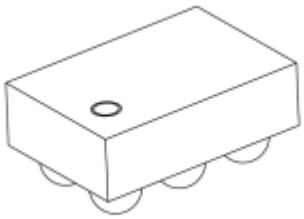
TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TCK22xxxG, TCK2065G, TCK1024G

Load Switch IC with Over current limited function

The TCK22xxxG, TCK2065G and TCK1024G are Load Switch ICs for power management with Over Current Limited function featuring low switch on resistance, ultra low quiescent current, high output current and wide input voltage range. Typical switch ON resistance is only 31 mΩ at V_{IN} = 5.0 V, I_{OUT} = -0.15 A load conditions. And these feature a thermal shut down function 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). So these devices are ideal for portable applications that require high-density board assembly such as cellular phone.



WCSP6E

Weight: 1 mg (typ.)

Feature

- Over current limit function
  I_{CL} = 400/740/1110/1540 mA (Option)
- Thermal shutdown function
- Inrush current reduction
- Output auto-discharge function
- True reverse current blocking function(Option)
- Under voltage lockout function(Option)
- 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
- Low quiescent current: I_Q = 25 μA (typ.) at V_{IN} = 5.5 V, I_{OUT} = 0 mA
- Pull down connection between CONTROL and GND
- Ultra small package : WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm)

Start of commercial production
2016-02

Function Table

Part number	Function						Device Marking
	Output current limit	True Reverse current blocking	Output auto-discharge	Under voltage lock out	Thermal shut down	Control pin polarity	
TCK22946G	400 mA	Built in	Built in	Built in	Built in	Active High	1T
TCK22951G	740 mA	Built in	Built in	Built in	Built in	Active High	2T
TCK2065G	1110 mA	Built in	Built in	Built in	Built in	Active High	3T
TCK1024G	1540 mA	Built in	Built in	Built in	Built in	Active High	4T
TCK22891G	400 mA	N/A	Built in	N/A	Built in	Active High	5T
TCK22892G	740 mA	N/A	Built in	N/A	Built in	Active High	6T
TCK22893G	1110 mA	N/A	Built in	N/A	Built in	Active High	7T
TCK22894G	1540 mA	N/A	Built in	N/A	Built in	Active High	8T

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}	Internally limited	-
Power dissipation	P_D	800 (Note 1)	mW
Operating temperature range	T_{opr}	−40 to 85	°C
Junction temeperature	Tj	150	°C
Storage temperature	T_{stg}	−55 to 150	°C

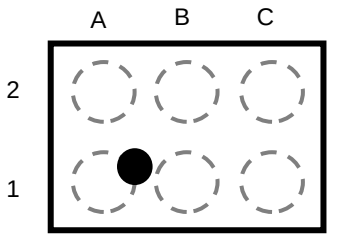
Note : Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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: Rating at mounting on a board
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

Operating conditions

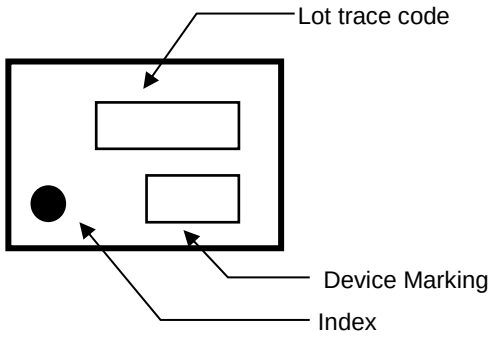
Characteristics	Symbol	Condition		Min	Max	Unit
Input voltage	V_{IN}	TCK22946G TCK22891G	—	1.1	5.5	V
		Others	—	1.4	5.5	
Output voltage	V_{OUT}	—		—	V_{IN}	V
CONTROL High-level input voltage	V_{IH}	1.2V < V_{IN} ≤ 5.5 V		1.0	—	V
		1.1V ≤V_{IN} ≤1.2 V		0.9	—	
CONTROL Low-level input voltage	V_{IL}	—		—	0.4	V

Pin Assignment(Top view)



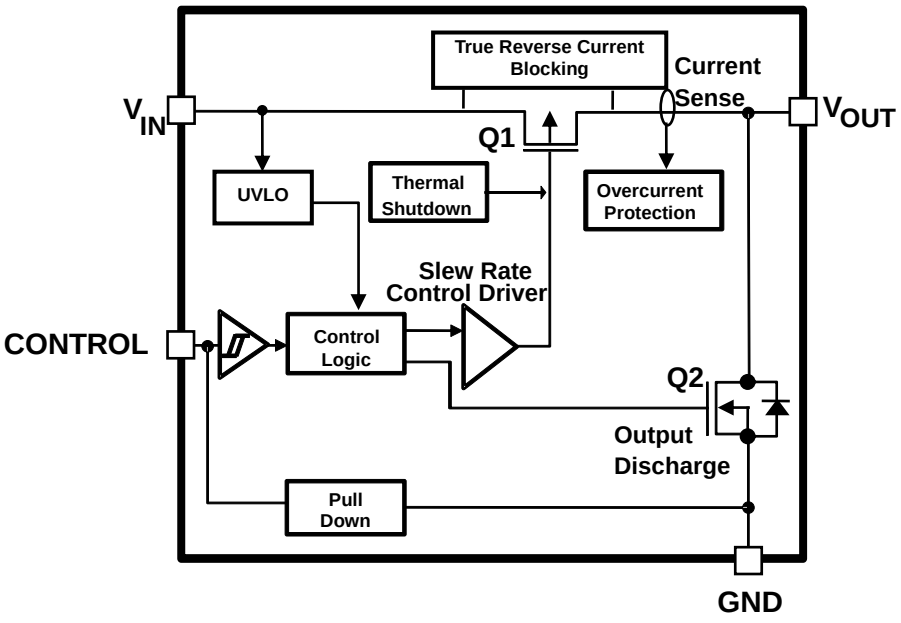
A1: V_{OUT}
B1: V_{OUT}
C1: GND
A2: V_{IN}
B2: V_{IN}
C2: CONTROL

Top marking

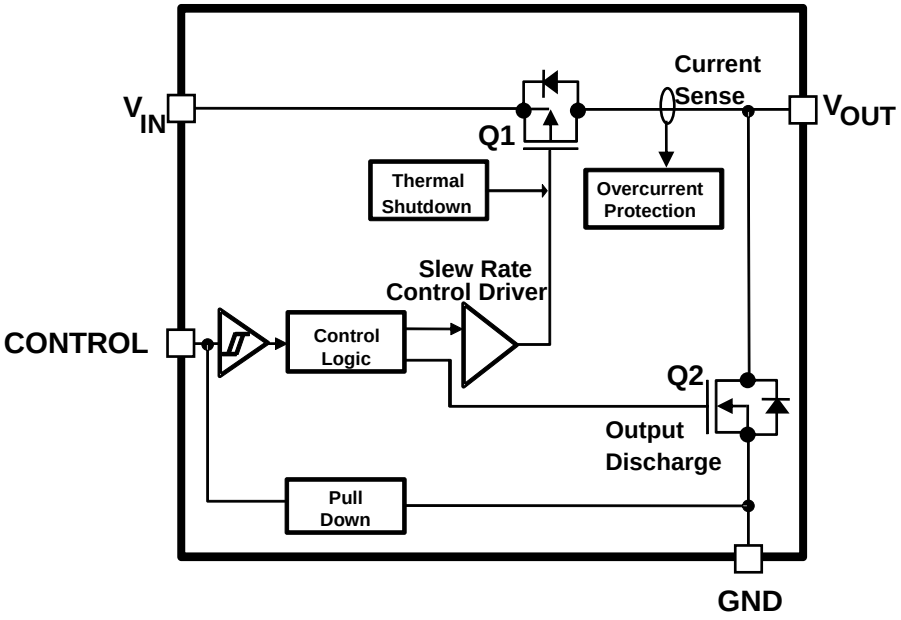


Block Diagram

TCK22946G, TCK22951G, TCK2065G, TCK1024G



TCK22891G, TCK22892G, TCK22893G, TCK22894G



Operation logic table

		TCK22946G, TCK22951G TCK2065G, TCK1024G	TCK22891G, TCK22892G TCK22893G, TCK22894G
Control "High"	Output Q_1	ON	ON
	Discharge Q_2	OFF	OFF
	Reverse current blocking	Active	—
Control "Low"	Output Q_1	OFF	OFF
	Discharge Q_2	ON	ON
	Reverse current blocking	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	—	16	—	—	—	μA
			V_{IN} = 5.5 V	—	25	—	—	50	μA
Quiescent current (OFF state)	$I_{Q(OFF)}$	V_{IN} = 5.5 V, V_{OUT} = OPEN,		—	0.6	—	—	2.5	μA
Reverse blocking current	I_{RB}	V_{OUT} = 5.0 V, V_{IN} = 0 V, RCB active (Note 2)		—	0.01	—	—	2	μA
Reverse blocking voltage threshold	V_{RB}	$V_{OUT} – V_{IN}$ (Note 2)		—	35	—	—	—	mV
Reverse blocking release voltage threshold	V_{RBR}	$V_{OUT} – V_{IN}$ (Note 2)		—	-15	—	—	—	mV
Under Voltage Lock Out (UVLO) rising threshold	V_{UVL_RI}	— (Note 2)		—	0.82	—	—	1.1	V
Under Voltage Lock Out (UVLO) falling threshold	V_{UVL_FA}	— (Note 2)		—	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 (Note 3)	—	141	—	—	—	
			V_{IN} = 1.1 V (Note 3)	—	179	—	—	—	
Output Limited Current	I_{CL}	V_{IN} = 5.5 V	TCK22946G TCK22891G	—	400	—	—	—	mA
			TCK22951G TCK22892G	—	740	—	—	—	
			TCK2065G TCK22893G	—	1110	—	—	—	
			TCK1024G TCK22894G	—	1540	—	—	—	
Output discharge on resistance	R_{SD}	—		—	100	—	—	—	Ω

Note 2: Only applies to the TCK22946G, TCK22951G, TCK2065G and TCK1024G
Note 3: Only applies to the TCK22946G and TCK22891G

AC Characteristics (Ta = 25°C)

V_{IN} = 5.0 V

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,	—	50	—	μs
V_{OUT} fall time	t_f	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	50	—	μs
Turn on delay	t_{ON}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	40	—	μs
Turn off delay	t_{OFF}	V_{IN}= 5.0 V , R_L = 500 Ω , C_L=0.1 μF,	—	10	—	μs

AC Waveform

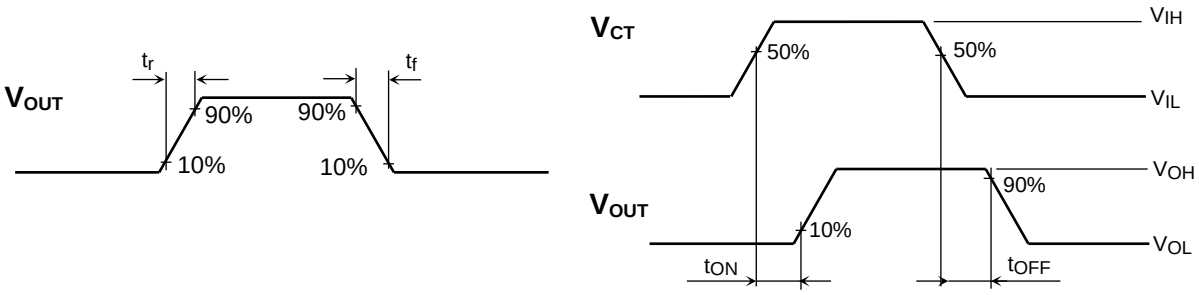
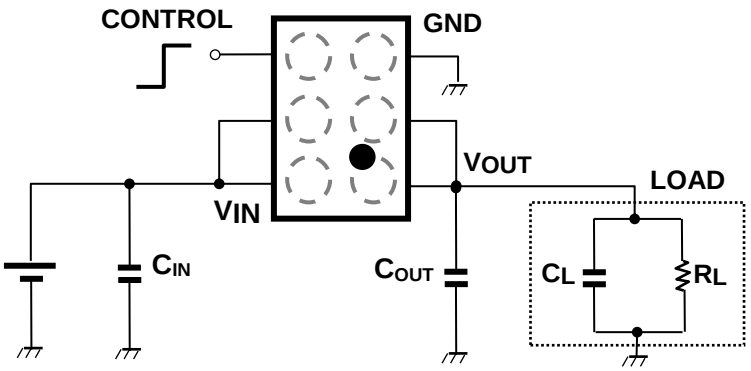


Figure 1 t_r, t_f, t_{ON}, t_{OFF} Waveforms

Application Note

1. Application circuit example (top view)

The figure below shows the example of configuration.



Control Voltage	Output Voltage
HIGH	ON
LOW	OFF
OPEN	OFF

1) Input and Output capacitor

An input capacitor (C_{IN}) and an output capacitor (C_{OUT}) are necessary for the stable operation. 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 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.

2. Over current limit function

This device has a built-in fold-back type of current-limiting circuit. Around 15% or more derating against typical values is recommended for system design with enough margin.

3. 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.

4. True reverse current blocking function(Option)

Some of these devices have 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)

5. Under-voltage Lockout function(Option)

Some of these devices have 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.

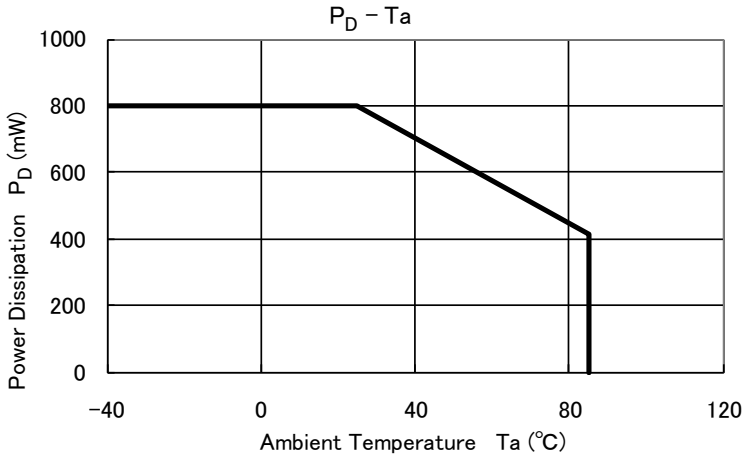
6. Instructions and directions for use

Each device has several built-in protection functions, but these do 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.

7. Power Dissipation

Power dissipation is measured on the board condition shown below.

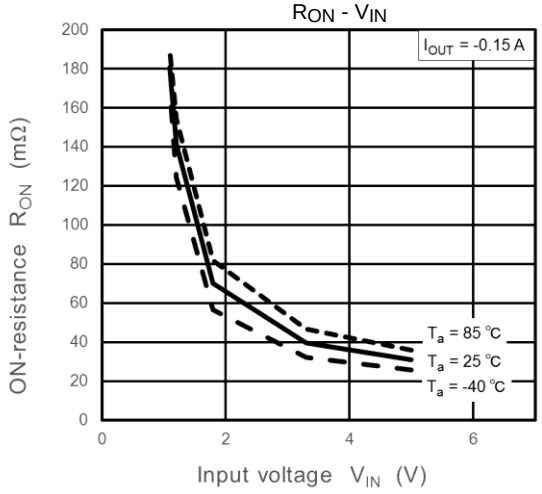
[The Board Condition]
Board material: Glass epoxy (FR4)
Board dimension: 40mm x 40mm (both sides of board), t=1.6mm
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
Through hole: diameter 0.5mm x 28



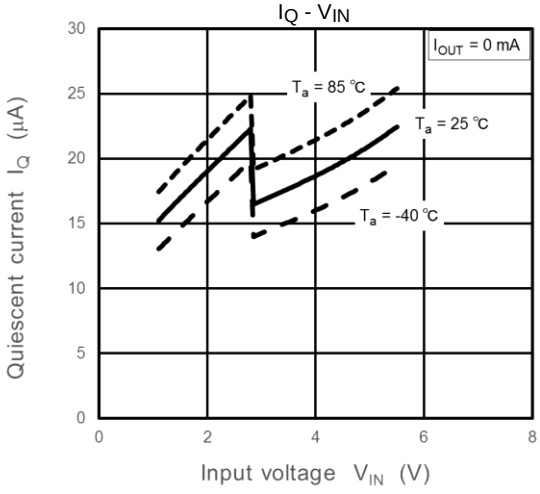
Please allow sufficient margin when designing a board pattern to fit the expected power dissipation. Also take into consideration the ambient temperature, input voltage, output current etc. and applying the appropriate derating for allowable power dissipation during operation.

TCK2291xG Representative Typical Characteristics

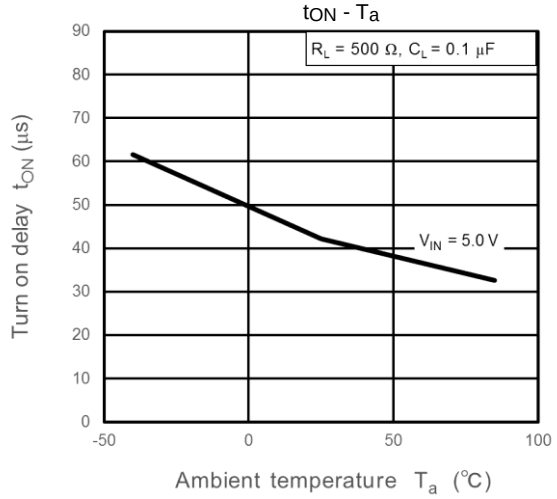
R_{ON} - V_{IN}



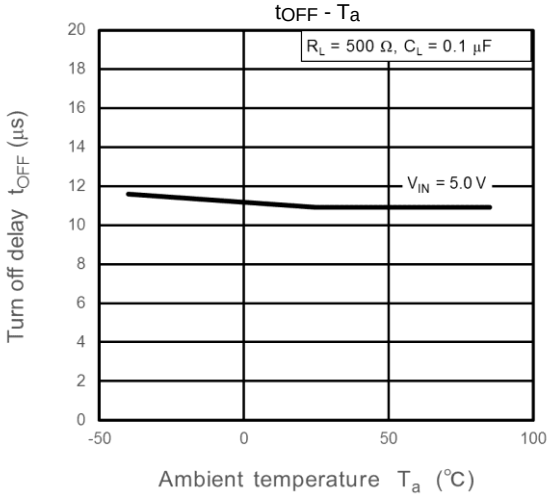
I_Q - V_{IN}



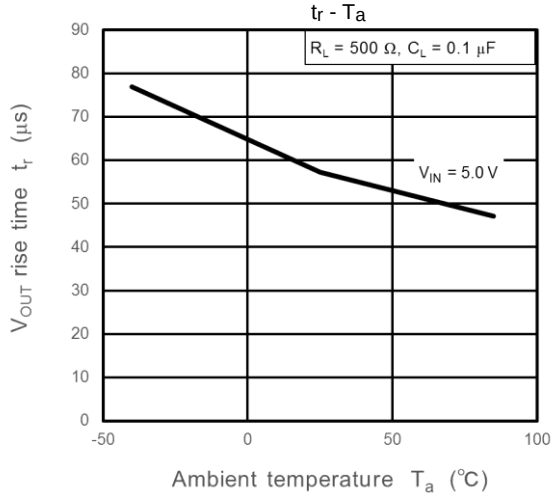
t_{ON} - Ta



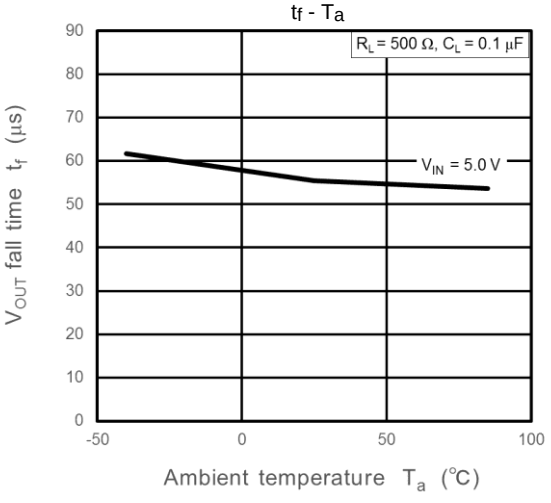
t_{OFF} - Ta



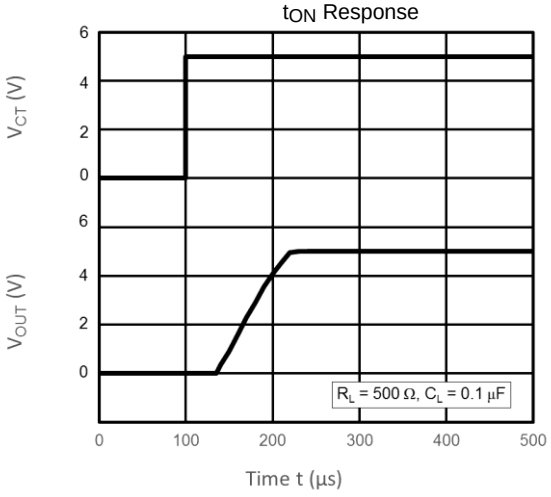
t_r - Ta



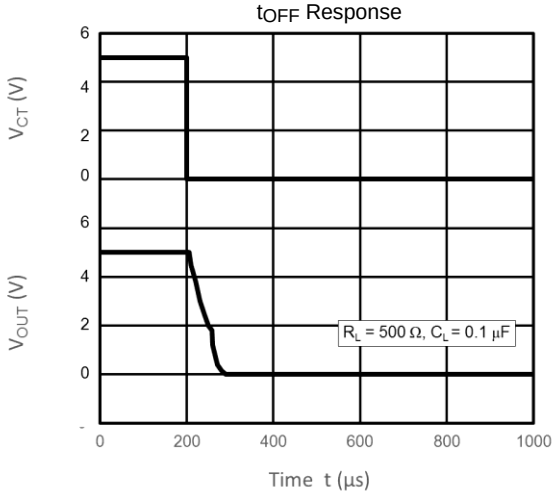
t_f - Ta



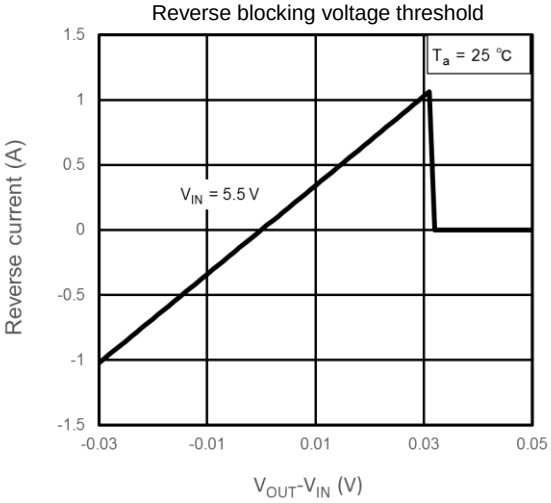
t_{ON} Response



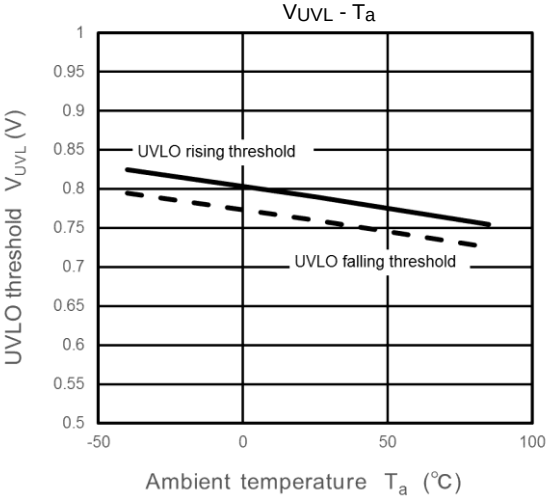
t_{OFF} Response



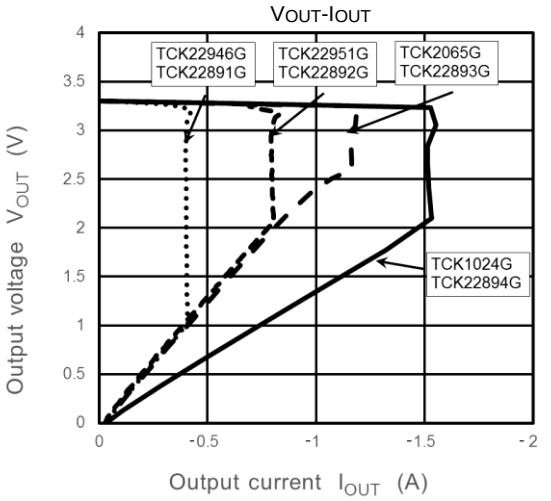
Reverse blocking voltage threshold



V_{UVL} - Ta



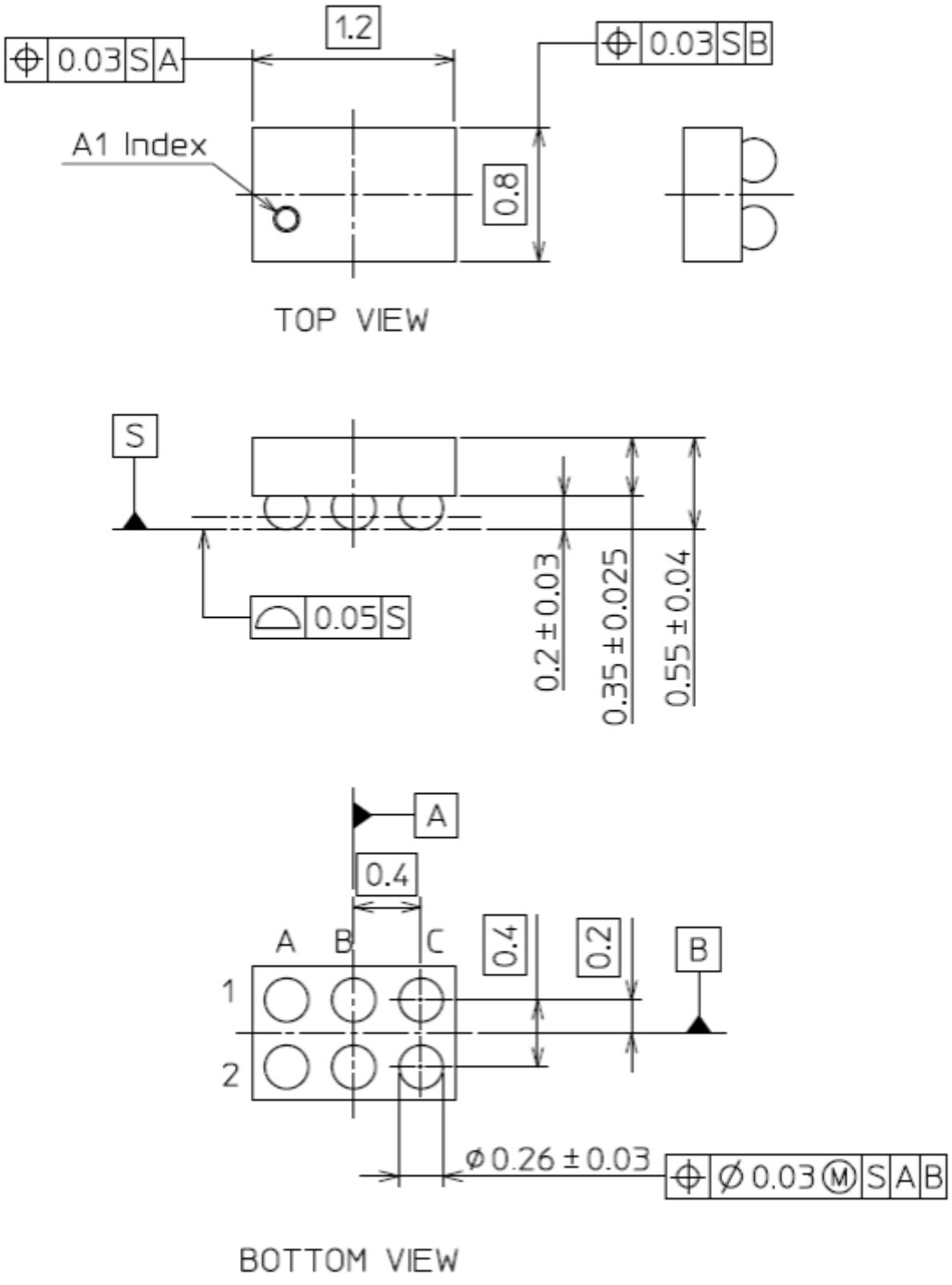
V_{OUT}-I_{OUT}



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

Package dimension

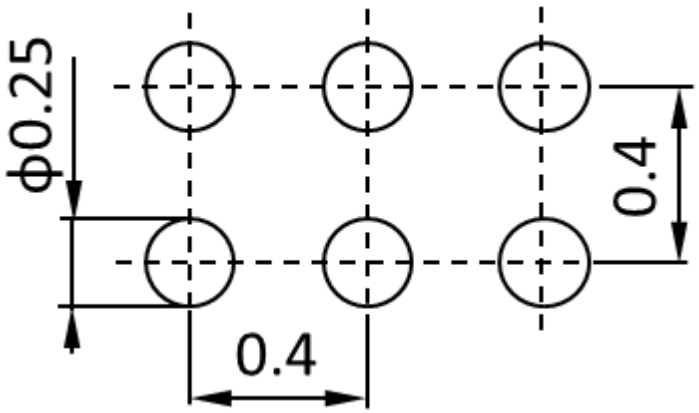
Unit: mm



Weight: 1 mg (typ.)

Land pattern dimensions (for reference only)

Unit：mm



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