

TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK128BG

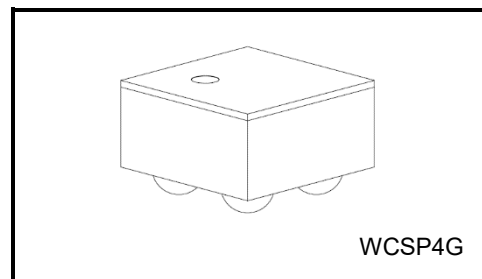
## 0.08 nA Ultra small IQ 1.0 A Load Switch IC in Ultra Small Package

TCK128BG 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. TCK128BG 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.



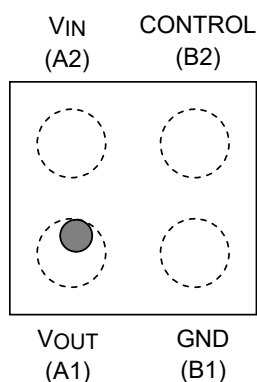
WCSP4G

Weight: 0.38 mg (typ.)

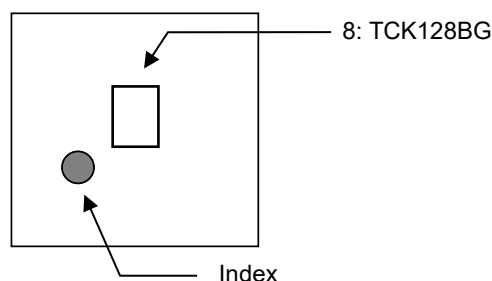
## Feature

- 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  $V_{IN} = 5.5$  V,  $V_{CT} = 0$  V,  $I_{OUT} = 0$  mA
- Low ON resistance  
 $R_{ON} = 58$  m $\Omega$  (typ.) at  $V_{IN} = 3.3$  V,  $I_{OUT} = -0.5$  A  
 $R_{ON} = 106$  m $\Omega$  (typ.) at  $V_{IN} = 1.8$  V,  $I_{OUT} = -0.5$  A
- Built in Slew rate control driver
- Built in Auto-discharge
- Active Low
- 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 <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 V <sub>IN</sub> +0.3		V
Output current	I <sub>OUT</sub>	DC	1.0	A
		Pulse	2.0 (Note 1)	A
Power dissipation	P <sub>D</sub>	1.0 (Note 2)		W
Junction temperature	T <sub>j</sub>	150		°C
Storage temperature	T <sub>stg</sub>	-55 to 150		°C

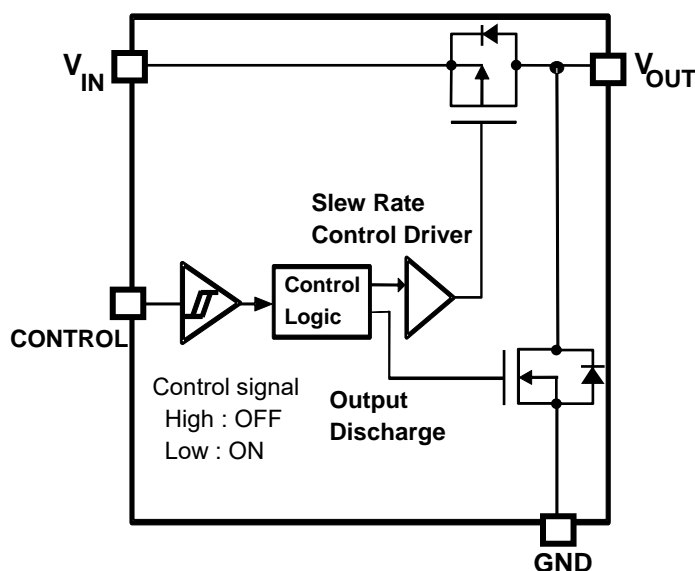
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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: 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 <sub>IN</sub>	—	1.0	5.5	V
Output current	I <sub>OUT</sub>	—	—	1.0	A
CONTROL High-level input voltage	V <sub>IH</sub>	1.0 V ≤ V <sub>IN</sub> ≤ 5.5 V	0.9	—	V
CONTROL Low-level input voltage	V <sub>IL</sub>		—	0.4	V
Operating Ambient temperature range	T <sub>aopr</sub>	—	-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 <sub>Q</sub>	V <sub>IN</sub> = 5.5 V, V <sub>CT</sub> = 0 V, I <sub>OUT</sub> = 0 mA	—	0.08	8	—	4.1 (Note 3)	100	nA
Standby current (OFF state)	I <sub>Q(OFF)</sub> + I <sub>SD(OFF)</sub>	V <sub>IN</sub> = V <sub>CT</sub> = 1.0 V, V <sub>OUT</sub> = OPEN	—	0.6	—	—	—	—	nA
		V <sub>IN</sub> = V <sub>CT</sub> = 4.5 V, V <sub>OUT</sub> = OPEN	—	3	—	—	86 (Note 3)	—	nA
		V <sub>IN</sub> = V <sub>CT</sub> = 5.5 V, V <sub>OUT</sub> = OPEN	—	13	45	—	148 (Note 3)	550	nA
On resistance	R <sub>ON</sub>	V <sub>IN</sub> = 5.0 V, I <sub>OUT</sub> = -0.5 A	—	46	—	—	—	68	mΩ
		V <sub>IN</sub> = 3.3 V, I <sub>OUT</sub> = -0.5 A	—	58	—	—	—	87	
		V <sub>IN</sub> = 1.8 V, I <sub>OUT</sub> = -0.5 A	—	106	—	—	—	169	
		V <sub>IN</sub> = 1.2 V, I <sub>OUT</sub> = -0.2 A	—	210	—	—	—	450	
		V <sub>IN</sub> = 1.0 V, I <sub>OUT</sub> = -0.05 A	—	343	—	—	—	—	
Discharge on resistance	R <sub>SD</sub>	V <sub>IN</sub> = 3.3 V, I <sub>OUT</sub> = 0.01 A	—	109	—	—	—	—	Ω

Note 2 : This parameter is warranted by design.

Note 3 : Ta = 85°C

### AC Characteristics (Ta = 25°C)

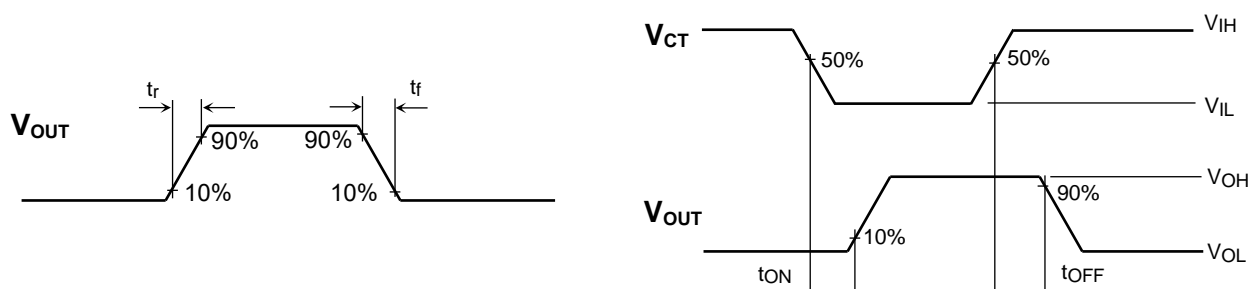
**V<sub>IN</sub> = 1.2 V**

Characteristics	Symbol	Test Condition (Figure 1)	Min	Typ.	Max	Unit
V <sub>OUT</sub> rise time	t <sub>r</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	197	—	μs
V <sub>OUT</sub> fall time	t <sub>f</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	24	—	μs
Turn on delay	t <sub>ON</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	335	—	μs
Turn off delay	t <sub>OFF</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	6	—	μs

**V<sub>IN</sub> = 3.3 V**

Characteristics	Symbol	Test Condition (Figure 1)	Min	Typ.	Max	Unit
V <sub>OUT</sub> rise time	t <sub>r</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	363	—	μs
V <sub>OUT</sub> fall time	t <sub>f</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	32	—	μs
Turn on delay	t <sub>ON</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	324	—	μs
Turn off delay	t <sub>OFF</sub>	R <sub>L</sub> = 500 Ω, C <sub>L</sub> = 0.1 μF	—	10	—	μs

### AC Waveform

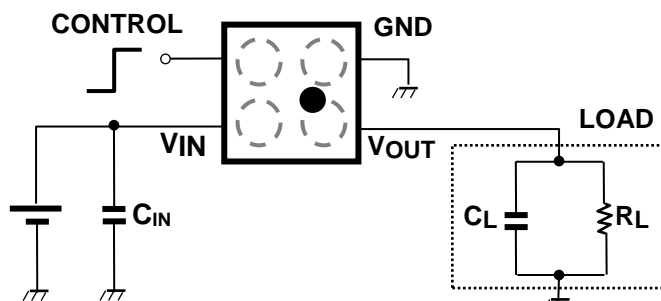


**Figure 1 t<sub>r</sub>, t<sub>f</sub>, t<sub>ON</sub>, t<sub>OFF</sub> Waveforms**

## Application Note

## 1. Application circuit example (top view)

The figure below shows the example of configuration for TCK128BG.



Part number	Control voltage	IC Operation
TCK128BG	Low	ON
	High	OFF

## 1) Input capacitor

An input capacitor ( $C_{IN}$ ) is not necessary for the guaranteed operation of TCK128BG. 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 TCK128BG. 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  $0.1\mu F$  is recommended.

## 3) Control pin

A control pin for TCK128BG is Active Low. This pin controls both 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 OFF state and discharge n-ch MOSFET is ON 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  $V_{IN}$  or 0 V as the control voltage for use with ultra-low current consumption.

## 5) Low input voltage and output voltage attenuation

When TCK128BG 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.

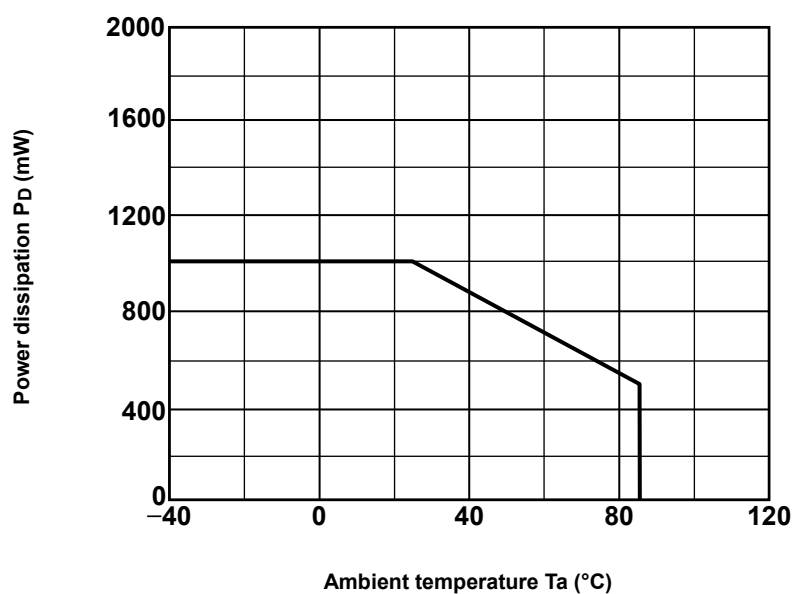
## 2. Power Dissipation

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]

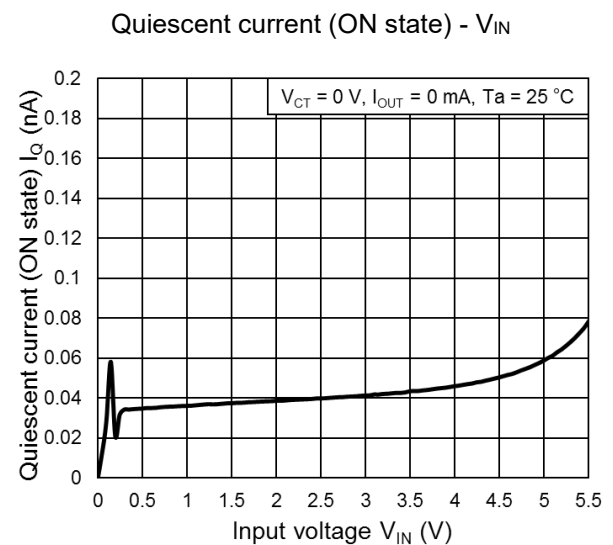
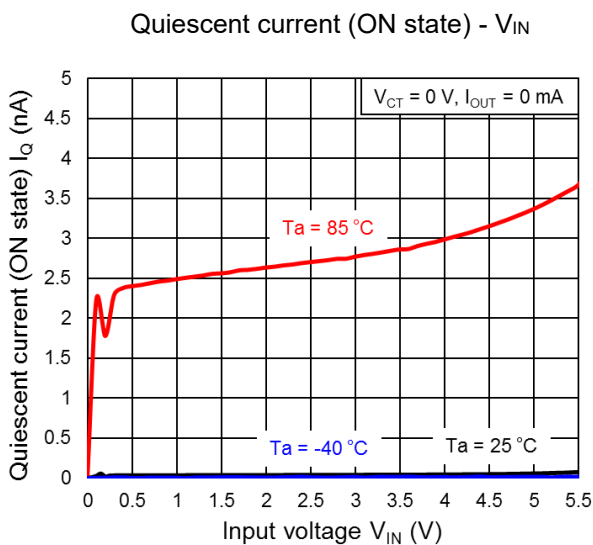
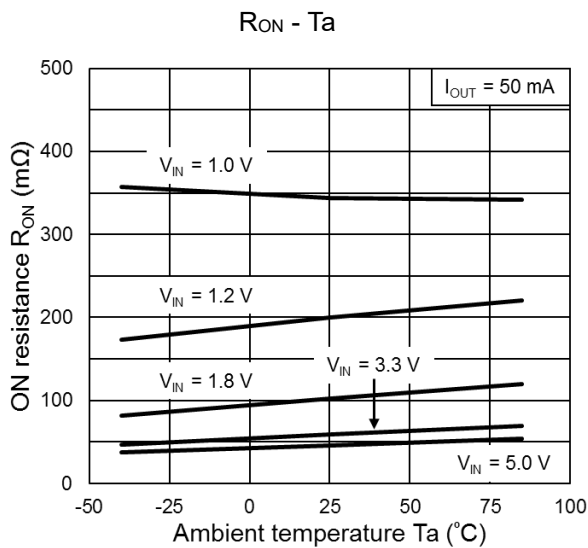
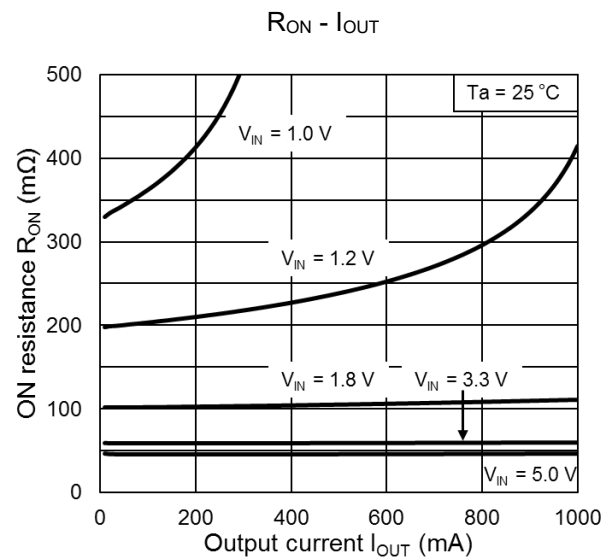
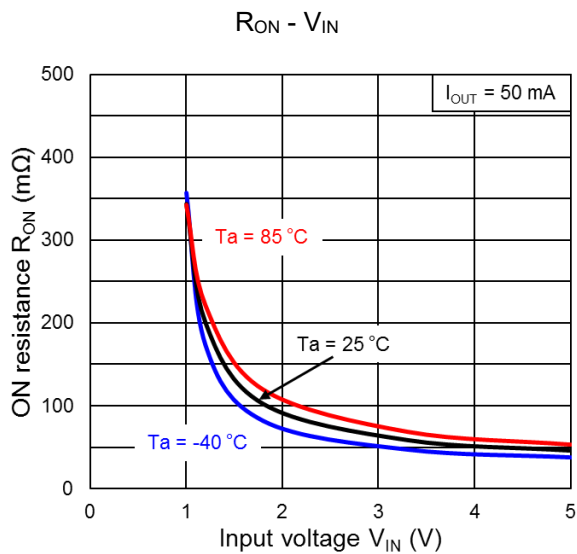
Glass epoxy board dimension : 40 mm x 40 mm , 4 layer

Metal pattern ratio : approximately 70% each layer



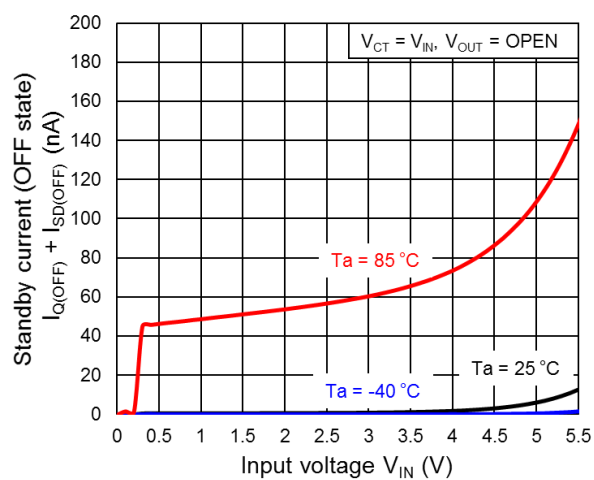
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

## Representative Typical Characteristics

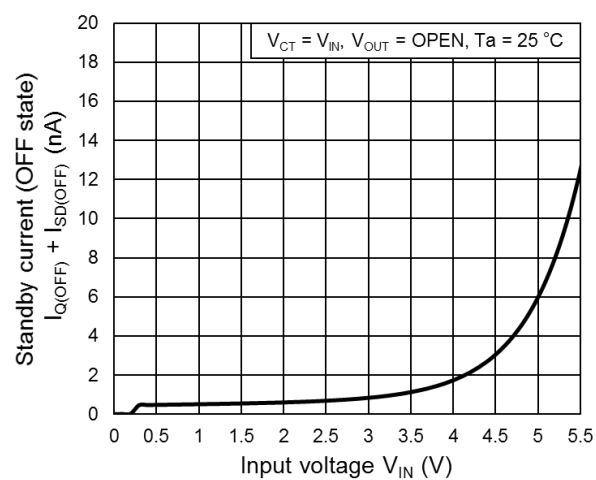


### Representative Typical Characteristics

Standby current (OFF state) -  $V_{IN}$



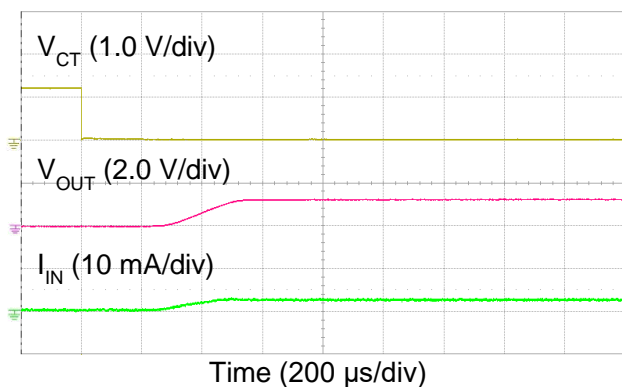
Standby current (OFF state) -  $V_{IN}$



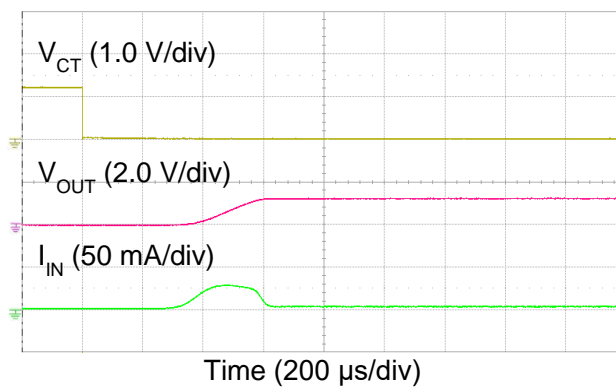


### $t_{ON}$ Response

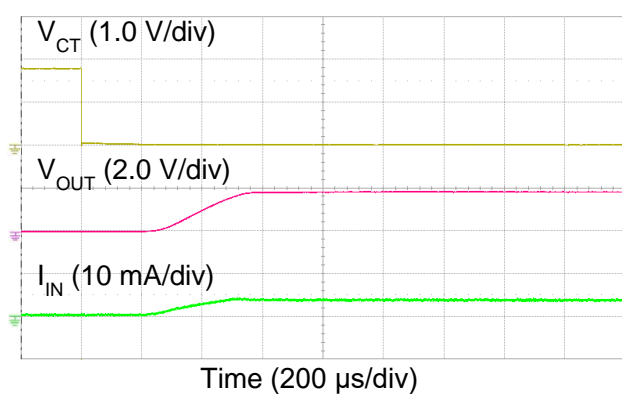
$V_{IN} = 1.2\text{ V}$ ,  $C_L = 0.1\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



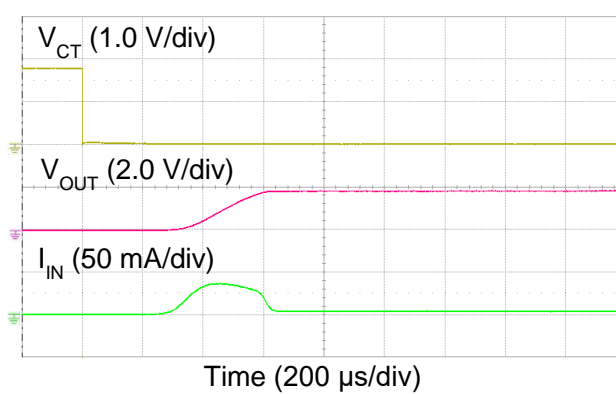
$V_{IN} = 1.2\text{ V}$ ,  $C_L = 4.7\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



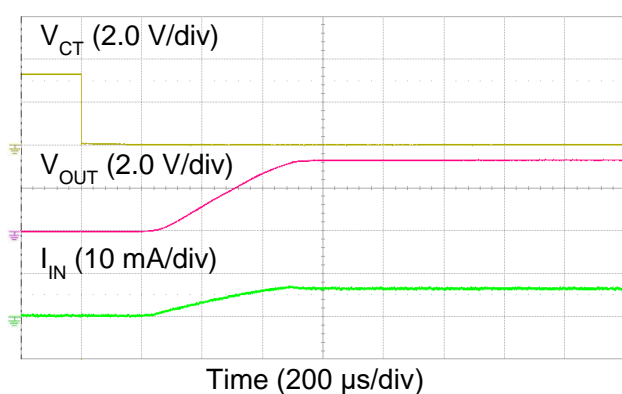
$V_{IN} = 1.8\text{ V}$ ,  $C_L = 0.1\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



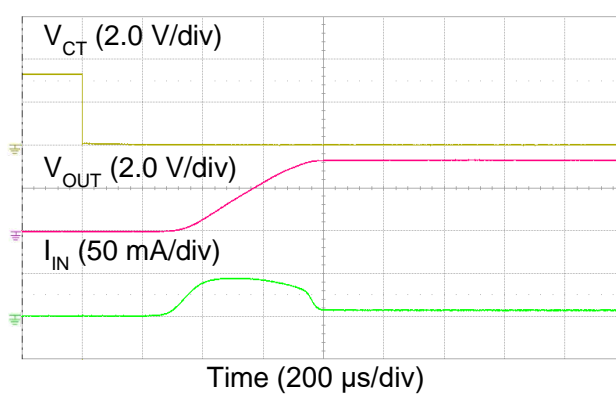
$V_{IN} = 1.8\text{ V}$ ,  $C_L = 4.7\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



$V_{IN} = 3.3\text{ V}$ ,  $C_L = 0.1\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$

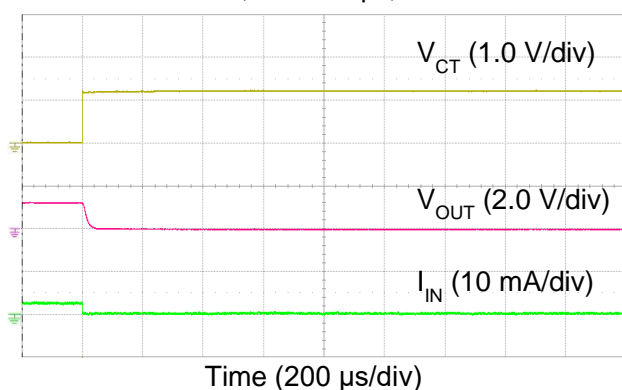


$V_{IN} = 3.3\text{ V}$ ,  $C_L = 4.7\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$

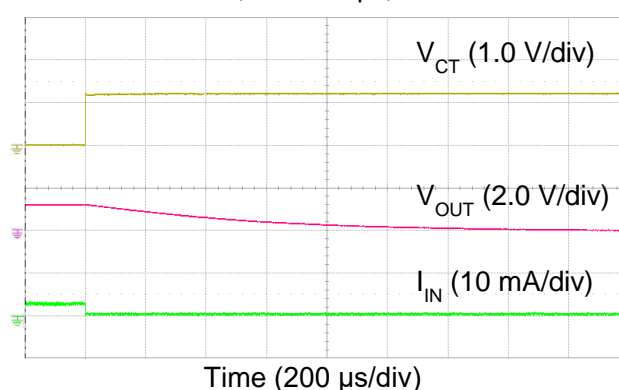


## $t_{OFF}$ Response

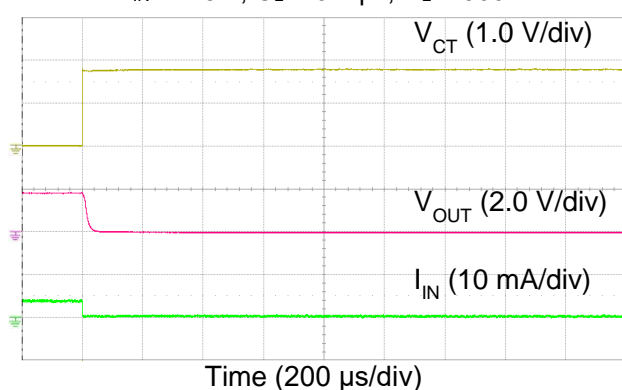
$V_{IN} = 1.2\text{ V}$ ,  $C_L = 0.1\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



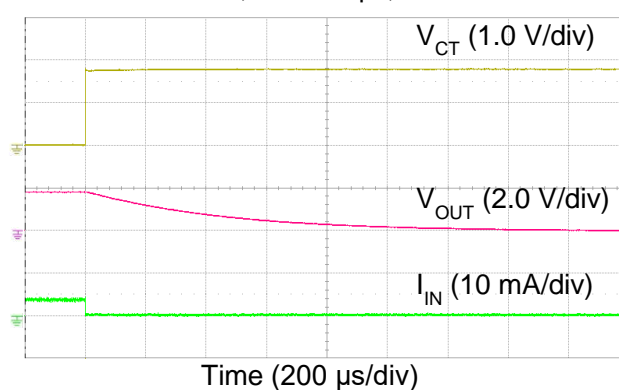
$V_{IN} = 1.2\text{ V}$ ,  $C_L = 4.7\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



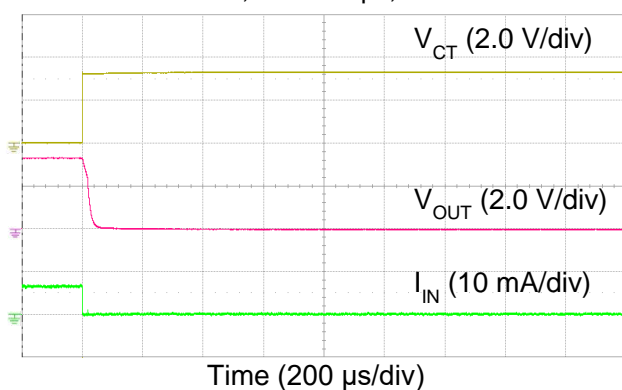
$V_{IN} = 1.8\text{ V}$ ,  $C_L = 0.1\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



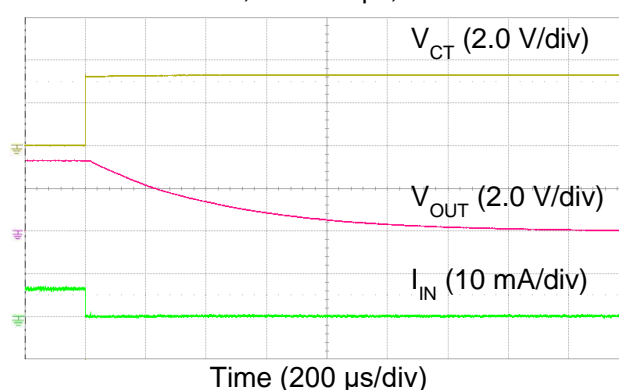
$V_{IN} = 1.8\text{ V}$ ,  $C_L = 4.7\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



$V_{IN} = 3.3\text{ V}$ ,  $C_L = 0.1\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$



$V_{IN} = 3.3\text{ V}$ ,  $C_L = 4.7\text{ }\mu\text{F}$ ,  $R_L = 500\text{ }\Omega$

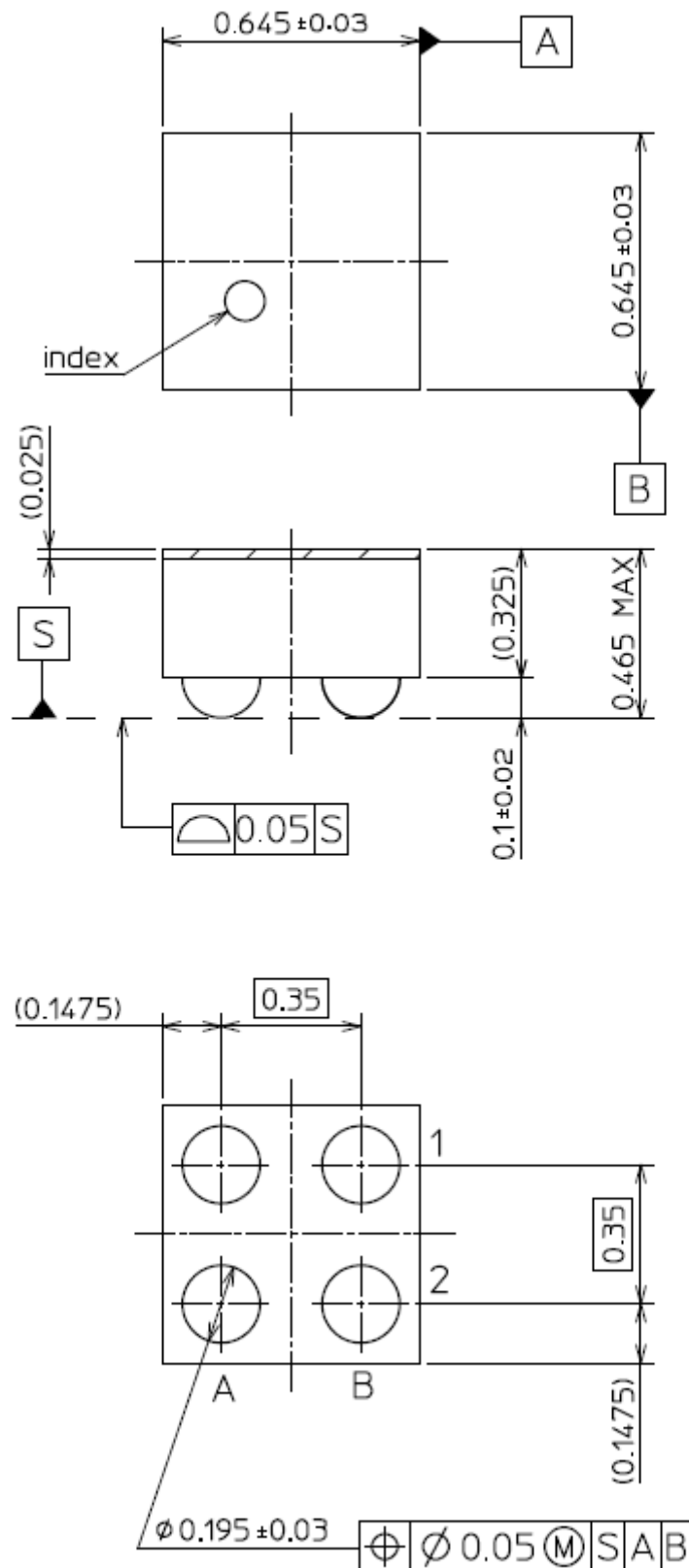


Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

## Package Information

WCSP4G

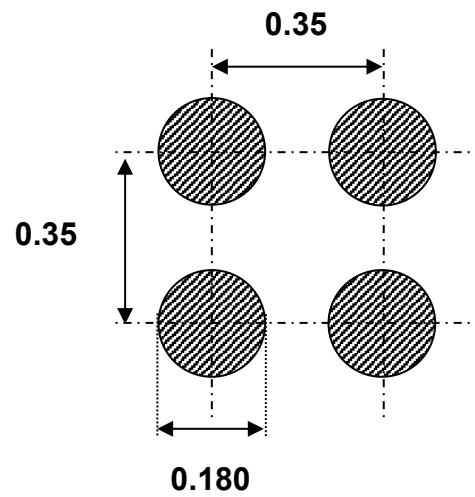
Unit: mm



**Weight: 0.38 mg (typ.)**

Land pattern dimensions for reference only

Unit: mm



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