

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK22xxxG, TCK2065G, TCK1024G

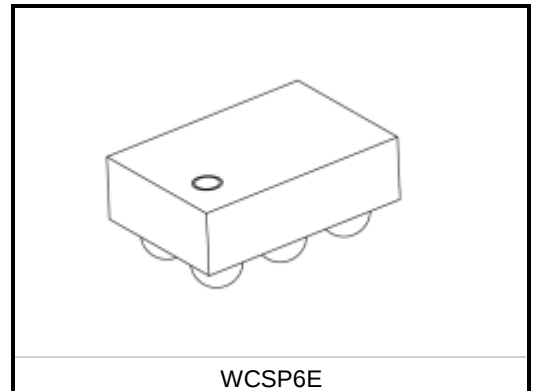
## Load Switch IC with Over current limited function

The TCK22xxxG, TCK2065G and TCK1024G are Load Switch ICs for power management with Over Current Limited function featuring low switch on resistance, ultra low quiescent current, high output current and wide input voltage operation. Typical switch ON resistance is only 31 mΩ at  $V_{IN} = 5.0\text{ V}$ ,  $I_{OUT} = -0.15\text{ A}$  load conditions. And these feature a thermal shut down function and output auto-discharge function.

These devices are available in 0.4 mm pitch ultra small package WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm). So these devices are ideal for portable applications that require high-density board assembly such as cellular phone.

### Feature

- Over current limit function  
 $I_{CL} = 400/740/1110/1540\text{ mA}$  (Option)
- Thermal shutdown function
- Inrush current reduction
- Output auto-discharge function
- True reverse current blocking function(Option)
- Under voltage lockout function(Option)
- 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  $V_{IN} = 1.8\text{ V}$ ,  $I_{OUT} = -0.15\text{ A}$
- Low quiescent current:  $I_Q = 25\text{ }\mu\text{A}$  (typ.) at  $V_{IN} = 5.5\text{ V}$ ,  $I_{OUT} = 0\text{ mA}$
- Pull down connection between CONTROL and GND
- Ultra small package : WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm)



Weight: 1 mg (typ.)

Start of commercial production  
2016-02

### Function Table

| Part number | Function             |                               |                       |                        |                   |                      | Device Marking |
|-------------|----------------------|-------------------------------|-----------------------|------------------------|-------------------|----------------------|----------------|
|             | Output current limit | True Reverse current blocking | Output auto-discharge | Under voltage lock out | Thermal shut down | Control pin polarity |                |
| TCK22946G   | 400 mA               | Built in                      | Built in              | Built in               | Built in          | Active High          | 1T             |
| TCK22951G   | 740 mA               | Built in                      | Built in              | Built in               | Built in          | Active High          | 2T             |
| TCK2065G    | 1110 mA              | Built in                      | Built in              | Built in               | Built in          | Active High          | 3T             |
| TCK1024G    | 1540 mA              | Built in                      | Built in              | Built in               | Built in          | Active High          | 4T             |
| TCK22891G   | 400 mA               | N/A                           | Built in              | N/A                    | Built in          | Active High          | 5T             |
| TCK22892G   | 740 mA               | N/A                           | Built in              | N/A                    | Built in          | Active High          | 6T             |
| TCK22893G   | 1110 mA              | N/A                           | Built in              | N/A                    | Built in          | Active High          | 7T             |
| TCK22894G   | 1540 mA              | N/A                           | Built in              | N/A                    | Built in          | Active High          | 8T             |

### 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> | Internally limited | -    |
| Power dissipation           | P <sub>D</sub>   | 800 (Note 1)       | 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: Rating at mounting on a board

Board material: Glass epoxy (FR4)

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

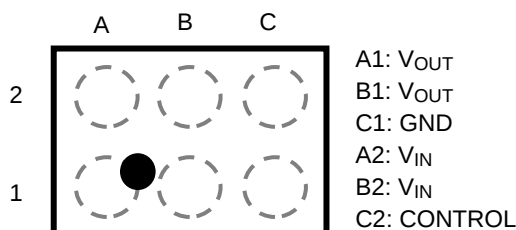
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%

Through hole: diameter 0.5mm x 28

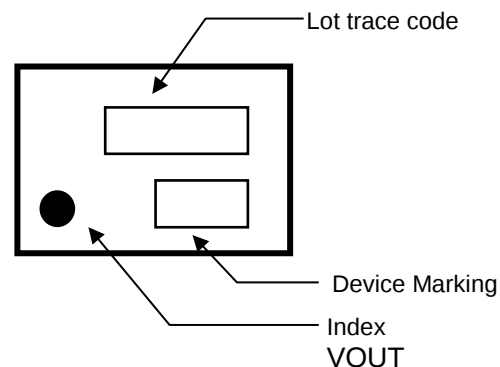
### Operating conditions

| Characteristics                  | Symbol           | Condition                      | Min | Max             | Unit |
|----------------------------------|------------------|--------------------------------|-----|-----------------|------|
| Input voltage                    | V <sub>IN</sub>  | TCK22946G                      | 1.1 | 5.5             | V    |
|                                  |                  | TCK22891G                      |     |                 |      |
|                                  |                  | Others                         |     |                 |      |
| Output voltage                   | V <sub>OUT</sub> | —                              | —   | V <sub>IN</sub> | V    |
| 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    |

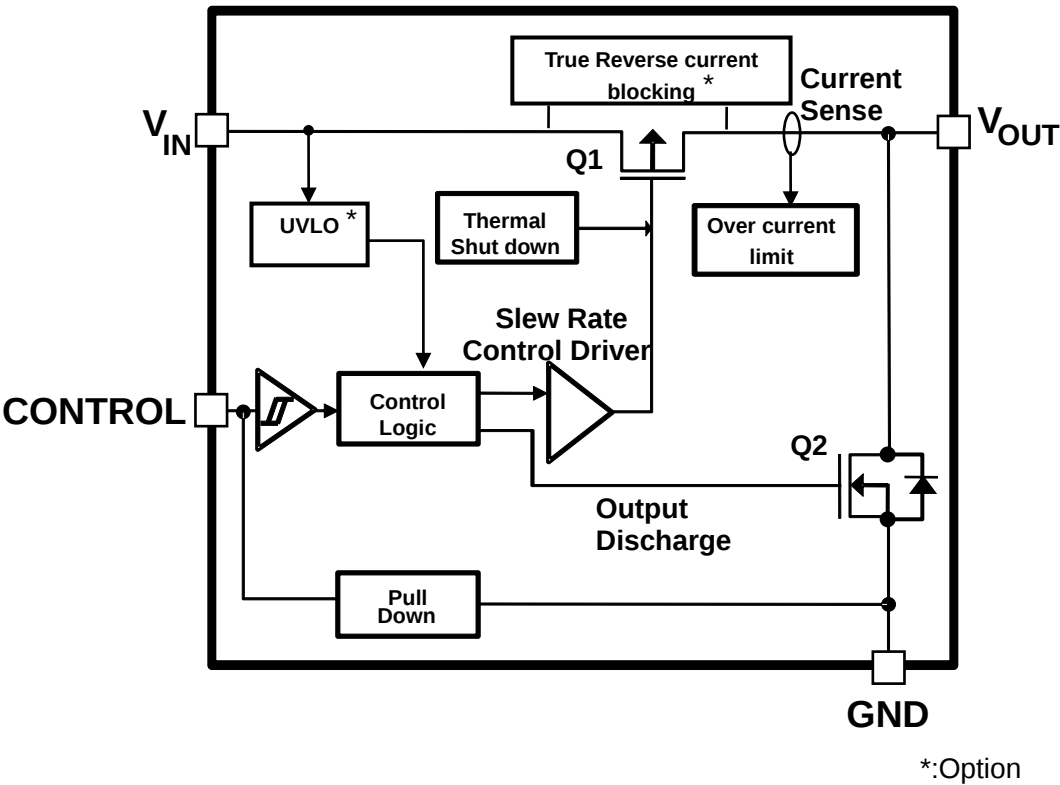
### Pin Assignment(Top view)



### Top marking



Block Diagram



Operation logic table

|                   |                          | TCK22946G<br>TCK22951G<br>TCK2065G<br>TCK1024G | TCK22891G<br>TCK22892G<br>TCK22893G<br>TCK22894G |
|-------------------|--------------------------|------------------------------------------------|--------------------------------------------------|
| Control<br>"High" | Output Q <sub>1</sub>    | ON                                             | ON                                               |
|                   | Discharge Q <sub>2</sub> | OFF                                            | OFF                                              |
|                   | Reverse current blocking | Active                                         | —                                                |
| Control<br>"Low"  | Output Q <sub>1</sub>    | OFF                                            | OFF                                              |
|                   | Discharge Q <sub>2</sub> | ON                                             | ON                                               |
|                   | Reverse current blocking | 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            | —         | 16   | —   | —                | —   | μA   |
|                                                 |         |                                                 | VIN = 5.5 V            | —         | 25   | —   | —                | 50  | μA   |
| Quiescent current ( OFF state)                  | IQ(OFF) | VIN = 5.5 V, VOUT = OPEN,                       |                        | —         | 0.6  | —   | —                | 2.5 | μA   |
| Reverse blocking current                        | IRB     | VOUT = 5.0 V,<br>VIN = 0 V, RCB active (Note 2) |                        | —         | 0.01 | —   | —                | 2   | μA   |
| Reverse blocking voltage threshold              | VRB     | VOUT – VIN<br>(Note 2)                          |                        | —         | 35   | —   | —                | —   | mV   |
| Reverse blocking release voltage threshold      | VRBR    | VOUT – VIN<br>(Note 2)                          |                        | —         | -15  | —   | —                | —   | mV   |
| Under Voltage Lock Out (UVLO) rising threshold  | VUVL_RI | — (Note 2)                                      |                        | —         | 0.82 | —   | —                | 1.1 | V    |
| Under Voltage Lock Out (UVLO) falling threshold | VUVL_FA | — (Note 2)                                      |                        | —         | 0.77 | —   | —                | —   | V    |
| On resistance                                   | RON     | IOUT = -0.15 A                                  | VIN = 5.0 V            | —         | 31   | —   | —                | 85  | mΩ   |
|                                                 |         |                                                 | VIN = 3.3 V            | —         | 40   | —   | —                | 95  |      |
|                                                 |         |                                                 | VIN = 1.8 V            | —         | 70   | —   | —                | 140 |      |
|                                                 |         |                                                 | VIN = 1.2 V (Note 3)   | —         | 141  | —   | —                | —   |      |
|                                                 |         |                                                 | VIN = 1.1 V (Note 3)   | —         | 179  | —   | —                | —   |      |
| Output Limited Current                          | ICL     | VIN = 5.5 V                                     | TCK22946G<br>TCK22891G | —         | 400  | —   | —                | —   | mA   |
|                                                 |         |                                                 | TCK22951G<br>TCK22892G | —         | 740  | —   | —                | —   |      |
|                                                 |         |                                                 | TCK2065G<br>TCK22893G  | —         | 1110 | —   | —                | —   |      |
|                                                 |         |                                                 | TCK1024G<br>TCK22894G  | —         | 1540 | —   | —                | —   |      |
| Output discharge on resistance                  | RSD     | —                                               |                        | —         | 100  | —   | —                | —   | Ω    |

Note 2: Only applies to the TCK22946G, TCK22951G, TCK2065G and TCK1024G

Note 3: Only applies to the TCK22946G and TCK22891G

## AC Characteristics (Ta = 25°C)

$V_{IN} = 5.0\text{ V}$

| Characteristics     | Symbol    | Test Condition(Figure 1)                                                   | Min | Typ. | Max | Unit          |
|---------------------|-----------|----------------------------------------------------------------------------|-----|------|-----|---------------|
| $V_{OUT}$ rise time | $t_r$     | $V_{IN} = 5.0\text{ V}$ , $R_L = 500\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , | —   | 50   | —   | $\mu\text{s}$ |
| $V_{OUT}$ fall time | $t_f$     | $V_{IN} = 5.0\text{ V}$ , $R_L = 500\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , | —   | 50   | —   | $\mu\text{s}$ |
| Turn on delay       | $t_{ON}$  | $V_{IN} = 5.0\text{ V}$ , $R_L = 500\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , | —   | 40   | —   | $\mu\text{s}$ |
| Turn off delay      | $t_{OFF}$ | $V_{IN} = 5.0\text{ V}$ , $R_L = 500\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , | —   | 10   | —   | $\mu\text{s}$ |

## AC Waveform

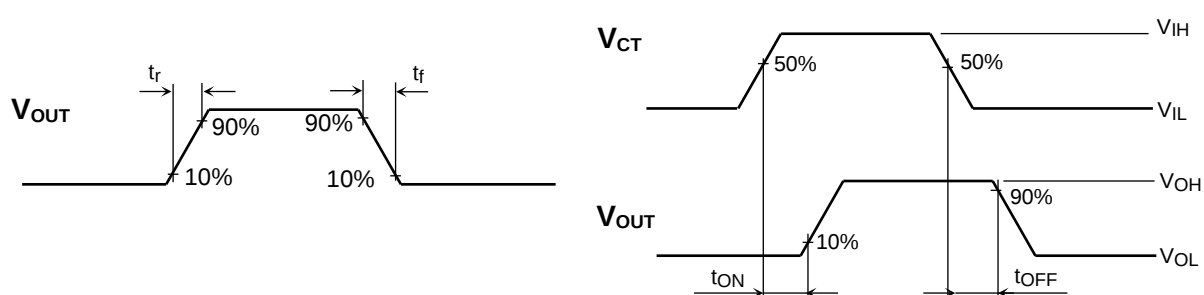
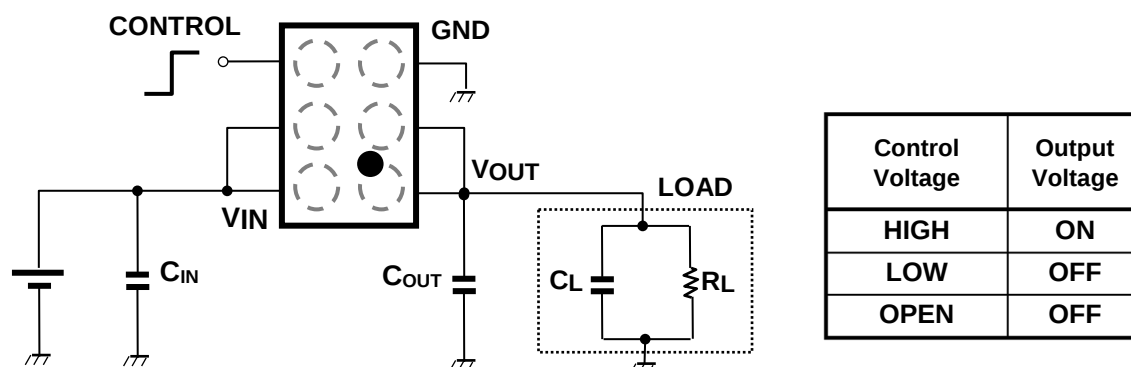


Figure 1  $t_r$ ,  $t_f$ ,  $t_{ON}$ ,  $t_{OFF}$  Waveforms

## Application Note

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

The figure below shows the recommended configuration.



#### 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. And they are 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 1.0μF as close to V<sub>IN</sub> pin to improve stability of the power supply.

#### 2) Control pin

The CONTROL pin controls state of the switch, operated by the control voltage and Schmitt trigger. Also, pull down resistance equivalent to a few MΩ is connected between CONTROL and GND, thus the load switch IC is in OFF state even when CONTROL pin is OPEN.

### 2. Over current limit function

This device has a built-in fold-back type of Current-limiting Circuit. Around 15% or more derating against typical values is recommended for system design with enough margin.

### 3. Thermal shutdown function

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

### 4. True reverse current blocking function(Optional)

Some of these devices have built-in True reverse current blocking circuit (TRCB) to block reverse current from V<sub>OUT</sub> to V<sub>IN</sub> regardless of output MOSFET ON/OFF condition. (Full-Time Reverse Current Protection)

### 5. Under-voltage Lockout function(Optional)

Some of these devices have a built-in Under-voltage Lockout Circuit to turn off switch if V<sub>IN</sub> drops below UVLO. This circuit has hysteresis and UVLO is released when V<sub>IN</sub> exceeds threshold.

### 6. Instructions and directions for use

Each device has several built-in protection 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.

## 7. Power Dissipation

Power dissipation is measured on the board condition shown below.

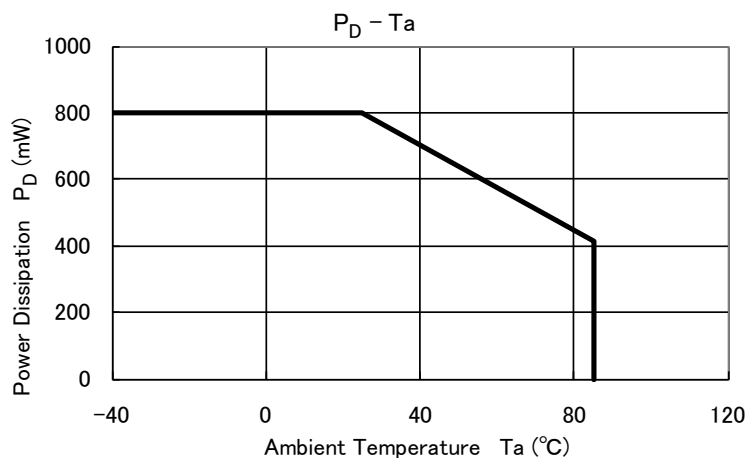
[The Board Condition]

Board material: Glass epoxy (FR4)

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

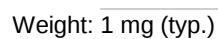
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%

Through hole: diameter 0.5mm x 28



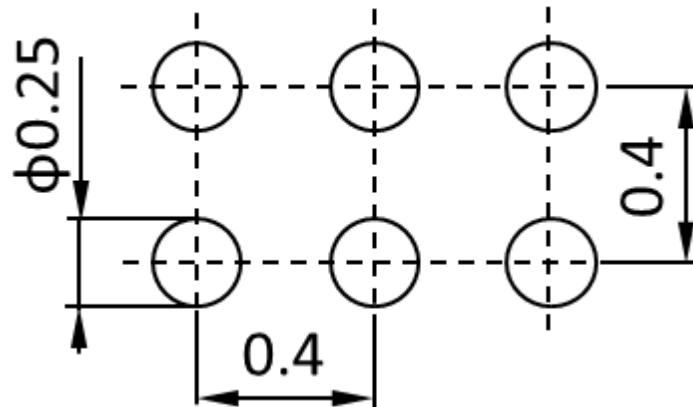
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

## Unit: mm



Land pattern dimensions (for reference only)

Unit: mm



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