

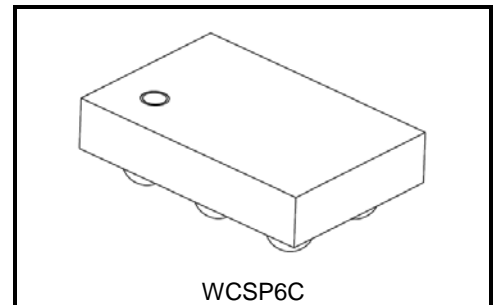
TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK111G, TCK112G

## 3A, 8 mΩ Ultra Low On Resistance Load Switch IC with Reverse Current Blocking and Thermal Shutdown function

The TCK111G and TCK112G are Load Switch ICs for power management with Reverse Current Blocking and Thermal Shutdown function featuring ultra low switch on resistance, high output current and wide input voltage operation from 1.1 to 5.5 V. Switch ON resistance is only 8.3 mΩ (typ.) at  $V_{IN} = 5.0$  V, -1.5 A load conditions and output current is available on 3.0 A. And these feature a slew rate control driver and output auto-discharge function.

This device are available in 0.5 mm pitch ultra small package WCSP6C (1.0 mm x 1.5 mm, t: 0.5 mm (typ.)). Thus they are ideal for portable applications that require high-density board assembly such as cellular phone.



Weight: 1.4 mg (typ.)

### Feature

- Low ON resistance:
  - $R_{ON} = 8.3$  mΩ (typ.) at  $V_{IN} = 5.0$  V, -1.5 A
  - $R_{ON} = 8.4$  mΩ (typ.) at  $V_{IN} = 3.3$  V, -1.5 A
  - $R_{ON} = 8.4$  mΩ (typ.) at  $V_{IN} = 1.8$  V, -1.5 A
  - $R_{ON} = 8.5$  mΩ (typ.) at  $V_{IN} = 1.1$  V, -1.5 A
- Wide input voltage operation:  $V_{IN} = 1.1$  to 5.5 V
- Reverse current blocking
- Inrush current reducing circuit
- Thermal Shutdown function
- Output auto-discharge ( TCK112G )
- Pull down connection between CONTROL and GND
- Ultra small package : WCSP6C (1.0mm x 1.5mm, t: 0.5 mm(typ.))

Start of commercial production  
2014-04

### 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	3.0	A
		Pulse	4.0 (Note 1)	A
Power dissipation	P <sub>D</sub>	1.2 (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 and the operating ranges. 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).

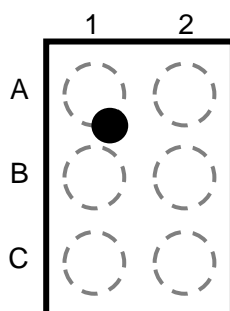
Note1: 100 μs pulse, 2% duty cycle

Note2: Rating at mounting on a board

(Board material: Glass epoxy (FR4))

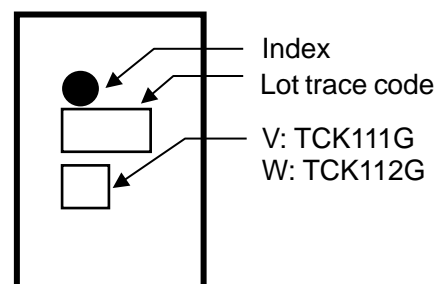
Board dimension: 25.4mm x 25.4mm (both sides of board), t=1.6mm, Cu pad area: 645mm<sup>2</sup>)

### Pin Assignment (Top view)



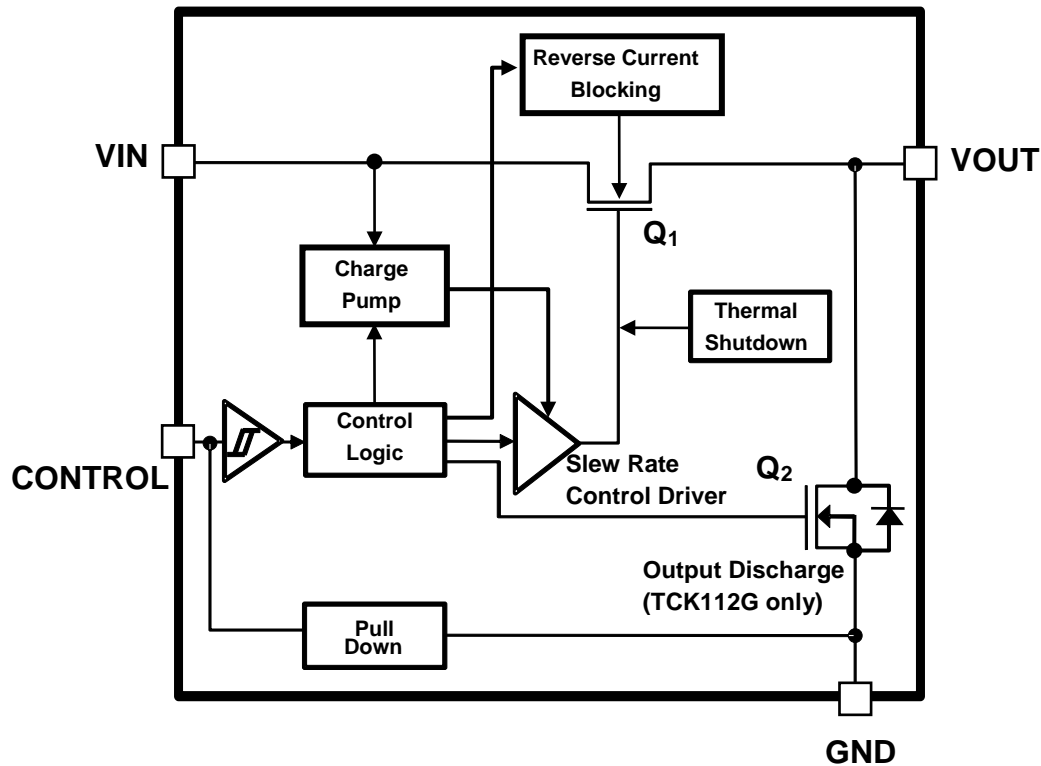
A1: VOUT  
 B1: VOUT  
 C1: GND  
 A2: VIN  
 B2: VIN  
 C2: CONTROL

### Top marking



Index  
 Lot trace code  
 V: TCK111G  
 W: TCK112G

### Block Diagram



### Function table

Part number	Function			
	Reverse current blocking	Thermal shutdown	Output auto-discharge	Control pin connection
TCK111G	Built in	Built in	N/A	Pull down
TCK112G	Built in	Built in	Built in	Pull down

### Operation Logic table

$1.1\text{ V} \leq V_{IN} \leq 5.5\text{ V}$  ( $T_a = -40$  to  $85^\circ\text{C}$ )

		TCK111G	TCK112G
Control "High"	Output Q <sub>1</sub>	ON	ON
	Discharge Q <sub>2</sub>	—	OFF
	Reverse current block	Active	Active
Control "Low"	Output Q <sub>1</sub>	OFF	OFF
	Discharge Q <sub>2</sub>	—	ON
	Reverse current block	Active	Active
Control "OPEN"	Output Q <sub>1</sub>	OFF	OFF
	Discharge Q <sub>2</sub>	—	ON
	Reverse current block	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		
Input voltage	V <sub>IN</sub>	—	1.1	—	5.5	1.1	5.5	V	
CONTROL High-level input voltage	V <sub>IH</sub>	1.2V < V <sub>IN</sub> ≤ 5.5 V	1.0	—	—	1.0	—	V	
		1.1V ≤ V <sub>IN</sub> ≤ 1.2 V	0.9	—	—	0.9	—		
CONTROL Low-level input voltage	V <sub>IL</sub>	V <sub>IN</sub> = 1.1 to 5.5 V	—	—	0.4	—	0.4	V	
Quiescent current ( ON state)	I <sub>Q</sub>	I <sub>OUT</sub> = 0 mA	V <sub>IN</sub> = V <sub>CT</sub> = 1.1 V	—	55	—	—	—	μA
			V <sub>IN</sub> = V <sub>CT</sub> = 1.8 V	—	50	—	—	—	μA
			V <sub>IN</sub> = V <sub>CT</sub> = 3.3 V	—	48	—	—	—	μA
			V <sub>IN</sub> = V <sub>CT</sub> = 5.0 V	—	69	—	—	106	μA
Standby current ( OFF state)	I <sub>Q(OFF)</sub>	V <sub>IN</sub> = 5.5 V, V <sub>CT</sub> = 0 V, V <sub>OUT</sub> = OPEN (Note 3)	—	0.5	—	—	1.4	μA	
Reverse blocking current	I <sub>RB</sub>	V <sub>OUT</sub> = 5.0 V, V <sub>IN</sub> = 0 V, V <sub>CT</sub> = 0 V	—	0.6	—	—	10	μA	
Reverse blocking voltage threshold	V <sub>RB</sub>	V <sub>OUT</sub> - V <sub>IN</sub>	—	40	—	—	—	mV	
Reverse blocking release voltage threshold	V <sub>RB(R)</sub>	V <sub>OUT</sub> - V <sub>IN</sub>	—	-30	—	—	—	mV	
On resistance	R <sub>ON</sub>	I <sub>OUT</sub> = -1.5 A	V <sub>IN</sub> = 5.0 V	—	8.3	—	—	15	mΩ
			V <sub>IN</sub> = 3.3 V	—	8.4	—	—	—	
			V <sub>IN</sub> = 1.8 V	—	8.4	—	—	—	
			V <sub>IN</sub> = 1.1 V	—	8.5	—	—	15	
Output discharge on resistance	R <sub>SD</sub>	— (TCK112G)	—	380	—	—	—	Ω	

Note 3 : Except OFF-state switch current ( I<sub>SD(OFF)</sub> : V<sub>IN</sub> = 5.5 V, V<sub>CT</sub> = 0 V, V<sub>OUT</sub> = GND ).

#### AC Characteristics (Ta = 25°C)

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> = 2.5 Ω , C <sub>L</sub> =1.0 μF	—	0.5	—	ms
V <sub>OUT</sub> fall time	t <sub>f</sub>	V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 2.5 Ω , C <sub>L</sub> =1.0 μF	—	5	—	μs
Turn on delay	t <sub>ON</sub>	V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 2.5 Ω , C <sub>L</sub> =1.0 μF	—	0.2	—	ms
Turn off delay	t <sub>OFF</sub>	V <sub>IN</sub> = 5.0 V , R <sub>L</sub> = 2.5 Ω , C <sub>L</sub> =1.0 μF	—	4	—	μs

#### AC Waveform

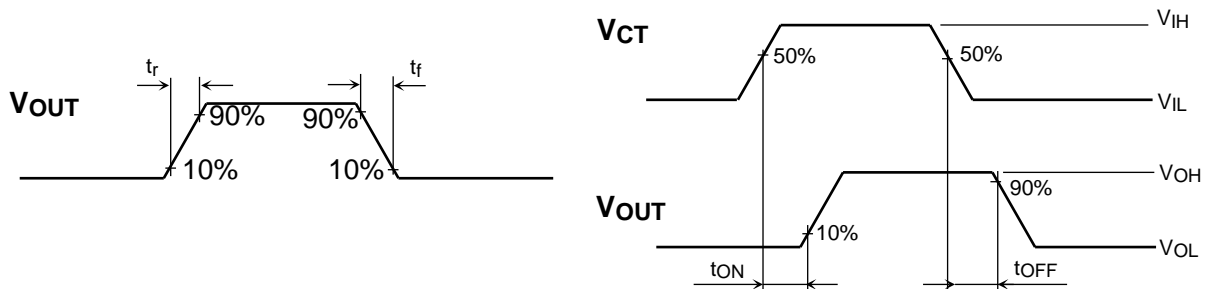
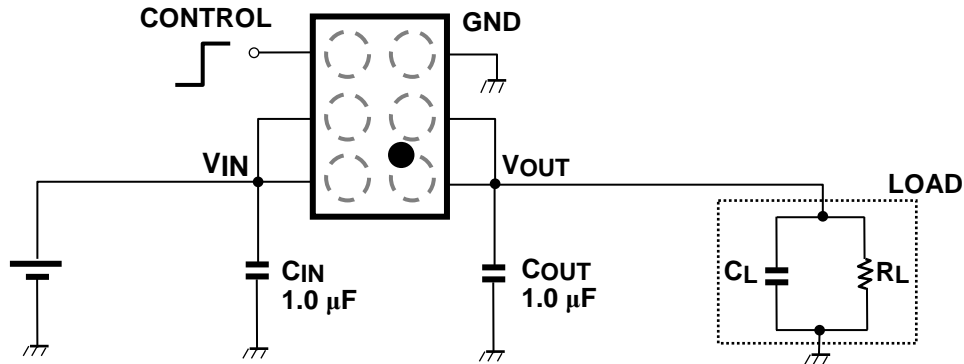


Figure 1 t<sub>r</sub>, t<sub>f</sub>, t<sub>ON</sub>, t<sub>OFF</sub> Waveforms

### Application Note

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

The figure below shows the example of configuration for TCK111G and TCK112G.



##### 1) Input and Output capacitor

An input capacitor ( $C_{IN}$ ) and an output capacitor ( $C_{OUT}$ ) are necessary for the stable operation of TCK111G and TCK112G. 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  $C_{IN}$  and  $C_{OUT}$  more than 1.0 $\mu F$  as close to VIN pin to improve stability of the power supply.

##### 2) Control pin

Control pins for TCK111G and TCK112G are both Active High, which control both the pass-through n-ch MOSFET and the discharge n-ch MOSFET (only for TCK112G), operated by the control voltage. Each control pin is equipped with Schmitt trigger. When the control voltage level is High, Output n-ch MOSFET is ON state and discharge n-ch MOSFET is OFF state. When control voltage level is Low, and the state of the MOSFETs is reversed. 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. In addition, CONTROL 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 function is designed in these products. This function is active regardless output n-ch MOSFET ON/OFF state in condition that  $V_{IN}$  is supplied

However these do 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 recommends inserting failsafe system into the design.

#### 3. Thermal shutdown function

Thermal shutdown function is designed in these products, but it 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 recommends inserting failsafe system into the design.

### 4. Power Dissipation

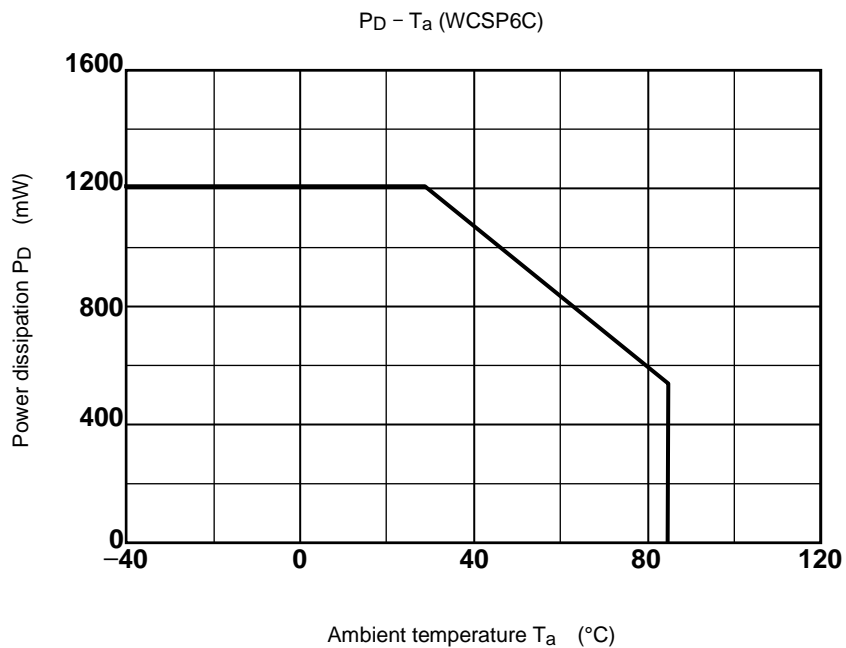
Board-mounted power dissipation ratings for TCK111G and TCK112G are available in the Absolute Maximum Ratings table.

Power dissipation is measured on the board condition shown below.

[The Board Condition]

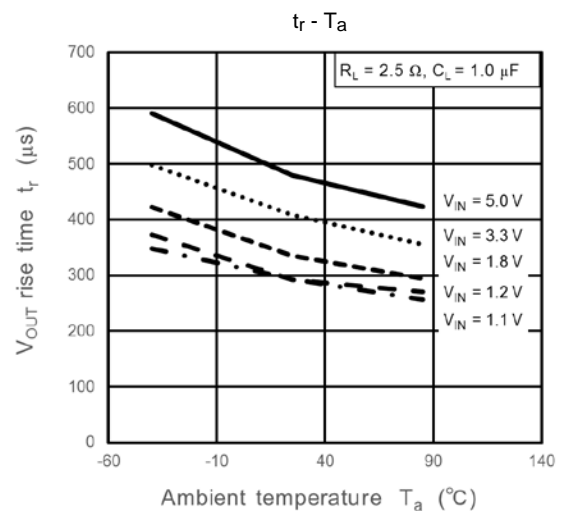
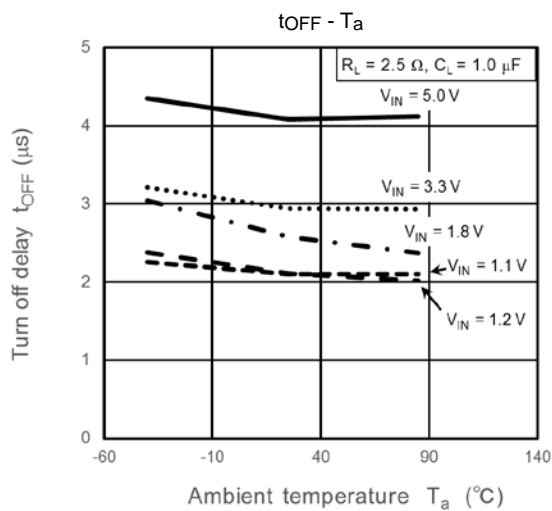
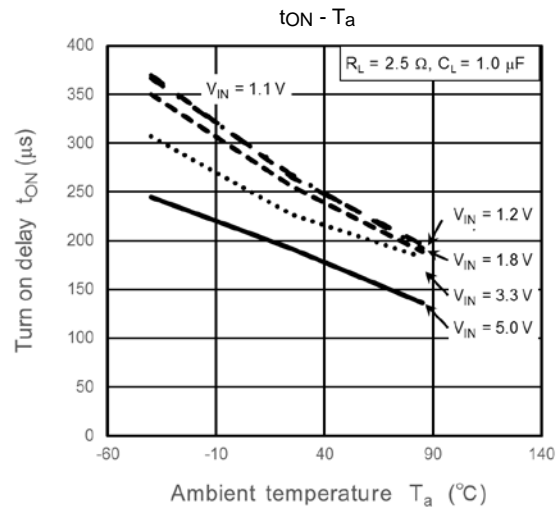
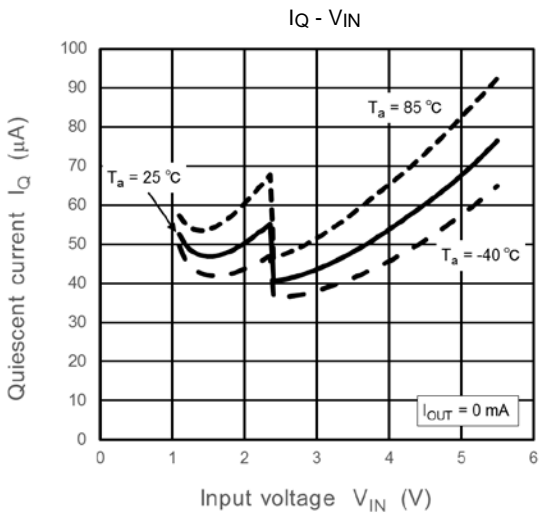
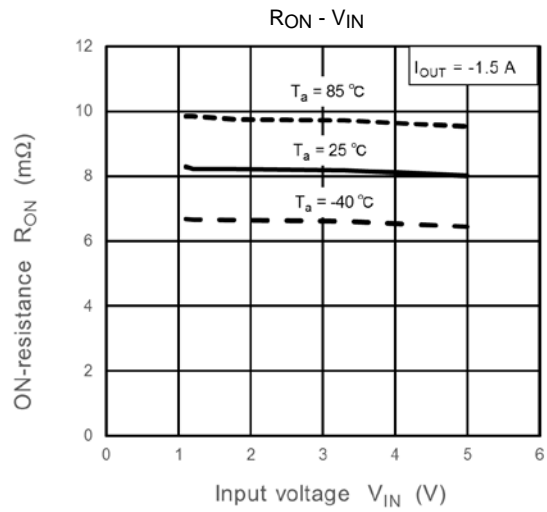
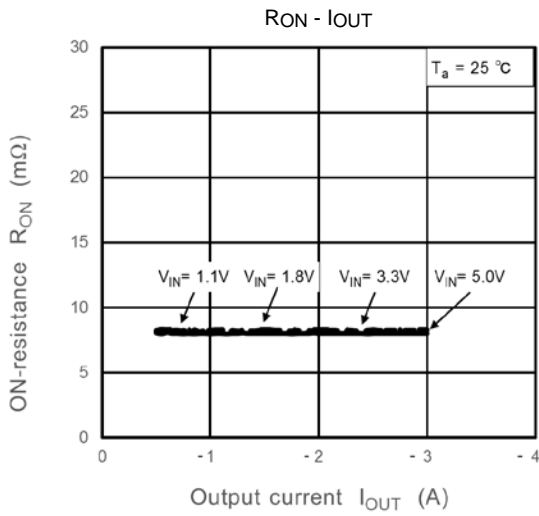
Board material: Glass epoxy (FR4)

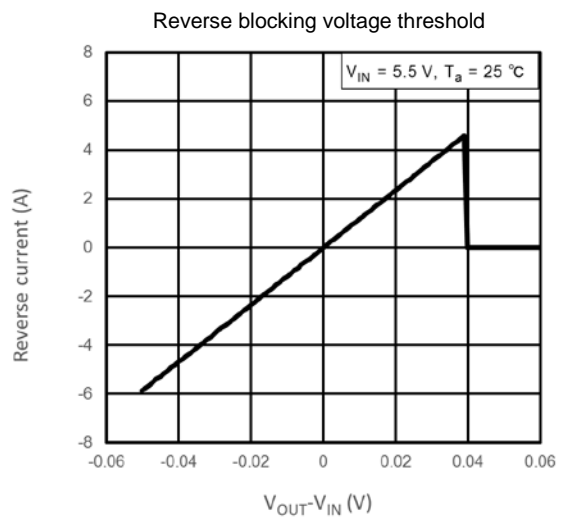
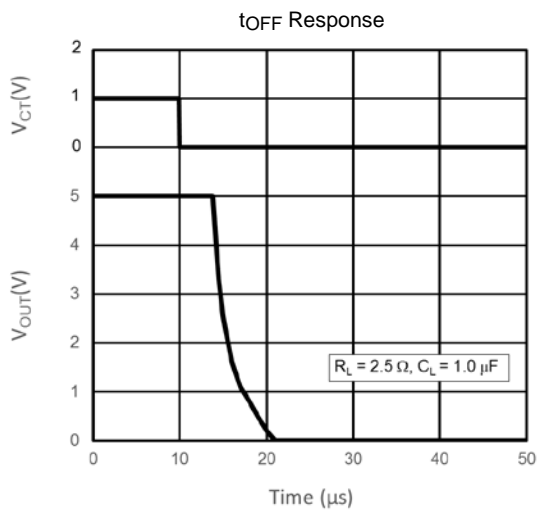
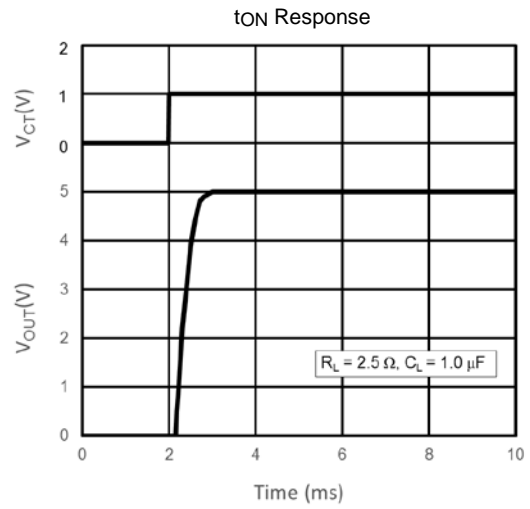
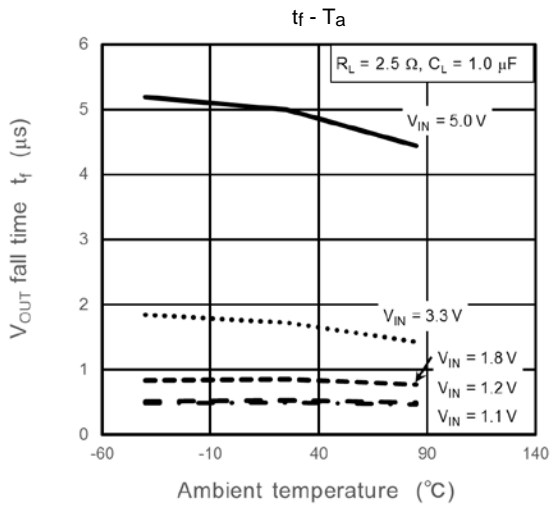
Board dimension: 25.4mm x 25.4mm (both sides of board), t=1.6mm, Cu pad area: 645mm<sup>2</sup>



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





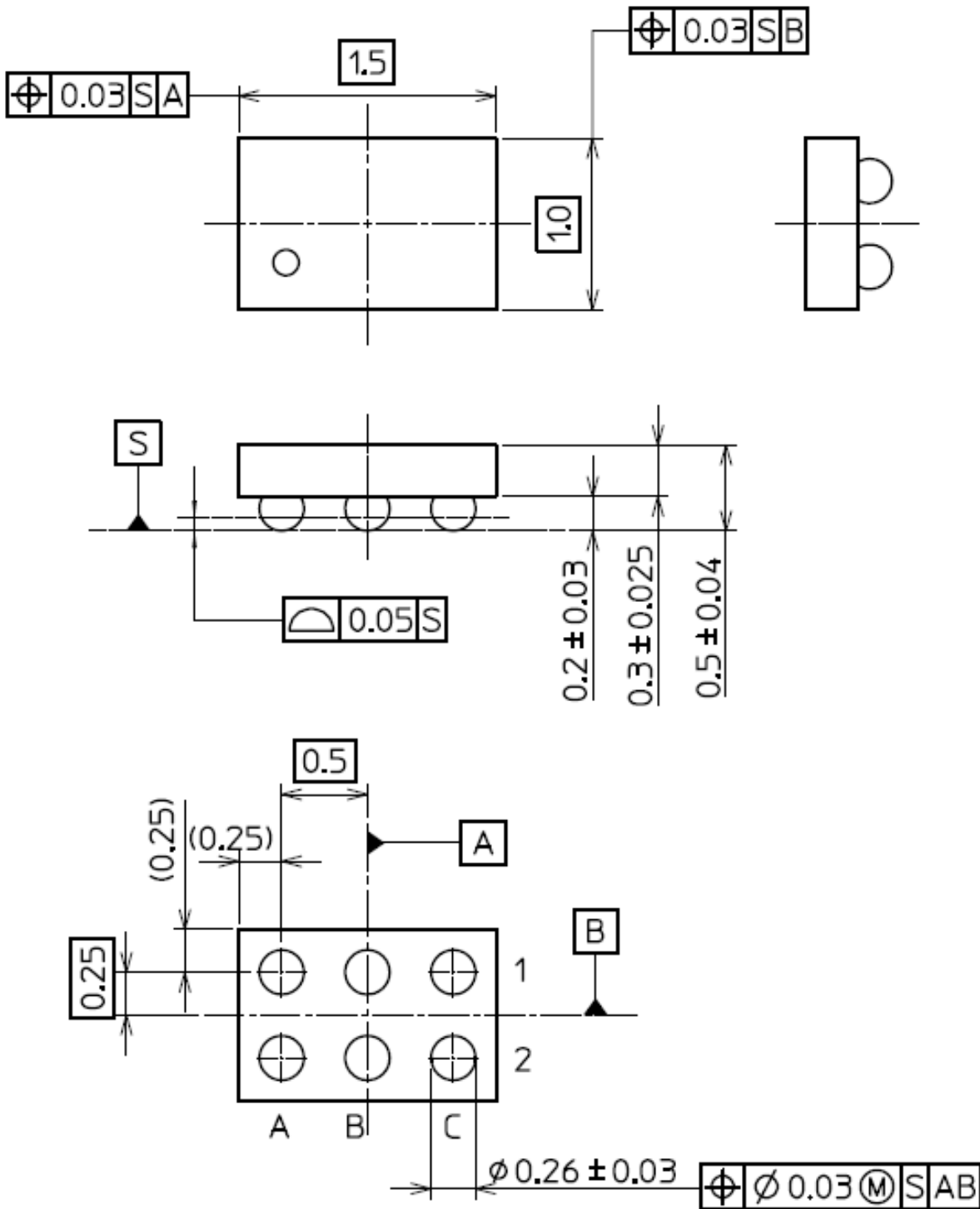
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.



### Package Information

WCSP6C

Unit: mm



Weight: 1.4 mg (typ.)

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