TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

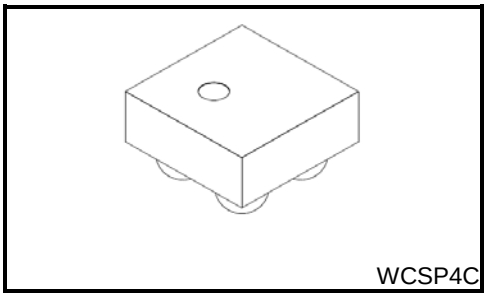
TCK206G, TCK207G, TCK208G

0.75 V, 2A Load Switch IC with Reverse Current Blocking in Ultra Small Package

The TCK206G, TCK207G and TCK208G are 0.75 V ultra low voltage load switch ICs for a power management with slew rate control driver and reverse current blocking(SW OFF state) function.

Switch ON resistance is only 18.4 mΩ (typ.) at 0.75 V, -1.5 A condition and output current is available up to 2.0 A (DC). TCK207G and TCK208G feature output auto-discharge function.

These devices are available in 0.5 mm pitch ultra small package WCSP4C (0.9 mm x 0.9 mm, t: 0.5 mm (typ.)). Thus, these devices are ideal for portable applications that require high-density board assembly such as cellular phone.

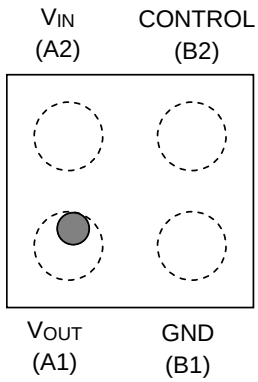


Weight : 0.9 mg (typ.)

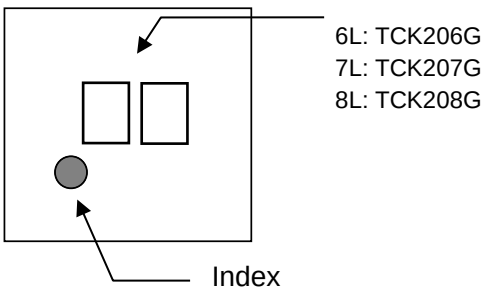
Feature

- Low input voltage operation: V_{IN} = 0.75 to 3.6 V
- High output current: I_{OUT} (DC) = 2.0 A
- Low ON resistance :
  R_{ON} = 18.1 mΩ (typ.) at V_{IN} = 3.3 V, -1.5 A
  R_{ON} = 18.2 mΩ (typ.) at V_{IN} = 1.2 V, -1.5 A
  R_{ON} = 18.4 mΩ (typ.) at V_{IN} = 0.75 V, -1.5 A
- Built in Slew rate control driver
- Built in Reverse current blocking(SW OFF state)
- Built in Auto-discharge (TCK207G and TCK208G)
- Active High and Pull down connection between CONTROL and GND (TCK206G and TCK207G)
- Active Low (TCK208G)
- Ultra small package : WCSP4C (0.9 mm x 0.9 mm, t: 0.5 mm)

Pin Assignment(Top view)



Top marking



Start of commercial production
2014-06

Absolute Maximum Ratings (Ta = 25°C)

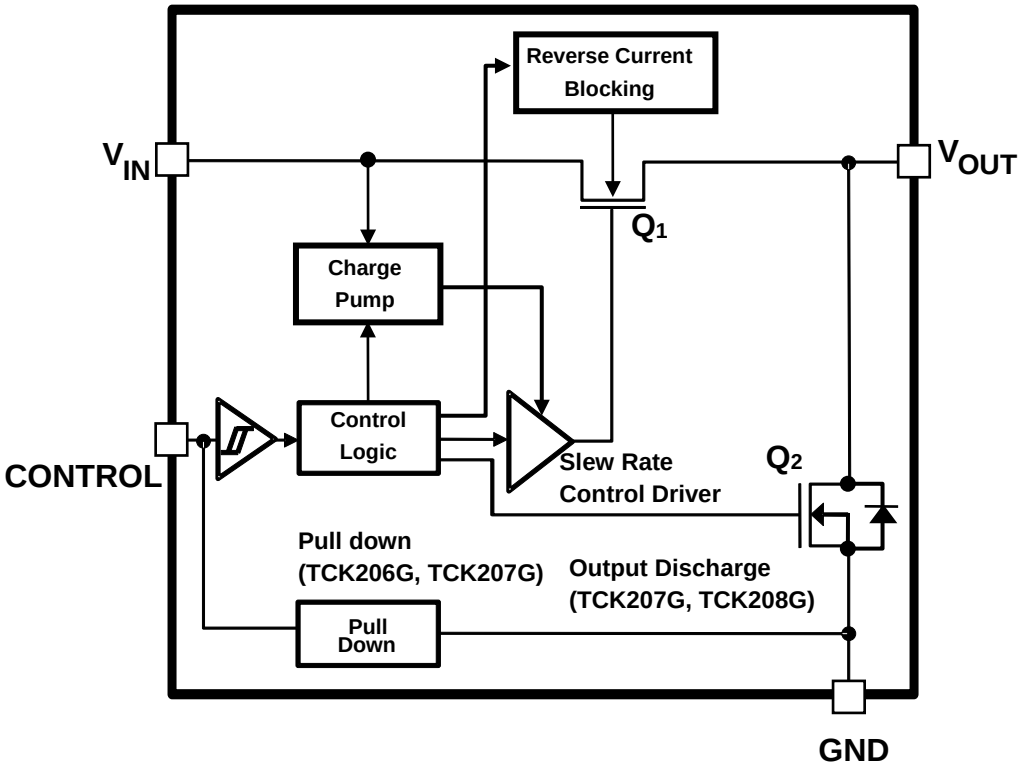
Characteristics	Symbol	Rating		Unit
Input voltage	V_{IN}	-0.3 to 4.0		V
Control voltage	V_{CT}	-0.3 to 4.0		V
Output voltage	V_{OUT}	-0.3 to V_{IN} +0.3		V
Output current	I_{OUT}	DC	2.0	A
		Pulse	3.0 (Note 1)	A
Power dissipation	P_D	800 (Note 2)		mW
Operating temperature range	T_{opr}	−40 to 85		°C
Junction temeperature	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. 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
(Glass epoxy(FR4) board dimension : 40mm x 40mm, both sides of board
Metal pattern ratio : a surface approximately 50%, the reverse side approximately 50%
Through hole : diameter 0.5mm x 28)

Block Diagram



Function table

Part number	Function		
	Reverse current blocking	Output auto-discharge	Control pin connection
TCK206G	Bulit in	N/A	Pull down (Active High)
TCK207G	Bulit in	Bulit in	Pull down (Active High)
TCK208G	Bulit in	Bulit in	OPEN (Active Low)

Operation Logic table

0.75 V ≤ V_{IN} ≤ 3.6V (Ta = -40 to 85°C)

		TCK206G	TCK207G	TCK208G
Control voltage "High"	Output Q_1	ON	ON	OFF
	Discharge Q_2	—	OFF	ON
	Reverse current block	Disable	Disable	Active
Control voltage "Low"	Output Q_1	OFF	OFF	ON
	Discharge Q_2	—	ON	OFF
	Reverse current block	Active	Active	Disable
Control voltage "OPEN"	Output Q_1	OFF	OFF	—
	Discharge Q_2	—	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_{IN}	—		0.75	—	3.6	0.75	3.6	V
CONTROL High-level input voltage	V_{IH}	—	0.9 V ≤V_{IN}	0.9	—	—	0.9	—	V
			V_{IN} < 0.9V	V_{IN}	—	—	V_{IN}	—	V
CONTROL Low-level input voltage	V_{IL}	—	0.9 V ≤V_{IN}	—	—	0.4	—	0.4	V
			V_{IN} < 0.9V	—	—	0.3	—	0.3	V
Quiescent current (ON state)	I_Q	V_{IN} = V_{CT} = 3.6 V, I_{OUT} = 0 mA	TCK206G TCK207G	—	22	—	—	35	μA
		V_{IN} = 3.6 V, V_{CT} = 0 V, I_{OUT} = 0 mA	TCK208G						
Standby current (SW OFF state)	$I_{Q(OFF)}$	V_{IN} = 3.6 V, V_{CT} = 0 V, V_{OUT} = OPEN (Note 3)	TCK206G TCK207G	—	0.7	—	—	5	μA
		V_{IN} = V_{CT} = 3.6 V, V_{OUT} = OPEN (Note 3)	TCK208G						
Reverse blocking current	I_{RB}	V_{OUT} = 3.6 V, V_{IN} = 0 V, V_{CT} = 0 V		—	0.1	—	—	10	μA
On resistance	R_{ON}	V_{IN} = 3.3 V, I_{OUT} = -1.5 A		—	18.1	—	—	28	mΩ
		V_{IN} = 1.8 V, I_{OUT} = -1.5 A		—	18.1	—	—	28	
		V_{IN} = 1.2 V, I_{OUT} = -1.5 A		—	18.2	—	—	28	
		V_{IN} = 1.0 V, I_{OUT} = -1.5 A		—	18.2	—	—	28	
		V_{IN} = 0.75 V, I_{OUT} = -1.5 A		—	18.4	—	—	28	
Discharge on resistance	R_{SD}	— (TCK207G and TCK208G)		—	380	—	—	—	Ω

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

AC Characteristics (Ta = 25°C)

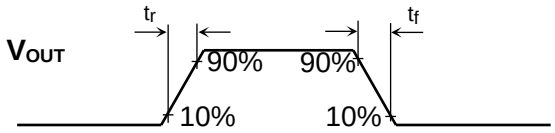
V_{IN} = 0.75 V

Characteristics	Symbol	Test Condition(Figure 1)		Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	R_L=500Ω , C_L=0.1μF		—	180	—	μs
V_{OUT} fall time	t_f	R_L=500Ω , C_L=0.1μF	TCK207G TCK208G	—	50	—	μs
			TCK206G	—	80	—	
Turn on delay	t_{ON}	R_L=500Ω , C_L=0.1μF		—	75	—	μs
Turn off delay	t_{OFF}	R_L=500Ω , C_L=0.1μF	TCK206G TCK207G	—	8	—	μs
			TCK208G	—	14	—	

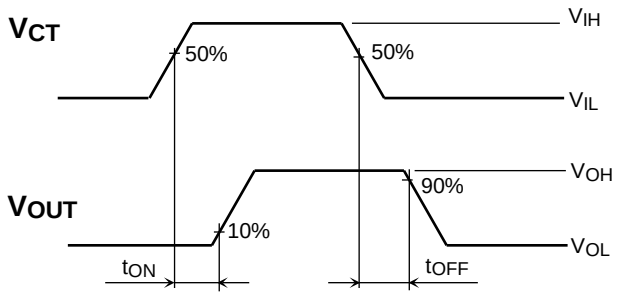
V_{IN} = 1.2 V

Characteristics	Symbol	Test Condition(Figure 1)		Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	R_L=500Ω , C_L=0.1μF		—	240	—	μs
V_{OUT} fall time	t_f	R_L=500Ω , C_L=0.1μF	TCK207G TCK208G	—	50	—	μs
			TCK206G	—	90	—	
Turn on delay	t_{ON}	R_L=500Ω , C_L=0.1μF		—	65	—	μs
Turn off delay	t_{OFF}	R_L=500Ω , C_L=0.1μF	TCK206G TCK207G	—	8	—	μs
			TCK208G	—	13	—	

AC Waveform



TCK206G, TCK207G



TCK208G

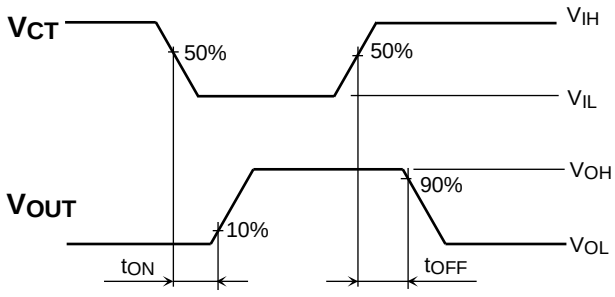
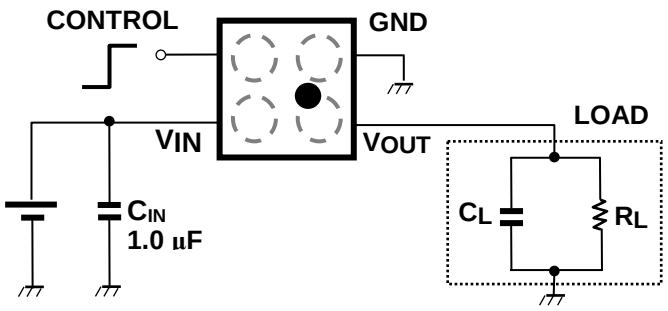


Figure 1 t_r, t_f, t_{ON}, t_{OFF} Waveforms

Application Note

1. Application circuit example (top view)

The figure below shows the example of configuration for TCK206G, TCK207G and TCK208G.



1) Input capacitor

An input capacitor (C_{IN}) is necessary for the stable operation of TCK206G, TCK207G and TCK208G. And it is effective to reduce voltage drop due to sharp changes in output current and also for improved stability of the power supply. When used, place C_{IN} more than 1.0 µF as close to V_{IN} pin to improve stability of the power supply.

2) Output capacitor

An output capacitor (C_{OUT}) is not necessary for the guaranteed operation of TCK206G, TCK207G and TCK208G. However, there is a possibility of overshoot or undershoot caused by output load transient response, board layout and parasitic components of load switch IC. In this case, an output capacitor C_{OUT} more than 0.1µF is recommended.

3) Control pin

Control pins for TCK206G and TCK207G are both Active High and TCK208G is Active Low. These control both the pass-through n-ch MOSFET and the discharge n-ch MOSFET (except TCK206G), operated by the control voltage. Each control pin is equipped with Schmitt trigger. When the control voltage level is High (Low; TCK208G), Output n-ch MOSFET is ON state and discharge n-ch MOSFET is SW OFF state. When control voltage level is Low (High; TCK208G), 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 SW OFF state even when CONTROL pin is OPEN(except TCK208G). 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(SW OFF state) function is designed in these products. This function is active at output n-ch MOSEFT turned off.

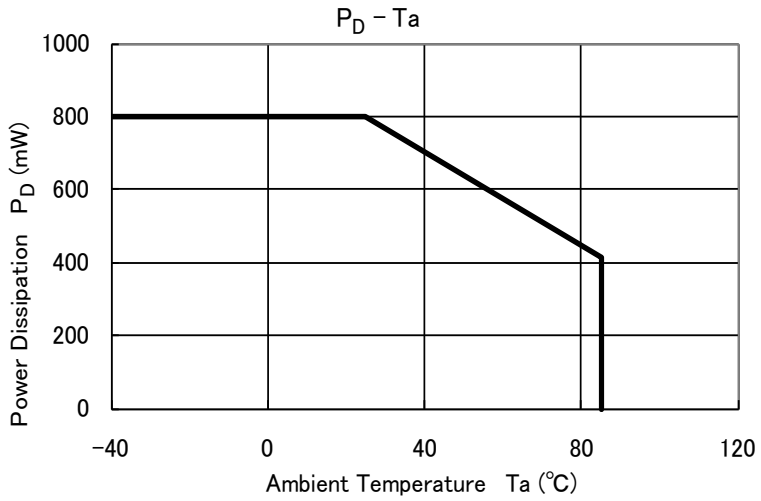
However it does not assure for the suppression of uprising device operation. In use of these products, please read through and understand dissipation idea for absolute maximum ratings from the above mention or our ‘Semiconductor Reliability Handbook’. Then use these products under absolute maximum ratings in any condition. Furthermore, Toshiba recommends inserting failsafe system into the design.

3. Power Dissipation

Board-mounted power dissipation ratings for TCK206G, TCK207G and TCK208G are available in the Absolute Maximum Ratings table

Power dissipation is measured on the board condition shown below.

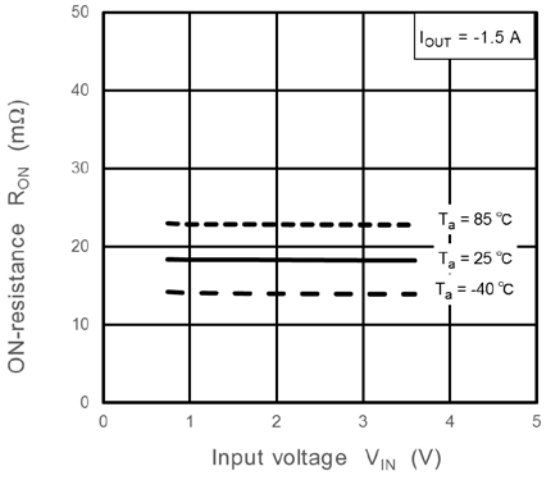
[The Board Condition]
Board material: Glass epoxy (FR4)
Board dimension: 40mm x 40mm (both sides of board), t=1.8mm
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
Through hole: diameter 0.5mm x 28



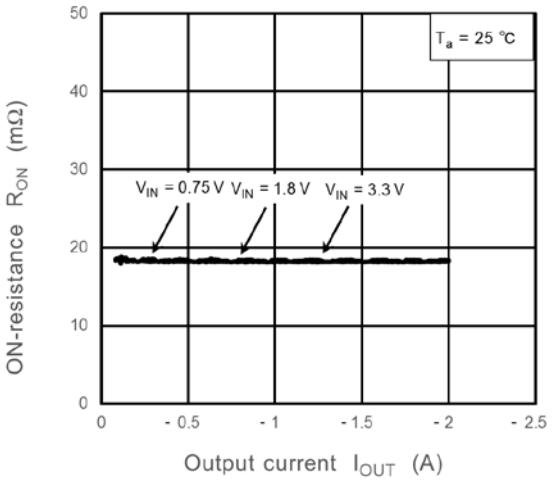
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

Representative Typical Characteristics

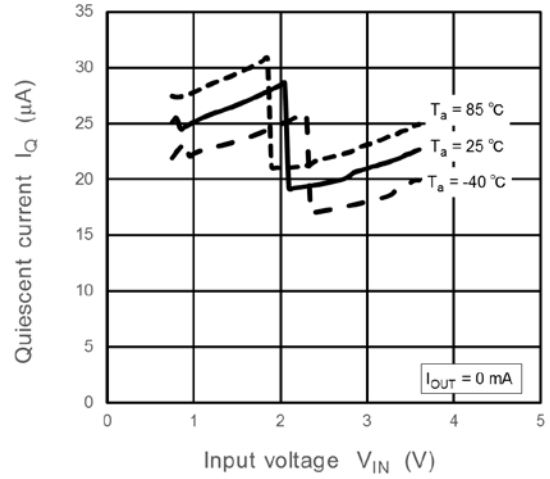
R_{ON} - V_{IN}



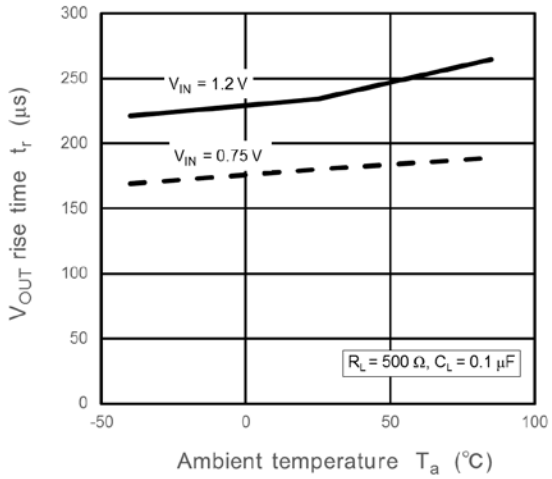
R_{ON} - I_{OUT}



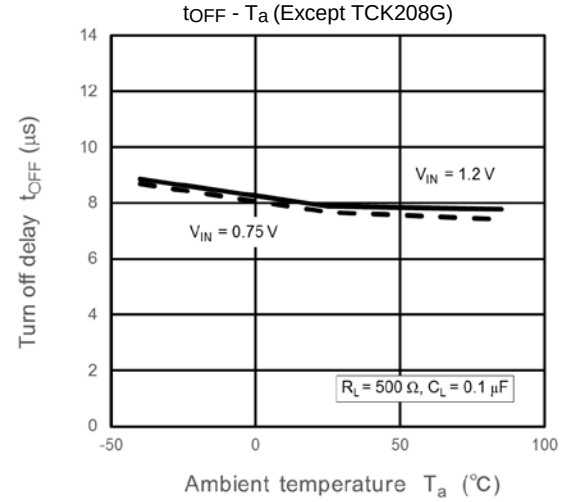
I_Q - V_{IN}



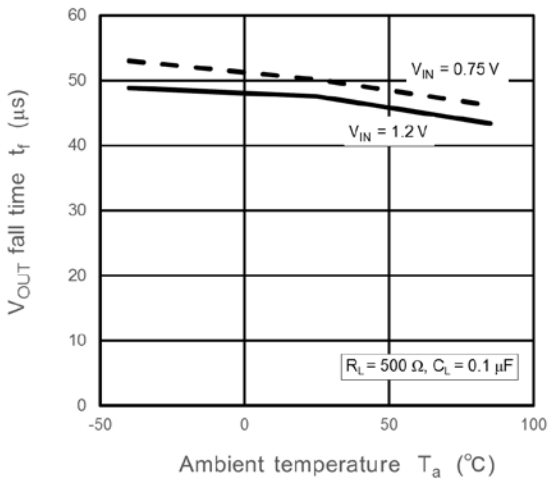
t_r - T_a



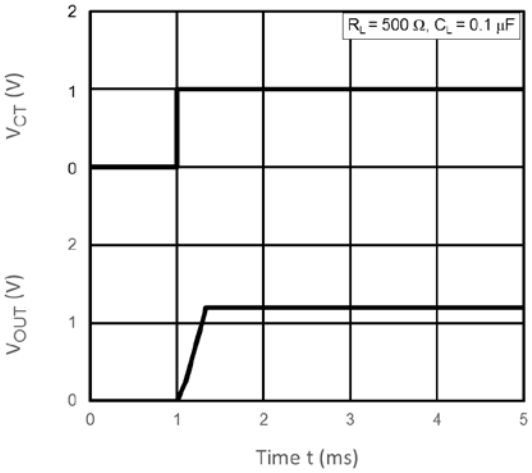
t_{OFF} - T_a (Except TCK208G)



t_f - T_a (Except TCK206G)



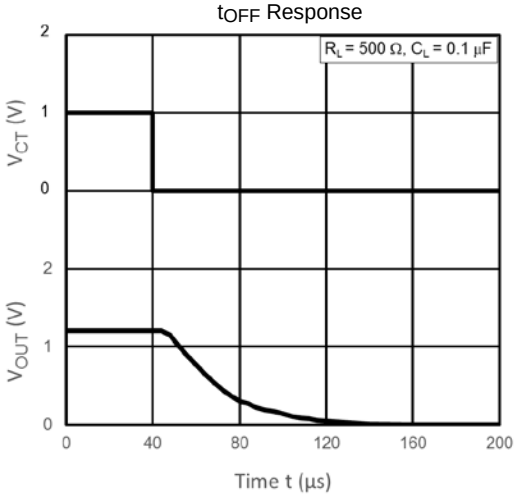
t_{ON} Response (Except TCK208G)



t_{OFF} Response Representative Typical Characteristics

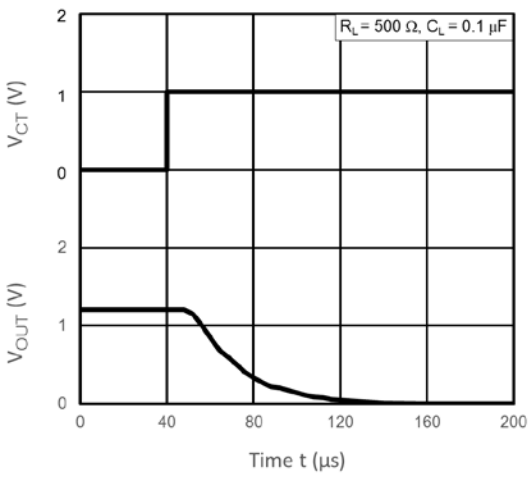
TCK206G, TCK207G Typical characteristics

t_{OFF} Response



TCK208G Typical characteristics

t_{OFF} Response

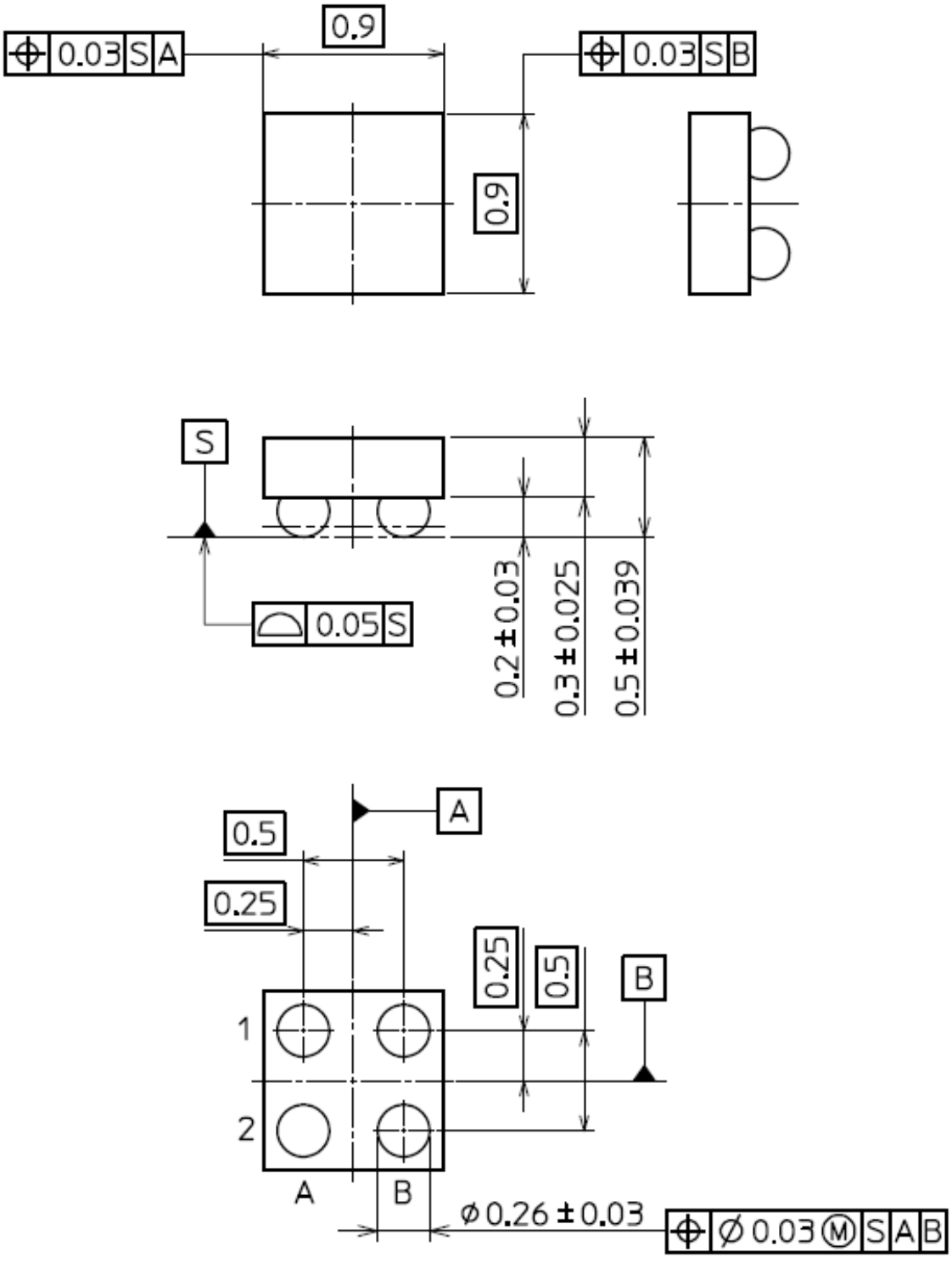


Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Package Information

WCSP4C

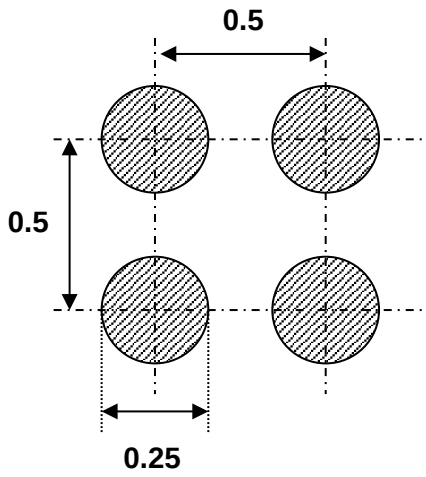
Unit: mm



Weight: 0.9 mg (typ.)

Land pattern dimensions (for reference only)

Unit: mm



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