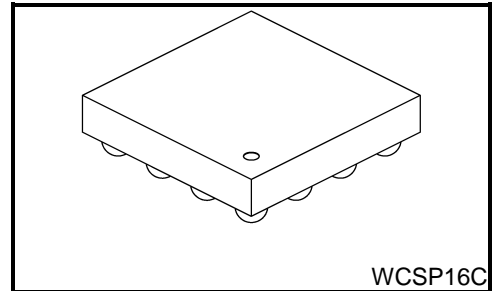


# TCK321G, TCK322G

## 36 V, Dual Inputs – Single Output Power Multiplexer IC with Over Voltage Protection

The TCK321G and TCK322G are 36 V high input voltage Dual Inputs-Single Output multiplexer load switch ICs. It has Over Voltage Protection featuring low switch ON resistance, high output current and wide input voltage operation. Switch ON resistance is only 98 mΩ at 4.5 V, - 1.0 A load conditions. And these feature a slew rate control driver, thermal shutdown and flag function. Also it can block reverse current if switch turned off. Output current is available up to 2.0 A per channel. Thus this is suitable for power management selector such as Battery Charge application.

This device is available in 0.5 mm pitch small package WCSP16C (1.9 mm x 1.9 mm, t: 0.5 mm (typ.)). Thus this devices is ideal for portable applications that require high-density board assembly such as mobile phone.

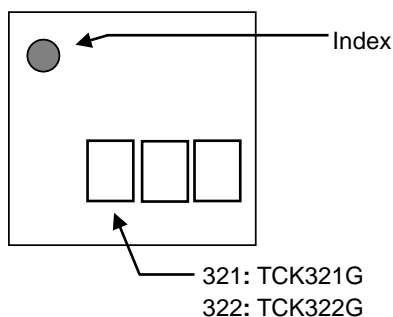


Weight : 3.9 mg ( typ.)

### Feature

- High output current:  $I_{OUT} (DC) = 2 \text{ A}$ , per channel
- Low ON resistance :  $R_{ON} = 98 \text{ m}\Omega$  (typ.) at  $V_{IN} = 4.5 \text{ V}$ , - 1.0 A, per channel
- Wide input voltage operation:  $V_{IN} = 2.3$  to 36 V
- Over Voltage Lockout : 12.0 V, 15.0 V (typ.)
- Under Voltage Lockout: 2.9 V (typ.)
- Reverse current blocking per channel(SW OFF state)
- Inrush current reducing circuit.
- Auto selection mode
- Manual selection mode
- Break Before Make switch
- Thermal Shutdown function
- Small package: 0.5 mm pitch WCSP16C (1.9 mm x 1.9 mm, t: 0.5 mm (typ.)), PD = 1.65 W

### Top marking



Start of commercial production  
2015-10

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

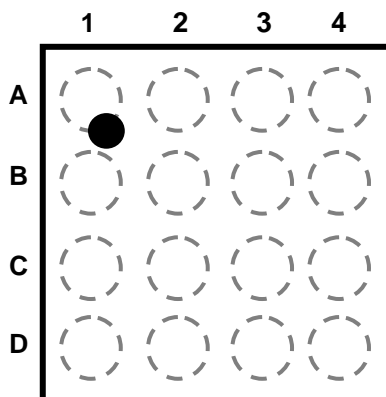
| Characteristics             | Symbol                              | Rating        |              | Unit |
|-----------------------------|-------------------------------------|---------------|--------------|------|
| Input voltage               | V <sub>INA</sub> , V <sub>INB</sub> | -0.3 to 40    |              | V    |
| Control voltage             | V <sub>CNT</sub> , V <sub>SEL</sub> | -0.3 to 6     |              | V    |
| Output voltage              | V <sub>OUT</sub>                    | -0.3 to 18    |              | V    |
| FLAG voltage                | V <sub>FLAG</sub>                   | -0.3 to 6     |              | V    |
| Output current              | I <sub>OUT</sub>                    | DC            | 2.0          | A    |
|                             |                                     | Pulse         | 3.0 (Note 1) |      |
| Power dissipation           | P <sub>D</sub>                      | 1.65 (Note 2) |              | W    |
| 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: 1 ms pulse, 1% duty cycle

Note2: Rating at mounting on a board: FR4 board. ( 40 mm × 40 mm × 1.6 mm, Cu 4 layer )

## Pin Assignment (Top view/Bottom bump)



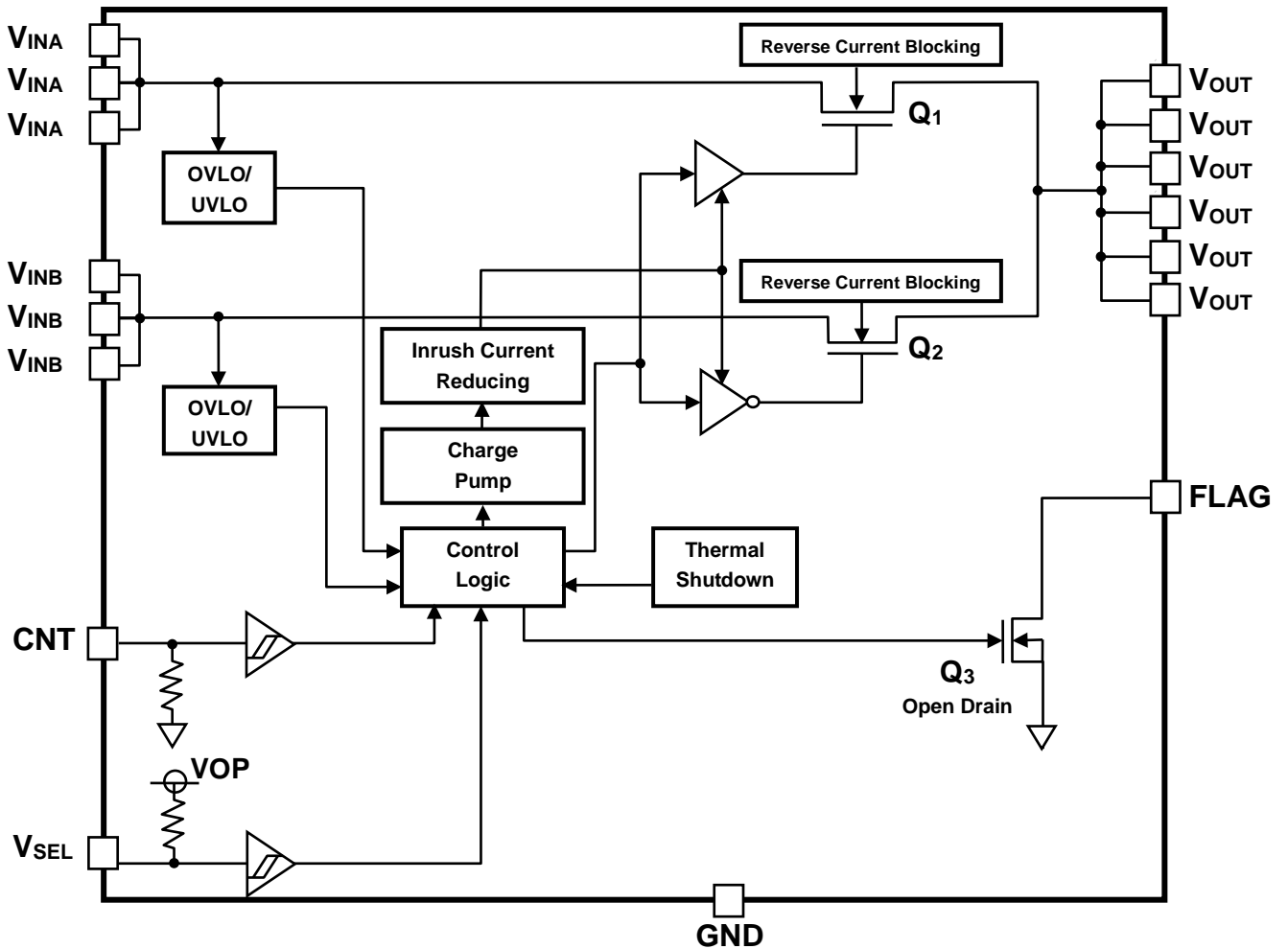
|   | 1                | 2                | 3                | 4                |
|---|------------------|------------------|------------------|------------------|
| A | FLAG             | V <sub>SEL</sub> | CNT              | GND              |
| B | V <sub>INA</sub> | V <sub>OUT</sub> | V <sub>OUT</sub> | V <sub>INB</sub> |
| C | V <sub>INA</sub> | V <sub>OUT</sub> | V <sub>OUT</sub> | V <sub>INB</sub> |
| D | V <sub>INA</sub> | V <sub>OUT</sub> | V <sub>OUT</sub> | V <sub>INB</sub> |

## Product list

| Part number | Over voltage lockout V <sub>INA</sub> | Over voltage lockout V <sub>INB</sub> | FLAG monitored in auto selection mode |
|-------------|---------------------------------------|---------------------------------------|---------------------------------------|
| TCK321G     | 12.0 V (typ.)                         | 12.0 V (typ.)                         | Q1                                    |
| TCK322G     | 15.0 V (typ.)                         | 15.0 V (typ.)                         | Q1                                    |

Please ask your local retailer about the devices with other OVLO, logic and functions.

## Block Diagram



## PIN Description

| PIN                  | Name                                | Description  |
|----------------------|-------------------------------------|--|
| A1                   | FLAG                                | Open drain acknowledge signal output.  |
| A2                   | V <sub>SEL</sub>                    | Input selector function. It is internally connected to VOP(Pull up).                     |
| A3                   | CNT                                 | Mode control function. It is internally connected to GND(Pull down)                      |
| A4                   | GND                                 | Ground   |
| B1,C1,D1<br>B4,C4,D4 | V <sub>INA</sub> , V <sub>INB</sub> | Input. Each has Over Voltage Lock Out (OVLO) and Under Voltage Lock Out function (UVLO). |
| B2,C2,D2<br>B3,C3,D3 | V <sub>OUT</sub>                    | Output.  |

Operation Logic Table

|                                 |                                 | CNT Low  | CNT High  |
|---------------------------------|---------------------------------|--|---|
| <b>V<sub>SEL</sub><br/>Low</b>  | V <sub>INA</sub> Q <sub>1</sub> | OFF  | OFF   |
|                                 | V <sub>INB</sub> Q <sub>2</sub> | OFF  | ON  |
|                                 | FLAG Q <sub>3</sub>             | OFF  | ON (When V <sub>INA</sub> or V <sub>INB</sub> is out of regular voltage ) |
|                                 | Reverse current block           | Q <sub>1</sub> Active / Q <sub>2</sub> Active  | Q <sub>1</sub> Active / Q <sub>2</sub> Inactive                           |
| <b>V<sub>SEL</sub><br/>High</b> | V <sub>INA</sub> Q <sub>1</sub> | <b>Auto selection mode</b><br><br>Supplied V <sub>INA</sub> ;<br>Q <sub>1</sub> and Q <sub>3</sub> ON, Q <sub>2</sub> OFF<br><br>Supplied V <sub>INB</sub> ;<br>Q <sub>2</sub> ON, Q <sub>1</sub> and Q <sub>3</sub> OFF<br><br>Supplied V <sub>INA</sub> and V <sub>INB</sub> ;<br>Q <sub>1</sub> and Q <sub>3</sub> ON, Q <sub>2</sub> OFF | ON  |
|                                 | V <sub>INB</sub> Q <sub>2</sub> |  | OFF   |
|                                 | FLAG Q <sub>3</sub>             |  | ON (When V <sub>INA</sub> or V <sub>INB</sub> is out of regular voltage ) |
|                                 | Reverse current block           |  | Q <sub>1</sub> Inactive / Q <sub>2</sub> Active                           |

## 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  |      |
| Input voltage                                   | V <sub>IN</sub>     | —   | 2.3       | —             | 36  | 2.3              | 36   | V    |
| VSEL, CNT High-level input voltage              | V <sub>IH</sub>     | V <sub>INA</sub> , V <sub>INB</sub> = 2.3 to 36 V                                       | 1.6       | —             | —   | 1.6              | —    | V    |
| VSEL, CNT Low-level input voltage               | V <sub>IL</sub>     | V <sub>INA</sub> , V <sub>INB</sub> = 2.3 to 36 V                                       | —         | —             | 0.4 | —                | 0.4  | V    |
| Over voltage lock out (OVLO) rising threshold   | VOVL_RI             | TCK321G   | —         | 12.0          | —   | 10.5             | 13.5 | V    |
|   |                     | TCK322G   | —         | 15.0          | —   | 13.4             | 16.6 |      |
| Over voltage lock out (OVLO) falling threshold  | VOVL_FA             | —   | —         | VOVL_RI - 0.5 | —   | —                | —    | V    |
| Under voltage lock out (UVLO) rising threshold  | VUVL_RI             | —   | —         | 2.9           | —   | 2.3              | 3.5  | V    |
| Under voltage lock out (UVLO) falling threshold | VUVL_FA             | —   | —         | VUVL_RI - 0.3 | —   | —                | —    | V    |
| Quiescent current (Switch ON state)             | I <sub>Q(ON)</sub>  | Q1 or Q2 = ON mode, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.0 V                    | —         | 140           | —   | —                | 200  | μA   |
| Quiescent current (Switch OFF state)            | I <sub>Q(OFF)</sub> | CNT and VSEL: Low, V <sub>INA</sub> or V <sub>INB</sub> = 5.0 V, V <sub>OUT</sub> = 0 V | —         | 60            | —   | —                | 90   | μA   |
| Switch OFF state current                        | I <sub>OFF</sub>    | CNT and VSEL: Low, V <sub>IN</sub> = Open, V <sub>OUT</sub> = 5 V                       | —         | 0.1           | —   | —                | 1    | μA   |
| Reverse blocking current                        | I <sub>RB</sub>     | CNT and VSEL: Low, V <sub>IN</sub> = 0 V, V <sub>OUT</sub> = 5.0 V                      | —         | 0.1           | —   | —                | 10   | μA   |
| On resistance                                   | R <sub>ON</sub>     | I <sub>OUT</sub> = -1.0 A, V <sub>IN</sub> = 4.5 V                                      | —         | 98            | —   | —                | 170  | mΩ   |
| FLAG Leak current                               | I <sub>LEAK</sub>   | V <sub>IO</sub> = 5.0 V   | —         | —             | 2   | —                | 2    | μA   |
| FLAG Output low voltage                         | V <sub>OL</sub>     | I <sub>SINK</sub> = 1 mA, V <sub>IO</sub> = 5.0 V                                       | —         | —             | 0.4 | —                | 0.4  | V    |
| VSEL, CNT Pull up resistance                    | R <sub>VC</sub>     | —   | —         | 500           | —   | —                | —    | kΩ   |

## AC Characteristics (Ta = 25°C)

| Characteristics                      | Symbol           | Test Condition (Figure 1, 2, 3, 4)   | Min | Typ. | Max | Unit |
|--------------------------------------|------------------|--|-----|------|-----|------|
| Hold time                            | t <sub>HD</sub>  | V <sub>UVL</sub> < V <sub>IN</sub> (5 V) < V <sub>OVL</sub> , R <sub>L</sub> = 50 Ω<br>Initial start up V <sub>OUT</sub> off state to charge-pump on state | —   | 15   | —   | ms   |
| V <sub>OUT</sub> OVP off time        | t <sub>OVP</sub> | V <sub>IN</sub> > V <sub>OVLO_RI</sub> , V <sub>IN</sub> rising = 2 V/μs,<br>R <sub>L</sub> = 50 Ω, V <sub>OUT</sub> to 80% of V <sub>OVLO_RI</sub>        | —   | 3    | —   | μs   |
| V <sub>OUT</sub> off time            | t <sub>OFF</sub> | V <sub>UVL</sub> < V <sub>IN</sub> (5 V) < V <sub>OVL</sub> , R <sub>L</sub> = 50 Ω,<br>CNT low to high to V <sub>OUT</sub> to 80% of V <sub>IN</sub>      | —   | 0.5  | —   | μs   |
| V <sub>OUT</sub> rise time           | t <sub>r</sub>   | V <sub>IN</sub> = 5.0 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 1.0 μF  | —   | 2    | —   | ms   |
| V <sub>OUT</sub> fall time           | t <sub>f</sub>   | V <sub>IN</sub> = 5.0 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 1.0 μF  | —   | 0.12 | —   | ms   |
| V <sub>IN</sub> selection delay time | t <sub>SEL</sub> | V <sub>IN</sub> = 5.0 V, R <sub>L</sub> = 50 Ω,  | —   | 0.5  | —   | μs   |
| Break Before Make time               | t <sub>BBM</sub> | V <sub>IN</sub> = 5.0 V, R <sub>L</sub> = 50 Ω,  | —   | 15   | —   | ms   |

Timing chart  
Manual selection mode

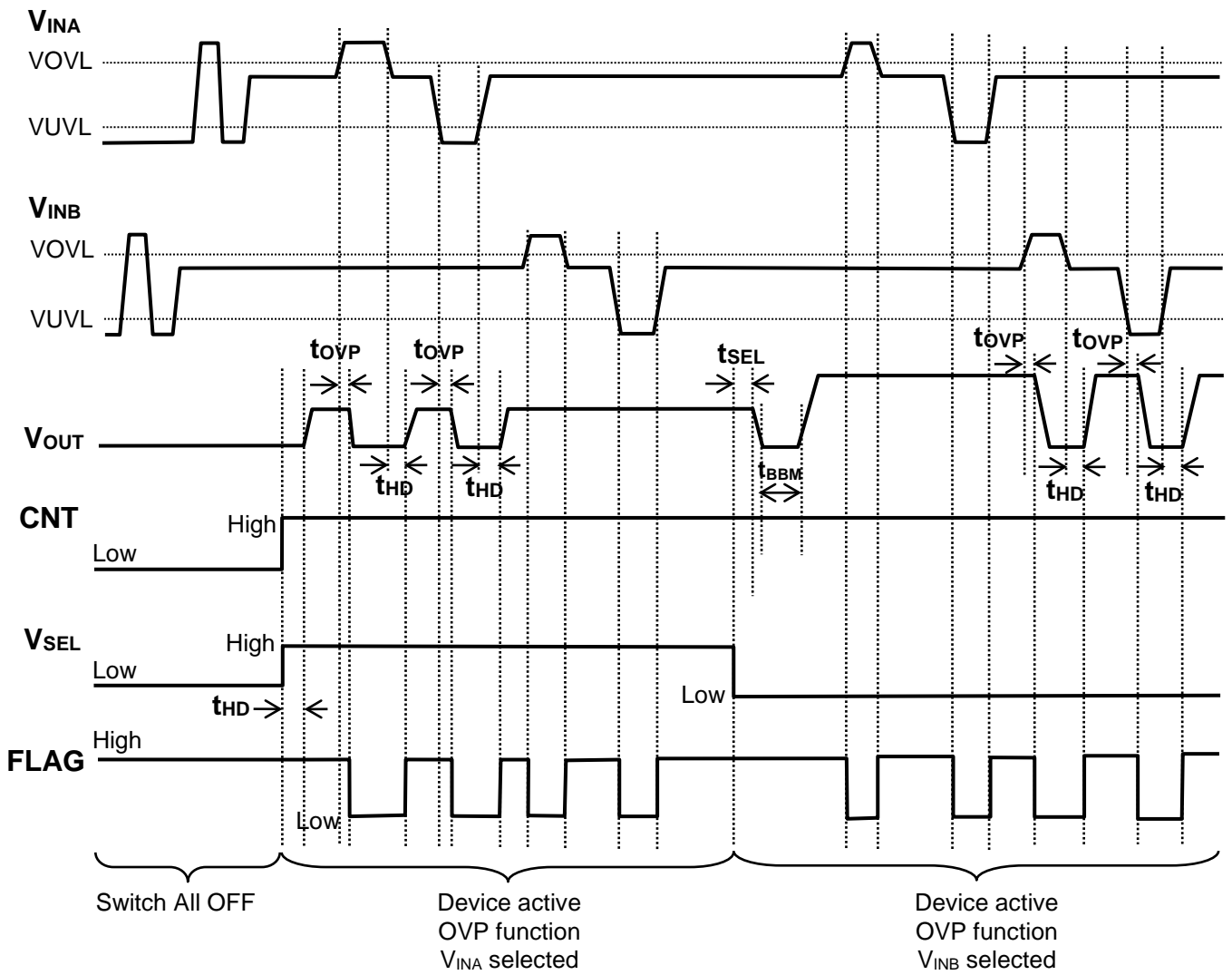


Fig.1 t<sub>HD</sub>, t<sub>toVP</sub>, t<sub>SEL</sub>

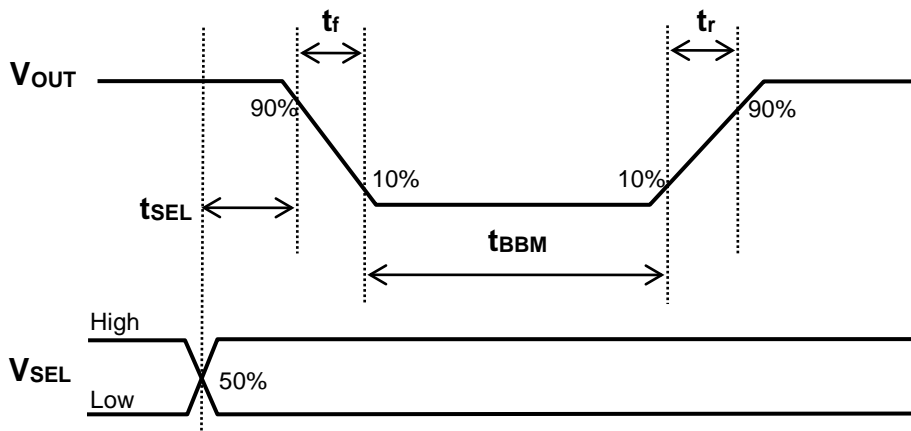


Fig.2 t<sub>r</sub>, t<sub>r</sub>, t<sub>BBM</sub>

## Timing chart Auto selection mode

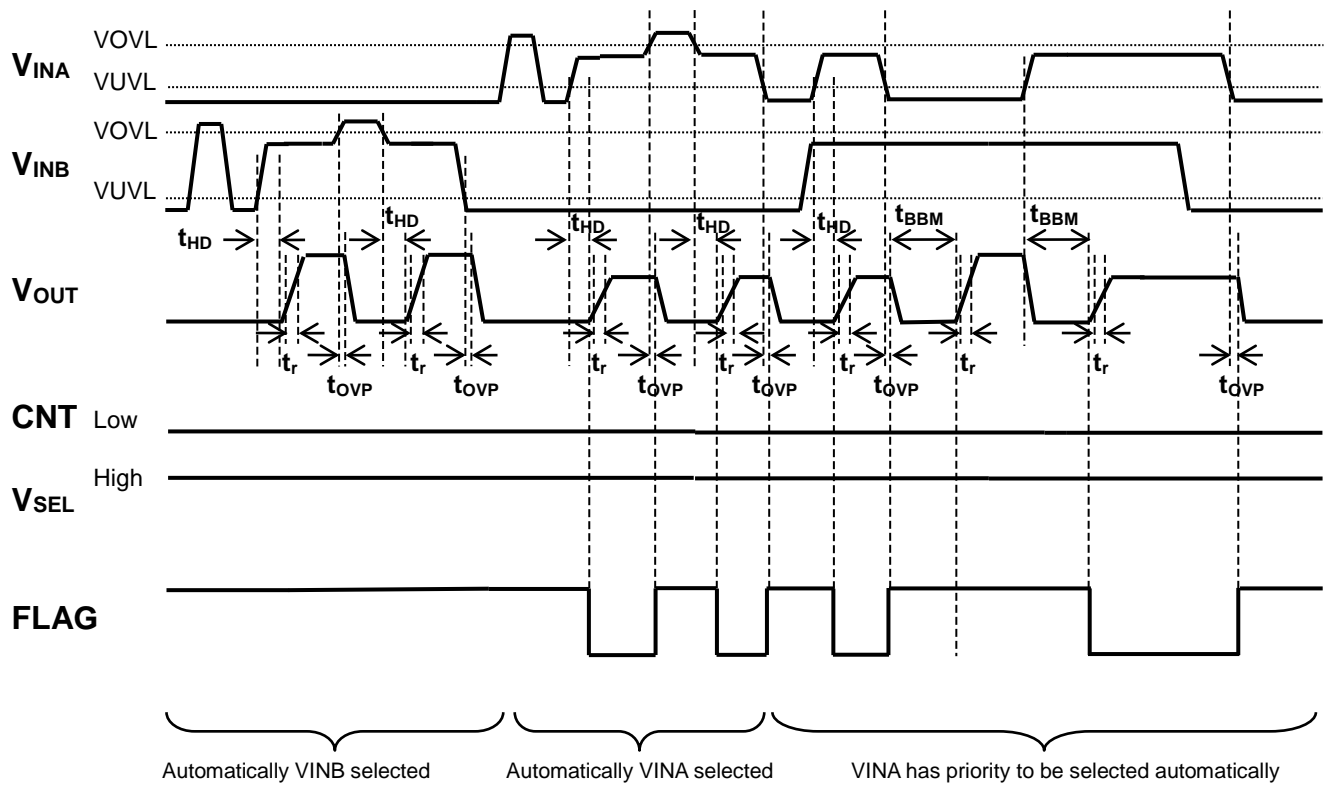


Fig.3  $t_{HD}$ ,  $t_{OVLP}$

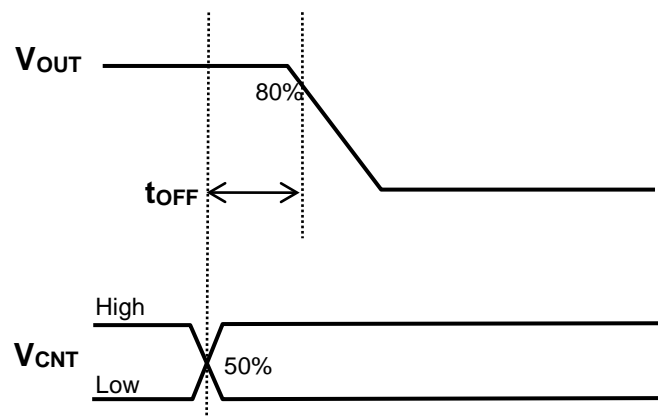
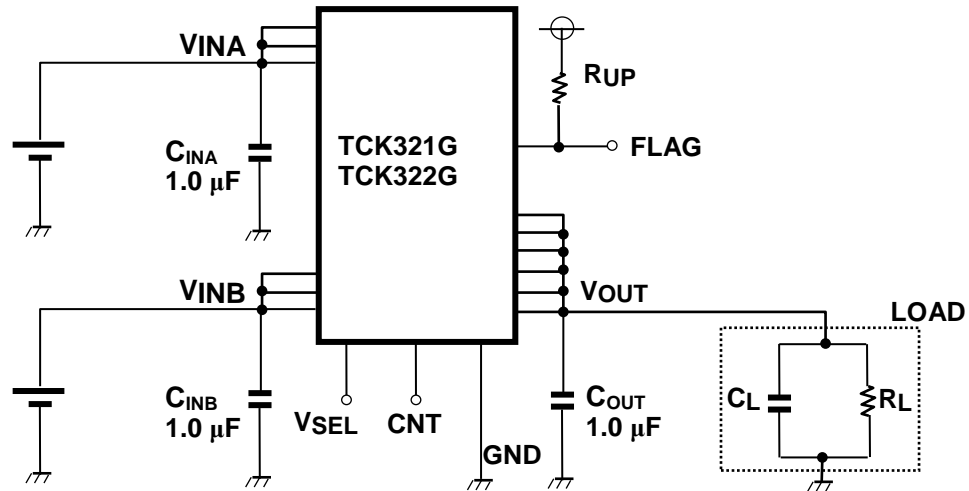


Fig.4  $t_{OFF}$

## Application Note

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



#### 1) Input and Output capacitor

An input capacitor (C<sub>IN</sub>) and an output capacitor (C<sub>OUT</sub>) are necessary for the stable operation of TCK321G and TCK322G. 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<sub>IN</sub> and C<sub>OUT</sub> more than 1.0 μF as close to V<sub>IN</sub> pin to improve stability of the power supply.

#### 2) Control pin

Control pins for TCK321G and TCK322G are operated by the control voltage and Schmitt trigger. V<sub>SEL</sub> pin has a tolerant function such that it can be used even if the control voltage is higher than the input voltage.

## 2. Reverse current blocking

Reverse current blocking(SW OFF state) function is designed in these products. This function is active at output n-ch MOSEFT turned off.

However 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.

## 3. Thermal shut down function

Thermal shutdown function is designed in these products, 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

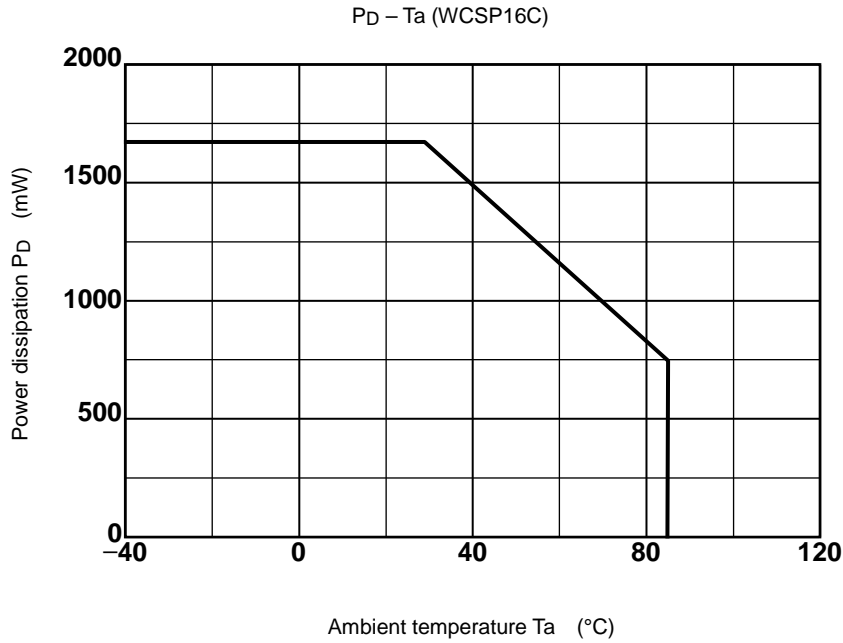
Board-mounted power dissipation ratings for TCK321G and TCK322G are available in the Absolute Maximum Ratings table.

Power dissipation is measured on the board condition shown below.

[The Board Condition]

Board material: Glass epoxy (FR4)

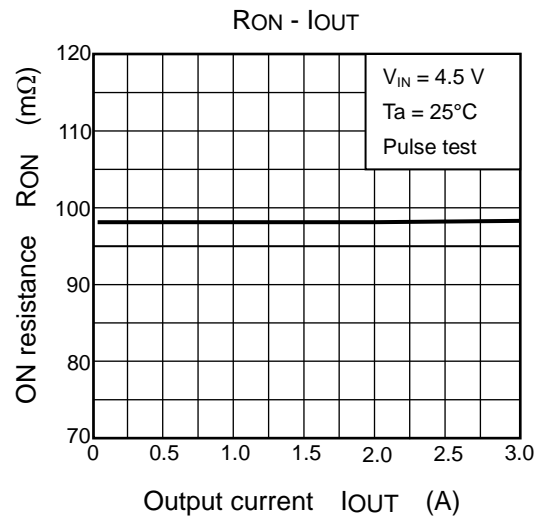
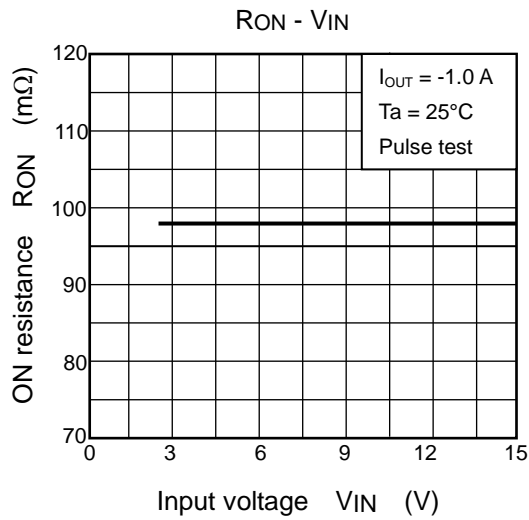
Board dimension: 40 mm x 40 mm (Cu 4 layer)



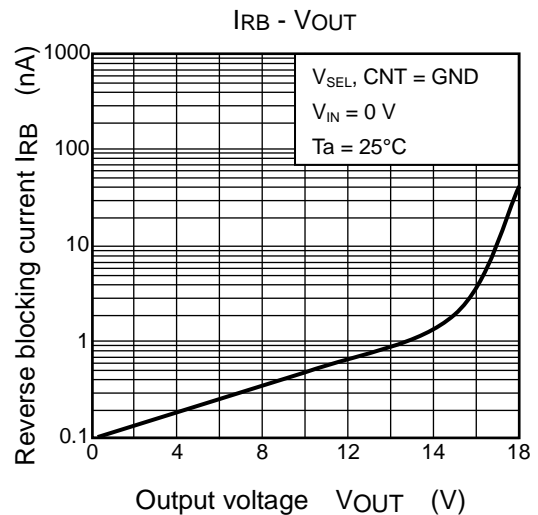
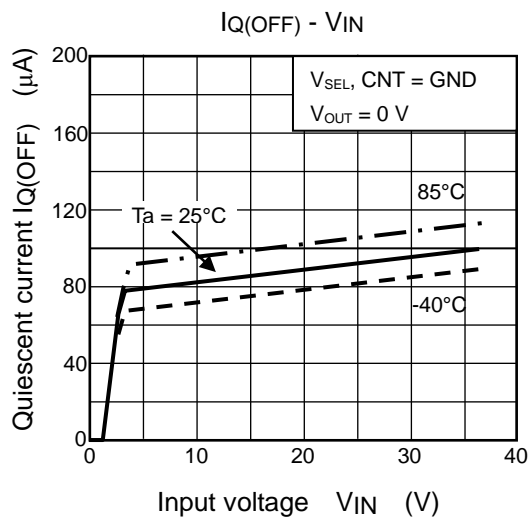
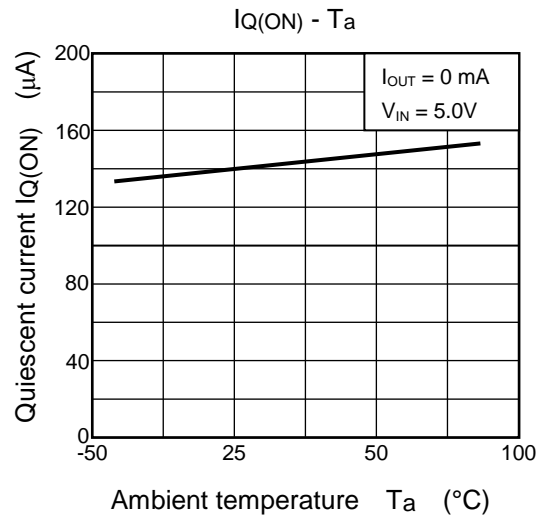
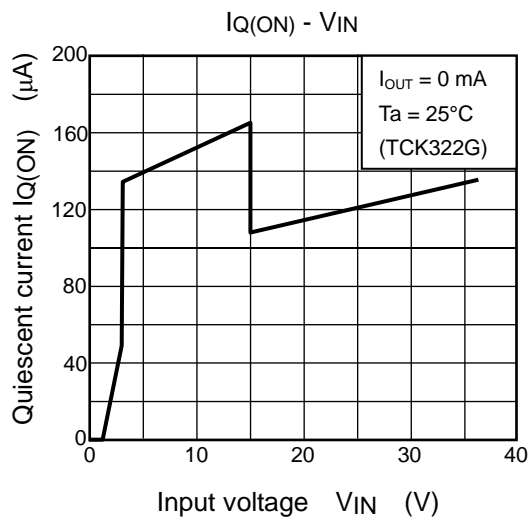
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc and applying the appropriate derating for allowable power dissipation during operation.

## Representative Typical Characteristics

### 1) ON resistance



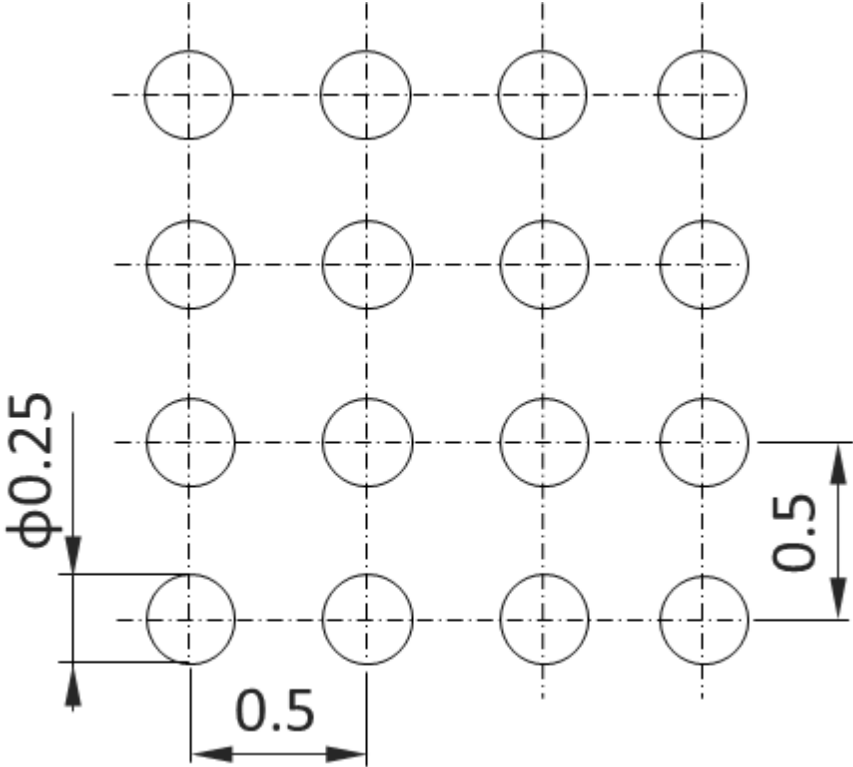
### 2) Quiescent current





Land pattern dimensions (for reference only)

Unit: mm



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