TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCK127BG

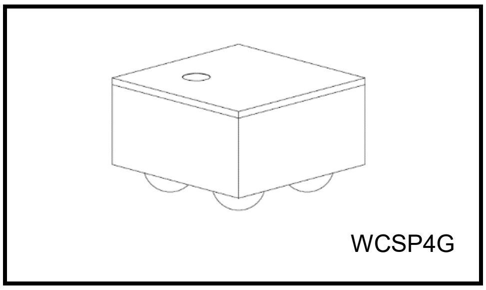
0.08 nA Ultra small IQ 1.0 A Load Switch IC in Ultra Small Package

TCK127BG is load switch IC for a general power management with slew rate control driver, featuring super low quiescent current, low switch ON resistance and wide input operation voltage range from 1.0 to 5.5 V.

Quiescent current is only 0.08 nA and output current is available up to 1.0 A. TCK127BG also feature output auto-discharge function.

This device is available in 0.35 mm pitch ultra small package WCSP4G (0.645 mm x 0.645 mm, t: 0.465 mm max.) with back side coating that protect from external damage.

Thus this device is ideal for portable applications that require high-density board assembly and ultra low power consumption such as wearables, smartphones, and IoT modules.

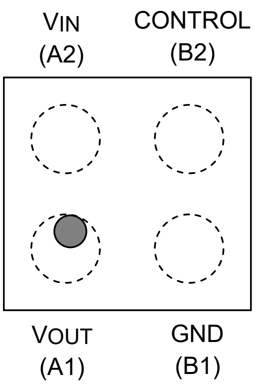


Weight: 0.38 mg (typ.)

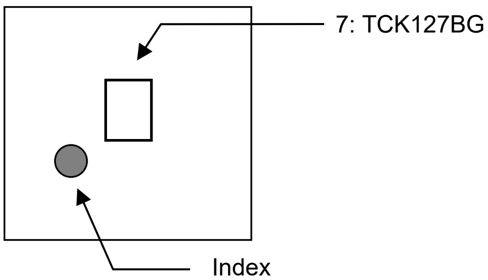
Feature

- Wide input operation voltage range : V_{IN} = 1.0 to 5.5 V
- High output current : I_{OUT} = 1.0 A
- Ultra small quiescent current : I_Q = 0.08 nA at V_{IN} = V_{CT} = 5.5 V, I_{OUT} = 0 mA
- Low ON resistance
  R_{ON} = 58 mΩ (typ.) at V_{IN} = 3.3 V, I_{OUT} = -0.5 A
  R_{ON} = 106 mΩ (typ.) at V_{IN} = 1.8 V, I_{OUT} = -0.5 A
- Built in Slew rate control driver
- Built in Auto-discharge
- Active High
- Ultra small package : WCSP4G with back side coating (0.645 mm x 0.645 mm, t: 0.465 mm max.)

Pin Assignment(Top view)



Top marking



Start of commercial production
2021-11

Absolute Maximum Ratings (Ta = 25°C)

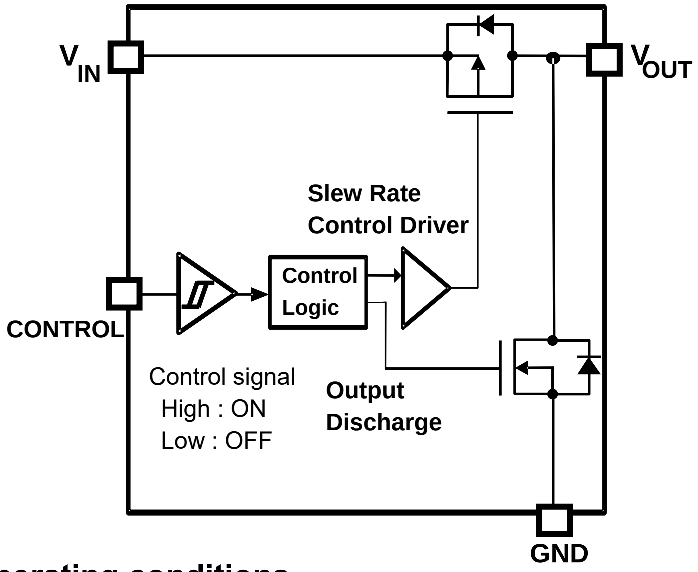
Characteristics	Symbol	Rating		Unit
Input voltage	V_{IN}	-0.3 to 6.0		V
Control voltage	V_{CT}	-0.3 to 6.0		V
Output voltage	V_{OUT}	-0.3 to V_{IN} +0.3		V
Output current	I_{OUT}	DC	1.0	A
		Pulse	2.0 (Note 1)	A
Power dissipation	P_D	1.0 (Note 2)		W
Junction temeperature	Tj	150		°C
Storage temperature	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 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: 300 μs pulse, 2% duty cycle

Note2: Rating at mounting on a board
Glass epoxy board dimension : 40 mm x 40 mm , 4 layer
Metal pattern ratio : approximately 70% each layer

Block Diagram



Operating conditions

Characteristics	Symbol	Condition	Min	Max	Unit
Input voltage	V_{IN}	—	1.0	5.5	V
Output current	I_{OUT}	—	—	1.0	A
CONTROL High-level input voltage	V_{IH}	1.0 V ≤ V_{IN} ≤ 5.5 V	0.9	—	V
CONTROL Low-level input voltage	V_{IL}		—	0.4	V
Operating Ambient temperature range	T_{a_opr}	—	-40	85	°C

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C (Note 2)			Unit
			Min	Typ.	Max	Min	Typ.	Max	
Quiescent current (ON state)	I_Q	$V_{IN} = V_{CT} = 5.5$ V, $I_{OUT} = 0$ mA	—	0.08	8	—	4.1 (Note 3)	100	nA
Standby current (OFF state)	$I_{Q(OFF)} + I_{SD(OFF)}$	$V_{IN} = 1.0$ V, $V_{CT} = 0$ V, V_{OUT} = OPEN	—	0.6	—	—	—	—	nA
		$V_{IN} = 4.5$ V, $V_{CT} = 0$ V, V_{OUT} = OPEN	—	3	—	—	86 (Note 3)	—	nA
		$V_{IN} = 5.5$ V, $V_{CT} = 0$ V, V_{OUT} = OPEN	—	13	45	—	148 (Note 3)	550	nA
On resistance	R_{ON}	$V_{IN} = 5.0$ V, $I_{OUT} = -0.5$ A	—	46	—	—	—	68	mΩ
		$V_{IN} = 3.3$ V, $I_{OUT} = -0.5$ A	—	58	—	—	—	87	
		$V_{IN} = 1.8$ V, $I_{OUT} = -0.5$ A	—	106	—	—	—	169	
		$V_{IN} = 1.2$ V, $I_{OUT} = -0.2$ A	—	210	—	—	—	450	
		$V_{IN} = 1.0$ V, $I_{OUT} = -0.05$ A	—	343	—	—	—	—	
Discharge on resistance	R_{SD}	$V_{IN} = 3.3$ V, $I_{OUT} = 0.01$ A	—	109	—	—	—	—	Ω

Note 2 : This parameter is warranted by design.
Note 3 : Ta = 85°C

AC Characteristics (Ta = 25°C)

V_{IN} = 1.2 V

Characteristics	Symbol	Test Condition (Figure 1)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	R_L = 500 Ω, C_L = 0.1 μF	—	197	—	μs
V_{OUT} fall time	t_f	R_L = 500 Ω, C_L = 0.1 μF	—	24	—	μs
Turn on delay	t_{ON}	R_L = 500 Ω, C_L = 0.1 μF	—	335	—	μs
Turn off delay	t_{OFF}	R_L = 500 Ω, C_L = 0.1 μF	—	6	—	μs

V_{IN} = 3.3 V

Characteristics	Symbol	Test Condition (Figure 1)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	R_L = 500 Ω, C_L = 0.1 μF	—	363	—	μs
V_{OUT} fall time	t_f	R_L = 500 Ω, C_L = 0.1 μF	—	32	—	μs
Turn on delay	t_{ON}	R_L = 500 Ω, C_L = 0.1 μF	—	324	—	μs
Turn off delay	t_{OFF}	R_L = 500 Ω, C_L = 0.1 μF	—	10	—	μs

AC Waveform

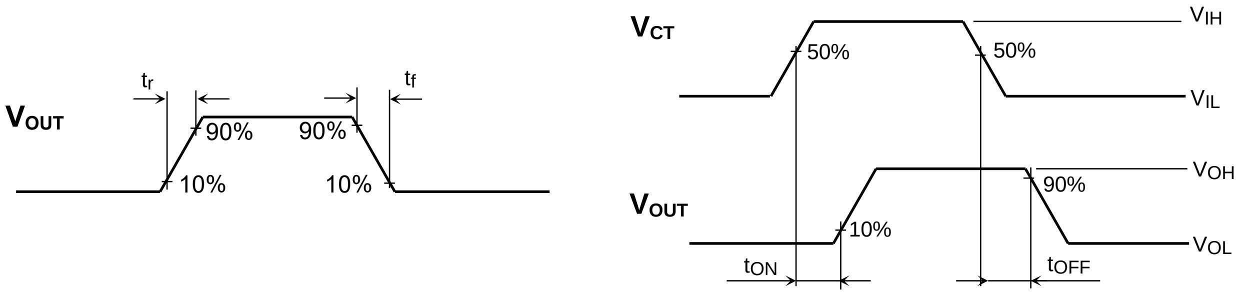
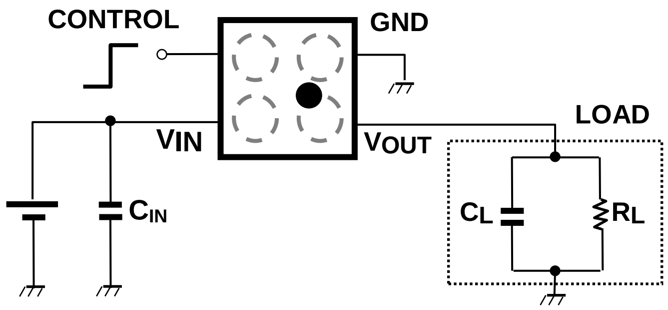


Figure 1 t_r, t_f, t_{ON}, t_{OFF} Waveforms

Application Note

1. Application circuit example (top view)

The figure below shows the example of configuration for TCK127BG.



Part number	Control voltage	IC Operation
TCK127BG	HIGH	ON
	LOW	OFF

1) Input capacitor
An input capacitor (C_{IN}) is not necessary for the guaranteed operation of TCK127BG. However, it is recommended to use input capacitors 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} as close to V_{IN} pin to improve stability of the power supply. Also, due to the C_{IN} selected, $V_{IN} < V_{OUT}$ may occur, causing a reverse current to flow through the body diode of the pass-through p-ch MOSFET of the load switch IC. In this case, a higher value for C_{IN} as compared to C_L is recommended.

2) Output capacitor
An output capacitor (C_{OUT}) is not necessary for the guaranteed operation of TCK127BG. 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 with C_{OUT} more than 0.1μF is recommended.

3) Control pin
A control pin for TCK127BG is Active High. This pin controls the pass-through p-ch MOSFET and the discharge n-ch MOSFET, operated by the control voltage (V_{CT}). The control pin is equipped with Schmitt trigger. When the control voltage level is High, p-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. 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.

4) Control voltage for Low Quiescent current
If there is a difference between the control voltage and the input voltage, the current consumption may increase due to the circuit configuration. Therefore, it is recommended to use same voltage with VIN or 0 V as the control voltage for use with ultra-low current consumption.

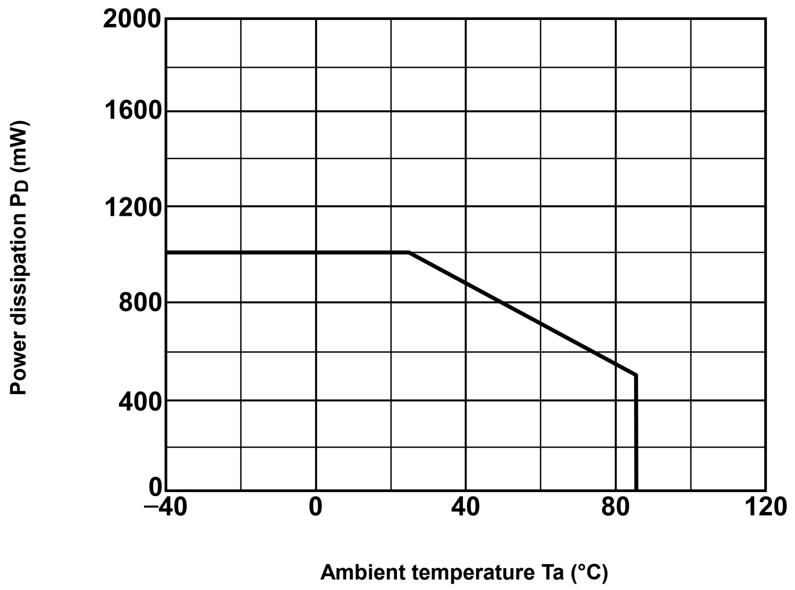
5) Low input voltage and output voltage attenuation
When TCK127BG is used at a low V_{IN} voltage, the R_{ON} becomes high, so there is output voltage attenuation when a large current flows. Therefore, carefully check the required output current and output voltage before use.

6) Assembly
If you use potting materials that contain halogen groups such as sulfur and chlorine, characteristic defects may occur due to corrosion or conductive ions. Therefore, do not use potting materials that contain halogen groups such as sulfur or chlorine. Also, regarding the use of potting materials, be sure to thoroughly check the electrical characteristics and reliability tests of the customer before use. This product has a back side coating (BSC), but it does not provide complete protection from mechanical impacts. When picking up or testing the product, be very careful not to damage it.

2. Power Dissipation

Board-mounted power dissipation ratings are available in the Absolute Maximum Ratings table.
Power dissipation is measured on the board condition shown below.

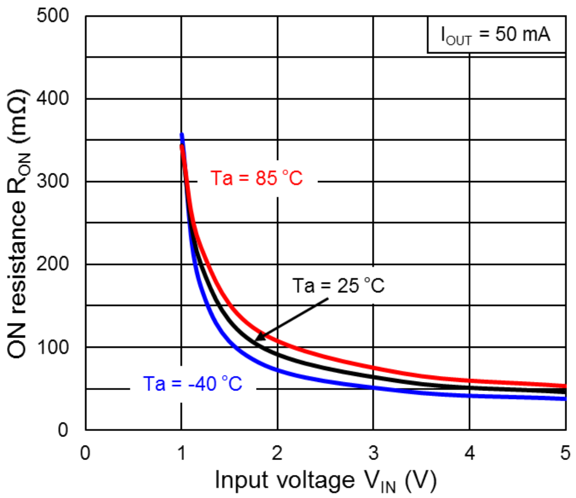
[The Board Condition]
Glass epoxy board dimension : 40 mm x 40 mm , 4 layer
Metal pattern ratio : approximately 70% each layer



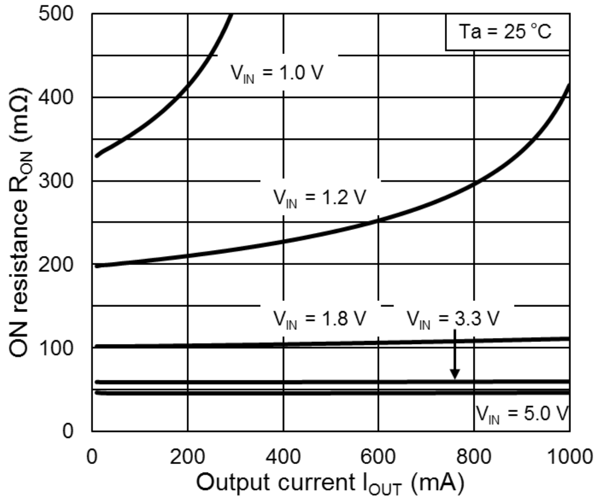
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

Representative Typical Characteristics

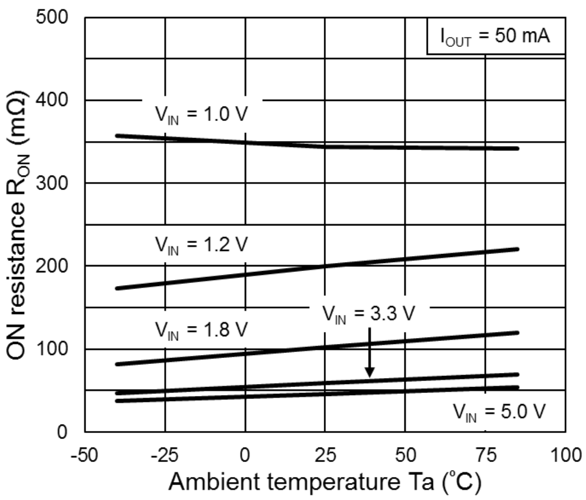
RON - VIN



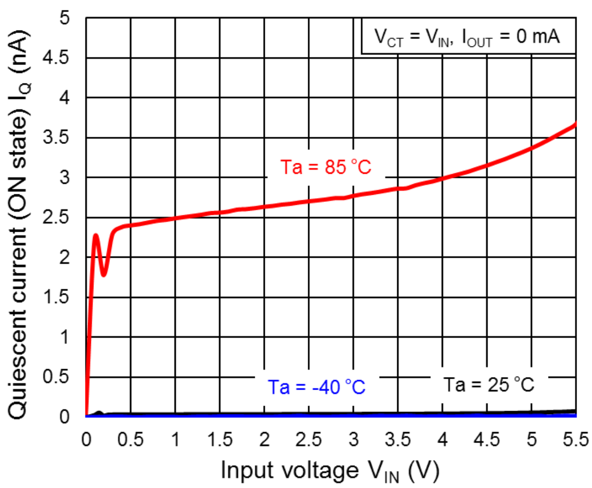
RON - IOUT



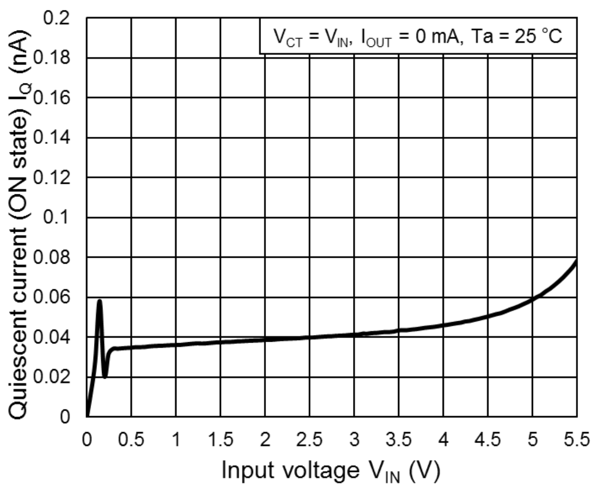
RON - Ta



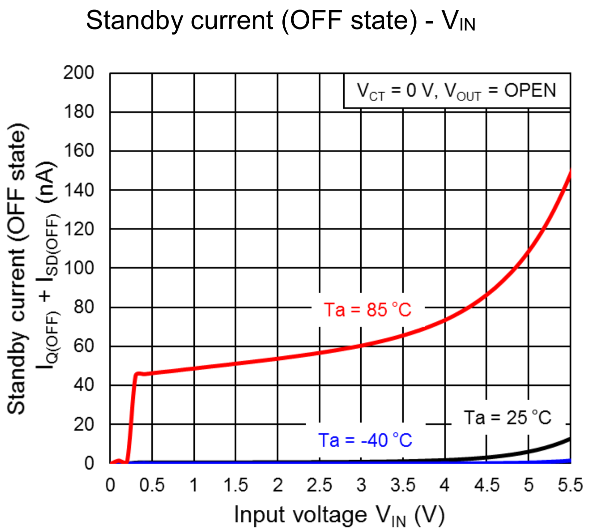
Quiescent current (ON state) - VIN

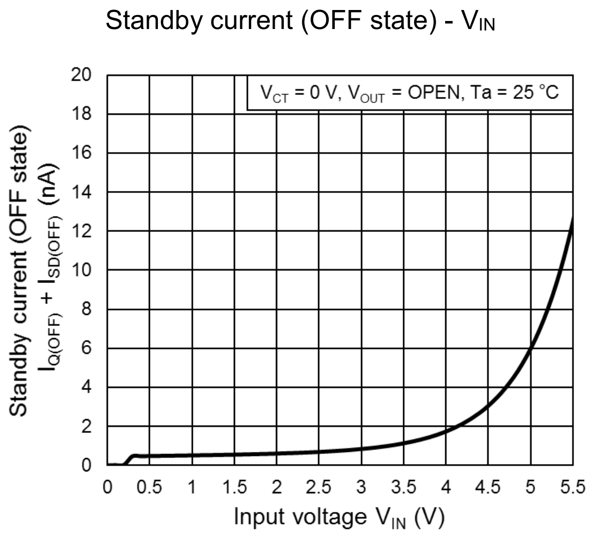


Quiescent current (ON state) - VIN



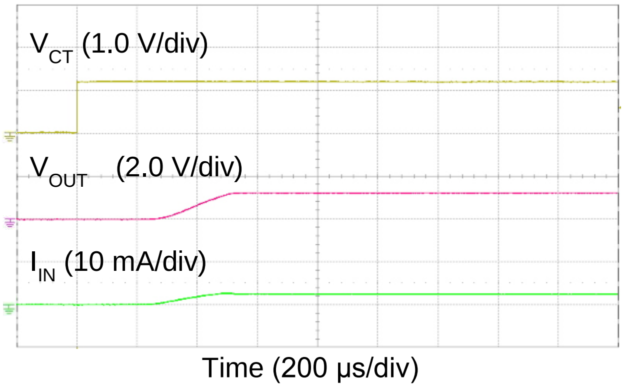
Representative Typical Characteristics



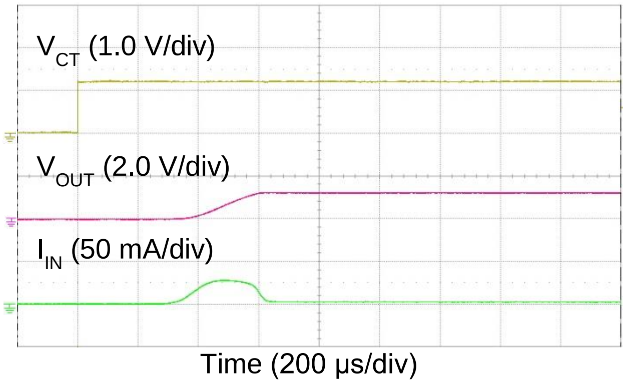


t_{ON} Response

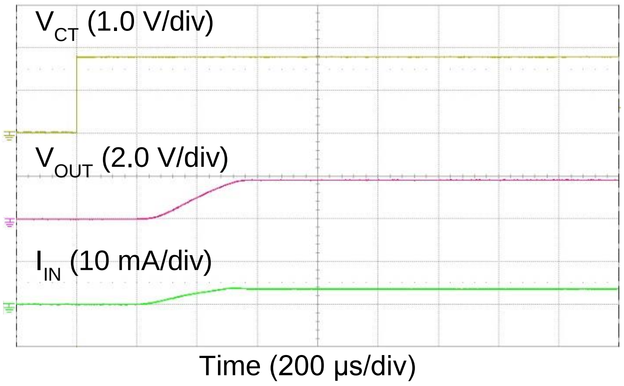
V_{IN} = 1.2 V, C_L = 0.1 μF, R_L = 500 Ω



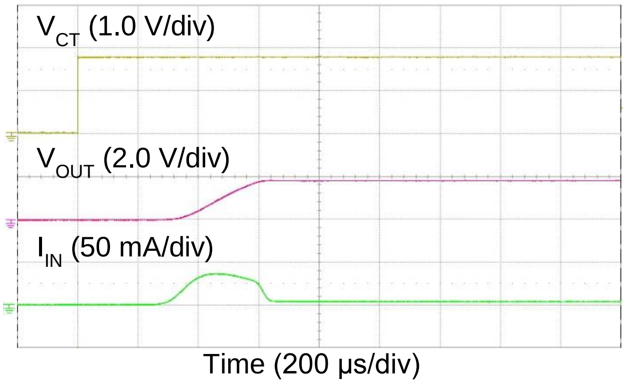
V_{IN} = 1.2 V, C_L = 4.7 μF, R_L = 500 Ω



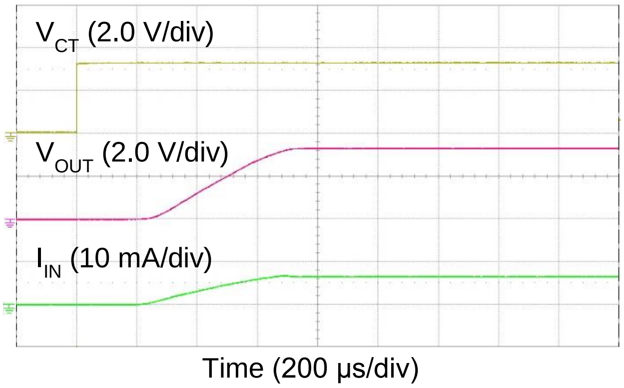
V_{IN} = 1.8 V, C_L = 0.1 μF, R_L = 500 Ω



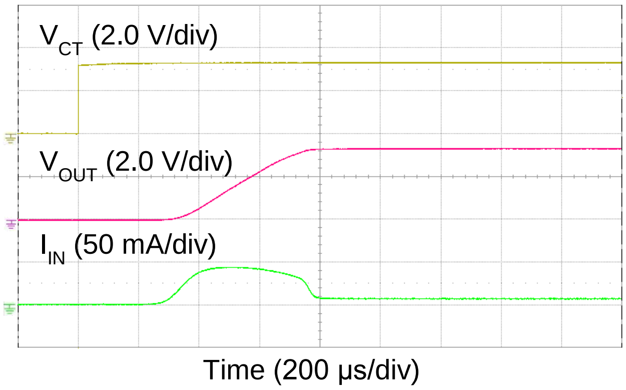
V_{IN} = 1.8 V, C_L = 4.7 μF, R_L = 500 Ω



V_{IN} = 3.3 V, C_L = 0.1 μF, R_L = 500 Ω

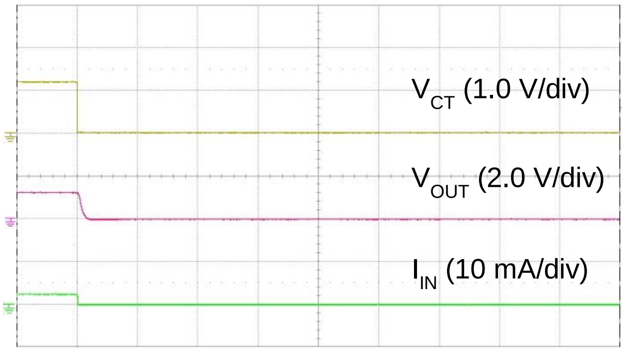


V_{IN} = 3.3 V, C_L = 4.7 μF, R_L = 500 Ω



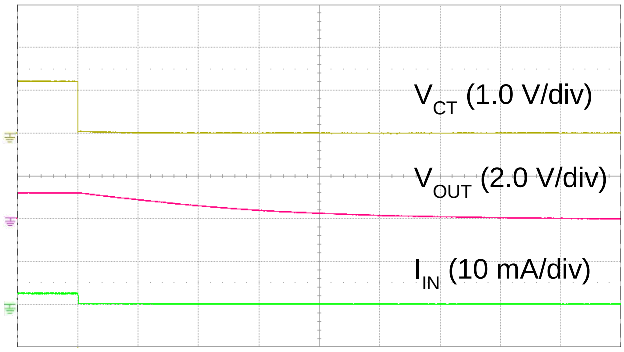
t_{OFF} Response

V_{IN} = 1.2 V, C_L = 0.1 μF, R_L = 500 Ω



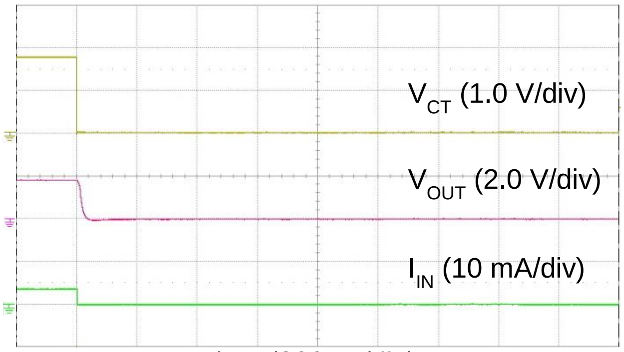
Time (200 μs/div)

V_{IN} = 1.2 V, C_L = 4.7 μF, R_L = 500 Ω



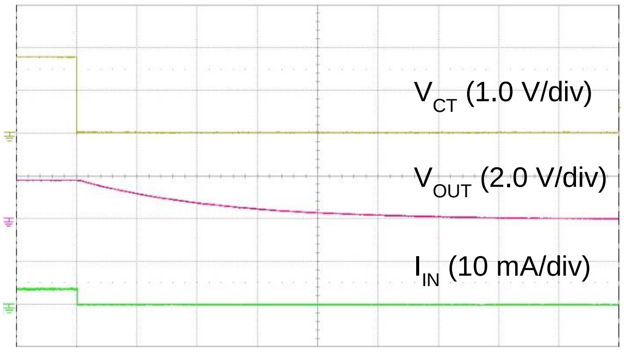
Time (200 μs/div)

V_{IN} = 1.8 V, C_L = 0.1 μF, R_L = 500 Ω



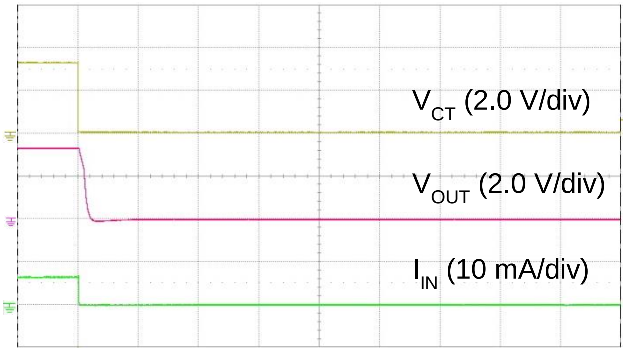
Time (200 μs/div)

V_{IN} = 1.8 V, C_L = 4.7 μF, R_L = 500 Ω



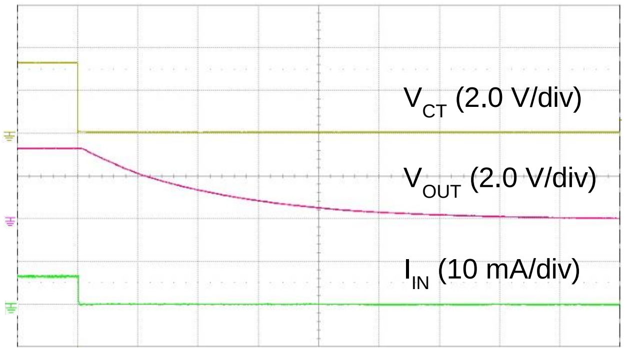
Time (200 μs/div)

V_{IN} = 3.3 V, C_L = 0.1 μF, R_L = 500 Ω



Time (200 μs/div)

V_{IN} = 3.3 V, C_L = 4.7 μF, R_L = 500 Ω



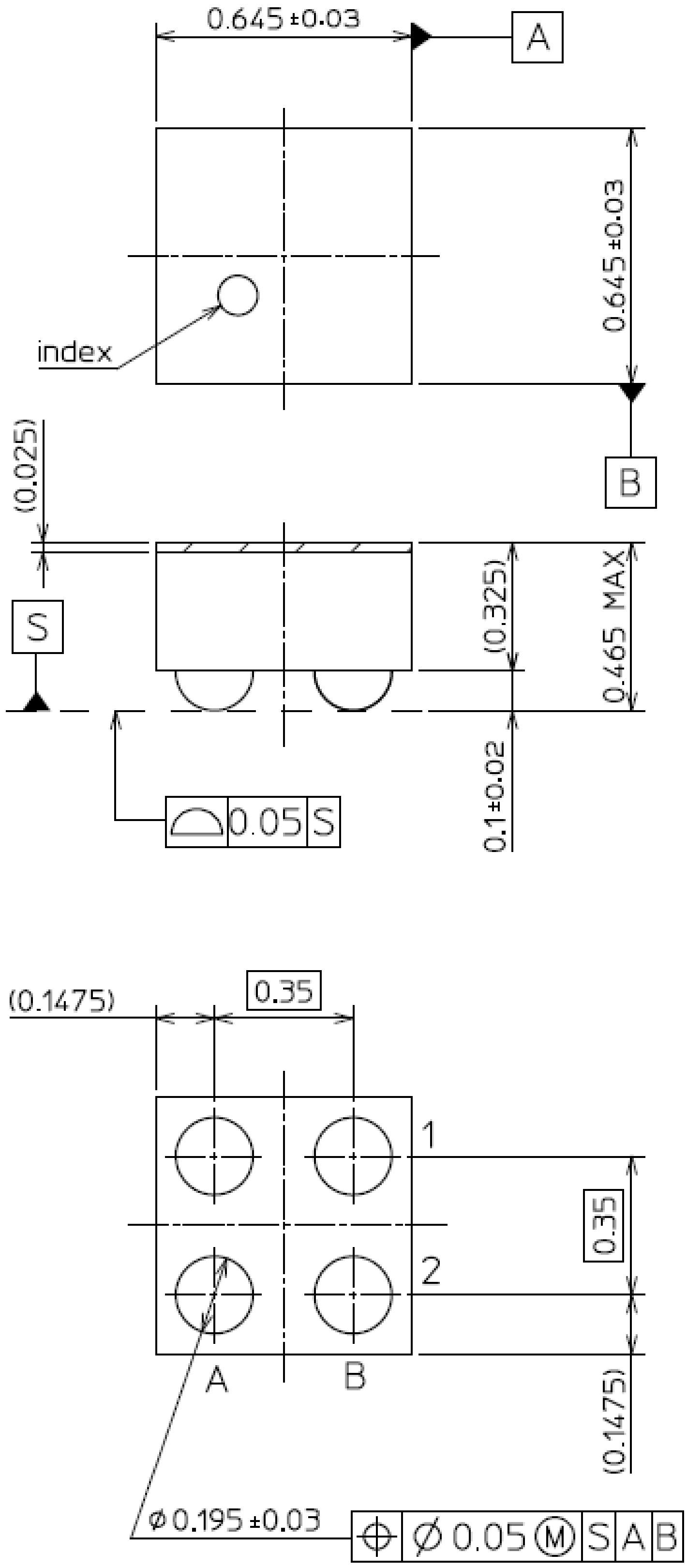
Time (200 μs/div)

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

Package Information

WCSP4G

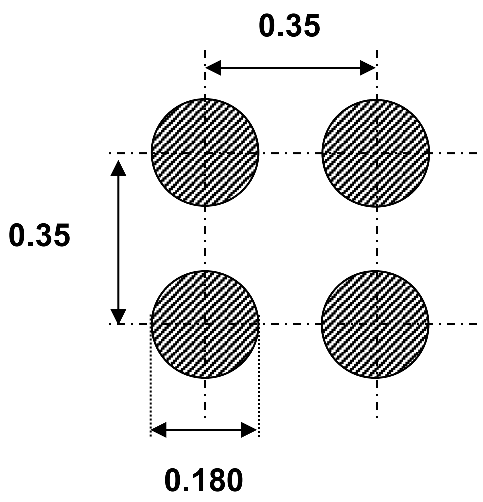
Unit: mm



Weight: 0.38 mg (typ.)

Land pattern dimensions for reference only

Unit: mm



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