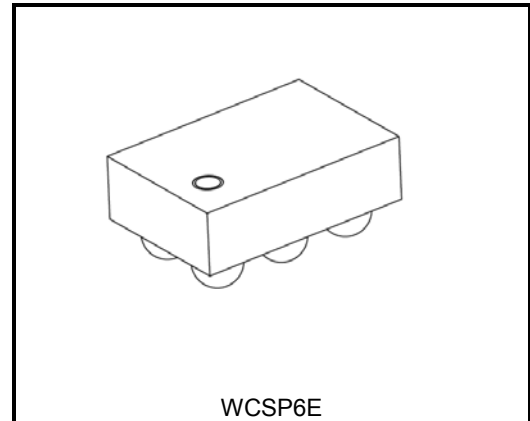
## 2A, 25mΩ Load Switch IC with Slew Rate Control Driver

The TCK2292xG and TCK2297xG are load switch ICs for power management with slew rate control driver featuring wide input voltage operation from 1.1 to 5.5 V. Switch ON resistance is only 25 mΩ typical at 5.0 V, -0.5 A load condition and these feature a slew rate control driver. TCK2292xG has output auto-discharge function. Output current type is available on 2 A.

This device is available in 0.4 mm pitch ultra small package WCSP6E (0.8 mm x 1.2 mm, t: 0.59 mm (max)). Thus this device is ideal for portable applications that require high-density board assembly such as cellular phone.

### Feature

- Wide input voltage operation:  $V_{IN} = 1.1$  to 5.5 V
- Low ON resistance:
  - $R_{ON} = 25$  mΩ (typ.) at  $V_{IN} = 5.0$  V,  $I_{OUT} = -0.5$  A
  - $R_{ON} = 31$  mΩ (typ.) at  $V_{IN} = 3.3$  V,  $I_{OUT} = -0.5$  A
  - $R_{ON} = 52$  mΩ (typ.) at  $V_{IN} = 1.8$  V,  $I_{OUT} = -0.5$  A
  - $R_{ON} = 104$  mΩ (typ.) at  $V_{IN} = 1.2$  V,  $I_{OUT} = -0.5$  A
- Low Quiescent Current:  $I_Q = 0.1$  μA (typ.) at  $I_{OUT} = 0$  mA (TCK22921G, TCK22971G)
- Slew Rate Control circuit
- Output auto-discharge (Option)
- Reverse current blocking
- Pull down connection between Control and GND (Option)
- Ultra small package: WCSP6E (0.8mm x 1.2mm, t: 0.59mm(max))



Weight: 1 mg (typ.)

Start of commercial production  
2016-06

### Function Table

| Part number | Function          |   |                       |                      |                        | Device Marking |
|-------------|-------------------|---|-----------------------|----------------------|------------------------|----------------|
|             | Rise time @VIN=5V | Reverse current blocking (SW OFF state) | Output auto-discharge | Control pin polarity | Control pin connection |                |
| TCK22921G   | 4.5 $\mu$ s       | Built in                                | Built in              | Active High          | Pull down              | 1R             |
| TCK22922G   | 666 $\mu$ s       | Built in                                | Built in              | Active High          | Pull down              | 2R             |
| TCK22923G   | 1364 $\mu$ s      | Built in                                | Built in              | Active High          | Pull down              | 3R             |
| TCK22925G   | 3380 $\mu$ s      | Built in                                | Built in              | Active High          | Pull down              | 4R             |
| TCK22971G   | 4.5 $\mu$ s       | Built in                                | N/A                   | Active High          | Pull down              | 5R             |
| TCK22972G   | 666 $\mu$ s       | Built in                                | N/A                   | Active High          | Pull down              | 6R             |
| TCK22973G   | 1364 $\mu$ s      | Built in                                | N/A                   | Active High          | Pull down              | 7R             |
| TCK22974G   | 3380 $\mu$ s      | Built in                                | N/A                   | Active High          | Pull down              | 8R             |
| TCK22975G   | 666 $\mu$ s       | Built in                                | N/A                   | Active Low           | Open                   | 9R             |

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

| Characteristics             | Symbol           | Rating       |             | Unit |
|-----------------------------|------------------|--------------|-------------|------|
| Input voltage               | V <sub>IN</sub>  | -0.3 to 6.0  |             | V    |
| Control voltage             | V <sub>CT</sub>  | -0.3 to 6.0  |             | V    |
| Output voltage              | V <sub>OUT</sub> | -0.3 to 6.0  |             | V    |
| Output current              | I <sub>OUT</sub> | DC           | 2.0         | A    |
|                             |                  | Pulse        | 3.0 (Note1) | A    |
| Power dissipation           | P <sub>D</sub>   | 800 (Note 2) |             | mW   |
| Operating temperature range | T <sub>opr</sub> | -40 to 85    |             | °C   |
| Junction teperature         | T <sub>j</sub>   | 150          |             | °C   |
| Storage temperature         | T <sub>stg</sub> | -55 to 150   |             | °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).

Note1: 100 μs pulse, 2% duty cycle

Note2: Rating at mounting on a board

Board material: Glass epoxy (FR4)

Board dimension: 40mm x 40mm (both sides of board), t=1.6mm

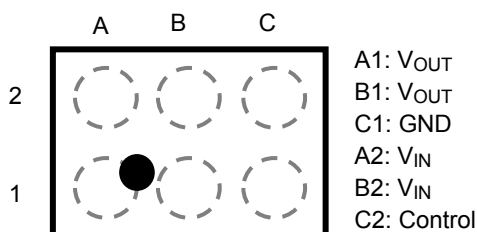
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%

Through hole: diameter 0.5mm x 28

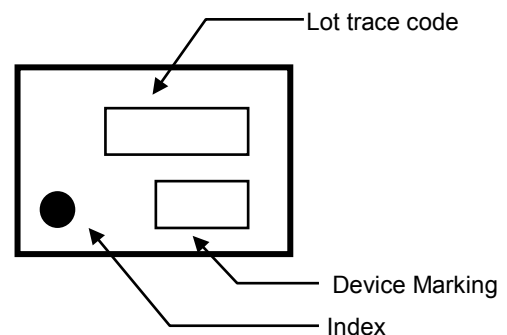
## Operating conditions

| Characteristics                  | Symbol           | Condition                      | Min | Max             | Unit |
|----------------------------------|------------------|--------------------------------|-----|-----------------|------|
| Input voltage                    | V <sub>IN</sub>  | —                              | 1.1 | 5.5             | V    |
| Output voltage                   | V <sub>OUT</sub> | —                              |     | V <sub>IN</sub> | V    |
| Output current                   | I <sub>OUT</sub> | 1.4V < V <sub>IN</sub>         |     | 2.0             | A    |
| Control High-level input voltage | V <sub>IH</sub>  | 1.2V < V <sub>IN</sub> ≤ 5.5 V | 1.0 | —               | V    |
|                                  |                  | 1.1V ≤ V <sub>IN</sub> ≤ 1.2 V | 0.9 | —               |      |
| Control Low-level input voltage  | V <sub>IL</sub>  |                                | —   | 0.4             | V    |

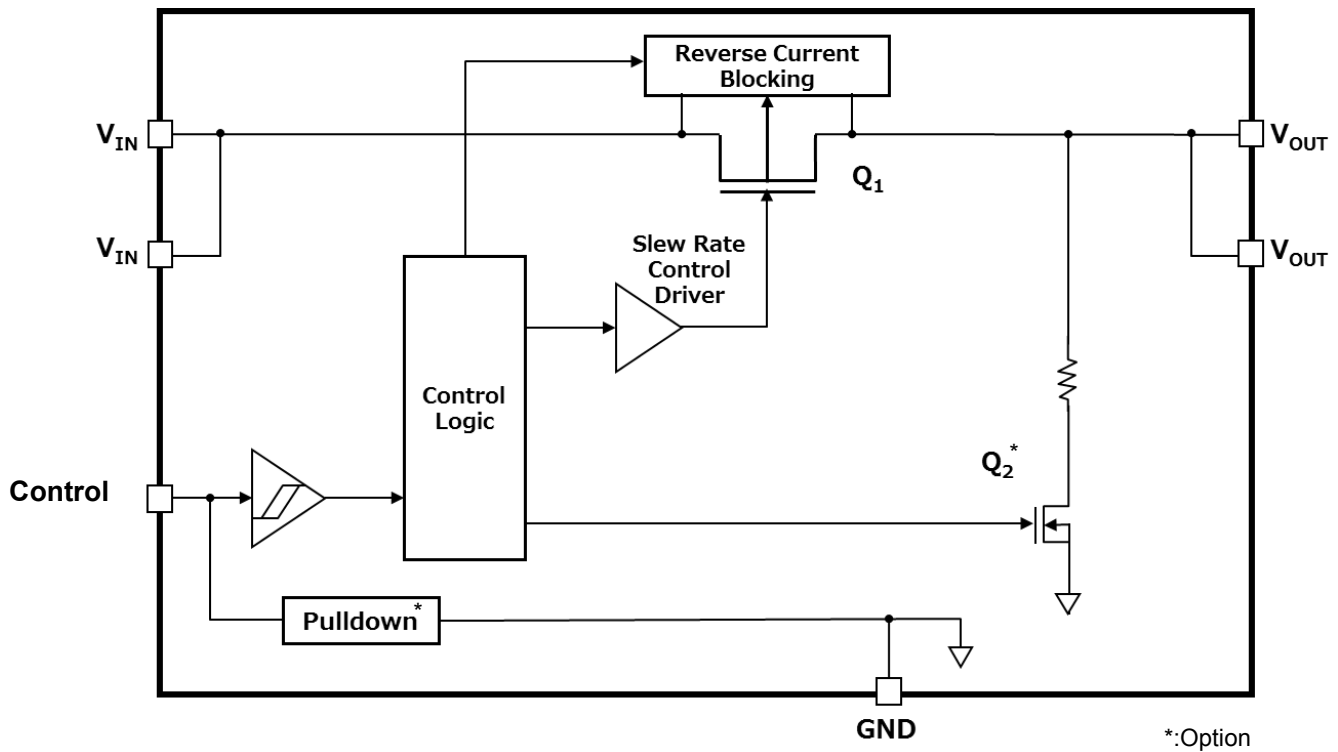
## Pin Assignment(Top view)



## Top marking



**Block Diagram**



**Operation logic table**

|                   |                          | TCK22921G<br>TCK22922G<br>TCK22923G<br>TCK22925G | TCK22971G<br>TCK22972G<br>TCK22973G<br>TCK22974G | TCK22975G |
|-------------------|--------------------------|--|--|-----------|
| Control<br>"High" | Output Q <sub>1</sub>    | ON   | ON   | OFF       |
|                   | Discharge Q <sub>2</sub> | OFF  | —  | —         |
|                   | Reverse current blocking | Inactive   | Inactive   | Active    |
| Control<br>"Low"  | Output Q <sub>1</sub>    | OFF  | OFF  | ON        |
|                   | Discharge Q <sub>2</sub> | ON   | —  | —         |
|                   | Reverse current blocking | Active   | Active   | Inactive  |

## Electrical Characteristics

### DC Characteristics (Ta = -40 to 85°C)

| Characteristics                    | Symbol               | Test Condition   | Ta = 25°C               |      |     | Ta = -40 to 85°C |     | Unit |    |
|------------------------------------|----------------------|--|-------------------------|------|-----|------------------|-----|------|----|
|                                    |                      |  | Min                     | Typ. | Max | Min              | Max |      |    |
| Quiescent current ( ON state)      | I <sub>Q</sub>       | I <sub>OUT</sub> = 0 mA<br>(Note 3)  | V <sub>IN</sub> = 1.8 V | —    | 0.1 | —                | —   | —    | μA |
|                                    |                      |  | V <sub>IN</sub> = 3.3 V | —    | 0.1 | —                | —   | —    | μA |
|                                    |                      |  | V <sub>IN</sub> = 5.5 V | —    | 0.1 | —                | —   | 0.5  | μA |
| Quiescent current ( ON state)      | I <sub>Q</sub>       | I <sub>OUT</sub> = 0 mA  | V <sub>IN</sub> = 1.8 V | —    | 1.2 | —                | —   | —    | μA |
|                                    |                      |  | V <sub>IN</sub> = 3.3 V | —    | 1.3 | —                | —   | —    | μA |
|                                    |                      |  | V <sub>IN</sub> = 5.5 V | —    | 1.4 | —                | —   | 2.5  | μA |
| Quiescent current ( OFF state)     | I <sub>Q(OFF)</sub>  | V <sub>IN</sub> = 5.5 V, V <sub>OUT</sub> = OPEN,<br>(Note 4)  | —                       | 0.07 | —   | —                | 0.4 | μA   |    |
| Switch leakage current( OFF state) | I <sub>SD(OFF)</sub> | V <sub>IN</sub> = 5.5 V, V <sub>OUT</sub> = GND, current<br>through from V <sub>IN</sub> to V <sub>OUT</sub> .<br>(Note 5) | —                       | 0.02 | —   | —                | 2   | μA   |    |
| Reverse blocking current           | I <sub>RB</sub>      | V <sub>OUT</sub> = 5.0 V,<br>V <sub>IN</sub> = 0 V   | —                       | 0.01 | —   | —                | 2   | μA   |    |
| On resistance                      | R <sub>ON</sub>      | I <sub>OUT</sub> = -0.5A   | V <sub>IN</sub> = 5.0 V | —    | 25  | —                | —   | 43   | mΩ |
|                                    |                      |  | V <sub>IN</sub> = 3.3 V | —    | 31  | —                | —   | 53   |    |
|                                    |                      |  | V <sub>IN</sub> = 1.8 V | —    | 52  | —                | —   | 83   |    |
|                                    |                      |  | V <sub>IN</sub> = 1.2 V | —    | 104 | —                | —   | 185  |    |
|                                    |                      |  | V <sub>IN</sub> = 1.1 V | —    | 136 | —                | —   | —    |    |
| Output discharge on resistance     | R <sub>SD</sub>      | — (Note 6)   | —                       | 100  | —   | —                | —   | Ω    |    |

Note 3: Only applies to the TCK22921G and TCK22971G

Note 4: Except OFF-state switch current

Note 5: Only applies to the TCK22971G, TCK22972G, TCK22973G, TCK22974G and TCK22975G

Note 6: Only applies to the TCK22921G, TCK22922G, TCK22923G, and TCK22925G

## AC Characteristics (Ta = 25°C)

V<sub>IN</sub> = 5.0 V

| Characteristics            | Symbol           | Test Condition(Figure 1)                   | Min       | Typ. | Max  | Unit |    |
|----------------------------|------------------|--|-----------|------|------|------|----|
| V <sub>OUT</sub> rise time | t <sub>r</sub>   | R <sub>L</sub> =5Ω , C <sub>L</sub> =1.0μF | TCK22921G | —    | 4.5  | —    | μs |
|                            |                  |  | TCK22971G | —    | 4.5  | —    |    |
|                            |                  |  | TCK22922G | —    | 666  | —    |    |
|                            |                  |  | TCK22972G | —    | 666  | —    |    |
|                            |                  |  | TCK22975G | —    | 666  | —    |    |
|                            |                  |  | TCK22923G | —    | 1364 | —    |    |
| TCK22973G                  | —                | 1364                                       | —         |      |      |      |    |
| TCK22925G                  | —                | 3380                                       | —         |      |      |      |    |
| TCK22974G                  | —                | 3380                                       | —         |      |      |      |    |
| V <sub>OUT</sub> fall time | t <sub>f</sub>   | R <sub>L</sub> =5Ω , C <sub>L</sub> =1.0μF | —         | 10   | —    | μs   |    |
| Turn on delay              | t <sub>ON</sub>  | R <sub>L</sub> =5Ω , C <sub>L</sub> =1.0μF | TCK22921G | —    | 3    | —    | μs |
|                            |                  |  | TCK22971G | —    | 3    | —    |    |
|                            |                  |  | TCK22922G | —    | 380  | —    |    |
|                            |                  |  | TCK22972G | —    | 380  | —    |    |
|                            |                  |  | TCK22975G | —    | 380  | —    |    |
|                            |                  |  | TCK22923G | —    | 750  | —    |    |
| TCK22973G                  | —                | 750  | —         |      |      |      |    |
| TCK22925G                  | —                | 2000                                       | —         |      |      |      |    |
| TCK22974G                  | —                | 2000                                       | —         |      |      |      |    |
| Turn off delay             | t <sub>OFF</sub> | R <sub>L</sub> =5Ω , C <sub>L</sub> =1.0μF | —         | 10   | —    | μs   |    |

## AC Waveform

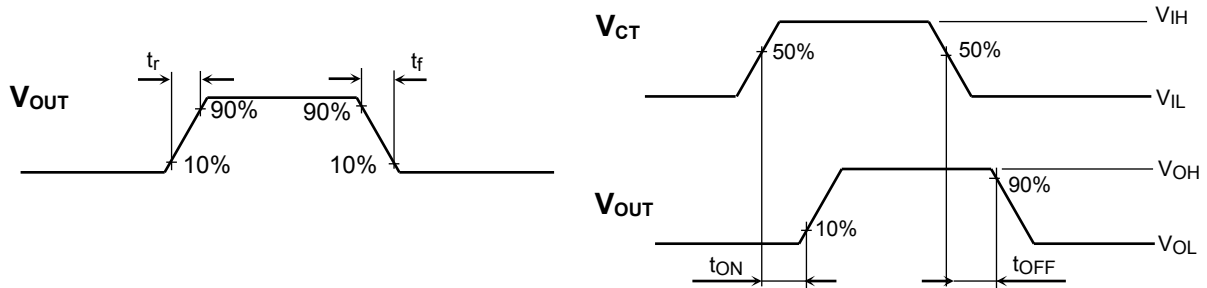


Figure 1 t<sub>r</sub>, t<sub>f</sub>, t<sub>ON</sub>, t<sub>OFF</sub> Waveforms(Active High)

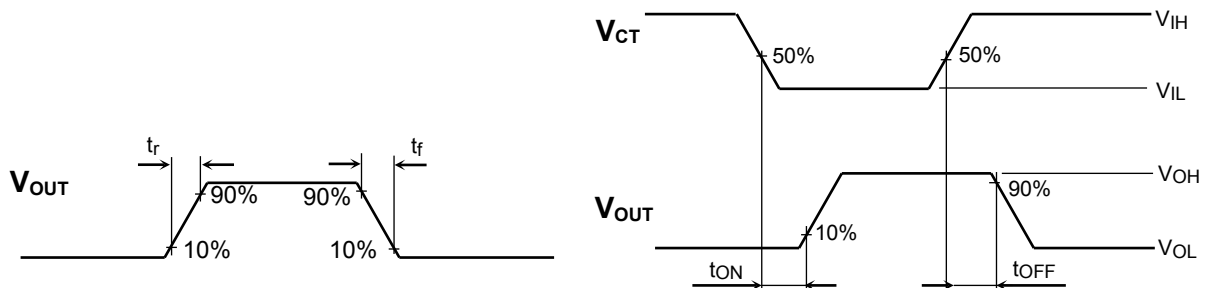
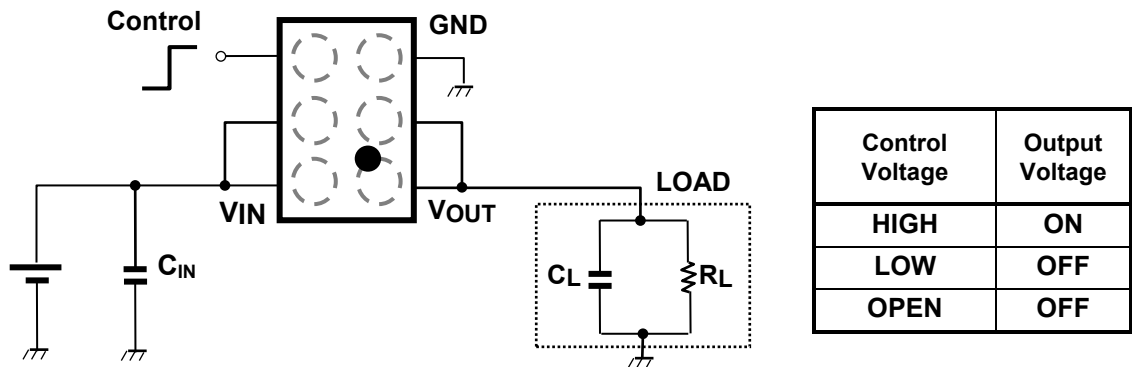


Figure 2 t<sub>r</sub>, t<sub>f</sub>, t<sub>ON</sub>, t<sub>OFF</sub> Waveforms(Active Low)

## Application Note

### 1. Application circuit example (top view)

The figure below shows the recommended configuration



#### 1) Input and Output capacitor

An input capacitor ( $C_{IN}$ ) and an output capacitor ( $C_{OUT}$ ) are highly recommended for the stable operation. And it is effective to reduce voltage overshoot or undershoot due to sharp changes in output current and also for improved stability of the power supply. When used, place  $C_{IN}$  and  $C_{OUT}$  more than  $1.0\mu F$  as close to  $V_{IN}$  pin to improve stability of the power supply.

#### 2) Control pin

The Control pin controls both the pass-through p-ch MOSFET and the discharge n-ch MOSFET (only for TCK2292xG), operated by the control voltage and Schmitt trigger. Also, pull down resistance equivalent to a few  $M\Omega$  is connected between Control and GND, thus the load switch IC is in OFF state even when Control pin is OPEN. (except TCK22975G). Products that Control pin is an open connection, please use be sure to fix the potential of the Control pin to High or Low.

### 2. Reverse current blocking

This device has a built-in Reverse current blocking (SW OFF state) circuit to block reverse current from VOUT to VIN when output n-ch MOSEFT turned off and input voltage is 0V.

### 3. Instructions and directions for use

This device has a built-in several functions, but these does not assure for the suppression of uprising device operation. In use of these products, please read through and understand dissipation idea for absolute maximum ratings from the above mention or our 'Semiconductor Reliability Handbook'. Then use these products under absolute maximum ratings in any condition. Furthermore, Toshiba recommend inserting failsafe system into the design.

#### 4. Power Dissipation

Power dissipation is measured on the board condition shown below.

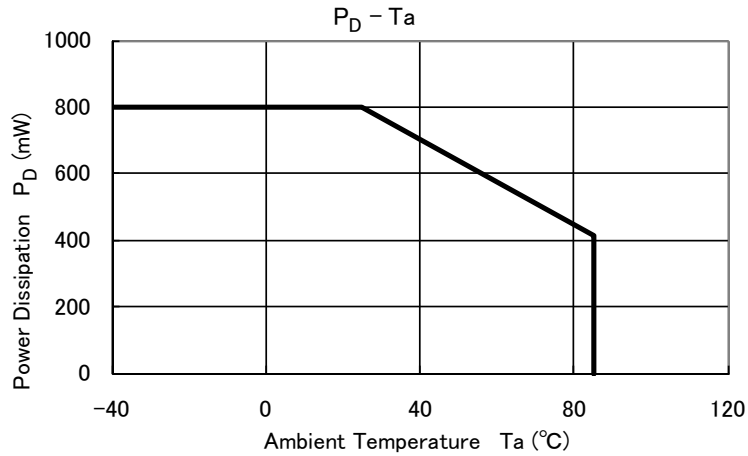
[The Board Condition]

Board material: Glass epoxy (FR4)

Board dimension: 40mm x 40mm (both sides of board), t=1.6mm

Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%

Through hole: diameter 0.5mm x 28

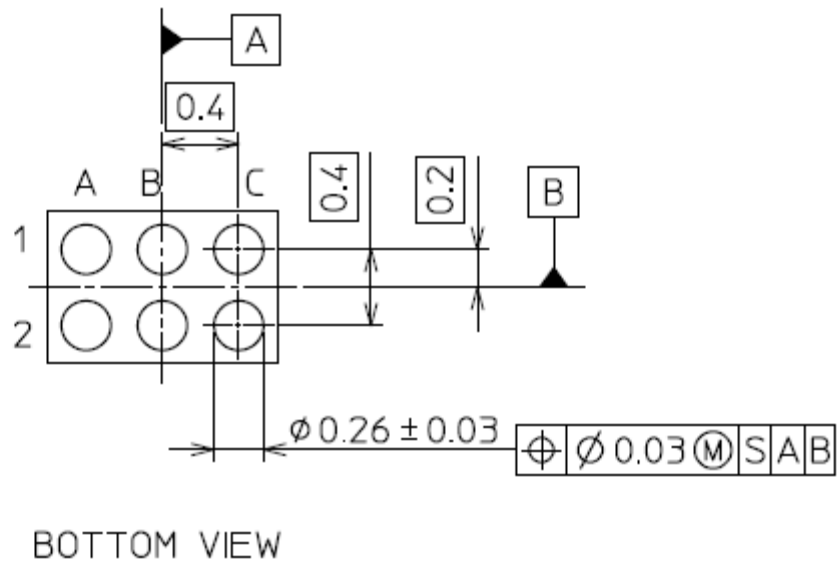
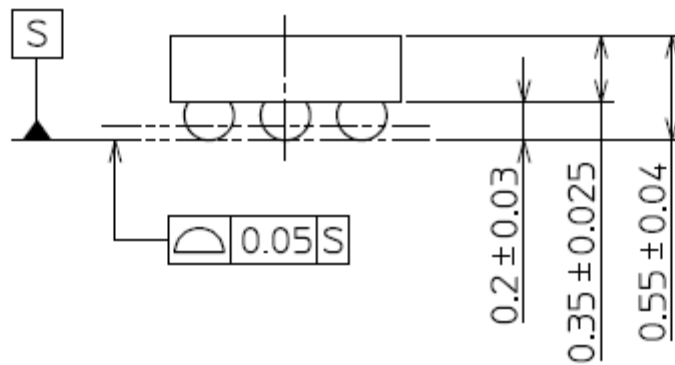
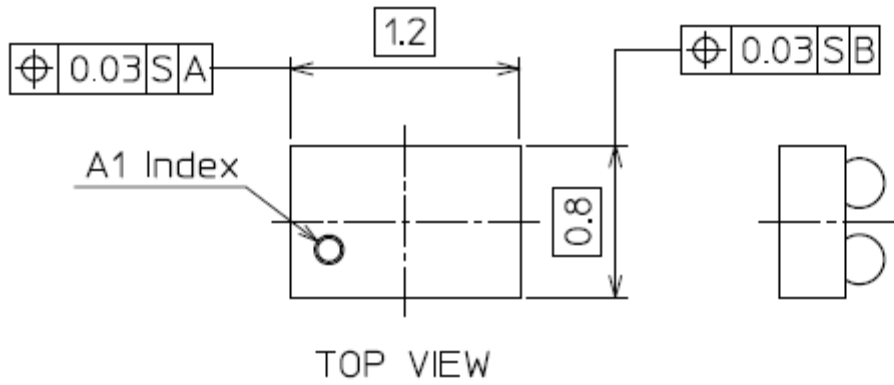


Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.



Package dimension

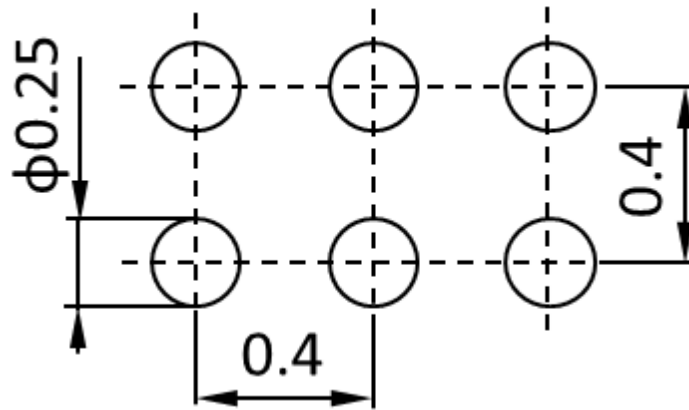
Unit: mm



Weight: 1 mg (typ.)

Land pattern dimensions (for reference only)

Unit: mm



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