

# TCK2291xG

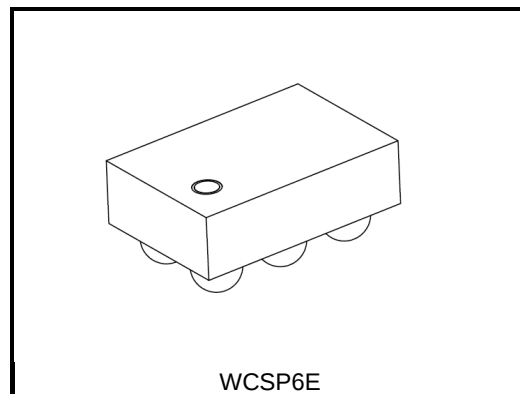
## 2A Load Switch IC with True Reverse Current Blocking

The TCK2291xG series is Load Switch ICs for power management with True Reverse Current Blocking and Thermal Shutdown function featuring low switch on resistance, ultra low quiescent current, high output current and wide input voltage operation from 1.1 to 5.5 V. Switch ON resistance is only 31 m $\Omega$  at 5.0 V, -0.15 A load conditions and output current is available on 2.0 A. And these feature a slew rate control driver and output auto-discharge function.

This device is available in 0.4 mm pitch ultra small package WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm). Thus this device is ideal for portable applications that require high-density board assembly such as cellular phone.

### Feature

- True Reverse Current Blocking
- Thermal Shutdown function
- Output auto-discharge (Option)
- Under voltage lockout
- Low ON resistance :  
 $R_{ON} = 31 \text{ m}\Omega$  (typ.) at  $V_{IN} = 5.0 \text{ V}$ ,  $I_{OUT} = -0.15 \text{ A}$   
 $R_{ON} = 40 \text{ m}\Omega$  (typ.) at  $V_{IN} = 3.3 \text{ V}$ ,  $I_{OUT} = -0.15 \text{ A}$   
 $R_{ON} = 70 \text{ m}\Omega$  (typ.) at  $V_{IN} = 1.8 \text{ V}$ ,  $I_{OUT} = -0.15 \text{ A}$   
 $R_{ON} = 141 \text{ m}\Omega$  (typ.) at  $V_{IN} = 1.2 \text{ V}$ ,  $I_{OUT} = -0.15 \text{ A}$
- Low Quiescent Current:  $I_Q = 11 \text{ }\mu\text{A}$  (typ.) at  $I_{OUT} = 0 \text{ mA}$
- Low standby current:  $I_{Q(OFF)} = 0.6 \text{ }\mu\text{A}$  (typ.) at OFF state
- Inrush current reduction circuit
- Pull down connection between Control and GND (Option)
- Ultra small package : WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm)



Weight: 1 mg (typ.)

Start of commercial production  
2016-06

## Function Table

| Part number | Function                      |                       |                        |                   |                      |                                  | Device Marking |
|-------------|-------------------------------|-----------------------|------------------------|-------------------|----------------------|----------------------------------|----------------|
|             | True Reverse current blocking | Output auto-discharge | Under voltage lock out | Thermal shut down | Control pin polarity | Control pin pull down connection |                |
| TCK22910G   | Built in                      | N/A                   | Built in               | Built in          | Active Low           | -                                | 4S             |
| TCK22911G   | Built in                      | Built in              | Built in               | Built in          | Active Low           | -                                | 3S             |
| TCK22912G   | Built in                      | N/A                   | Built in               | Built in          | Active High          | Built in                         | 2S             |
| TCK22913G   | Built in                      | Built in              | Built in               | Built in          | Active High          | Built in                         | 1S             |

## 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 temeperature       | 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

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

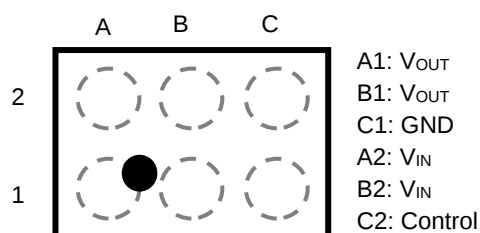
Metal pattern ratio : a surface approximately 50%, the reverse side approximately 50%

Through hole : diameter 0.5mm x 28)

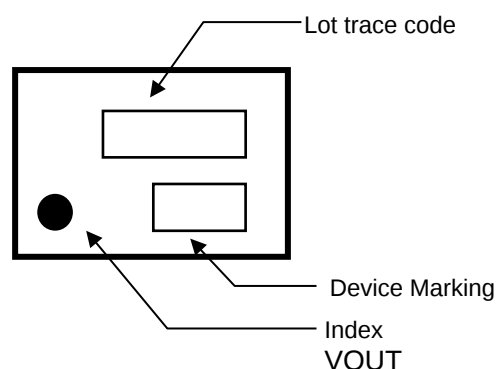
## Operating conditions

| 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> | 1.8 V ≤ 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    |

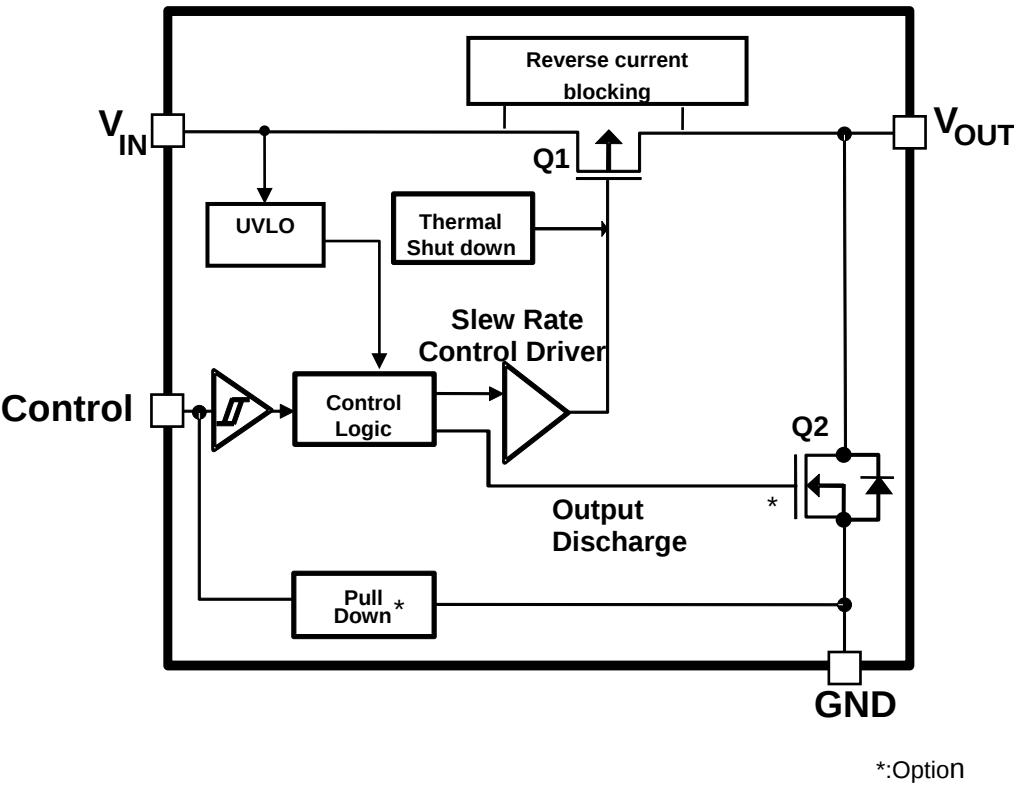
## Pin Assignment(Top view)



## Top marking



Block Diagram



\*:Option

Operation logic table

|                   |                                | TCK22910G | TCK22911G | TCK22912G | TCK22913G |
|-------------------|--------------------------------|-----------|-----------|-----------|-----------|
| Control<br>“High” | Output Q <sub>1</sub>          | OFF       | OFF       | ON        | ON        |
|                   | Discharge Q <sub>2</sub>       | —         | ON        | —         | OFF       |
|                   | Reverse<br>current<br>blocking | Active    | Active    | Active    | Active    |
| Control<br>“Low”  | Output Q <sub>1</sub>          | ON        | ON        | OFF       | OFF       |
|                   | Discharge Q <sub>2</sub>       | —         | OFF       | —         | ON        |
|                   | Reverse<br>current<br>blocking | Active    | Active    | Active    | Active    |

## 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)                      | IQ       | IOUT = 0 mA                                                        | VIN = 1.1 V       | —         | 9    | —   | —                | —    | μA   |
|                                                    |          |                                                                    | VIN = 5.5 V       | —         | 11   | —   | —                | 20   | μA   |
| Quiescent current ( OFF state)                     | IQ(OFF)  | VIN = 5.5 V, VOUT = OPEN,<br>(Note 3)                              |                   | —         | 0.6  | —   | —                | 2.5  | μA   |
| Switch leakage current( OFF state)                 | ISD(OFF) | VOUT = GND,<br>current through<br>from VIN to<br>VOUT.<br>(Note 4) | VIN = VCT = 5.5 V | —         | 20   | —   | —                | 2000 | nA   |
| Reverse blocking current                           | IRB      | VOUT = 5.0 V,<br>VIN = 0 V, RCB active                             |                   | —         | 0.01 | —   | —                | 2    | μA   |
| Reverse blocking voltage threshold                 | VRB      | VOUT – VIN                                                         |                   | —         | 35   | —   | —                | —    | mV   |
| Reverse blocking release voltage threshold         | VRBR     | VOUT – VIN                                                         |                   | —         | -15  | —   | —                | —    | mV   |
| Under Voltage Lock Out (UVLO)<br>rising threshold  | VUVL_RI  | —                                                                  |                   | —         | 0.82 | —   | —                | 1.1  | V    |
| Under Voltage Lock Out (UVLO)<br>falling threshold | VUVL_FA  | —                                                                  |                   | —         | 0.77 | —   | —                | —    | V    |
| On resistance                                      | RON      | IOUT = -0.1 A                                                      | VIN = 5.0 V       | —         | 31   | —   | —                | 85   | mΩ   |
|                                                    |          |                                                                    | VIN = 3.3 V       | —         | 40   | —   | —                | 95   |      |
|                                                    |          |                                                                    | VIN = 1.8 V       | —         | 70   | —   | —                | 140  |      |
|                                                    |          |                                                                    | VIN = 1.2 V       | —         | 141  | —   | —                | —    |      |
|                                                    |          |                                                                    | VIN = 1.1 V       | —         | 179  | —   | —                | —    |      |
| Output discharge on resistance                     | RSD      | — (Note 5)                                                         |                   | —         | 100  | —   | —                | —    | Ω    |

Note 3 : Except ISD(OFF) OFF-state switch current

Note 4 : Only applies to the TCK22910G and TCK22912G

Note 5 : Only applies to the TCK22911G and TCK22913G

### AC Characteristics (Ta = 25°C)

#### V<sub>IN</sub> = 5.0 V, TCK22910G

| Characteristics            | Symbol           | Test Condition(Figure 2)                                                   | Min | Typ. | Max | Unit |
|----------------------------|------------------|----------------------------------------------------------------------------|-----|------|-----|------|
| V <sub>OUT</sub> rise time | t <sub>r</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 1.4  | —   | ms   |
| V <sub>OUT</sub> fall time | t <sub>f</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 120  | —   | μs   |
| Turn on delay              | t <sub>ON</sub>  | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 800  | —   | μs   |
| Turn off delay             | t <sub>OFF</sub> | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 5    | —   | μs   |

#### V<sub>IN</sub> = 5.0 V, TCK22911G

| Characteristics            | Symbol           | Test Condition(Figure 2)                                                   | Min | Typ. | Max | Unit |
|----------------------------|------------------|----------------------------------------------------------------------------|-----|------|-----|------|
| V <sub>OUT</sub> rise time | t <sub>r</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 1.4  | —   | ms   |
| V <sub>OUT</sub> fall time | t <sub>f</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 60   | —   | μs   |
| Turn on delay              | t <sub>ON</sub>  | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 800  | —   | μs   |
| Turn off delay             | t <sub>OFF</sub> | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 5    | —   | μs   |

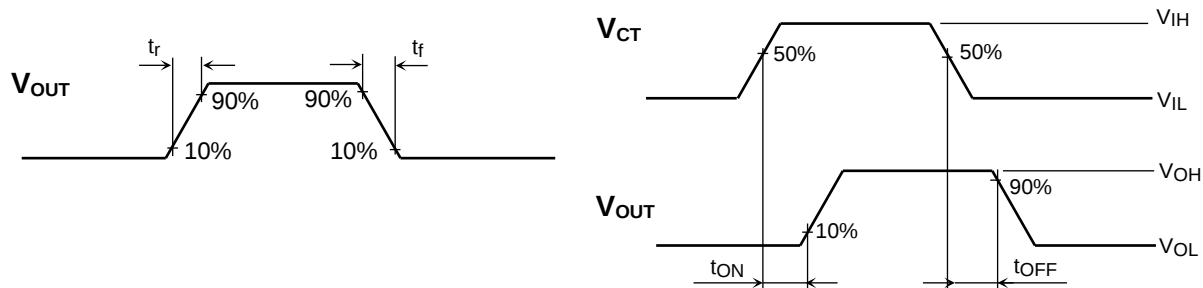
#### V<sub>IN</sub> = 5.0 V, TCK22912G

| Characteristics            | Symbol           | Test Condition(Figure 1)                                                   | Min | Typ. | Max | Unit |
|----------------------------|------------------|----------------------------------------------------------------------------|-----|------|-----|------|
| V <sub>OUT</sub> rise time | t <sub>r</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 1.4  | —   | ms   |
| V <sub>OUT</sub> fall time | t <sub>f</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 120  | —   | μs   |
| Turn on delay              | t <sub>ON</sub>  | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 800  | —   | μs   |
| Turn off delay             | t <sub>OFF</sub> | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 10   | —   | μs   |

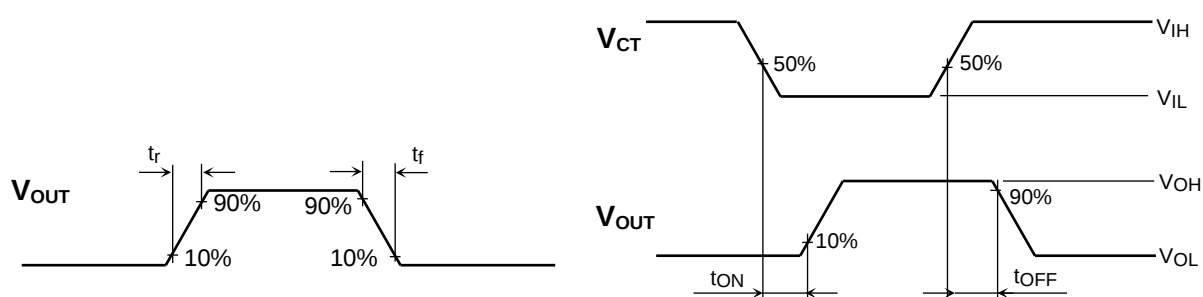
#### V<sub>IN</sub> = 5.0 V, TCK22913G

| Characteristics            | Symbol           | Test Condition(Figure 1)                                                   | Min | Typ. | Max | Unit |
|----------------------------|------------------|----------------------------------------------------------------------------|-----|------|-----|------|
| V <sub>OUT</sub> rise time | t <sub>r</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 1.4  | —   | ms   |
| V <sub>OUT</sub> fall time | t <sub>f</sub>   | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 60   | —   | μs   |
| Turn on delay              | t <sub>ON</sub>  | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 800  | —   | μs   |
| Turn off delay             | t <sub>OFF</sub> | V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 500 Ω , C <sub>L</sub> =0.1 μF, | —   | 10   | —   | μs   |

## AC Waveform



**Figure 1**  $t_r$ ,  $t_f$ ,  $t_{ON}$ ,  $t_{OFF}$  Waveforms(Active High)

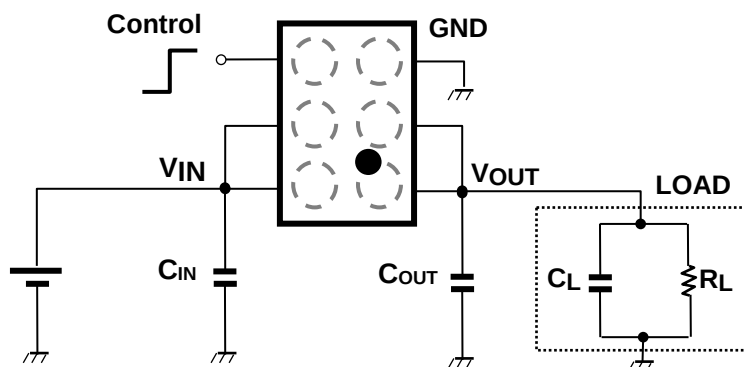


**Figure 2**  $t_r$ ,  $t_f$ ,  $t_{ON}$ ,  $t_{OFF}$  Waveforms(Active Low)

## Application Note

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

The figure below shows the recommended configuration for TCK2291xG.



#### 1) Input and Output capacitor

An input capacitor ( $C_{IN}$ ) and an output capacitor ( $C_{OUT}$ ) are necessary for the stable operation of TCK2291xG. 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  $1.0\mu\text{F}$  as close to  $V_{IN}$  pin to improve stability of the power supply.

#### 2) Control pin

The Control pin for TCK2291xG controls state of the switch, operated by the control voltage and Schmitt trigger. Also, pull down resistance equivalent to a few  $\text{M}\Omega$  is connected between Control and GND, thus the load switch IC is in OFF state even when Control pin is OPEN. (except TCK22910G and TCK22911G). A control pins for TCK22910G and TCK22911G is Active low. 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. Thermal shutdown function

This device has a built-in Thermal shutdown circuit. If the junction temperature goes beyond  $170^\circ\text{C}$  (Typ.), thermal shutdown circuit operates and turns off power switch. When the junction temperature decreases lower than  $150^\circ\text{C}$ , the power switch is turned on due to hysteresis. This operation is repeated as long as the junction temperature continues increasing.

### 3. True reverse current blocking

This device has built-in True reverse current blocking circuit (TRCB) to block reverse current from VOUT to VIN regardless of output MOSFET ON/OFF condition. (Full-Time Reverse Current Protection)

### 4. Under-voltage Lockout

This device has a built-in Under-voltage Lockout Circuit to turn off switch if  $V_{IN}$  drops below UVLO. This circuit has hysteresis and UVLO is released when  $V_{IN}$  exceeds threshold.

### 5. 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.

## 6. Power Dissipation

Power dissipation is measured on the board condition shown below.

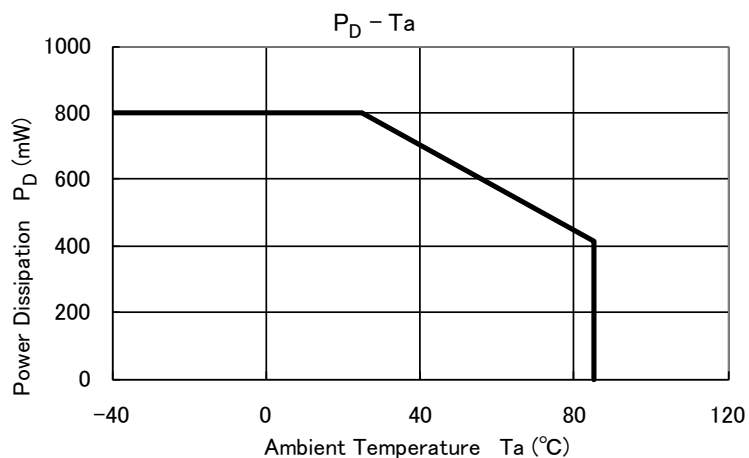
[The Board Condition]

Board material: Glass epoxy (FR4)

Board dimension: 40mm x 40mm (both sides of board),  $t=1.6\text{mm}$

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

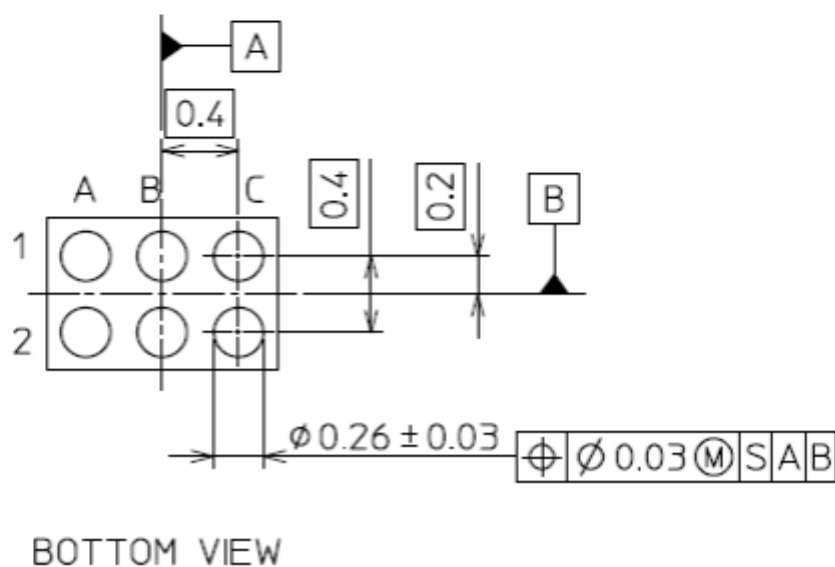
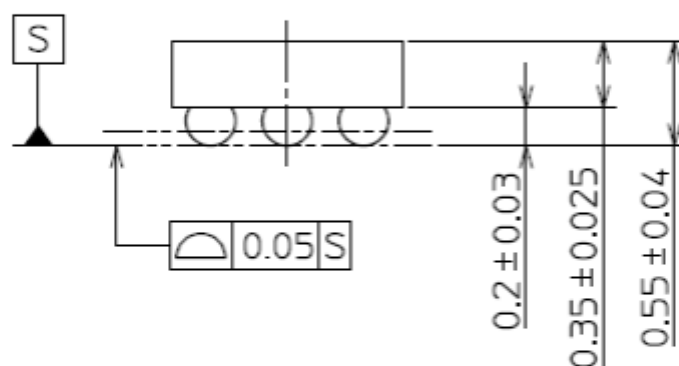
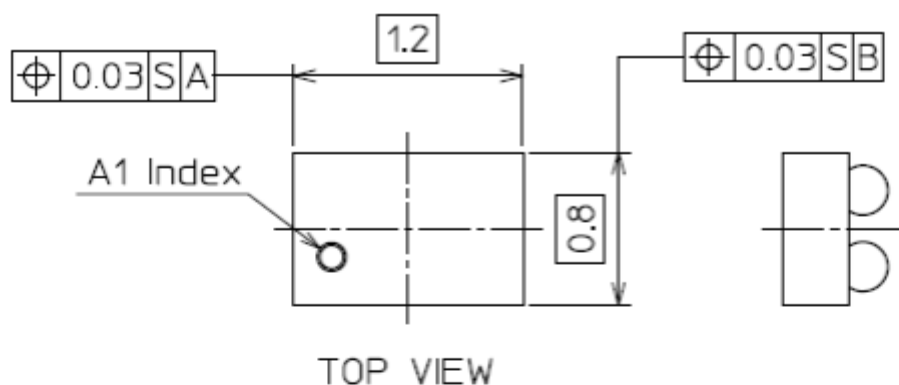
Through hole: diameter 0.5mm x 28



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

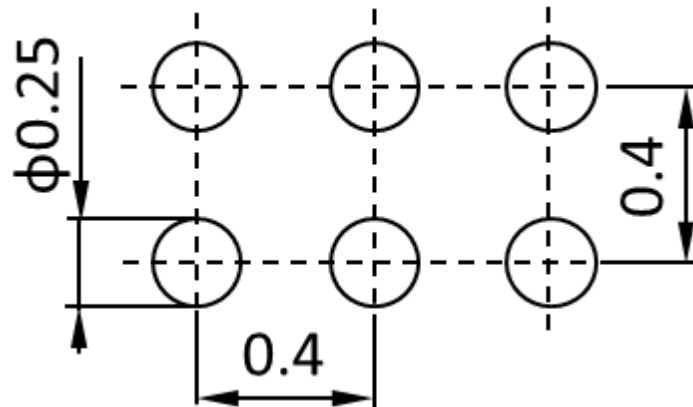
Unit: mm



Weight: 1 mg (typ.)

Land pattern dimensions (for reference only)

Unit: mm



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