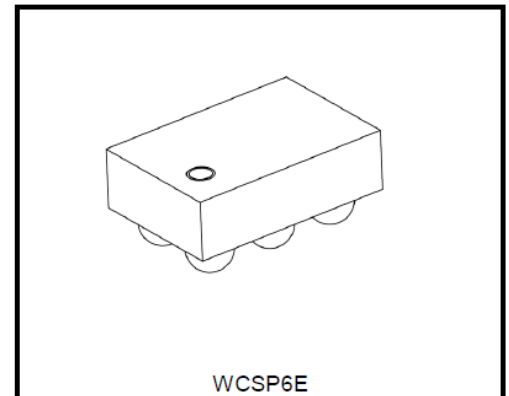


TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK401G, TCK402G

## External FET Driver IC

The TCK401G and TCK402G are 28 V high input voltage External FET driver IC. It has wide input voltage operation. And this features a slew rate control driver with small package WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm). Also it can block reverse current if switch turned off by using external series FET. Thus this is suitable for power management selector such as Battery Charge application.

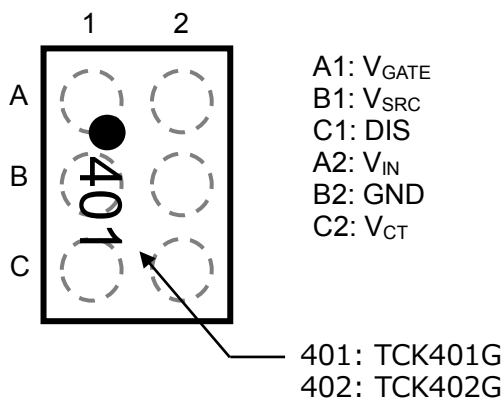


Weight: 1 mg(typ.)

### Feature

- High maximum input voltage:  $V_{IN\ max} = 40\ V$
- Wide input voltage operation:  $V_{IN} = 2.7\ to\ 28\ V$
- Auto output discharge terminal
- Charge pump circuit
- Inrush current reducing circuit.
- Over Voltage lock out (Over 28 V)
- Under Voltage lock out (Under 2.7 V)
- Reverse Current Protection by External Back to Back MOSFET

### Top marking (Top view)



Start of commercial production  
2017-10

- Absolute Maximum Ratings (Ta = 25°C)**

| Characteristics             | Symbol            | Rating  | Unit |
|-----------------------------|-------------------|---|------|
| Input voltage               | V <sub>IN</sub>   | -0.3 to 40                                    | V    |
| Control voltage             | V <sub>CT</sub>   | -0.3 to 6                                     | V    |
| Output GATE voltage         | V <sub>GATE</sub> | -0.3 to V <sub>IN_opr</sub> + V <sub>GS</sub> | V    |
| SRC voltage                 | V <sub>SRC</sub>  | -0.3 to V <sub>GATE</sub>                     | V    |
| DIS voltage                 | V <sub>DIS</sub>  | -0.3 to 40                                    | V    |
| Power dissipation           | P <sub>D</sub>    | 800 (Note 1)                                  | mW   |
| Operating temperature range | T <sub>opr</sub>  | -40 to 85                                     | °C   |
| Junction temperature        | 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).

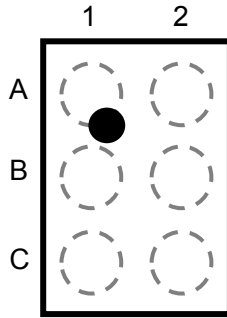
Note1: Rating at mounting on a board: FR4 board. ( 40 mm × 40 mm × 1.6 mm, Cu 4 layer )

- Recommended Operating Conditions**

| Characteristics                  | Symbol              | Min. | Typ. | Max. | Unit |
|----------------------------------|---------------------|------|------|------|------|
| Input operation voltage          | V <sub>IN_opr</sub> | 2.7  | 5.0  | 28   | V    |
| Capacitance                      | C <sub>IN</sub>     | 0.1  | 1    | —    | μF   |
|                                  | C <sub>GATE</sub>   | —    | 2000 | —    | pF   |
| CONTROL High-level input voltage | V <sub>IH</sub>     | 1.6  | —    | —    | V    |
| CONTROL Low-level input voltage  | V <sub>IL</sub>     | —    | —    | 0.4  | V    |

- Pin Assignment (Top view)

- WCSP6E

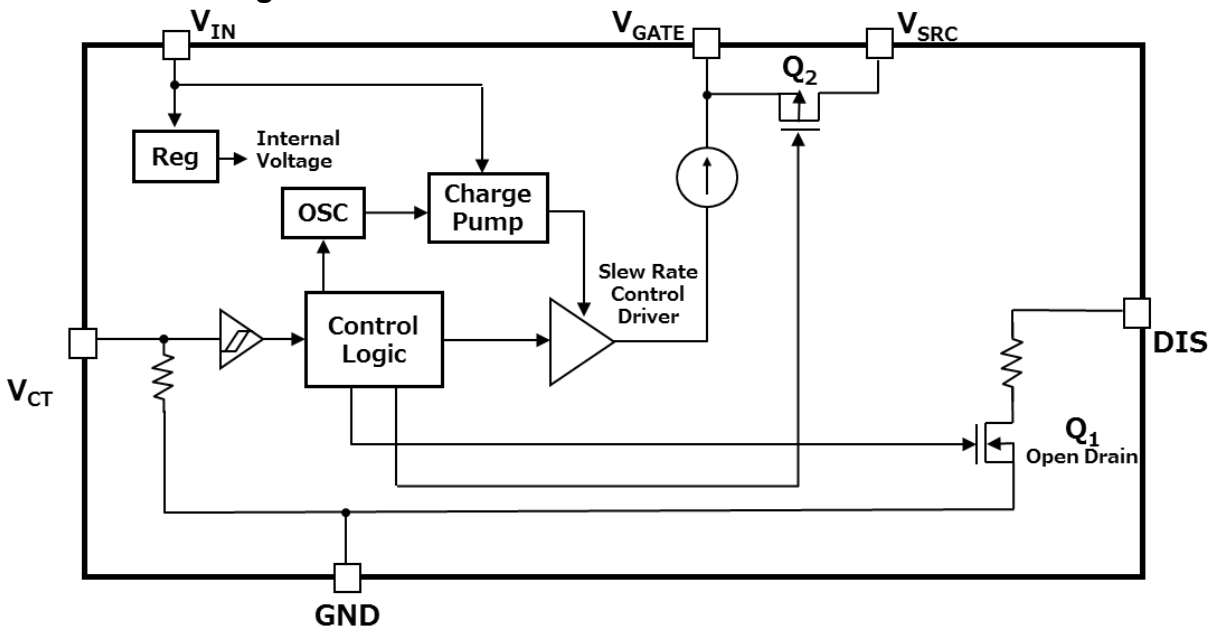


| Pin # | Name              | Pin # | Name            |
|-------|-------------------|-------|-----------------|
| A1    | V <sub>GATE</sub> | A2    | V <sub>IN</sub> |
| B1    | V <sub>SRC</sub>  | B2    | GND             |
| C1    | DIS               | C2    | V <sub>CT</sub> |

- Product list

| Part number | VCT function | VCT resistance |
|-------------|--------------|----------------|
| TCK401G     | Active High  | Pull down      |
| TCK402G     | Active Low   | Pull down      |

- Block Diagram



### TCK401G PIN Description

| PIN | Name              | Description  |
|-----|-------------------|--|
| A1  | V <sub>GATE</sub> | Gate-Driver Output.  |
| A2  | V <sub>IN</sub>   | Supply voltage input.  |
| B1  | V <sub>SRC</sub>  | Recommend connecting V <sub>SRC</sub> terminal to the common source connection of the external MOSFETs.                                    |
| B2  | GND               | Ground   |
| C1  | DIS               | Output Discharge terminal.   |
| C2  | V <sub>CT</sub>   | Mode control input terminal. When V <sub>CT</sub> =High turn the external MOSFETs on, V <sub>CT</sub> =Low, turn the external MOSFETs off. |

- **TCK402G PIN Description**

| PIN | Name              | Description  |
|-----|-------------------|--|
| A1  | V <sub>GATE</sub> | Gate-Driver Output.  |
| A2  | V <sub>IN</sub>   | Supply voltage input.  |
| B1  | V <sub>SRC</sub>  | Recommend connecting V <sub>SRC</sub> terminal to the common source connection of the external MOSFETs.                                    |
| B2  | GND               | Ground   |
| C1  | DIS               | Output Discharge terminal.   |
| C2  | V <sub>CT</sub>   | Mode control input terminal. When V <sub>CT</sub> =Low turn the external MOSFETs on, V <sub>CT</sub> =High, turn the external MOSFETs off. |

- **TCK401G Operation Status Table**

2.7V ≤ V<sub>IN</sub> ≤ 28 V (Ta = -40 to 85°C)

| V <sub>CT</sub> | V <sub>GATE</sub>                          | Discharge Q1 | comment         |
|-----------------|--|--------------|-----------------|
| High            | ON<br>(V <sub>IN</sub> + V <sub>GS</sub> ) | OFF          | Driver ON mode  |
| Open            | OFF  | ON           | Driver OFF mode |
| Low             |  |              |                 |

- **TCK402G Operation Status Table**

2.7V ≤ V<sub>IN</sub> ≤ 28 V (Ta = -40 to 85°C)

| V <sub>CT</sub> | V <sub>GATE</sub>                          | Discharge Q1 | comment         |
|-----------------|--|--------------|-----------------|
| Low             | ON<br>(V <sub>IN</sub> + V <sub>GS</sub> ) | OFF          | Driver ON mode  |
| Open            |  |              |                 |
| High            | OFF  | ON           | Driver OFF mode |

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

| Characteristics                    | Symbol    | Test Condition    | Ta = 25°C              |      |      | Ta = -40 to 85°C<br>(Note 2) |      | Unit |    |
|------------------------------------|-----------|-------------------|------------------------|------|------|------------------------------|------|------|----|
|                                    |           |                   | Min.                   | Typ. | Max. | Min.                         | Max. |      |    |
| Input quiescent current (ON state) | IQ(ON)    | TCK401G           | VCT: High, VIN = 5.0 V | —    | 121  | —                            | —    | 222  | μA |
|                                    |           |                   | VCT: High, VIN = 9.0 V | —    | 144  | —                            | —    | 283  | μA |
|                                    |           |                   | VCT: High, VIN = 12 V  | —    | 159  | —                            | —    | 294  | μA |
|                                    |           |                   | VCT: High, VIN = 20 V  | —    | 198  | —                            | —    | 376  | μA |
|                                    |           | TCK402G           | VCT: Low, VIN = 5.0 V  | —    | 121  | —                            | —    | 222  | μA |
|                                    |           |                   | VCT: Low, VIN = 9.0 V  | —    | 144  | —                            | —    | 283  | μA |
|                                    |           |                   | VCT: Low, VIN = 12 V   | —    | 159  | —                            | —    | 294  | μA |
|                                    |           |                   | VCT: Low, VIN = 20 V   | —    | 198  | —                            | —    | 376  | μA |
| Standby current (OFF state)        | IQ(OFF)   | TCK401G           | VCT: Low, VIN = 5.0 V  | —    | 3.0  | —                            | —    | 4.8  | μA |
|                                    |           |                   | VCT: Low, VIN = 9.0 V  | —    | 5.9  | —                            | —    | 8.2  | μA |
|                                    |           |                   | VCT: Low, VIN = 12 V   | —    | 8.0  | —                            | —    | 11.2 | μA |
|                                    |           |                   | VCT: Low, VIN = 20 V   | —    | 13.8 | —                            | —    | 19.2 | μA |
|                                    |           | TCK402G           | VCT: High, VIN = 5.0 V | —    | 3.0  | —                            | —    | 4.8  | μA |
|                                    |           |                   | VCT: High, VIN = 9.0 V | —    | 5.9  | —                            | —    | 8.2  | μA |
|                                    |           |                   | VCT: High, VIN = 12 V  | —    | 8.0  | —                            | —    | 11.2 | μA |
|                                    |           |                   | VCT: High, VIN = 20 V  | —    | 13.8 | —                            | —    | 19.2 | μA |
| GATE Drive voltage(VGATE-VIN)      | VGS       | VIN = 3 V         | —                      | 4.0  | —    | 2.8                          | 5.1  | V    |    |
|                                    |           | VIN = 5 V         | —                      | 6.5  | —    | 5.1                          | 7.9  | V    |    |
|                                    |           | VIN = 9.0 V       | —                      | 6.5  | —    | 5.1                          | 7.9  | V    |    |
|                                    |           | 12 V ≤ VIN ≤ 28 V | —                      | 8.5  | —    | 6.9                          | 10.0 | V    |    |
| Output current                     | IGATE(ON) | VIN = 5 V         | —                      | 38   | —    | —                            | —    | μA   |    |
| DIS resistance                     | RDIS      | —                 | —                      | 21   | —    | —                            | —    | kΩ   |    |
| Control pull down resistance       | RCT       | VCT= 5 V          | —                      | 600  | —    | —                            | —    | kΩ   |    |

Note 2: This parameter is warranted by design.

• **AC Characteristics (Ta = 25°C, VIN=5V, CGATE=2000pF)**

| Characteristics | Symbol | Test Condition (Figure 1,2)                                       | Min. | Typ. | Max. | Unit |
|-----------------|--------|---|------|------|------|------|
| VGATE ON time   | tON    | Initial startup time of VGATE (Note 3) voltage from 0V to VIN +1V | —    | 0.58 | 0.8  | ms   |
| VGATE OFF time  | tOFF   | VGATE =0.5V   | —    | 16.6 | —    | μs   |
| VGATE rise time | tr     | VGATE rising from VIN +1V to VIN +3V                              | —    | 0.2  | —    | ms   |
| VGATE fall time | tf     | VGATE falling from VIN +3V to VIN +1V                             | —    | 1.5  | —    | μs   |

• **AC Characteristics (Ta = 25°C, VIN=9V, CGATE=2000pF)**

| Characteristics | Symbol | Test Condition (Figure 1,2)                                       | Min. | Typ. | Max. | Unit |
|-----------------|--------|---|------|------|------|------|
| VGATE ON time   | tON    | Initial startup time of VGATE (Note 3) voltage from 0V to VIN +1V | —    | 0.78 | 1.0  | ms   |
| VGATE OFF time  | tOFF   | VGATE=0.5V  | —    | 19.7 | —    | μs   |
| VGATE rise time | tr     | VGATE rising from VIN +1V to VIN +4V                              | —    | 0.35 | —    | ms   |
| VGATE fall time | tf     | VGATE falling from VIN +4V to VIN +1V                             | —    | 1.6  | —    | μs   |

• **AC Characteristics (Ta = 25°C, VIN=12V, CGATE=2000pF)**

| Characteristics | Symbol | Test Condition (Figure 1,2)                                       | Min. | Typ. | Max. | Unit |
|-----------------|--------|---|------|------|------|------|
| VGATE ON time   | tON    | Initial startup time of VGATE (Note 3) voltage from 0V to VIN +1V | —    | 0.92 | 1.2  | ms   |
| VGATE OFF time  | tOFF   | VGATE=0.5V  | —    | 21.3 | —    | μs   |
| VGATE rise time | tr     | VGATE rising from VIN +1V to VIN +5V                              | —    | 0.6  | —    | ms   |
| VGATE fall time | tf     | VGATE falling from VIN +5V to VIN +1V                             | —    | 1.7  | —    | μs   |

Note 3: This parameter is warranted by design.

### Timing chart

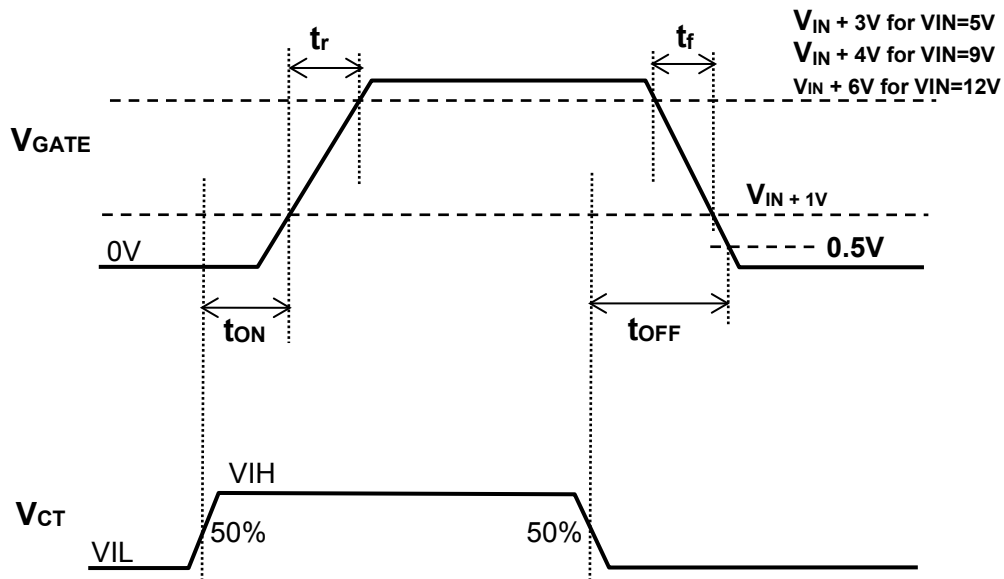


Fig.1 Active High (TCK401G)

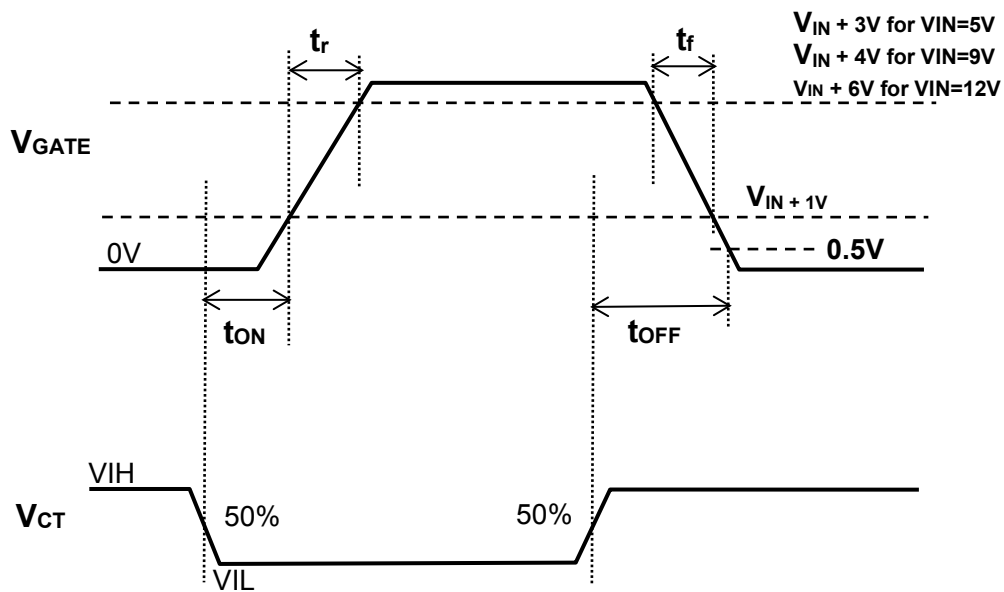
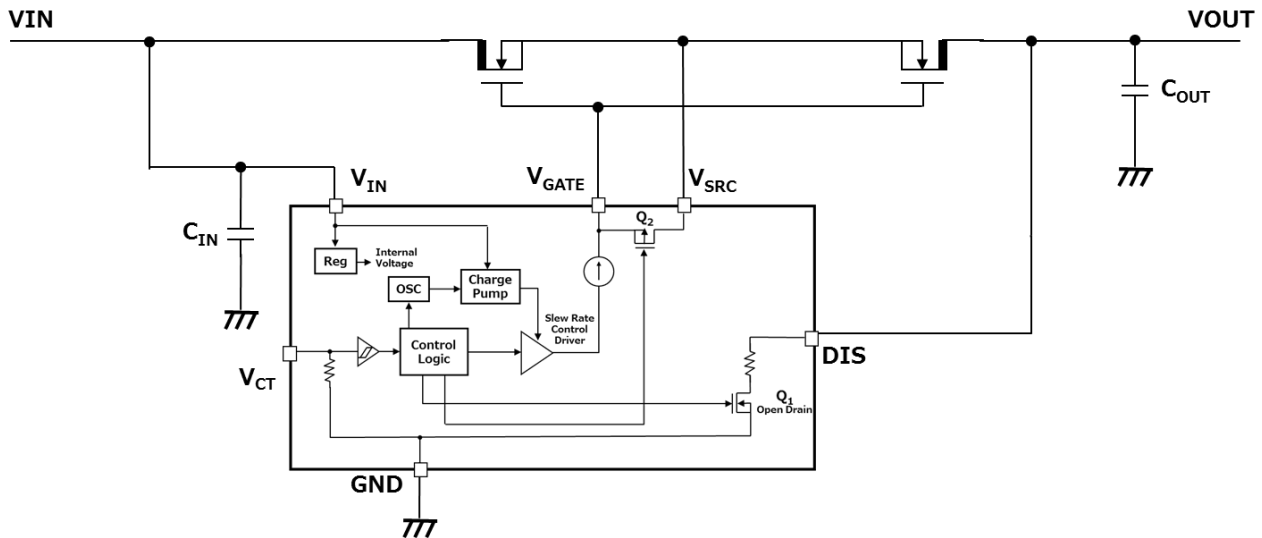


Fig.2 Active Low (TCK402G)

### Application Note

#### Application circuit example



#### 1) Input and Output capacitor

An input capacitor ( $C_{IN}$ ) and an output capacitor ( $C_{OUT}$ ) is recommended for the stable operation of TCK401G and TCK402G. 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) $V_{CT}$ pin

$V_{CT}$  pin for TCK401G and TCK402G is operated by the control voltage and Schmitt trigger.  $V_{CT}$  pin has a tolerant function such that it can be used even if the control voltage is higher than the input voltage.

#### 3) SRC Pin

For Dual MOSFET Driver,  $V_{SRC}$  work for short between  $V_{GATE}$  and MOSFET source when Driver IC Turn off. If there are enough margins of  $V_{GS}$  of MOSFET,  $V_{SRC}$  terminal Open state is no problem.

For Single MOSFET Driver, if there are enough margins of  $V_{GS}$  of MOSFET,  $V_{SRC}$  pin Open state is no problem. If there are not enough margins, we recommend connecting  $V_{SRC}$  and  $V_{OUT}$ . If connect  $V_{SRC}$  and  $V_{OUT}$ ,  $t_{OFF}$  time become longer because of  $C_{OUT}$ . Therefore, please consider enough margins for MOSFET selection.

#### 4) DIS Pin

If need Discharge function when Driver IC Turn off, please connect DIS Pin to  $V_{OUT}$ . If no need, DIS Pin Open state is no problem.

#### 5) Over Voltage Protection off time ( $t_{OVP}$ )

Over Voltage ( $V_{IN}$  is over  $V_{IN\_opr\ max}$ ) Protection off time ( $t_{OVP}$ ) is similar  $V_{GATE}$  OFF time ( $t_{OFF}$ ).

### Timing chart

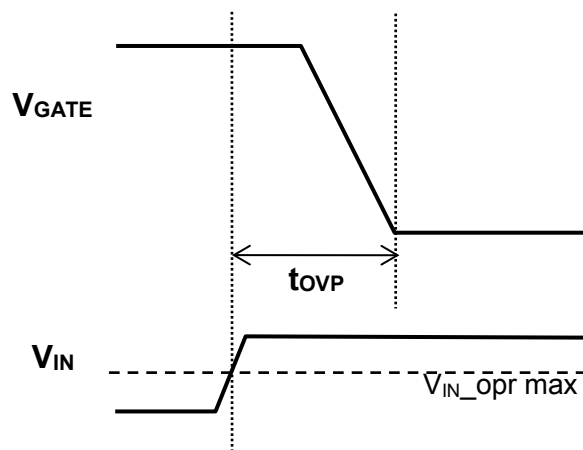
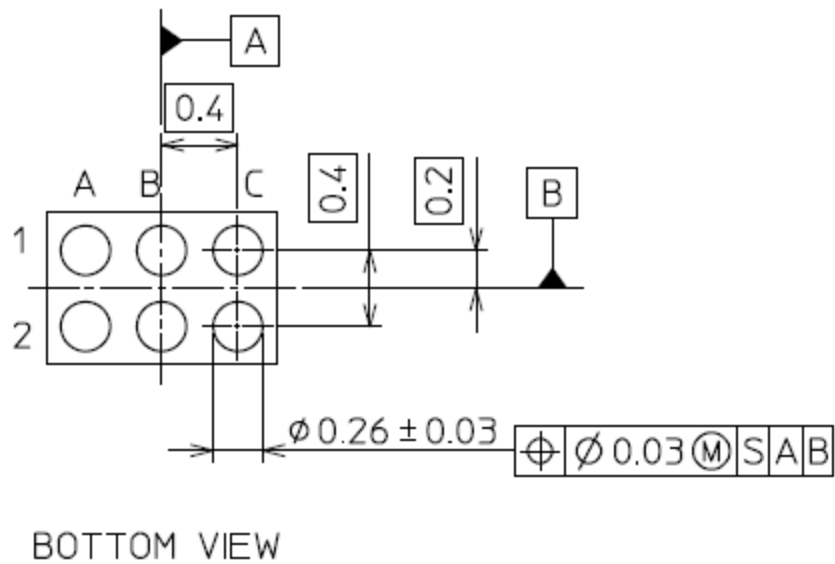
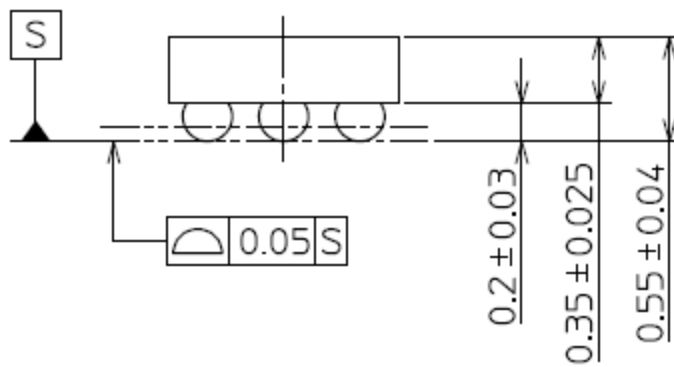
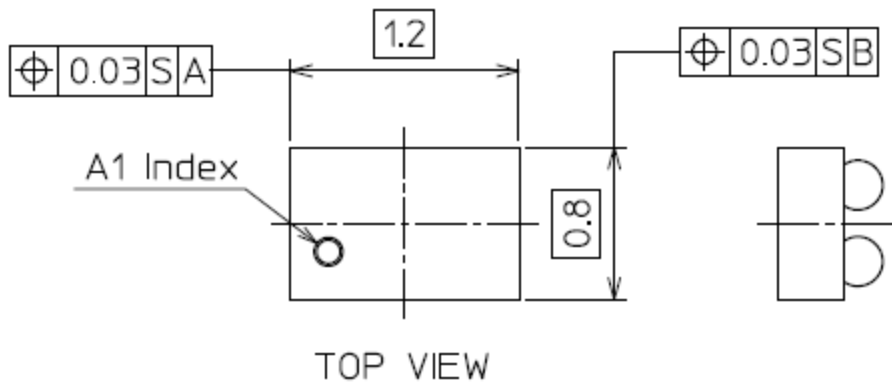


Fig.3  $t_{OVP}$



- Package dimension

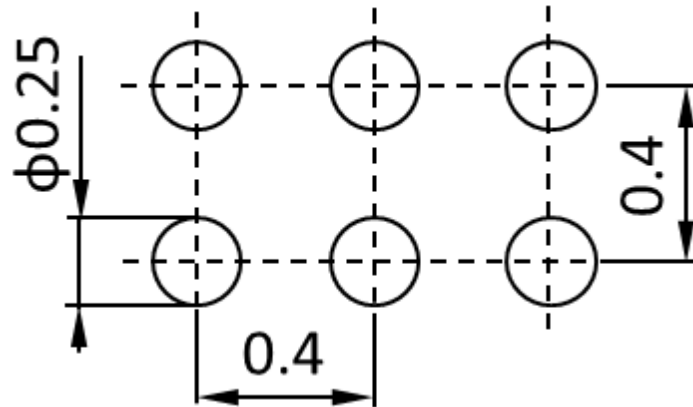
Unit: mm



Weight: 1 mg (typ.)

Land pattern dimensions (for reference only)

Unit: mm



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