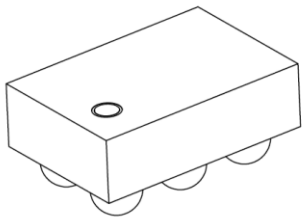
TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCK2291xG

2A Load Switch IC with True Reverse Current Blocking

The TCK2291xG series is Load Switch ICs for power management with True Reverse Current Blocking and Thermal Shutdown function featuring low switch on resistance, ultra low quiescent current, high output current and wide input operating voltage range of 1.1 to 5.5 V. Switch ON resistance is only 31 mΩ at 5.0 V, -0.15 A load conditions and output current is available on 2.0 A. And these feature a slew rate control driver and output auto-discharge function.

These devices are available in 0.4 mm pitch ultra small package WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm). Thus these devices are ideal for portable applications that require high-density board assembly such as cellular phone.



WCSP6E

Weight: 1 mg (typ.)

Feature

- True Reverse Current Blocking
- Thermal Shutdown function
- Output auto-discharge (Option)
- Under voltage lockout
- Low ON resistance :
  R_{ON} = 31 mΩ (typ.) at V_{IN} = 5.0 V, I_{OUT} = -0.15 A
  R_{ON} = 40 mΩ (typ.) at V_{IN} = 3.3 V, I_{OUT} = -0.15 A
  R_{ON} = 70 mΩ (typ.) at V_{IN} = 1.8 V, I_{OUT} = -0.15 A
  R_{ON} = 141 mΩ (typ.) at V_{IN} = 1.2 V, I_{OUT} = -0.15 A
- Low Quiescent Current: I_Q = 11 μA (typ.) at I_{OUT} = 0 mA
- Low standby current: $I_{Q(OFF)}$ = 0.6 μA (typ.) at OFF state
- Inrush current reduction circuitt
- Pull down connection between Control and GND(Option)
- Ultra small package : WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm)

Start of commercial production
2016-06

Function Table

Part number	Function						Device Marking
	True Reverse current blocking	Output auto-discharge	Under voltage lock out	Thermal shutdown	Control pin polarity	Control pin pull down connection	
TCK22910G	Built in	N/A	Built in	Built in	Active Low	N/A	4S
TCK22911G	Built in	Built in	Built in	Built in	Active Low	N/A	3S
TCK22912G	Built in	N/A	Built in	Built in	Active High	Built in	2S
TCK22913G	Built in	Built in	Built in	Built in	Active High	Built in	1S

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 6.0		V
Output current	I_{OUT}	DC	2.0	A
		Pulse	3.0 (Note1)	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).

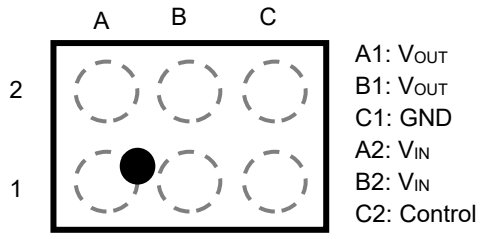
Note1: 100 μs pulse, 2% duty cycle

Note2: Rating at mounting on a board
Glass epoxy board dimension : 40mm x 40mm (both sides of board), t=1.6mm
Metal pattern ratio : a surface approximately 50%, the reverse side approximately 50%
Through hole : diameter 0.5mm x 28)

Operating conditions

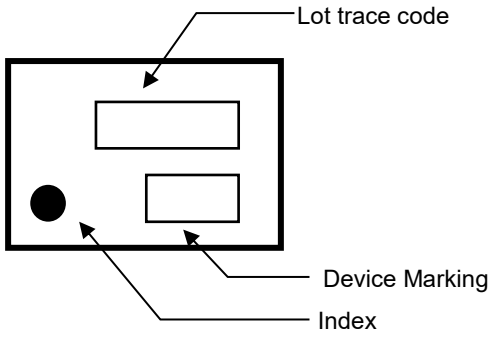
Characteristics	Symbol	Condition	Min	Max	Unit
Input voltage	V_{IN}	—	1.1	5.5	V
Output voltage	V_{OUT}	—	—	V_{IN}	V
Output current	I_{OUT}	1.8 V ≤ V_{IN}	—	2.0	A
Control High-level input voltage	V_{IH}	1.2V < V_{IN} ≤ 5.5 V	1.0	—	V
		1.1V ≤V_{IN} ≤1.2 V	0.9	—	
Control Low-level input voltage	V_{IL}	—	—	0.4	V

Pin Assignment(Top view)

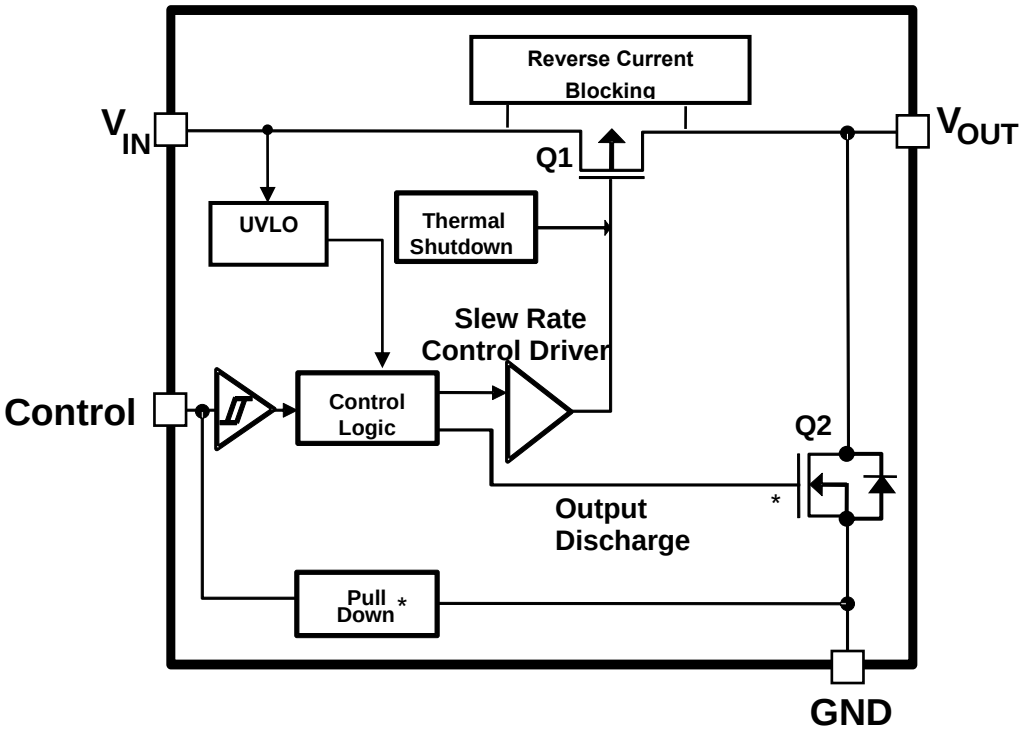


A1: V_{OUT}
B1: V_{OUT}
C1: GND
A2: V_{IN}
B2: V_{IN}
C2: Control

Top marking



Block Diagram



*:Option

Operation logic table

		TCK22910G	TCK22911G	TCK22912G	TCK22913G
Control "High"	Output Q_1	OFF	OFF	ON	ON
	Discharge Q_2	—	ON	—	OFF
	Reverse current blocking	Active	Active	Active	Active
Control "Low"	Output Q_1	ON	ON	OFF	OFF
	Discharge Q_2	—	OFF	—	ON
	Reverse current blocking	Active	Active	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	
Quiescent current (ON state)	I_Q	I_{OUT} = 0 mA	V_{IN} = 1.1 V	—	9	—	—	—	μA
			V_{IN} = 5.5 V	—	11	—	—	20	μA
Quiescent current (OFF state)	$I_{Q(OFF)}$	V_{IN} = 5.5 V, V_{OUT} = OPEN, (Note 3)		—	0.6	—	—	2.5	μA
Switch leakage current(OFF state)	$I_{SD(OFF)}$	V_{OUT} = GND, current through from V_{IN} to V_{OUT}. (Note 4)	V_{IN} = V_{CT} = 5.5 V	—	20	—	—	2000	nA
Reverse blocking current	I_{RB}	V_{OUT} = 5.0 V, V_{IN} = 0 V, RCB active		—	0.01	—	—	2	μA
Reverse blocking voltage threshold	V_{RB}	V_{OUT} – V_{IN}		—	35	—	—	—	mV
Reverse blocking release voltage threshold	V_{RBR}	V_{OUT} – V_{IN}		—	-15	—	—	—	mV
Under Voltage Lock Out (UVLO) rising threshold	V_{UVL_RI}	—		—	0.82	—	—	1.1	V
Under Voltage Lock Out (UVLO) falling threshold	V_{UVL_FA}	—		—	0.77	—	—	—	V
On resistance	R_{ON}	I_{OUT} = -0.15 A	V_{IN} = 5.0 V	—	31	—	—	85	mΩ
			V_{IN} = 3.3 V	—	40	—	—	95	
			V_{IN} = 1.8 V	—	70	—	—	140	
			V_{IN} = 1.2 V	—	141	—	—	—	
			V_{IN} = 1.1 V	—	179	—	—	—	
Output discharge on resistance	R_{SD}	— (Note 5)		—	100	—	—	—	Ω

Note 3 : Except $I_{SD(OFF)}$ OFF-state switch current

Note 4 : Only applies to the TCK22910G and TCK22912G

Note 5 : Only applies to the TCK22911G and TCK22913G

AC Characteristics (Ta = 25°C)

V_{IN} = 5.0 V, TCK22910G

Characteristics	Symbol	Test Condition(Figure 2)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	1.4	—	ms
V_{OUT} fall time	t_f	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	120	—	μs
Turn on delay	t_{ON}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	800	—	μs
Turn off delay	t_{OFF}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	5	—	μs

V_{IN} = 5.0 V, TCK22911G

Characteristics	Symbol	Test Condition(Figure 2)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	1.4	—	ms
V_{OUT} fall time	t_f	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	60	—	μs
Turn on delay	t_{ON}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	800	—	μs
Turn off delay	t_{OFF}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	5	—	μs

V_{IN} = 5.0 V, TCK22912G

Characteristics	Symbol	Test Condition(Figure 1)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	1.4	—	ms
V_{OUT} fall time	t_f	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	120	—	μs
Turn on delay	t_{ON}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	800	—	μs
Turn off delay	t_{OFF}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	10	—	μs

V_{IN} = 5.0 V, TCK22913G

Characteristics	Symbol	Test Condition(Figure 1)	Min	Typ.	Max	Unit
V_{OUT} rise time	t_r	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	1.4	—	ms
V_{OUT} fall time	t_f	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	60	—	μs
Turn on delay	t_{ON}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	800	—	μs
Turn off delay	t_{OFF}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	10	—	μs

AC Waveform

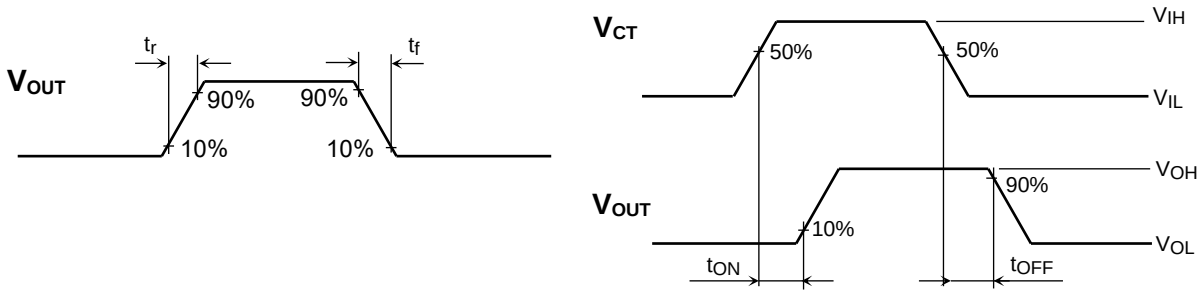


Figure 1 t_r, t_f, t_{ON}, t_{OFF} Waveforms(Active High)

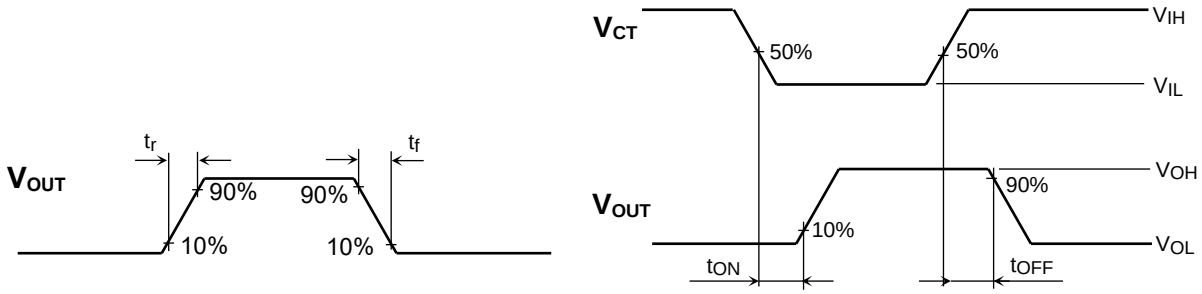
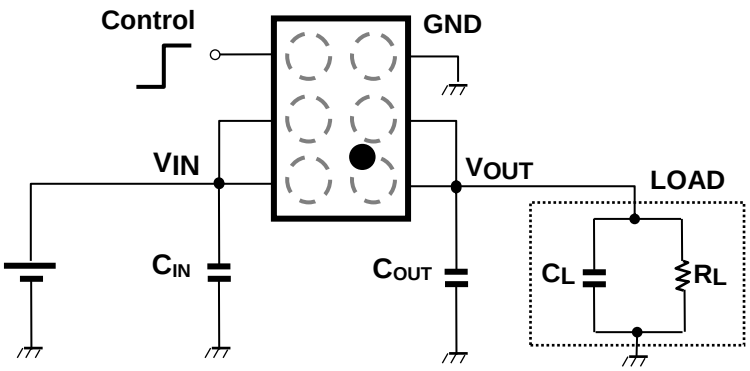


Figure 2 t_r, t_f, t_{ON}, t_{OFF} Waveforms(Active Low)

Application Note

1. Application circuit example (top view)

The figure below shows the example of configuration for TCK2291xG.



1) Input and Output capacitor

An input capacitor (C_{IN}) and an output capacitor (C_{OUT}) are necessary for the stable operation of TCK2291xG. And 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 V_{IN} pin and V_{OUT} pin to improve stability of the power supply.

2) Control pin

The Control pin for TCK2291xG controls state of the switch, operated by the control voltage. Control pin is equipped with Schmitt trigger. 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. (except TCK22910G and TCK22911G). A control pins for TCK22910G and TCK22911G is Active low. Products that Control pin is an open connection, please use be sure to fix the potential of the Control pin to High or Low.

2. Thermal shutdown function

Each device has a built-in thermal shutdown circuit. If the junction temperature goes beyond 170°C (Typ.), thermal shutdown circuit operates and turns off power switch. When the junction temperature decreases lower than 150°C, the power switch is turned on due to hysteresis. This operation is repeated as long as the junction temperature continues increasing.

3. True reverse current blocking

Each device has built-in true reverse current blocking circuit (TRCB) to block reverse current from V_{OUT} to V_{IN} regardless of output MOSFET ON/OFF condition. (Full-Time Reverse Current Protection)

4. Under-voltage Lockout

Each device has a built-in under-voltage lockout circuit to turn off switch if V_{IN} drops below UVLO. This circuit has hysteresis and UVLO is released when V_{IN} exceeds threshold.

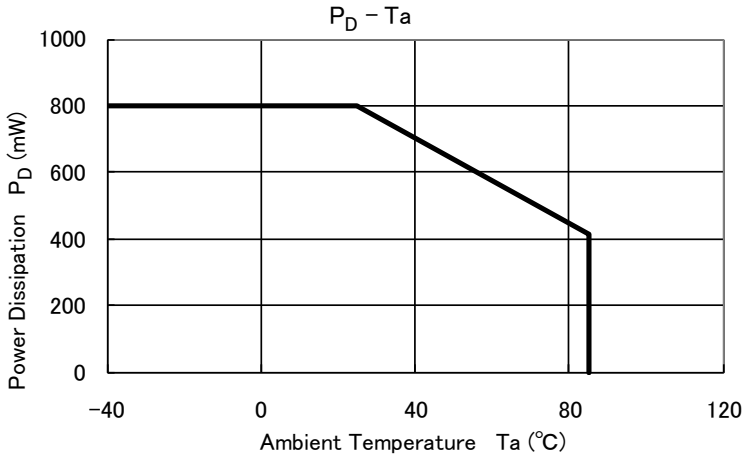
5. Instructions and directions for use

Each device has a built-in several functions, but these do not assure 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.

6. Power Dissipation

Power dissipation is measured on the board condition shown below.

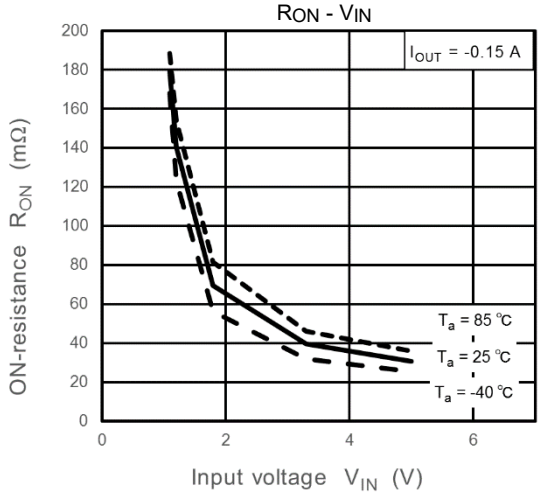
[The Board Condition]
Board material: Glass epoxy (FR4)
Board dimension: 40mm x 40mm (both sides of board), t=1.6mm
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
Through hole: diameter 0.5mm x 28



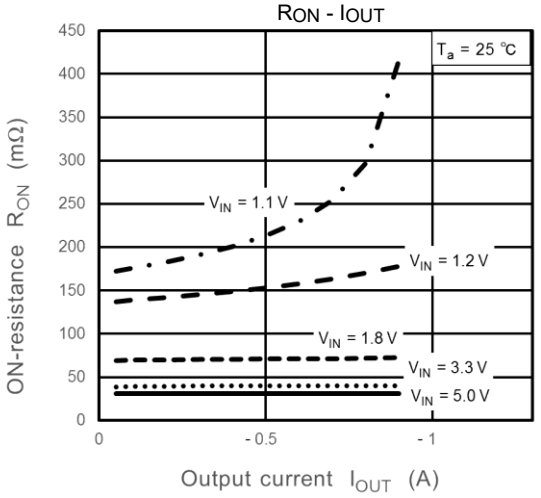
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current, etc. and applying the appropriate derating for allowable power dissipation during operation.

TCK2291xG Representative Typical Characteristics

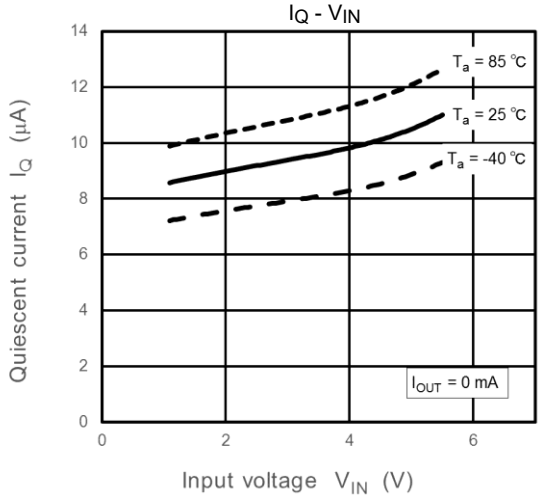
RON - VIN



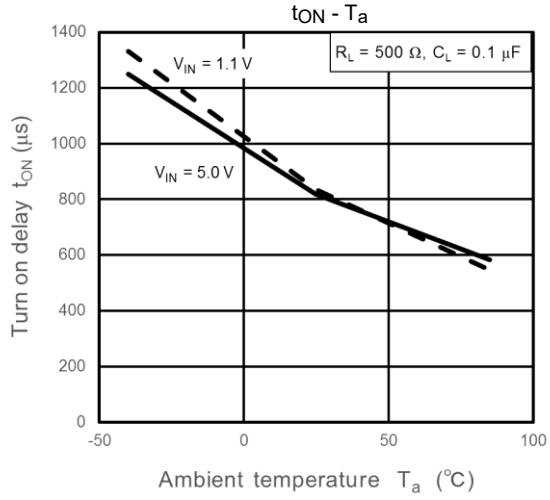
RON - IOUT



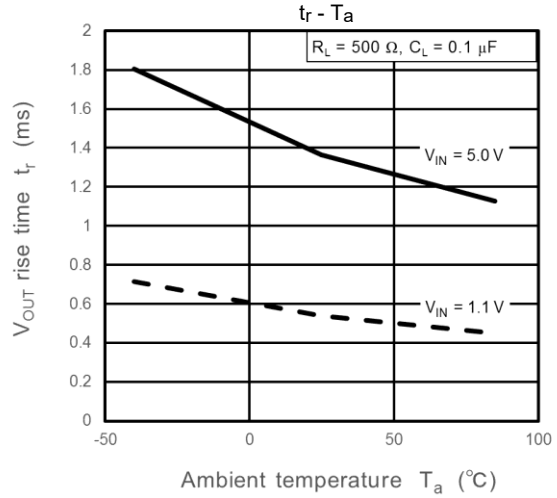
IQ - VIN



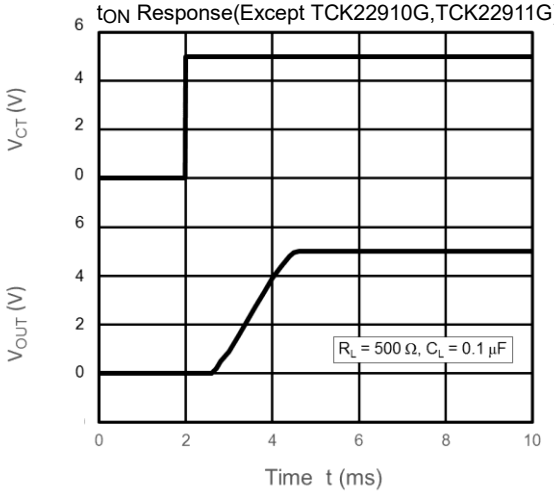
tON - Ta

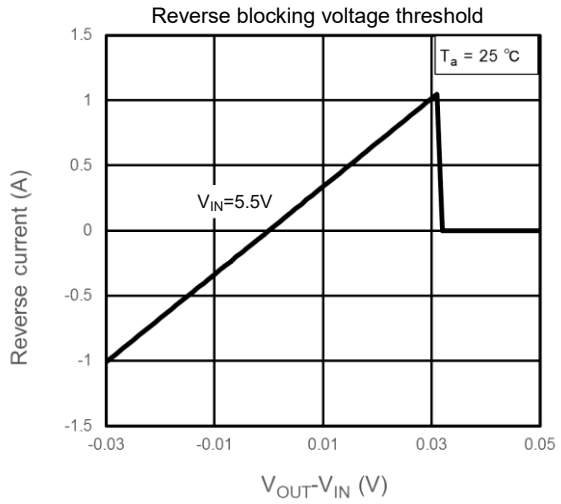


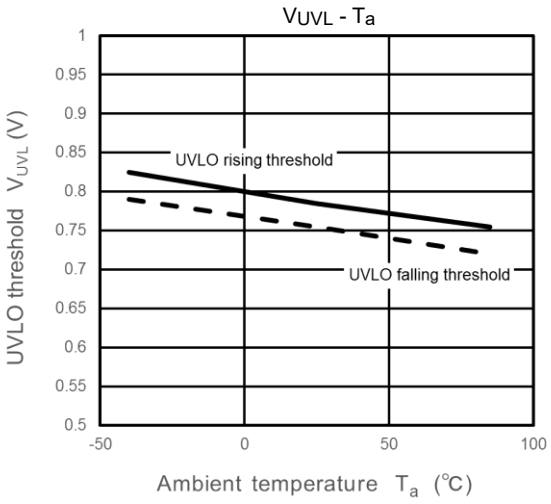
tr - Ta



tON Response(Except TCK22910G,TCK22911G)

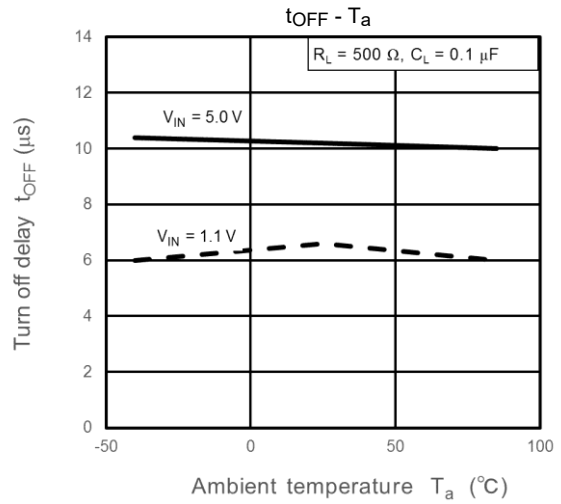






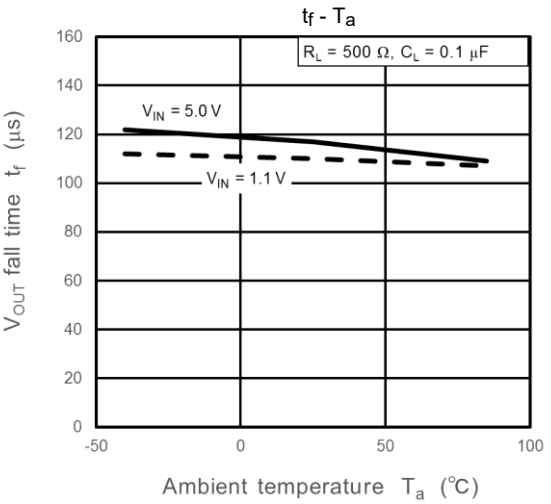
t_{OFF}-T_a Representative Typical Characteristics

TCK22912G, TCK22913G



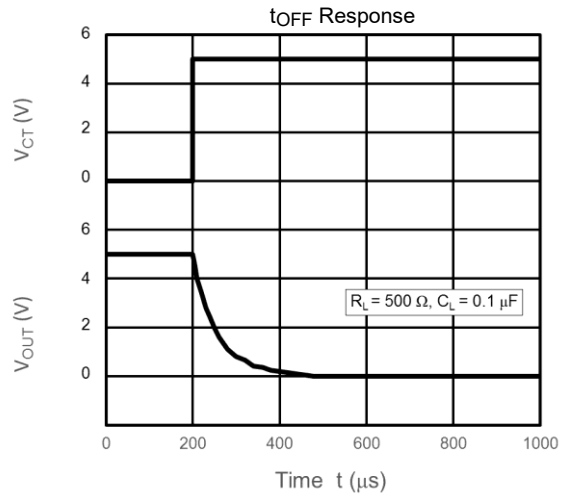
t_f-T_a Representative Typical Characteristics

TCK22910G, TCK22912G

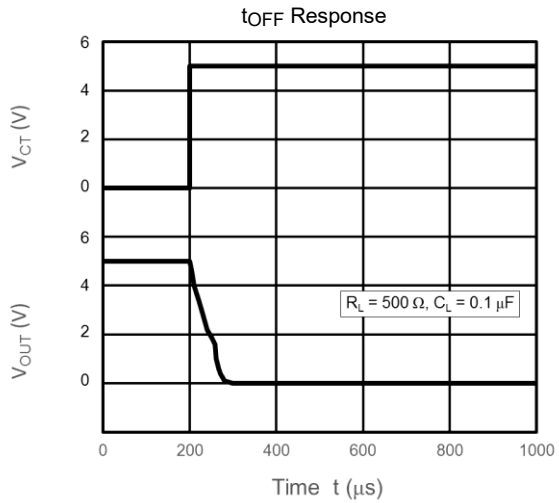


t_{OFF} Response Representative Typical Characteristics

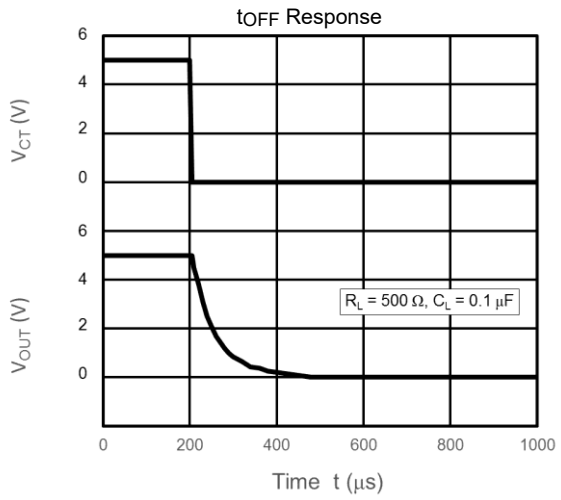
TCK22910G



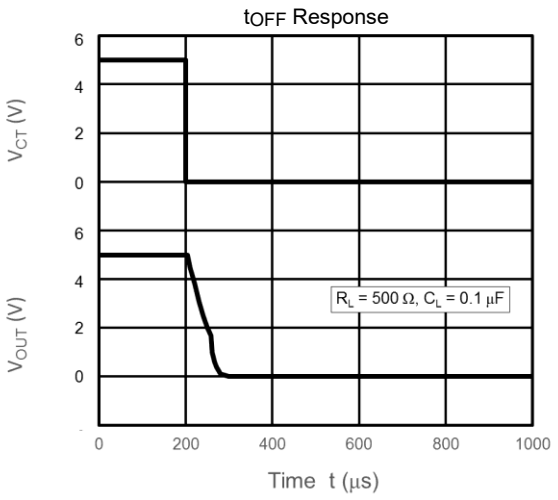
TCK22911G



TCK22912



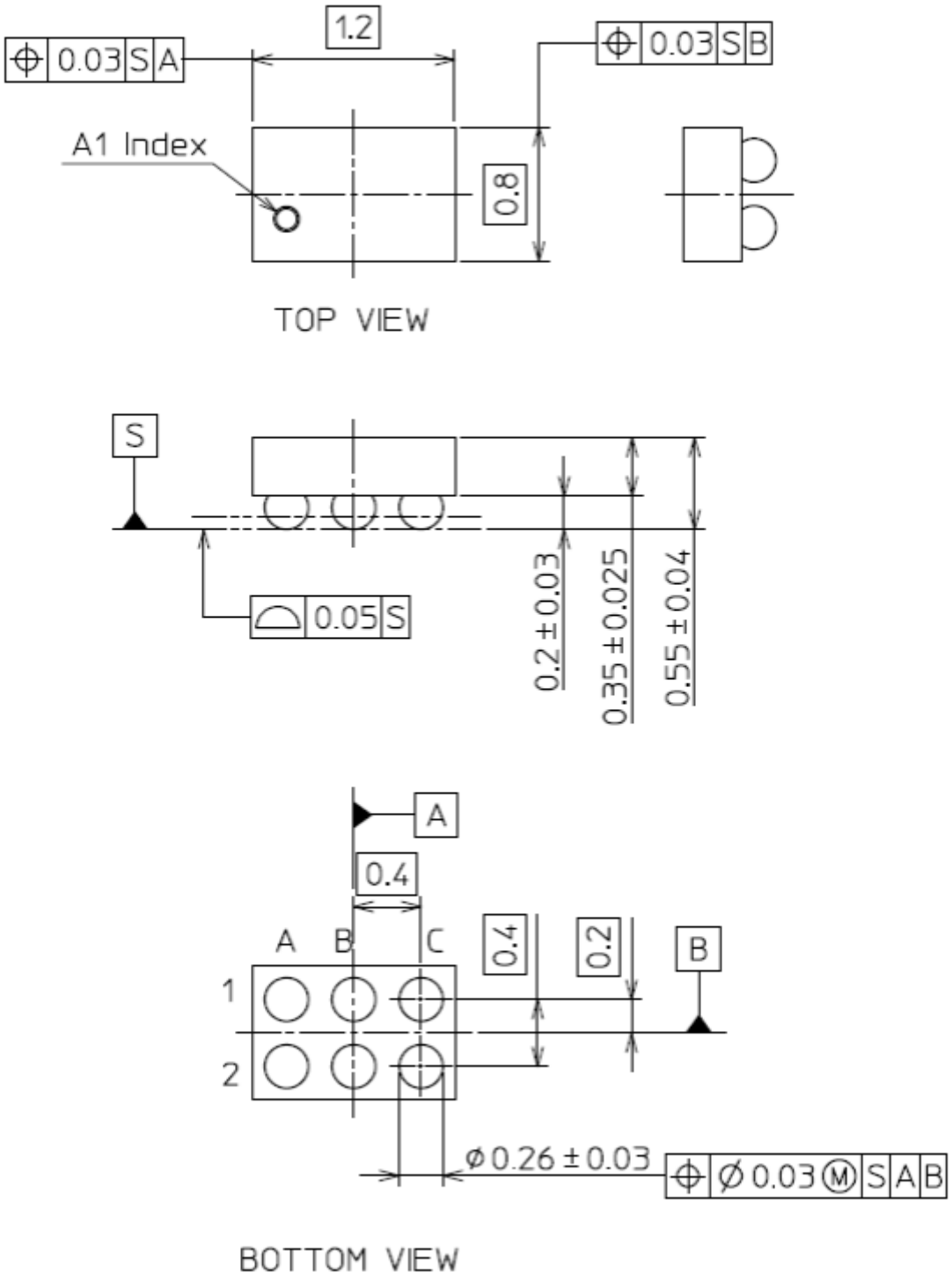
TCK22913G



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

Package dimension

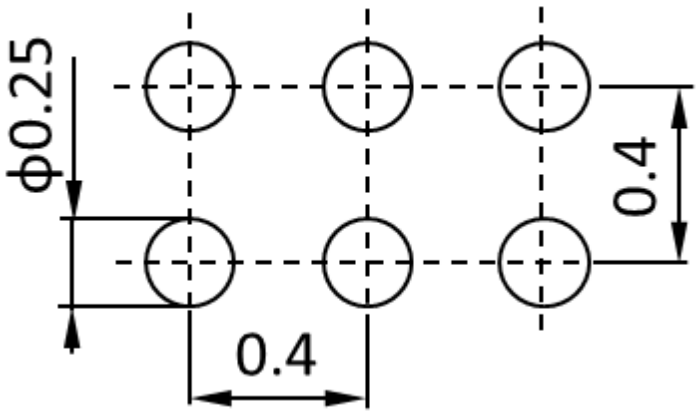
Unit: mm



Weight: 1 mg (typ.)

Land pattern dimensions (for reference only)

Unit: mm



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