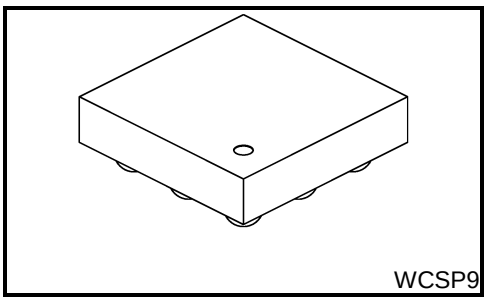
TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCK301G, TCK302G, TCK303G

28 V, Single input – Single Output Load Switch IC with Over Voltage Protection

The TCK30 series are 28 V high input voltage Single Inputs－Single Output load switch ICs. It has Over Voltage Protection function featuring low switch ON resistance, high output current and wide input voltage operation. Switch ON resistance is only 73 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 3 A. Thus this is suitable for power management such as Battery Charge application.

This device is available in 0.5mm pitch ultra small package WCSP9 (1.5 mm x 1.5 mm, t**:** 0.5 mm (Typ**.**)).Thus this devices is ideal for portable applications that require high-density board assembly such as cellular phone.



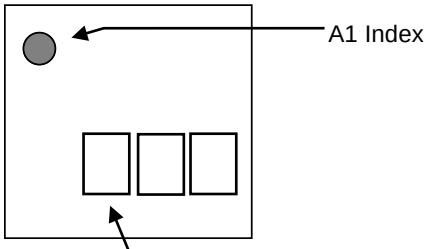
WCSP9

Weight**:** 3.5 mg (Typ.)

Feature

- High input voltage**:** V_{IN} (Max) = 28 V
- High output current**:** I_{OUT} (DC) = 3.0 A
- Low ON resistance **:** R_{ON} = 73 mΩ (Typ.) at V_{IN} = 4.5 V, I_{OUT} = - 1.0 A
- Over Voltage Lockout **:** 6.6 V, 10.5 V, and 15.5 V (Typ.)
- Under Voltage Lockout**:** 2.9 V (Typ.)
- FLAG indicates
- Internal 15 ms startup hold
- Reverse current blocking (SW OFF state)
- Inrush current reducing circuit
- Thermal Shutdown function
- Small package**:** 0.5 mm pitch WCSP9 (1.5 mm x 1.5 mm, t**:** 0.5 mm (Typ.)) , P_D = 1.65 W

Top marking



301**:** TCK301G
302**:** TCK302G
303**:** TCK303G

Start of commercial production
2015-05

Absolute Maximum Ratings (Ta = 25°C)

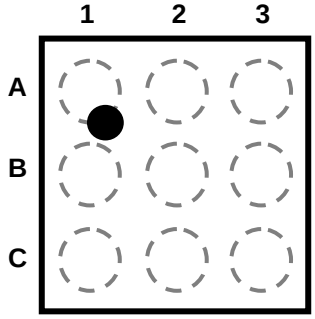
Characteristics	Symbol	Rating			Unit
Input voltage	V_{IN}	-0.3 to 30			V
Control voltage	V_{CT}, V_{CE}	-0.3 to 6			V
Output voltage	V_{OUT}	-0.3 to 18			V
Flag voltage	V_{FLAG}	-0.3 to 6			V
Output current	I_{OUT}	DC	3.0		A
		Pulse	4.0	(Note 1)	
Power dissipation	P_D	1.65		(Note 2)	W
Operating temperature 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. 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)



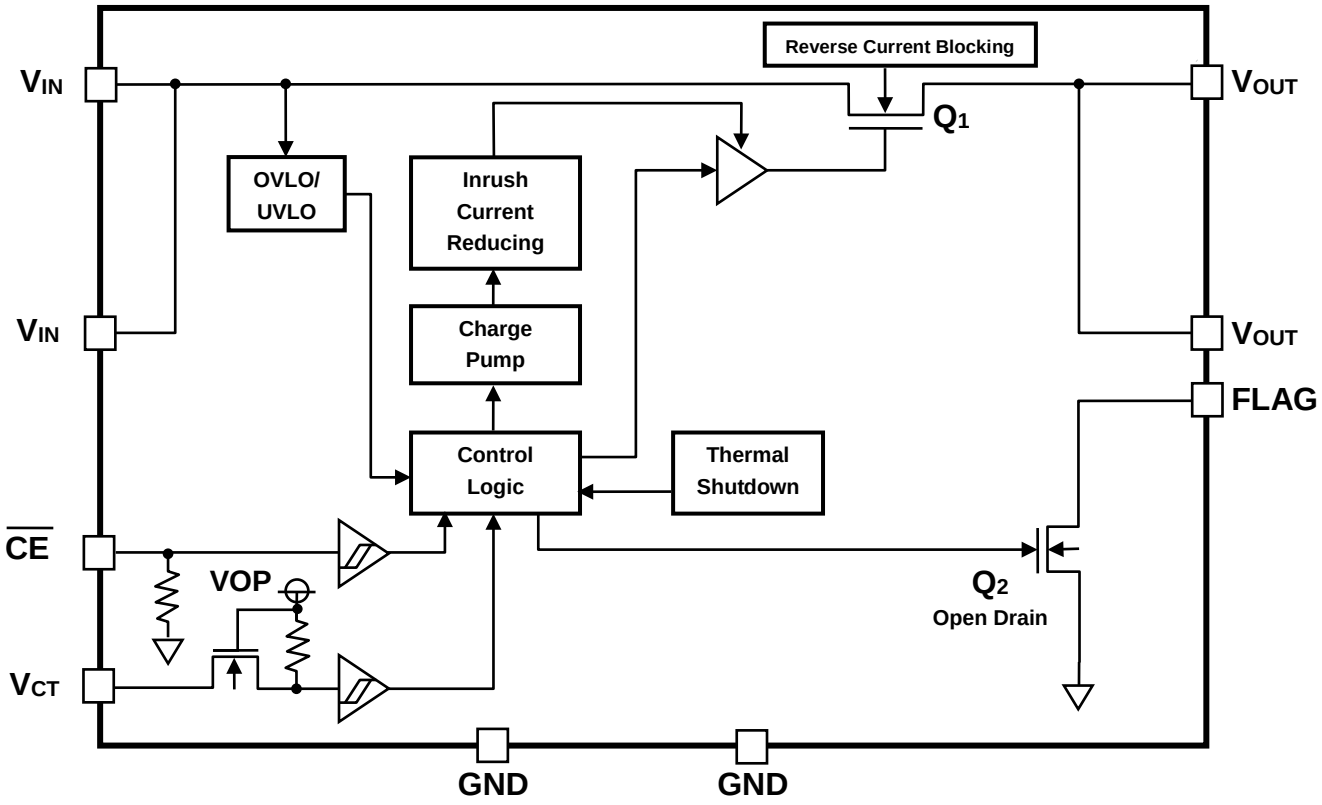
	1	2	3
A	FLAG	V_{CT}	$\overline{CE}$
B	V_{IN}	GND	V_{OUT}
C	V_{IN}	GND	V_{OUT}

Product list

Part number	Over voltage lockout	$\overline{CE}$ function	VCT function	VCT resistance
TCK301G	6.6 V (Typ.)	Active Low	Active High	Pull up
TCK302G	10.5 V (Typ.)	Active Low	Active High	Pull up
TCK303G	15.5 V (Typ.)	Active Low	Active High	Pull up

Please ask your local retailer about the devices with other OVLO, logic function and pull up resistance.

Block Diagram



PIN Description

PIN	Name	Description
A1	FLAG	Open drain acknowledge signal output. When input voltage is in regular range (V_{UVL} < V_{IN} < V_{OVL}), Q_2 turn ON. FLAG output turn to be high impedance in irregular input voltage range, $\overline{CE}$ High state and thermal shutdown operation.
A2	V_{CT}	Switch Control function. It is internally connected to VOP (Pull up).
A3	$\overline{CE}$	Chip Enable function. It is internally connected to GND(Pull down).
B1, C1	V_{IN}	Input. It has Over Voltage Lock Out (OVLO) and Under Voltage Lock Out function (UVLO).
B2, C2	GND	Ground
B3, C3	V_{OUT}	Output

Operation Logic Table

TCK301G, TCK302G, TCK303G

		$\overline{CE}$ "Low"	$\overline{CE}$ " High"
V_{CT} "HIGH	Q_1 (Main Switch)	ON	OFF
	Q_2 (FLAG out)	ON (When V_{UVL} < V_{IN} < V_{OVL}), OFF (When V_{UVL} > V_{IN}, or V_{IN} > V_{OVL}), OFF (Thermal shut down = active)	OFF
	Reverse current block	Disable	Active
V_{CT} "LOW"	Q_1 (Main Switch)	OFF	OFF
	Q_2 (FLAG out)	ON (When V_{UVL} < V_{IN} < V_{OVL}), OFF (When V_{UVL} > V_{IN}, or V_{IN} > V_{OVL}), OFF (Thermal shut down = active)	OFF
	Reverse current block	Active	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_{IN}	—	2.3	—	28	2.3	28	V
$\overline{CE}$,V_{CT} High-level input voltage	V_{IH}	V_{IN} = 2.3 to 28 V	1.6	—	—	1.6	—	V
$\overline{CE}$,V_{CT} Low-level input voltage	V_{IL}	V_{IN} = 2.3 to 28 V	—	—	0.3	—	0.3	V
Over voltage lock out (OVLO) rising threshold	V_{OVL_RI}	TCK301G	—	6.6	—	5.9	7.3	V
		TCK302G	—	10.5	—	9.1	11.9	
		TCK303G	—	15.5	—	13.9	17.1	
Over voltage lock out (OVLO) falling threshold	V_{OVL_FA}	TCK301G	—	V_{OVL_RI} - 0.35	—	—	—	V
		TCK302G, TCK303G	—	V_{OVL_RI} - 0.5	—	—	—	
Under voltage lock out (UVLO) rising threshold	V_{UVL_RI}	—	—	2.9	—	2.3	3.5	V
Under voltage lock out (UVLO) falling threshold	V_{UVL_FA}	—	—	V_{UVL_RI} - 0.3	—	—	—	V
Quiescent current (ON state)	$I_{Q(ON)}$	$\overline{CE}$ = Open, V_{CT} = Open I_{OUT} = 0 mA, V_{IN} = 5.0 V	—	130	—	—	190	μA
Quiescent current (OFF state)	$I_{Q(OFF1)}$	$\overline{CE}$ = 0 V, V_{CT} = 0 V, V_{IN} = 5.0 V, V_{OUT} = 0 V	—	75	—	—	115	μA
Input Shutdown Current	$I_{Q(OFF2)}$	$\overline{CE}$ = 3.0 V, V_{CT} = Open, V_{IN} = 5.0 V, V_{OUT} = 0 V	—	1.3	—	—	10	μA
Switch OFF state current	I_{OFF}	$\overline{CE}$ = 3.0 V, V_{CT} = Open, V_{IN} = Open, V_{OUT} = 5 V	—	0.1	—	—	1	μA
Reverse blocking current	I_{RB}	V_{OUT} = 5.0 V, V_{IN} = 0 V, V_{CT} = 0 V	—	0.1	—	—	10	μA
On resistance	R_{ON}	I_{OUT} = -1.0 A, V_{IN} = 4.5 V	—	73	—	—	140	mΩ
FLAG Leak current	I_{LEAK}	V_{IO} = 5.0 V	—	—	2	—	2	μA
FLAG Output low voltage	V_{OL}	I_{SINK} = 1 mA, V_{IO} = 5.0 V	—	—	0.4	—	0.4	V
$\overline{CE}$ built-in resistance	R_{CE}	—	—	530	—	—	—	kΩ
V_{CT} built-in resistance	R_{VCT}	—	—	530	—	—	—	

AC Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition (Figure 1, 2)	Min	Typ.	Max	Unit
Hold time	t_{HD}	V_{UVL} < V_{IN}(5V) < V_{OVL}, R_L = 50 Ω Initial start up V_{OUT} off state to charge-pump on state	—	15	—	ms
V_{OUT} OVP off time	t_{OVP}	V_{IN} >V_{OVLO_RI} , V_{IN} rising = 2V/μs, R_L = 50 Ω, V_{OUT} to 80% of V_{OVLO_RI}	—	3	—	μs
V_{OUT} off time	t_{OFF}	V_{UVL} < V_{IN} (5V) < V_{OVL}, R_L = 50 Ω, V_{OUT} to 80% of V_{IN}	—	2	—	μs
V_{OUT} rise time	t_r	V_{IN}= 5.0V , R_L = 50 Ω , C_L=1.0 uF	—	2	—	ms
V_{OUT} fall time	t_f	V_{IN}= 5.0V , R_L = 50 Ω , C_L=1.0 uF	—	0.12	—	ms
V_{CT} delay time (Enable to Disable)	t_{CT1}	V_{IN}= 5.0V , R_L = 50 Ω	—	0.5	—	μs
V_{CT} delay time (Disable to Enable)	t_{CT2}	V_{IN}= 5.0V , R_L = 50 Ω	—	3.2	—	ms

Timing chart

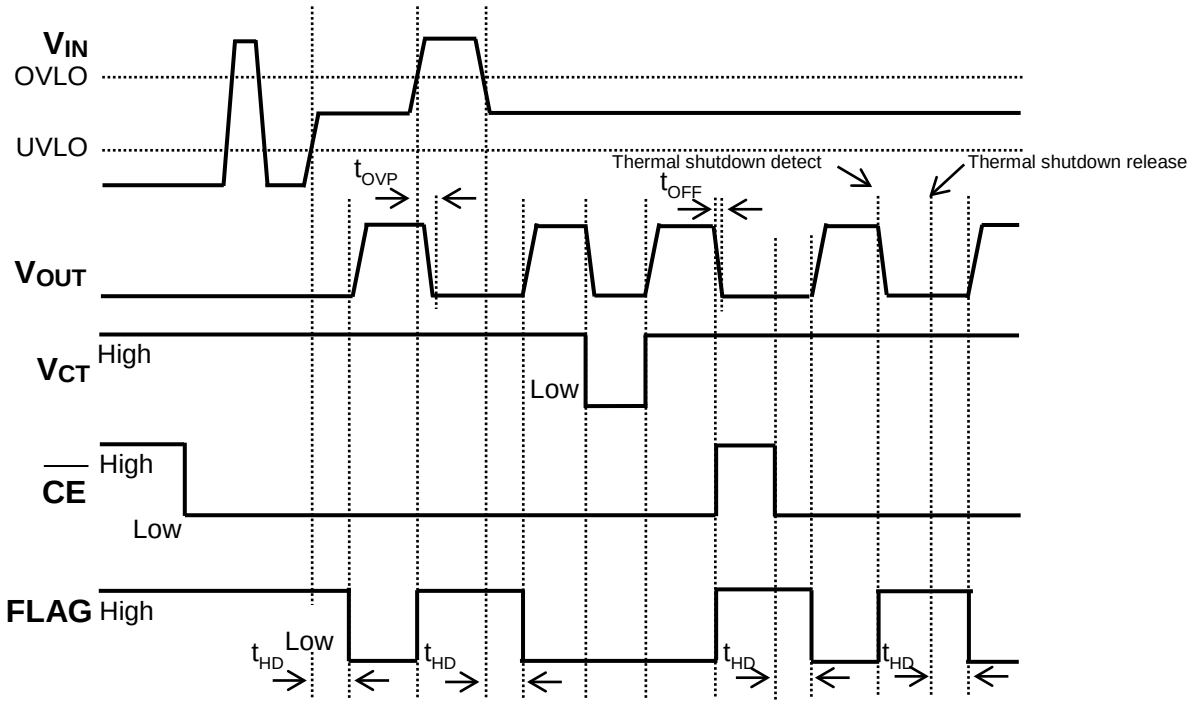


Fig.1 t_{HD}, t_{OVP}, t_{OFF}

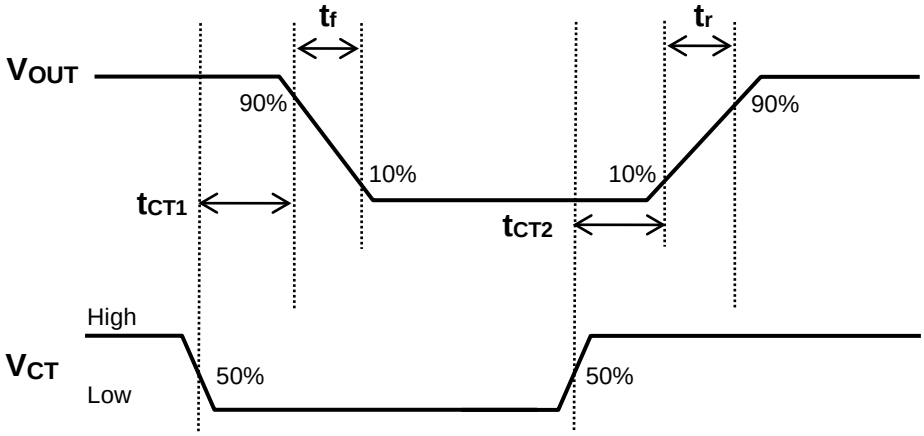
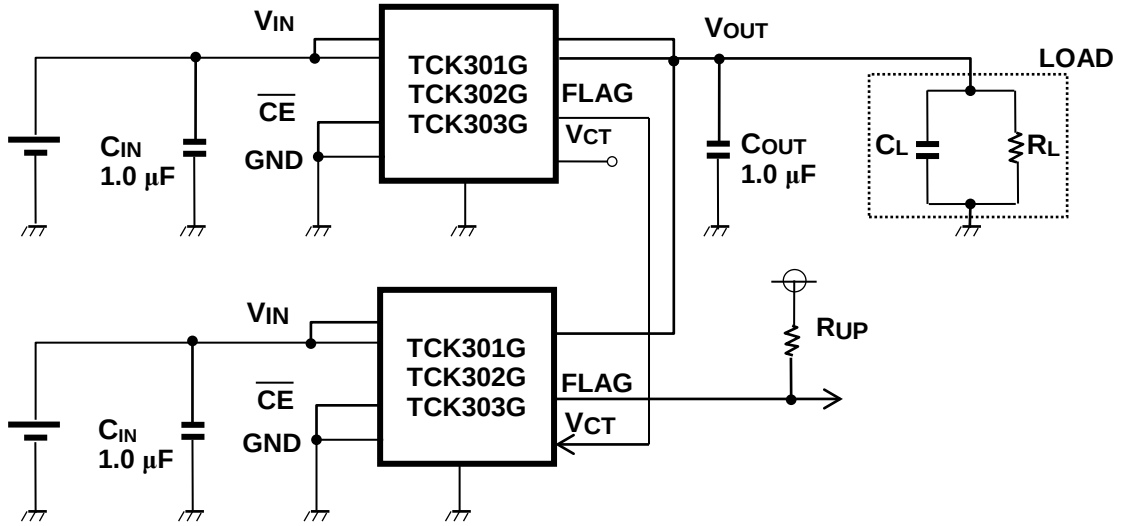


Fig.2 t_r, t_f, t_{CT}

Application Note

1. Application circuit example (top view)



1) Input and Output capacitor

An input capacitor (C_{IN}) and an output capacitor (C_{OUT}) are necessary for the stable operation of TCK301G, TCK302G and TCK303G. 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_{IN} and C_{OUT} more than 1.0μF as close to V_{IN} pin to improve stability of the power supply.

2) Control pin

Control pins for TCK301G, TCK302G and TCK303G is operated by the control voltage and Schmitt trigger. V_{CT} 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.

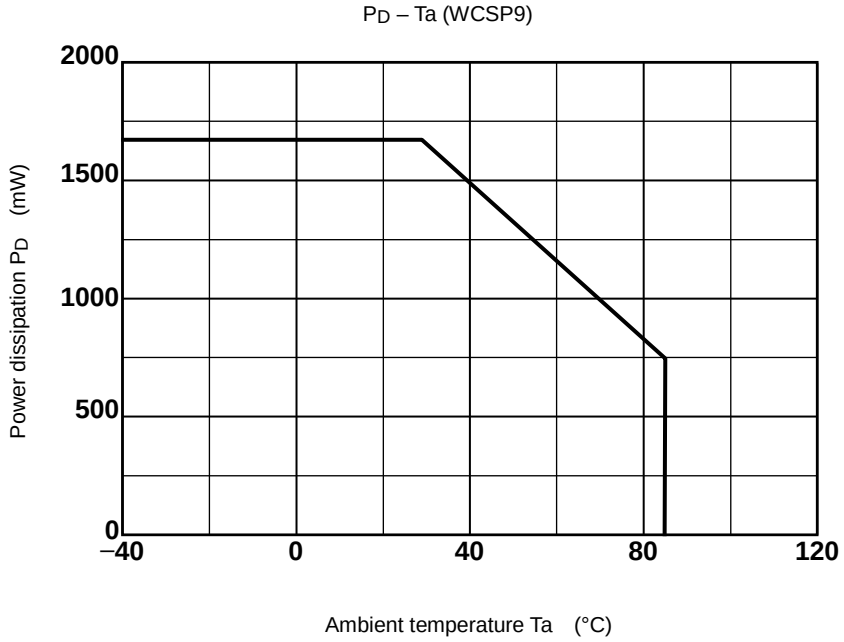
3. Thermal shut down function

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 TCK301G, TCK302G and TCK303G are available in the Absolute Maximum Ratings table.
Power dissipation is measured on the board condition shown below.

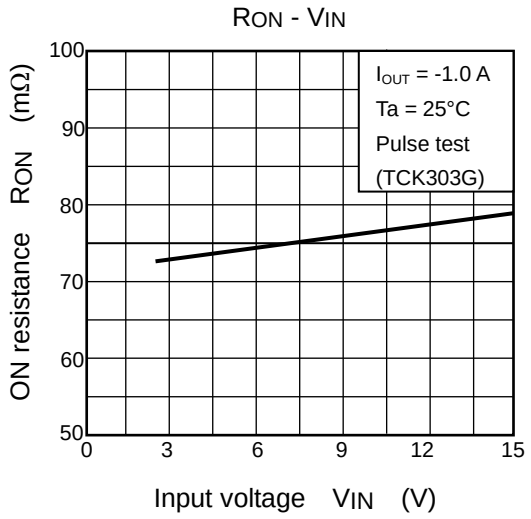
[The Board Condition]
Board material**:** Glass epoxy (FR4)
Board dimension**:** 40 mm x 40 mm (Cu 4 layer)

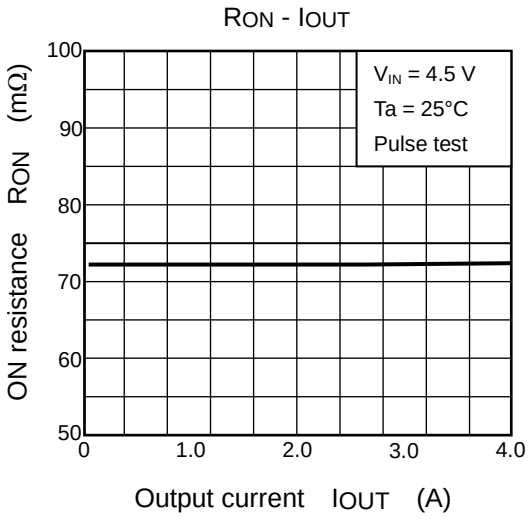


Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

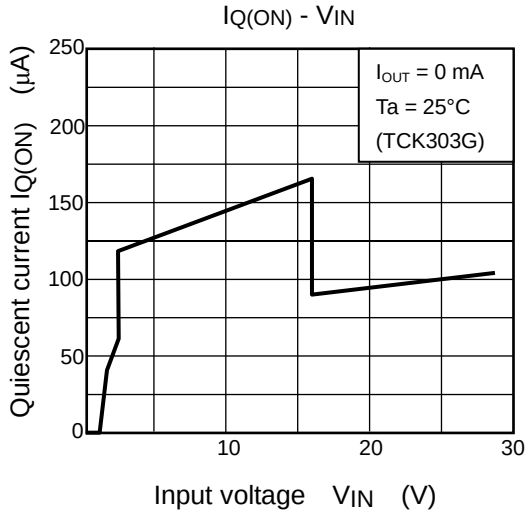
Representative Typical Characteristics

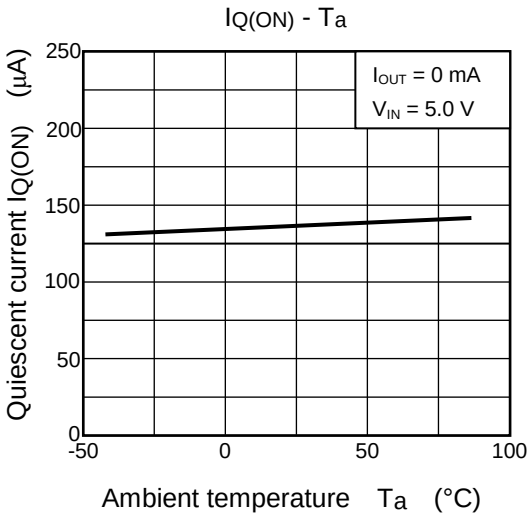
1) ON resistance

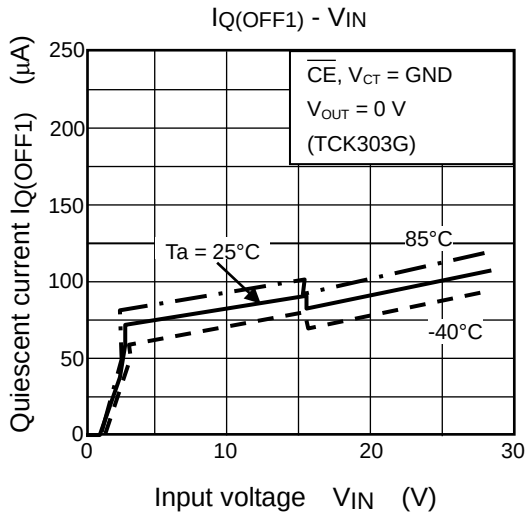


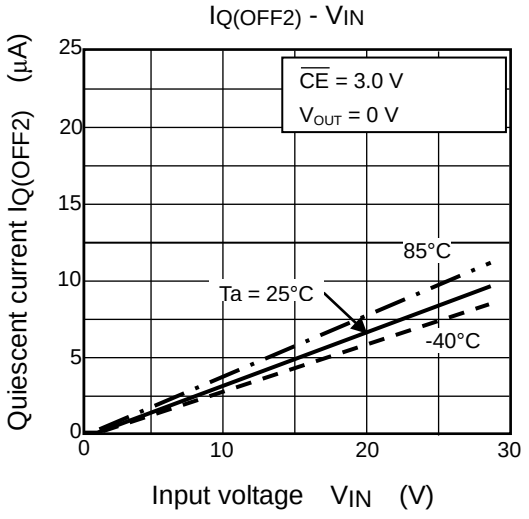


2) Quiescent current



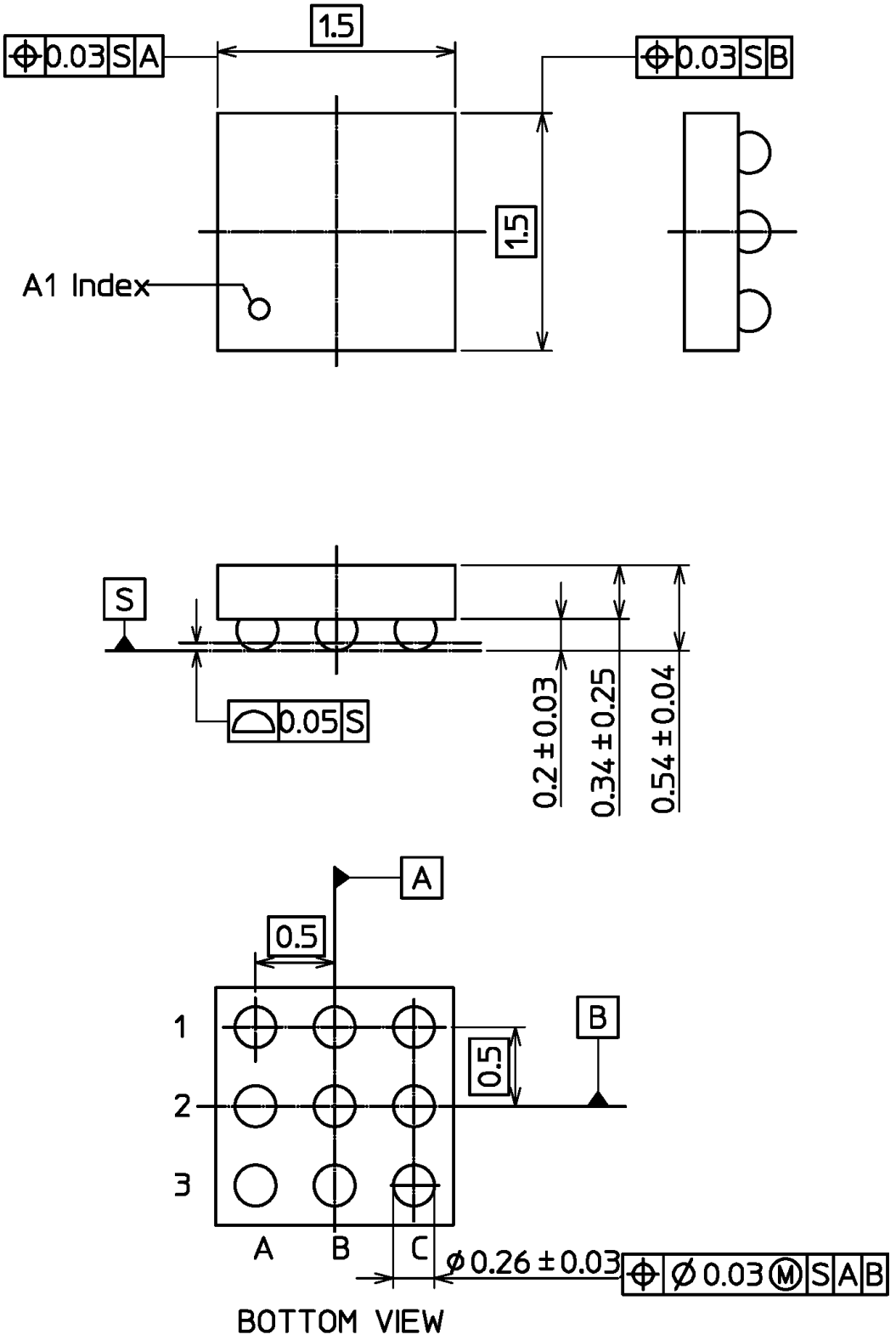






Package Dimensions

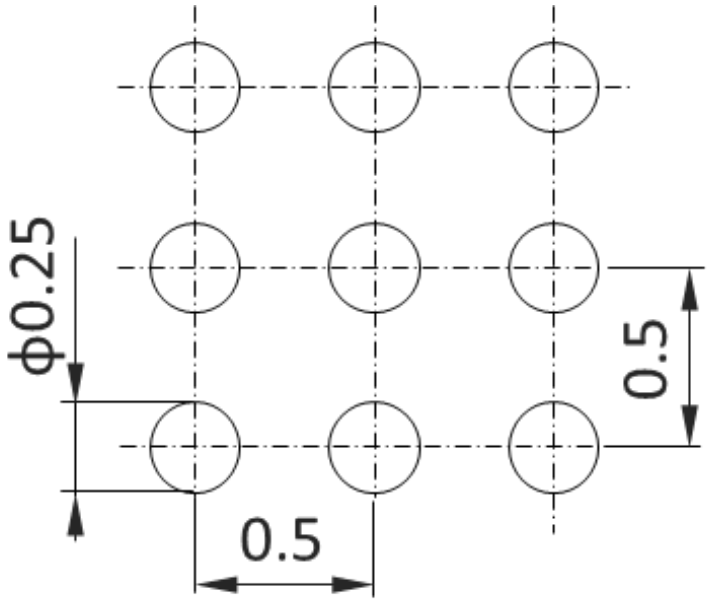
WCSP9 Unit: mm



Weight: 3.5 mg (Typ.)

Land pattern dimensions (for reference only)

Unit：mm



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