TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

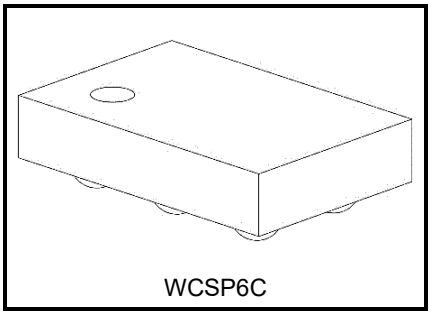
TCK111G, TCK112G

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

1. Description

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.

These devices 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.



WCSP6C

Weight: 1.4 mg (typ.)

2. Features

- 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 (1.0 mm x 1.5 mm, t: 0.5 mm (typ.))

Notice

This device is sensitive to electrostatic discharge. Please ensure equipment and tools are adequately earthed when handling.

Start of commercial production
2014-04

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3. Absolute Maximum Ratings (Ta = 25°C)（Note）

Characteristics	Symbol	Rating		Unit
Input voltage	V_{IN}	-0.3 to 6.0		V
Control voltage	V_{CT}	-0.3 to 6.0		V
Output voltage	V_{OUT}	-0.3 to 6.0		V
Output current	I_{OUT}	DC	3.0	A
		Pulse	4.0 (Note 1)	A
Power dissipation	P_D	1.2 (Note 2)		W
Operating temperature range	T_{opr}	−40 to 85		°C
Junction temperature	Tj	150		°C
Storage temperature	T_{stg}	−55 to 150		°C

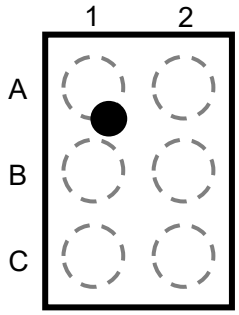
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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: 25.4 mm x 25.4 mm (both sides of board), t=1.6 mm, Cu pad area: 645 mm^2)

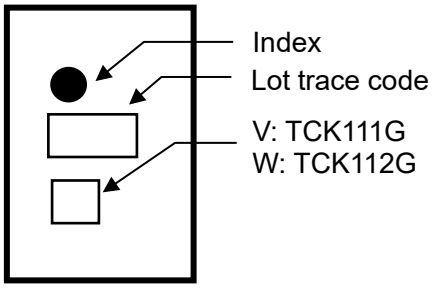
4. Pin Assignment, Top Marking (Top view)

Pin Assignment



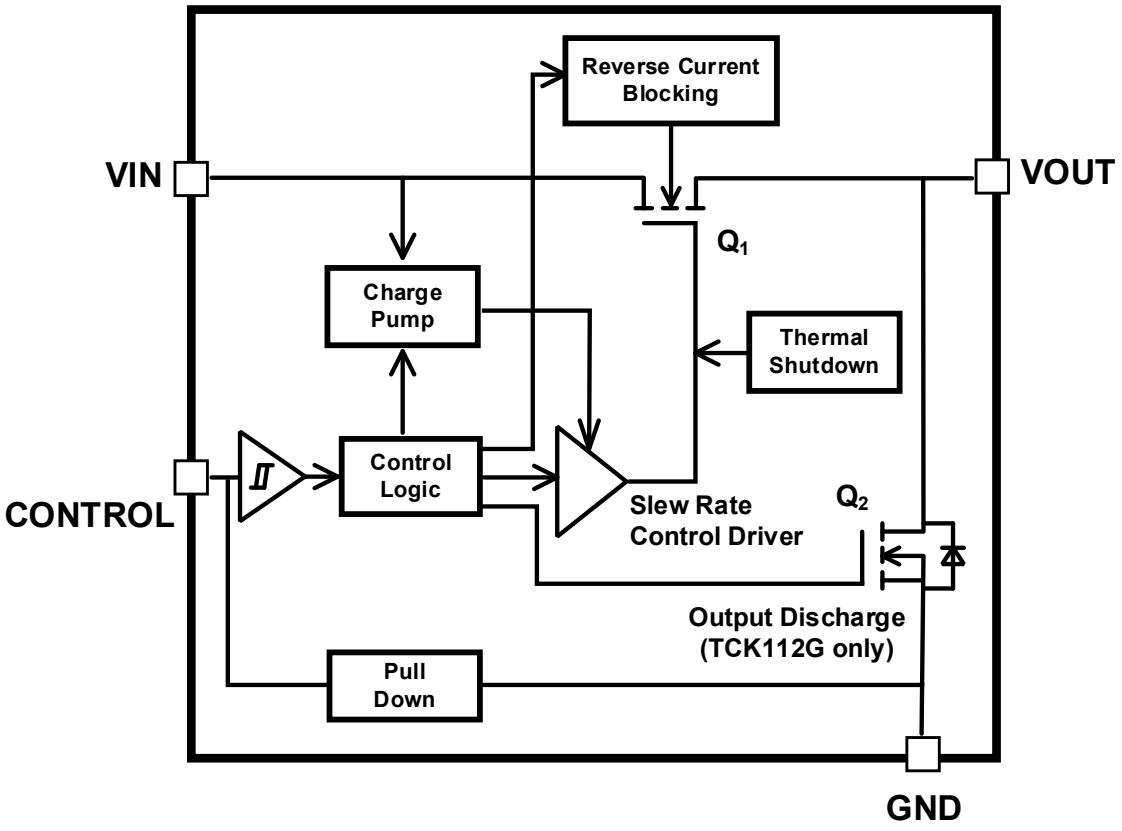
A1: VOUT
B1: VOUT
C1: GND
A2: VIN
B2: VIN
C2: CONTROL

Top Marking



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5. Block Diagram



5.1. 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

5.2. Operation Logic table

1.1 V ≤ V_{IN} ≤ 5.5 V (Ta = -40 to 85°C)

		TCK111G	TCK112G
Control "High"	Output Q_1	ON	ON
	Discharge Q_2	—	OFF
	Reverse current block	Active	Active
Control "Low"	Output Q_1	OFF	OFF
	Discharge Q_2	—	ON
	Reverse current block	Active	Active
Control "OPEN"	Output Q_1	OFF	OFF
	Discharge Q_2	—	ON
	Reverse current block	Active	Active

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6. Electrical Characteristics

6.1. 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_{IN}	—		1.1	—	5.5	1.1	5.5	V
CONTROL High-level input voltage	V_{IH}	1.2V < V_{IN} ≤ 5.5 V		1.0	—	—	1.0	—	V
		1.1V ≤ V_{IN} ≤ 1.2 V		0.9	—	—	0.9	—	
CONTROL Low-level input voltage	V_{IL}	V_{IN} = 1.1 to 5.5 V		—	—	0.4	—	0.4	V
Quiescent current (ON state)	I_Q	I_{OUT} = 0 mA	V_{IN} = V_{CT} = 1.1 V	—	55	—	—	—	μA
			V_{IN} = V_{CT} = 1.8 V	—	50	—	—	—	μA
			V_{IN} = V_{CT} = 3.3 V	—	48	—	—	—	μA
			V_{IN} = V_{CT} = 5.0 V	—	69	—	—	106	μA
Standby current (OFF state)	$I_{Q(OFF)}$	V_{IN} = 5.5 V, V_{CT} = 0 V, VOUT = OPEN (Note 3)		—	0.5	—	—	1.4	μA
Reverse blocking current	I_{RB}	V_{OUT} = 5.0 V, V_{IN} = 0 V, V_{CT} = 0 V		—	0.6	—	—	10	μA
Reverse blocking voltage threshold	V_{RB}	V_{OUT} – V_{IN}		—	40	—	—	—	mV
Reverse blocking release voltage threshold	V_{RBR}	V_{OUT} – V_{IN}		—	-30	—	—	—	mV
On resistance	R_{ON}	I_{OUT} = -1.5 A	V_{IN} = 5.0 V	—	8.3	—	—	15	mΩ
			V_{IN} = 3.3 V	—	8.4	—	—	—	
			V_{IN} = 1.8 V	—	8.4	—	—	—	
			V_{IN} = 1.1 V	—	8.5	—	—	15	
Output discharge on resistance	R_{SD}	(TCK112G only)		—	380	—	—	—	Ω

Note 3 : Except OFF-state switch current ($I_{SD(OFF)}$: V_{IN} = 5.5 V, V_{CT} = 0 V, V_{OUT} = GND).

6.2. AC Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition (Figure 1)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	V_{IN} = 5.0 V , R_L = 2.5 Ω , C_L = 1.0 μF	—	0.5	—	ms
V_{OUT} fall time	t_f	V_{IN} = 5.0 V , R_L = 2.5 Ω , C_L = 1.0 μF	—	5	—	μs
Turn on delay	t_{ON}	V_{IN} = 5.0 V , R_L = 2.5 Ω , C_L = 1.0 μF	—	0.2	—	ms
Turn off delay	t_{OFF}	V_{IN} = 5.0 V , R_L = 2.5 Ω , C_L = 1.0 μF	—	4	—	μs

AC Waveform

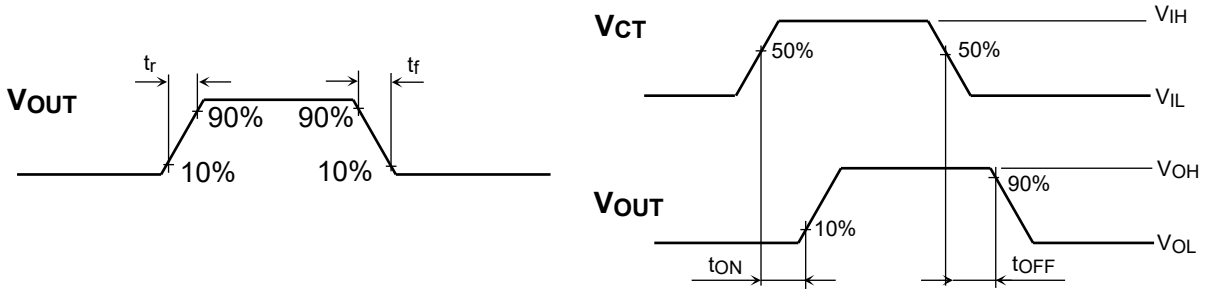


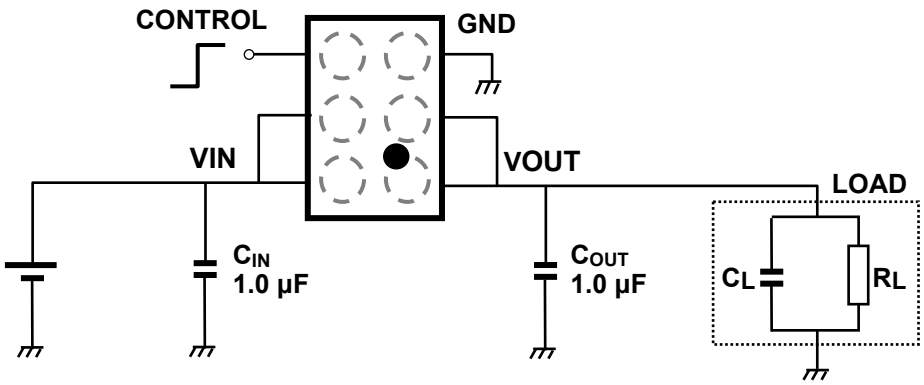
Figure 1: t_r, t_f, t_{ON}, t_{OFF} Waveforms

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7. Application Note

7.1. Application circuit example (top view)

The below figure 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 1.0µF 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 MΩ 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.

7.2. 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.

7.3. 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.

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7.4. Power Dissipation

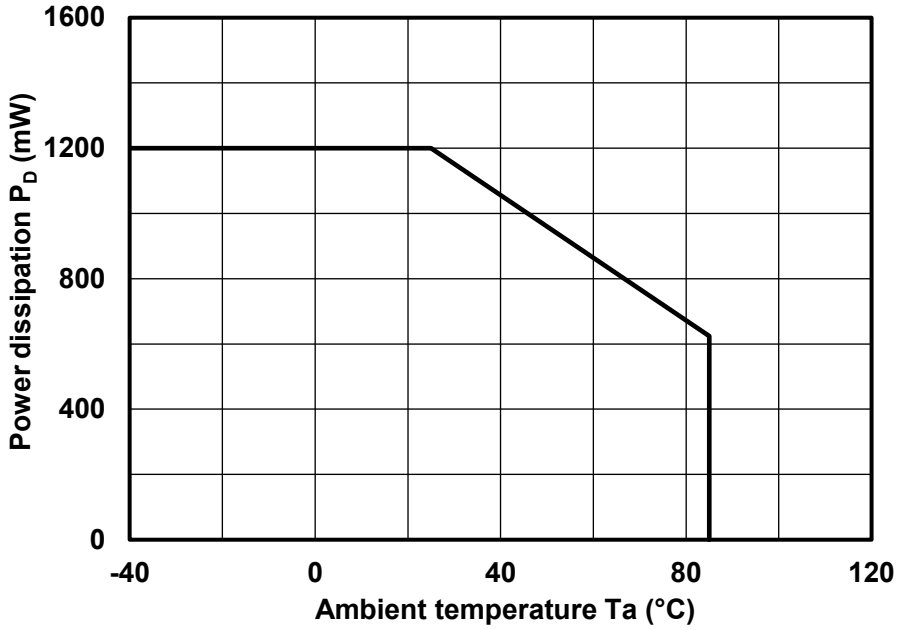
Board-mounted power dissipation ratings for TCK111G and TCK112G are available in the Absolute Maximum Ratings table.

Power dissipation is measured on the board condition shown below.

[The Board Condition]

Board material: Glass epoxy (FR4)

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

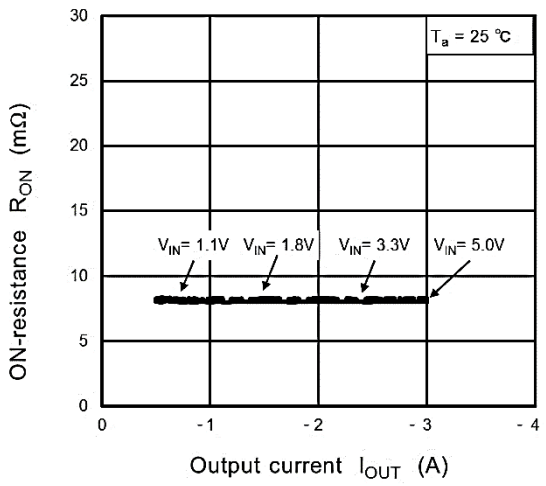


Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

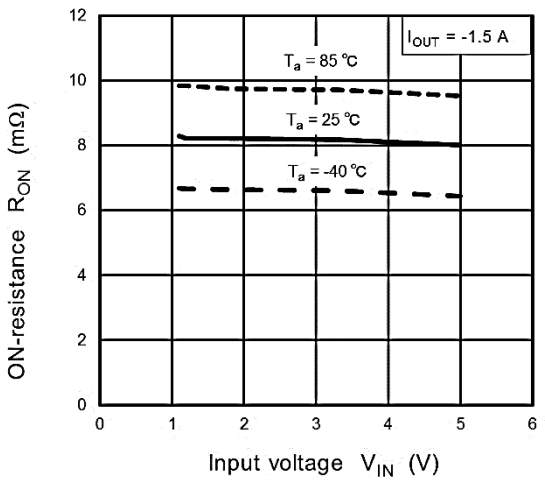
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8. Representative Typical Characteristics（Note）

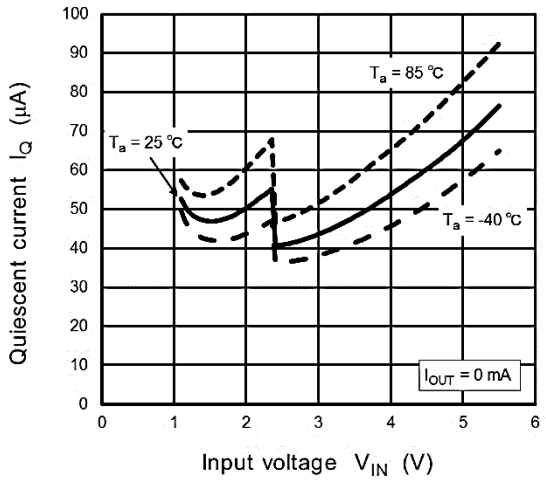
R_{ON} - I_{OUT}



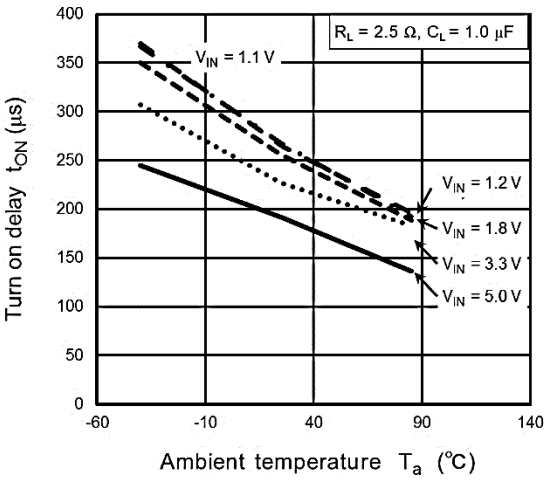
R_{ON} - V_{IN}



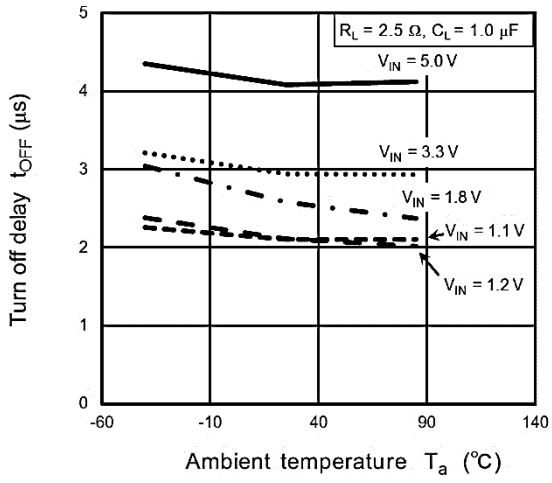
I_Q - V_{IN}



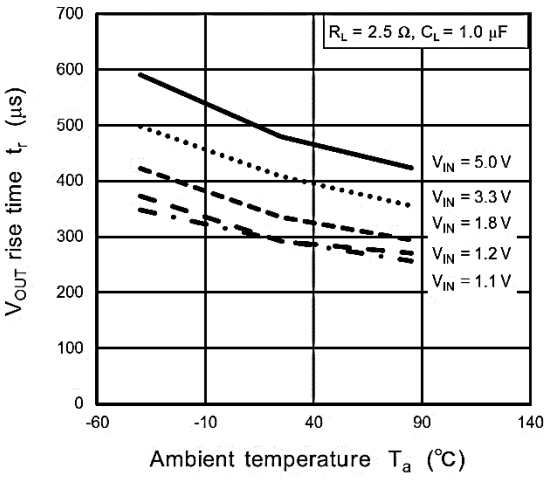
t_{ON} - T_a



t_{OFF} - T_a



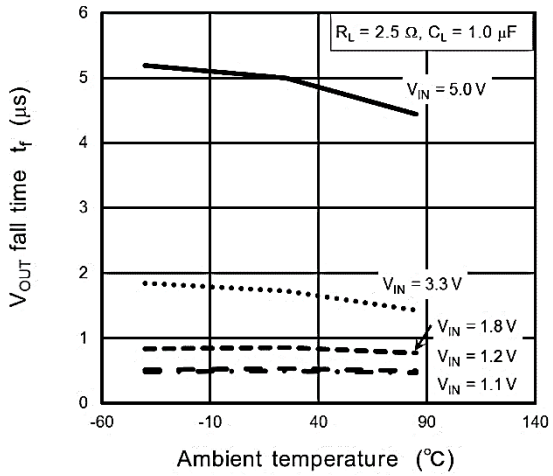
t_r - T_a



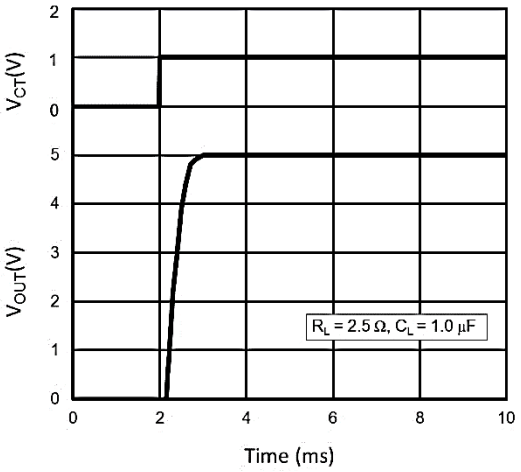
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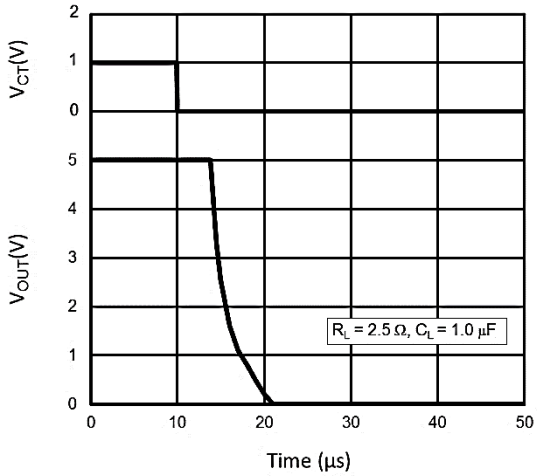
t_f - T_a



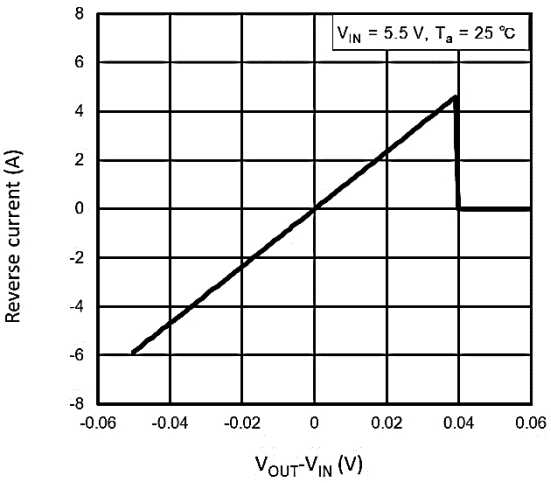
t_{ON} Response



t_{OFF} Response



Reverse blocking voltage threshold



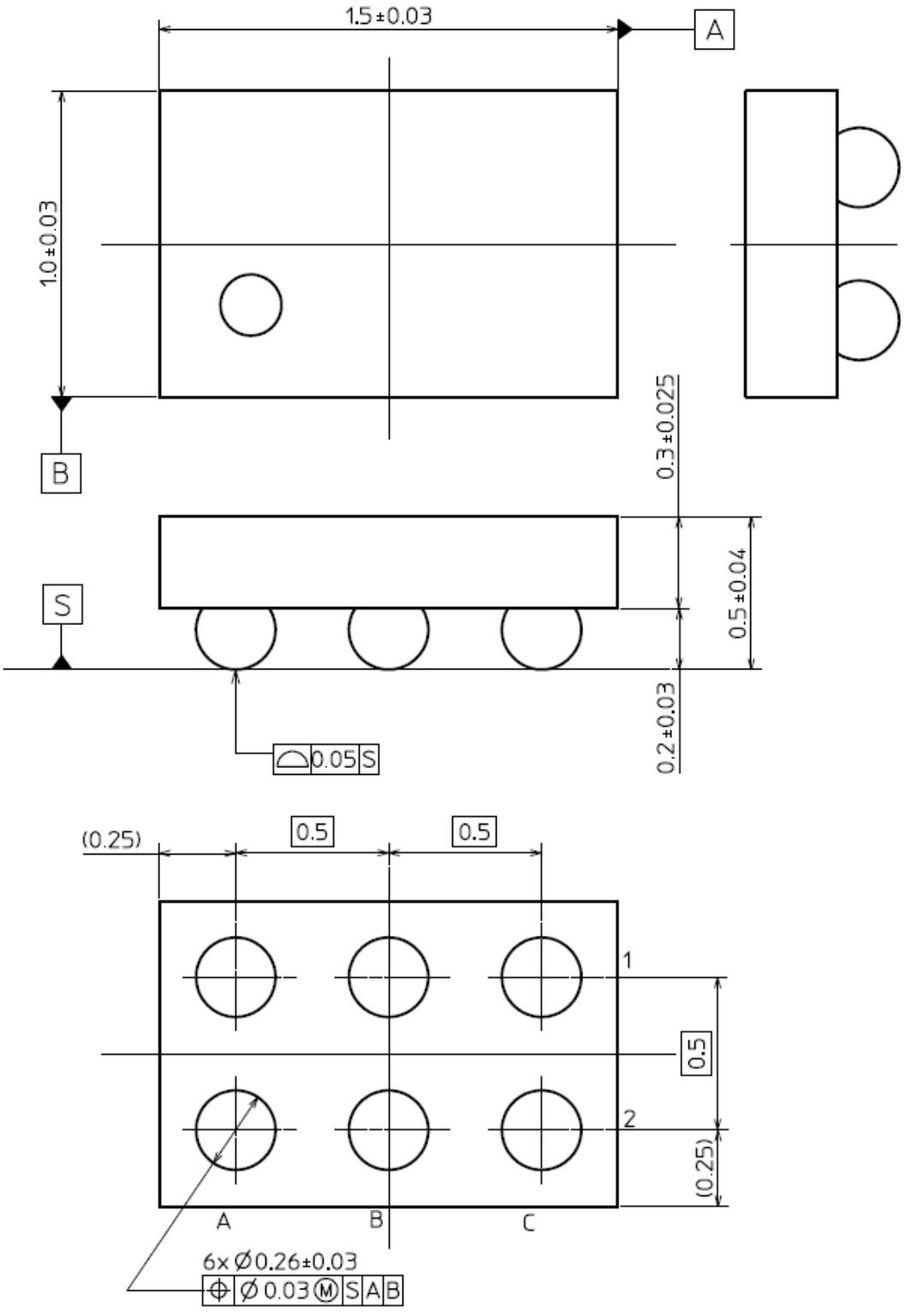
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9. Package Information

WCSP6C

Unit: mm

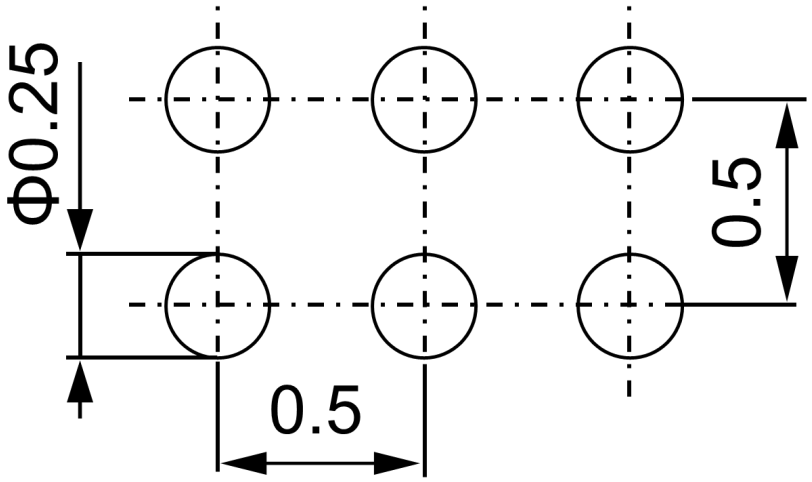


Weight: 1.4 mg (typ.)

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10. Land pattern Dimensions (for reference only)

Unit: mm



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