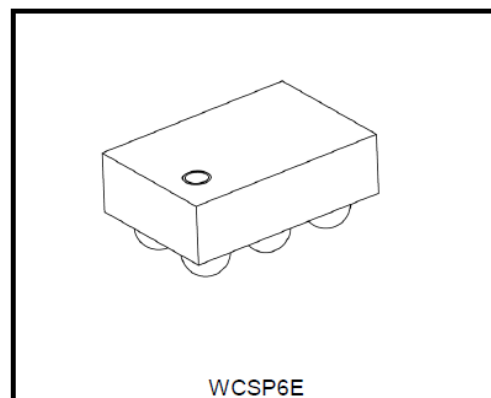


TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK401G, TCK402G

## External FET Driver IC

The TCK401G and TCK402G are 28 V high input voltage External FET driver ICs. They have wide input voltage range. And they feature a slew rate control driver with small package WCSP6E (0.8 mm x 1.2 mm, t: 0.55 mm). Also they can block reverse current if switch turned off by using external series FET. Thus they are suitable for power management selector such as Battery Charge application.

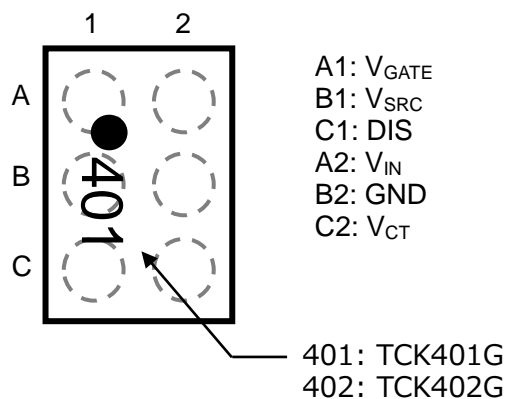


Weight: 1 mg(typ.)

### Feature

- High maximum input voltage:  $V_{IN\ max} = 40\ V$
- Wide input voltage range:  $V_{IN} = 2.7\ to\ 28\ V$
- Auto output discharge
- Charge pump circuit
- Inrush current reducing circuit.
- Over voltage lock out (Over 28 V)
- Under voltage lock out (Under 2.7 V)
- Reverse current protection by External Back to Back MOSFET

### Top marking (Top view)



Start of commercial production  
2017-10

### • Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Input voltage	V <sub>IN</sub>	-0.3 to 40	V
Control voltage	V <sub>CT</sub>	-0.3 to 6	V
Output GATE voltage	V <sub>GATE</sub>	-0.3 to V <sub>IN_opr</sub> + V <sub>GS</sub>	V
SRC voltage	V <sub>SRC</sub>	-0.3 to V <sub>GATE</sub>	V
DIS voltage	V <sub>DIS</sub>	-0.3 to 40	V
Power dissipation	P <sub>D</sub>	800 (Note 1)	mW
Operating temperature range	T <sub>opr</sub>	-40 to 85	°C
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. 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).

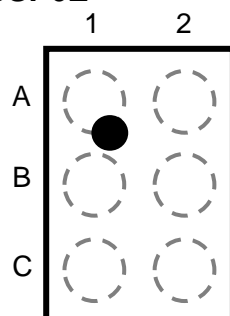
Note1: Rating at mounting on a board: FR4 board. ( 40 mm × 40 mm × 1.6 mm, Cu 4 layer )

### • Operating Conditions

Characteristics	Symbol	Min.	Typ.	Max.	Unit
Input operation voltage	V <sub>IN_opr</sub>	2.7	5.0	28	V
Capacitance	C <sub>IN</sub>	0.1	1	—	μF
	C <sub>GATE</sub>	—	2000	—	pF
CONTROL High-level input voltage	V <sub>IH</sub>	1.6	—	—	V
CONTROL Low-level input voltage	V <sub>IL</sub>	—	—	0.4	V

### Pin Assignment (Top view)

#### WCSP6E

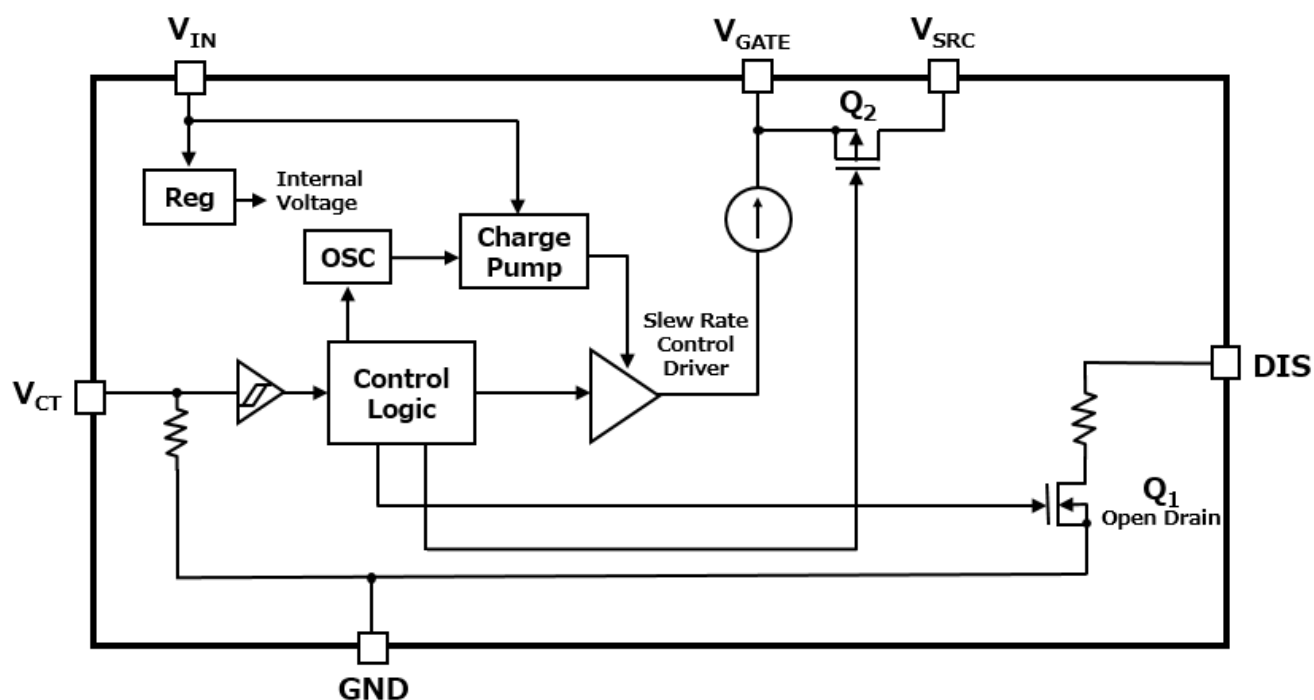


Pin #	Name	Pin #	Name
A1	$V_{GATE}$	A2	$V_{IN}$
B1	$V_{SRC}$	B2	GND
C1	DIS	C2	$V_{CT}$

### Product list

Part number	VCT function	VCT resistance
TCK401G	Active High	Pull down
TCK402G	Active Low	Pull down

### Block Diagram



### TCK401G PIN Description

PIN	Name	Description
A1	V <sub>GATE</sub>	Gate-Driver Output.
A2	V <sub>IN</sub>	Supply voltage input.
B1	V <sub>SRC</sub>	Recommend connecting V <sub>SRC</sub> terminal to the common source connection of the external MOSFETs.
B2	GND	Ground
C1	DIS	Output Discharge terminal.
C2	V <sub>CT</sub>	Mode control input terminal. When V <sub>CT</sub> =High turn the external MOSFETs on, V <sub>CT</sub> =Low, turn the external MOSFETs off.

### • TCK402G PIN Description

PIN	Name	Description
A1	V <sub>GATE</sub>	Gate-Driver Output.
A2	V <sub>IN</sub>	Supply voltage input.
B1	V <sub>SRC</sub>	Recommend connecting V <sub>SRC</sub> terminal to the common source connection of the external MOSFETs.
B2	GND	Ground
C1	DIS	Output Discharge terminal.
C2	V <sub>CT</sub>	Mode control input terminal. When V <sub>CT</sub> =Low turn the external MOSFETs on, V <sub>CT</sub> =High, turn the external MOSFETs off.

•

### TCK401G Operation Status Table

2.7V ≤ V<sub>IN</sub> ≤ 28 V (Ta = -40 to 85°C)

V <sub>CT</sub>	V <sub>GATE</sub>	Discharge Q1	comment
High	ON (V <sub>IN</sub> + V <sub>GS</sub> )	OFF	Driver ON mode
Open	OFF	ON	Driver OFF mode
Low			

### TCK402G Operation Status Table

2.7V ≤ V<sub>IN</sub> ≤ 28 V (Ta = -40 to 85°C)

V <sub>CT</sub>	V <sub>GATE</sub>	Discharge Q1	comment
Low	ON (V <sub>IN</sub> + V <sub>GS</sub> )	OFF	Driver ON mode
Open			
High	OFF	ON	Driver OFF mode

### DC Characteristics (Ta = -40 to 85°C)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = −40 to 85°C (Note 2)		Unit
				Min.	Typ.	Max.	Min	Max	
Input quiescent current (ON state)	IQ(ON)	TCK401G	VCT: High, VIN = 5.0 V	—	121	—	—	222	μA
			VCT: High, VIN = 9.0 V	—	144	—	—	283	μA
			VCT: High, VIN = 12 V	—	159	—	—	294	μA
			VCT: High, VIN = 20 V	—	198	—	—	376	μA
		TCK402G	VCT: Low, VIN = 5.0 V	—	121	—	—	222	μA
			VCT: Low, VIN = 9.0 V	—	144	—	—	283	μA
			VCT: Low, VIN = 12 V	—	159	—	—	294	μA
			VCT: Low, VIN = 20 V	—	198	—	—	376	μA
Standby current (OFF state)	IQ(OFF)	TCK401G	VCT: Low, VIN = 5.0 V	—	3.0	—	—	4.8	μA
			VCT: Low, VIN = 9.0 V	—	5.9	—	—	8.2	μA
			VCT: Low, VIN = 12 V	—	8.0	—	—	11.2	μA
			VCT: Low, VIN = 20 V	—	13.8	—	—	19.2	μA
		TCK402G	VCT: High, VIN = 5.0 V	—	3.0	—	—	4.8	μA
			VCT: High, VIN = 9.0 V	—	5.9	—	—	8.2	μA
			VCT: High, VIN = 12 V	—	8.0	—	—	11.2	μA
			VCT: High, VIN = 20 V	—	13.8	—	—	19.2	μA
GATE Drive voltage(VGATE-VIN)	VGS	VIN = 3 V		—	4.0	—	2.8	5.1	V
		VIN = 5 V		—	6.5	—	5.1	7.9	V
		VIN = 9.0 V		—	6.5	—	5.1	7.9	V
		12 V ≤ VIN ≤ 28 V		—	8.5	—	6.9	10.0	V
Output current	IGATE(ON)	VIN = 5 V		—	38	—	—	—	μA
DIS resistance	RDIS	—		—	21	—	—	—	kΩ
Control pull down resistance	RCT	VCT= 5 V		—	600	—	—	—	kΩ

Note 2: This parameter is warranted by design.

• **AC Characteristics ( $T_a = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{ V}$ ,  $C_{GATE} = 2000\text{ pF}$ )**

Characteristics	Symbol	Test Condition (Figure 1,2)	Min.	Typ.	Max.	Unit
VGATE ON time	$t_{ON}$	Initial startup time of VGATE (Note 3) voltage from 0 V to $V_{IN} + 1\text{ V}$	—	0.58	0.8	ms
VGATE OFF time	$t_{OFF}$	$V_{GATE} = 0.5\text{ V}$	—	16.6	—	$\mu\text{s}$
VGATE rise time	$t_r$	VGATE rising from $V_{IN} + 1\text{ V}$ to $V_{IN} + 3\text{ V}$	—	0.2	—	ms
VGATE fall time	$t_f$	VGATE falling from $V_{IN} + 3\text{ V}$ to $V_{IN} + 1\text{ V}$	—	1.5	—	$\mu\text{s}$

Note 3: This parameter is warranted by design.

• **AC Characteristics ( $T_a = 25^\circ\text{C}$ ,  $V_{IN} = 9\text{ V}$ ,  $C_{GATE} = 2000\text{ pF}$ )**

Characteristics	Symbol	Test Condition (Figure 1,2)	Min.	Typ.	Max.	Unit
VGATE ON time	$t_{ON}$	Initial startup time of VGATE (Note 4) voltage from 0 V to $V_{IN} + 1\text{ V}$	—	0.78	1.0	ms
VGATE OFF time	$t_{OFF}$	$V_{GATE} = 0.5\text{ V}$	—	19.7	—	$\mu\text{s}$
VGATE rise time	$t_r$	VGATE rising from $V_{IN} + 1\text{ V}$ to $V_{IN} + 4\text{ V}$	—	0.35	—	ms
VGATE fall time	$t_f$	VGATE falling from $V_{IN} + 4\text{ V}$ to $V_{IN} + 1\text{ V}$	—	1.6	—	$\mu\text{s}$

Note 4: This parameter is warranted by design.

• **AC Characteristics ( $T_a = 25^\circ\text{C}$ ,  $V_{IN} = 12\text{ V}$ ,  $C_{GATE} = 2000\text{ pF}$ )**

Characteristics	Symbol	Test Condition (Figure 1,2)	Min.	Typ.	Max.	Unit
VGATE ON time	$t_{ON}$	Initial startup time of VGATE (Note 5) voltage from 0 V to $V_{IN} + 1\text{ V}$	—	0.92	1.2	ms
VGATE OFF time	$t_{OFF}$	$V_{GATE} = 0.5\text{ V}$	—	21.3	—	$\mu\text{s}$
VGATE rise time	$t_r$	VGATE rising from $V_{IN} + 1\text{ V}$ to $V_{IN} + 5\text{ V}$	—	0.6	—	ms
VGATE fall time	$t_f$	VGATE falling from $V_{IN} + 5\text{ V}$ to $V_{IN} + 1\text{ V}$	—	1.7	—	$\mu\text{s}$

Note 5: This parameter is warranted by design.

### Timing chart

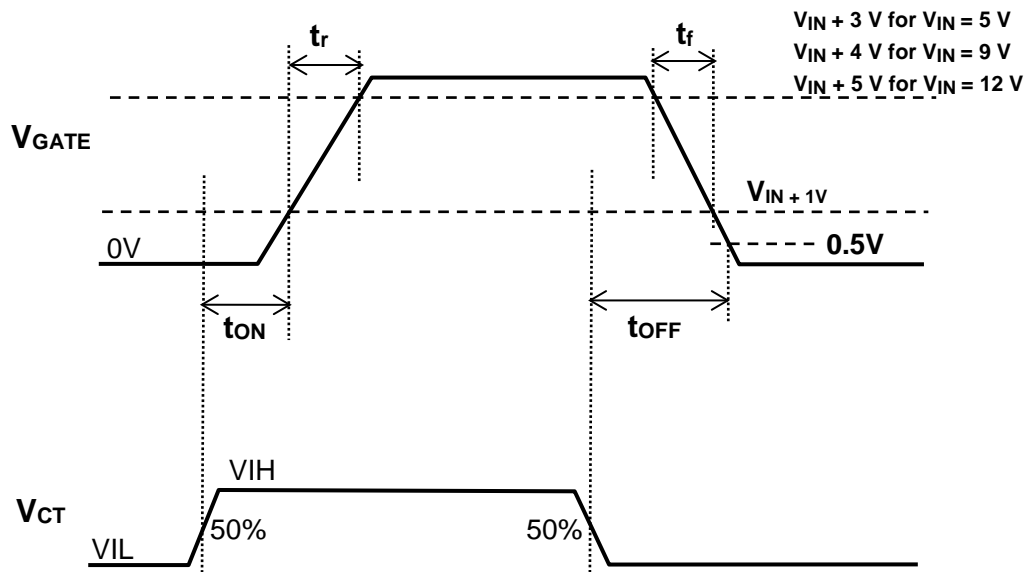


Fig.1 Active High (TCK401G)

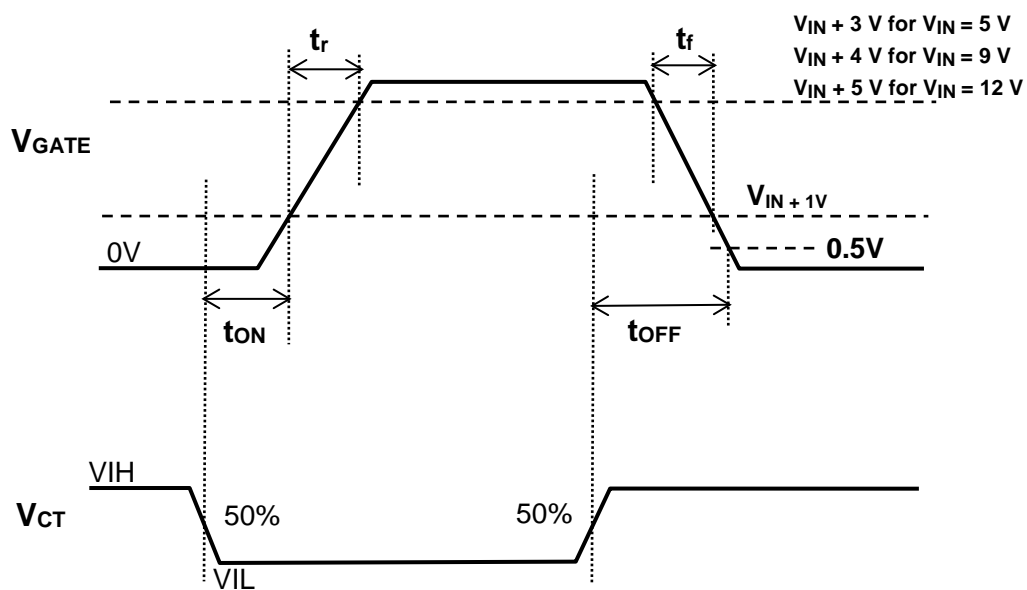
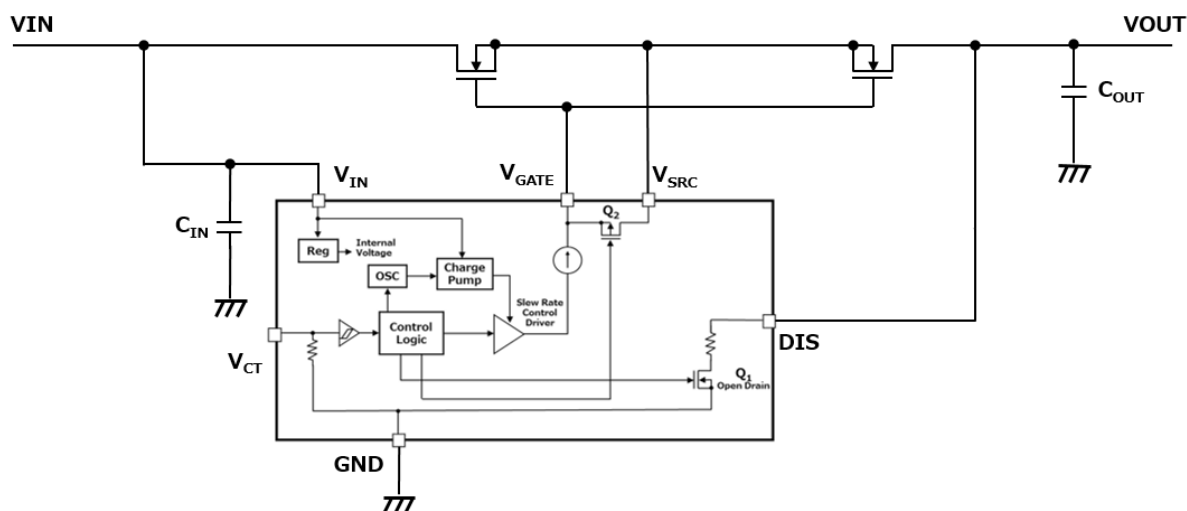


Fig.2 Active Low (TCK402G)

- Application Note
  - Application circuit example



### 1) Input and Output capacitor

An input capacitor ( $C_{IN}$ ) and an output capacitor ( $C_{OUT}$ ) are recommended for the stable operation of TCK401G and TCK402G. 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  $1.0\mu F$  as close to TCK40xG to improve stability of the power supply.

### 2) $V_{CT}$ pin

$V_{CT}$  pin for TCK401G and TCK402G is operated by the control voltage and has 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.

### 3) $V_{SRC}$ Pin

For Dual MOSFET Driver,  $V_{SRC}$  works to short between  $V_{GATE}$  and MOSFET source when Driver IC turn off. If there are enough margins of  $V_{GS}$  of MOSFET,  $V_{SRC}$  terminal Open state is no problem.

For Single MOSFET Driver, if there is enough margin of  $V_{GS}$  of MOSFET,  $V_{SRC}$  pin Open state is no problem. If there are not enough margins, we recommend connecting  $V_{SRC}$  and  $V_{OUT}$ . If connect  $V_{SRC}$  and  $V_{OUT}$ ,  $t_{OFF}$  time become longer because of  $C_{OUT}$ . Therefore, please consider enough margins for MOSFET selection.

### 4) DIS Pin

If discharge function is needed when Driver IC turns off, please connect DIS Pin to  $V_{OUT}$ . If no need, DIS Pin Open state is no problem.

### 5) Over Voltage Protection off time ( $t_{OVP}$ )

Over Voltage ( $V_{IN}$  is over  $V_{IN\_opr\_max}$ ) Protection off time ( $t_{OVP}$ ) is similar to  $V_{GATE}$  OFF time ( $t_{OFF}$ ).

## Timing chart

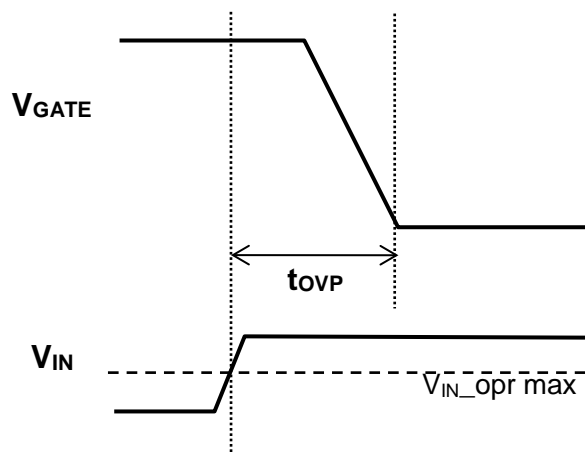
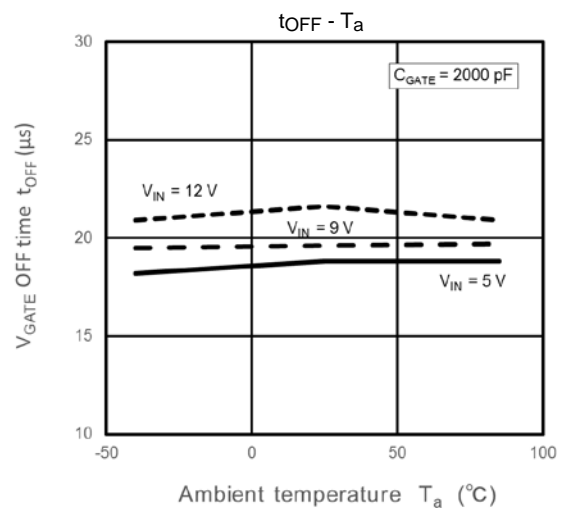
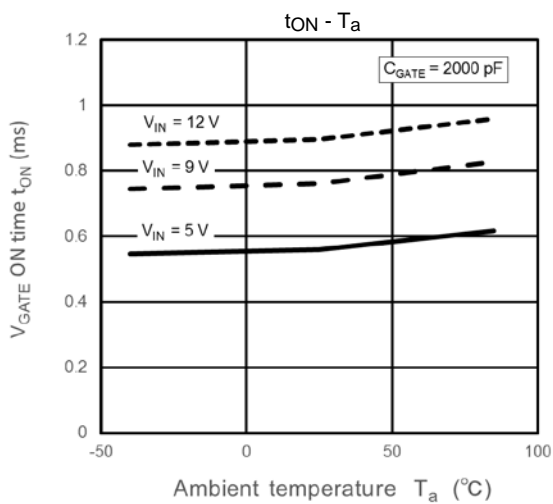
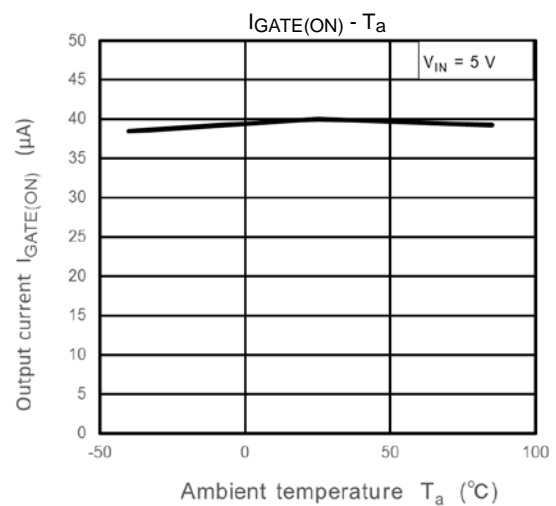
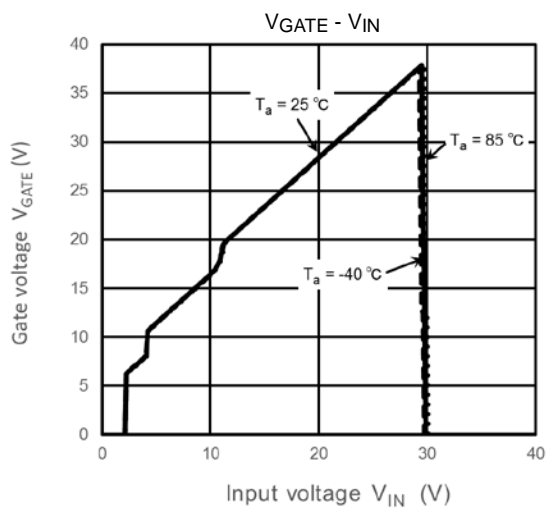
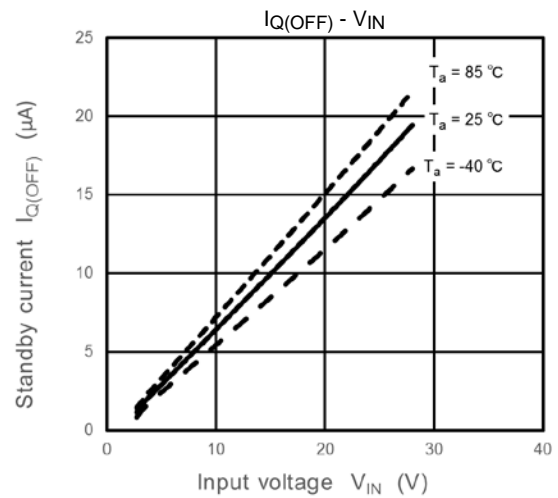
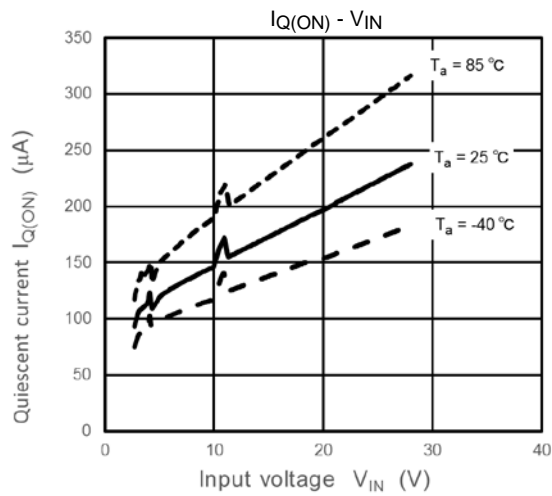
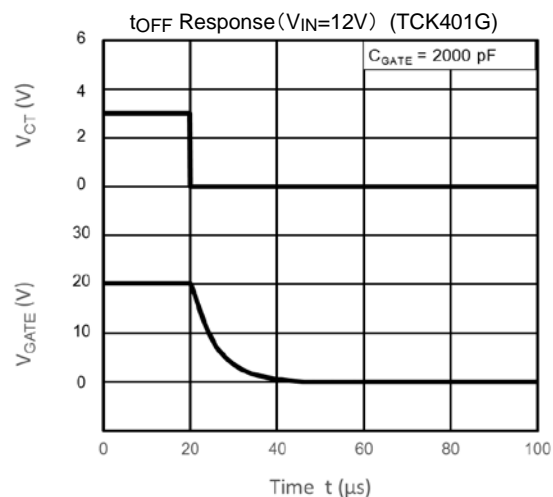
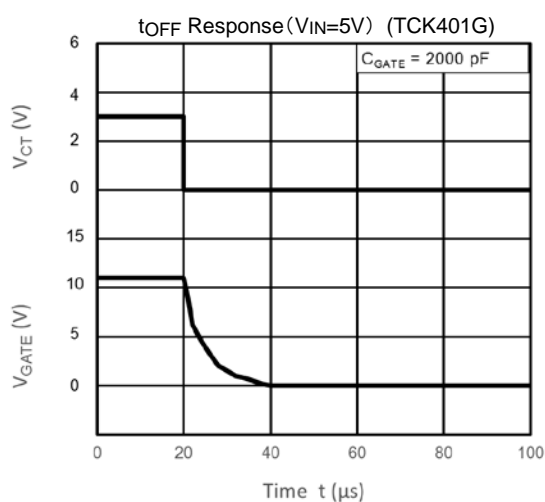
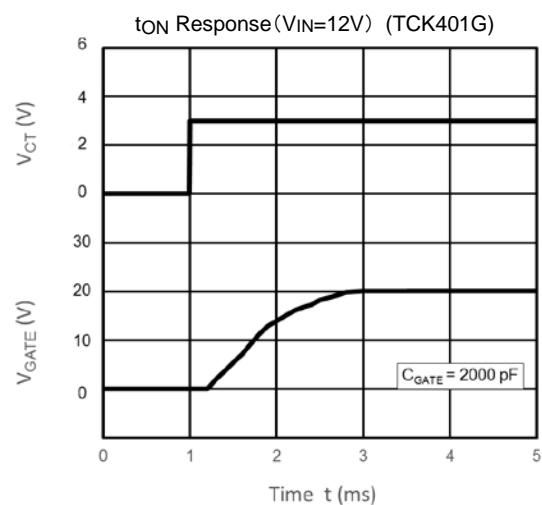
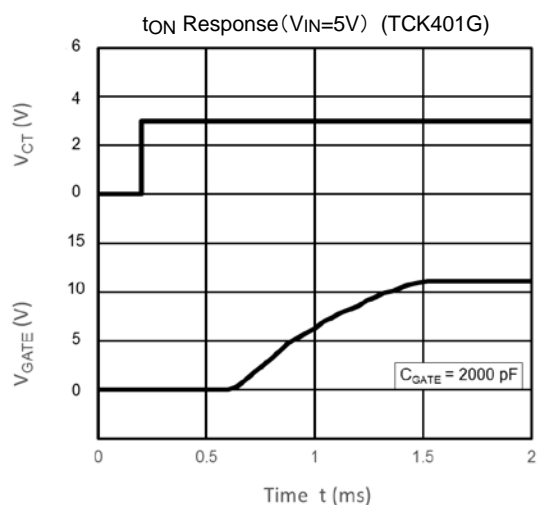


Fig.3  $t_{OVP}$



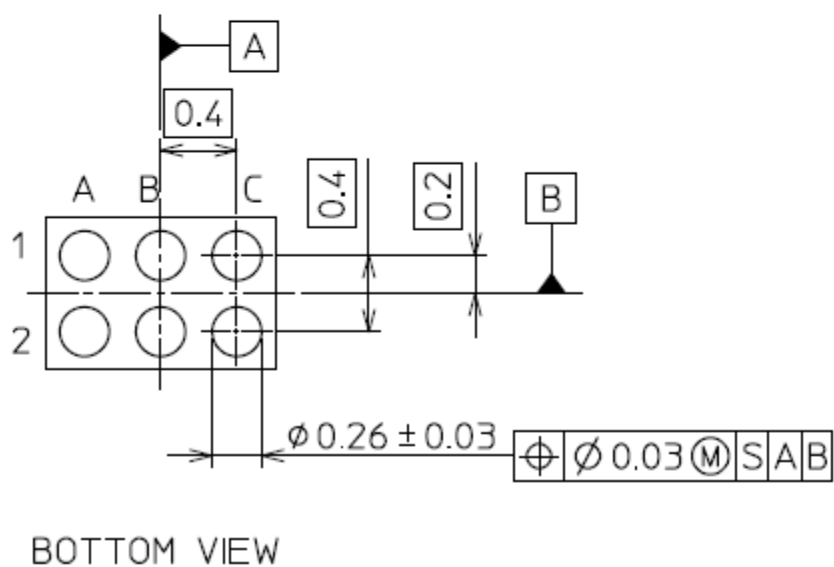
### Representative Typical Characteristics





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

## Unit: mm

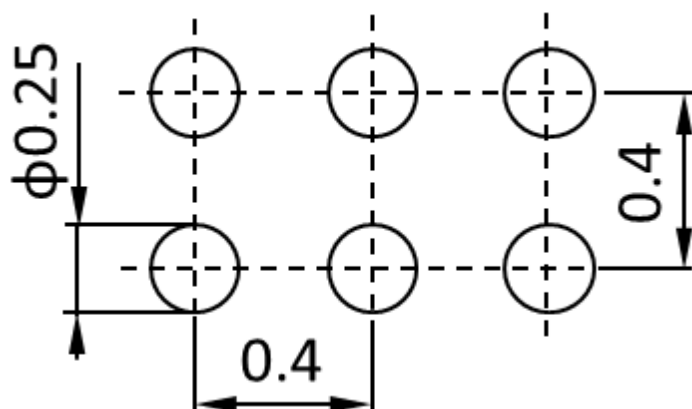


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2019-12-13

Land pattern dimensions (for reference only)

Unit: mm



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