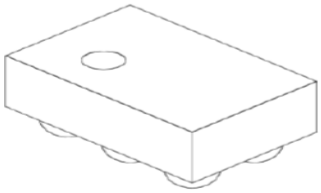
TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

# TCK42xG Series

Over Voltage Protection MOSFET Gate Driver IC

## 1. Description

TCK42xG series is Over Voltage Protection Gate Driver IC for External N-channel MOSFET. This product support to MOSFET operating in wide voltage line from 2.7 V to 28 V with various Over Voltage Lock Out lineups. And this features low standby current, less than 1 μA, built in charge pump circuit and MOSFET gate-source protection circuit. Package is very small and thin WCSP6G (1.2 mm x 0.8 mm (typ.), t: 0.35 mm (max)). Thus this is suitable for mobile, wearable system and power management circuit such as load switch application.



WCSP6G

Weight : 0.61 mg ( typ.)

## 2. Applications

Load switch circuit for mobile, wearable, and IoT equipment

## 3. Features

- Gate driver for N-channel Common Drain MOSFET
- Gate driver for N-channel Single High side MOSFET
- High maximum input voltage: $V_{IN\ max}$ = 40 V
- Wide input voltage operation: $V_{IN}$ = 2.7 to 28 V
- Gate-Source protection circuit
- Over Voltage Lock Out : $V_{IN\_OVLO}$ = 6.31 V, 10.83 V, 14.29 V, 23.26 V and 27.73 V typ
- Under Voltage Lock Out : $V_{IN\_UVLO}$ = 2.0 V typ
- Built in Charge pump circuit: Gate source voltage $V_{GS}$ = 5.6 V and 10 V typ
- Low standby current : $I_{Q(OFF)}$ = 0.9 μA max at $V_{IN}$ = 12 V (Except TCK424G, TCK425G)

Start of commercial production
2021-11

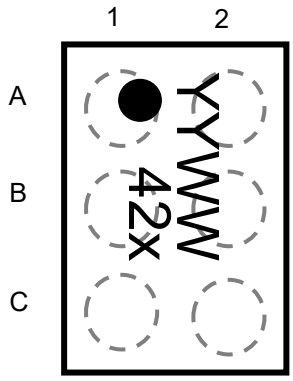
## 4. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Input voltage | $V_{IN}$ | -0.3 to 40 | V |
| Output voltage | $V_{OUT}$ | -0.3 to 40 | V |
| Control voltage | $V_{CT}$ | -0.3 to 6 | V |
| Output GATE voltage | $V_{GATE1,2}$ | -0.3 to 40 | V |
| Power dissipation | $P_D$ | 800 (Note 1) | mW |
| Operating temperature range | $T_{opr}$ | -40 to 85 | °C |
| Junction temperature | 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: FR4 board. ( 40 mm × 40 mm × 1.6 mm, Cu 4 layer )

## 5. Top Marking, Pin Assignment (top view)




A1: VGATE1
B1: VGATE2
C1: VOUT
A2: VIN
B2: GND
C2: VCT

YYWW: Lot No.

42x: Device name code
420: TCK420G
421: TCK421G
422: TCK422G
423: TCK423G
424: TCK424G
425: TCK425G

## 6. Operating Ranges

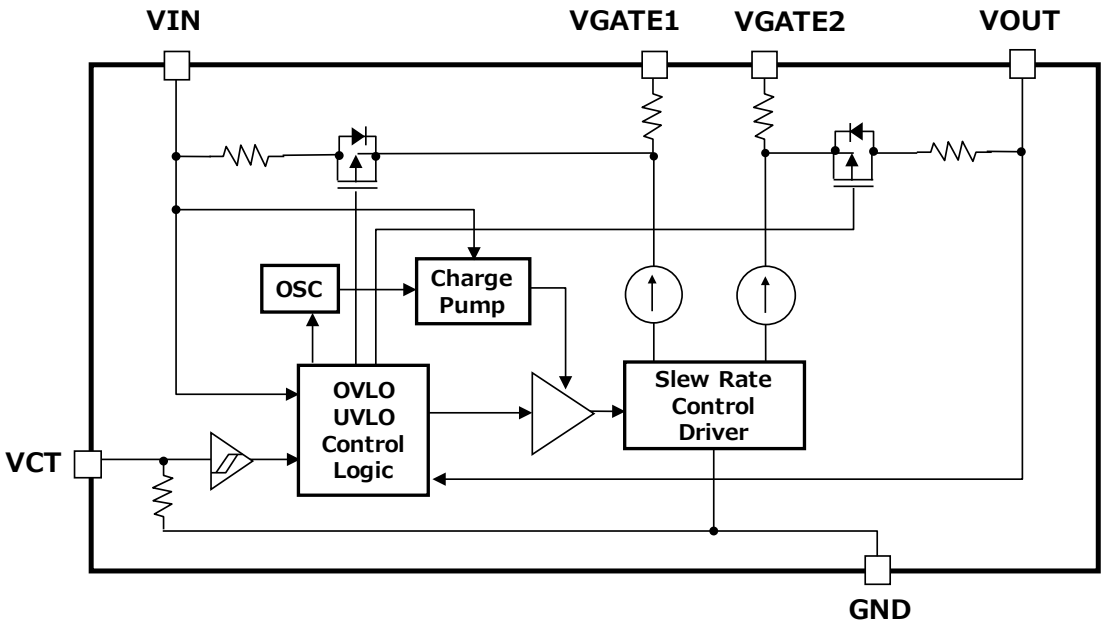
| Characteristics | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Input operation voltage | $V_{IN\_opr}$ (Note 2) | 2.7 | — | 28 | V |
| CONTROL High-level input voltage | $V_{IH}$ | 1.2 | — | 5.5 | V |
| CONTROL Low-level input voltage | $V_{IL}$ | — | — | 0.4 | V |

Note 2: $V_{IN\_opr} < V_{IN\_OVLO\ Max}$ of each product

## 7. List of Products Number, OVLO and VGS

| Product number | OVLO threshold, falling typ (V) | External MOSFET Gate-Source voltage (Control ON) typ (V) |
|---|---|---|
| TCK420G | 27.73 | 10 |
| TCK421G | 23.26 | 10 |
| TCK422G | 14.29 | 10 |
| TCK423G | 14.29 | 5.6 |
| TCK424G | 10.83 | 5.6 |
| TCK425G | 6.31 | 5.6 |

## 8. Block Diagram




## 9. PIN Description

| PIN | Name | Description |
|---|---|---|
| A1 | VGATE1 | Gate Driver Output for Gate 1<br>Or OPEN state (Non connection) for Single MOSFET use case |
| B1 | VGATE2 | Gate Driver Output for Gate 2 |
| C1 | VOUT | Monitoring Output voltage<br>Connecting Output (Source 2) of Common Drain MOSFET<br>Or Connecting Output (Source) of single MOSFET use case |
| A2 | VIN | Input power supply voltage<br>Connecting Output (Source 1) of Common Drain MOSFET<br>Or Connecting Output (Drain) of single MOSFET use case |
| B2 | GND | Ground |
| C2 | VCT | Mode control input terminal<br>VCT=High turn the external MOSFETs ON, VCT=Low, turn the external MOSFETs OFF |

## 10. Operation Table

**2.7V ≤ $V_{IN}$ ≤ 28 V (Ta = -40 to 85°C)**

| VCT | VGATE1, VGATE2 |
|---|---|
| High | Driver ON mode |
| Open | Driver OFF mode |
| Low | |

# 11. Electrical Characteristics

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

| Characteristics | | Symbol | Test Condition | Ta = 25°C | | | Ta = -40 to 85°C (Note 3) | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| VIN UVLO threshold, $V_{OUT}$ falling | | $V_{IN\_UVLO}$ | — | — | 2.0 | — | — | 2.5 | V |
| VIN UVLO hysteresis | | $V_{IN\_UVhyst}$ | — | — | 0.2 | — | — | — | V |
| VIN OVLO threshold, $V_{OUT}$ falling | TCK420G | $V_{IN\_OVLO}$ | — | — | 27.73 | — | 26.50 | 28.50 | V |
| | TCK421G | | — | — | 23.26 | — | 22.34 | 24.05 | V |
| | TCK422G<br>TCK423G | | — | — | 14.29 | — | 13.61 | 14.91 | V |
| | TCK424G | | — | — | 10.83 | — | 10.35 | 11.47 | V |
| | TCK425G | | — | — | 6.31 | — | 5.76 | 6.87 | V |
| VIN OVLO hysteresis | TCK420G | $V_{IN\_OVhyst}$ | — | — | 0.17 | — | — | — | V |
| | TCK421G<br>TCK422G<br>TCK423G<br>TCK424G<br>TCK425G | | — | — | 0.12 | — | — | — | V |
| Input quiescent current (ON state) | TCK420G<br>TCK421G<br>TCK422G | $I_{Q(ON)}$ | $V_{CT}$: High, $V_{IN}$ = 2.7 V | — | 140 | — | — | 200 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 4 V | — | 130 | — | — | 420 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 5 V | — | 140 | — | — | 300 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 9 V | — | 170 | — | — | 460 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 12 V | — | 185 | — | — | 490 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 20 V (Except TCK422G) | — | 220 | — | — | 560 | μA |
| | TCK423G<br>TCK424G<br>TCK425G | | $V_{CT}$: High, $V_{IN}$ = 2.7 V | — | 75 | — | — | 130 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 4 V | — | 95 | — | — | 150 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 5 V | — | 100 | — | — | 160 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 9 V (Except TCK425G) | — | 125 | — | — | 200 | μA |
| | | | $V_{CT}$: High, $V_{IN}$ = 12 V (TCK423G only) | — | 140 | — | — | 225 | μA |
| Standby current (OFF state) | | $I_{Q(OFF)}$ | $V_{CT}$: Low, $V_{IN}$ = 2.7 V | — | 0.14 | — | — | 0.3 | μA |
| | | | $V_{CT}$: Low, $V_{IN}$ = 4 V | — | 0.25 | — | — | 0.4 | μA |
| | | | $V_{CT}$: Low, $V_{IN}$ = 5 V | — | 0.28 | — | — | 0.5 | μA |
| | | | $V_{CT}$: Low, $V_{IN}$ = 9 V (Except TCK425G) | — | 0.42 | — | — | 0.7 | μA |
| | | | $V_{CT}$: Low, $V_{IN}$ = 12 V (Except TCK424G, TCK425G) | — | 0.52 | — | — | 0.9 | μA |
| | | | $V_{CT}$: Low, $V_{IN}$ = 20 V (TCK420G and TCK421G) | — | 0.80 | — | — | 1.3 | μA |

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

| Characteristics | | Symbol | Test Condition | Ta = 25°C | | | Ta = -40 to 85°C (Note 3) | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| GATE Drive voltage ($V_{GATE1}$-$V_{IN}$) ($V_{GATE2}$-$V_{OUT}$) | TCK420G TCK421G TCK422G | $V_{GS}$ (Note 4) | $V_{IN}$ = 2.7 V | — | 9.2 | — | 8 | 10 | V |
| | | | $V_{IN}$ = 5 V | — | 10 | — | 9 | 11 | V |
| | | | $V_{IN}$ = 9 V | — | 10 | — | 9 | 11 | V |
| | | | $V_{IN}$ = 12 V | — | 10 | — | 9 | 11 | V |
| | | | $V_{IN}$ = 20 V (Except TCK422G) | — | 10 | — | 9 | 11 | V |
| | | | $V_{IN}$ = 24 V (TCK420G only) | — | 10 | — | 9 | 11 | V |
| | TCK423G TCK424G TCK425G | | $V_{IN}$ = 2.7 V | — | 5.6 | — | 4.9 | 6.3 | V |
| | | | $V_{IN}$ = 5 V | — | 5.6 | — | 5.0 | 6.3 | V |
| | | | $V_{IN}$ = 9 V (Except TCK425G) | — | 5.6 | — | 5.0 | 6.3 | V |
| | | | $V_{IN}$ = 12 V (TCK423G only) | — | 5.6 | — | 5.0 | 6.3 | V |
| Control pull down resistance | | $R_{CT}$ | $V_{CT}$ = 5 V | — | 550 | — | — | — | kΩ |

Note 3: This parameter is warranted by design
Note 4: $V_{IN}$ is stable power supply condition

### 11.2. AC Characteristics (Ta = 25°C, $V_{IN}$ = 5 V, $C_{GATE1,2}$ (Note 5) = 4000 pF)

| Characteristics | | Symbol | Test Condition (Figure 2,3,4) | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{GS}$ ON time | | $t_{ON}$ | Initial startup time<br>$V_{GATE2} - V_{OUT}$ = 1 V after $V_{CT}$ = High, $I_{OUT}$ = 0 mA | — | 2.9 | — | ms |
| $V_{GS}$ OFF time | TCK420G<br>TCK421G<br>TCK422G | $t_{OFF}$ | $V_{GATE2}$ - $V_{OUT}$ = 1 V, after $V_{CT}$ = Low, $I_{OUT}$ = 0 mA | — | 52 | — | μs |
| | TCK423G<br>TCK424G<br>TCK425G | | | — | 23 | — | μs |

### 11.3. AC Characteristics (Ta = 25°C, $V_{IN}$ = 12 V, $C_{GATE1,2}$ (Note 5) = 4000 pF)

| Characteristics | | Symbol | Test Condition (Figure 2,3,4) | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{GS}$ ON time | | $t_{ON}$ | Initial startup time<br>$V_{GATE2} - V_{OUT}$ = 1 V after $V_{CT}$ = High, $I_{OUT}$ = 0 mA | — | 2.9 | — | ms |
| $V_{GS}$ OFF time | TCK420G<br>TCK421G<br>TCK422G | $t_{OFF}$ | $V_{GATE2}$ - $V_{OUT}$ = 1 V, after $V_{CT}$ = Low, $I_{OUT}$ = 0 mA | — | 44 | — | μs |
| | TCK423G | | | — | 16.4 | — | μs |

## TCK420G, TCK421G

### 11.4. AC Characteristics (Ta = 25°C, $V_{IN}$ = 20 V, $C_{GATE1,2}$ (Note 5) = 4000 pF)

| Characteristics | Symbol | Test Condition (Figure 2,3,4) | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{GS}$ ON time | $t_{ON}$ | Initial startup time<br>$V_{GATE2} - V_{OUT}$ = 1 V after $V_{CT}$ = High, $I_{OUT}$ = 0 mA | — | 2.9 | — | ms |
| $V_{GS}$ OFF time | $t_{OFF}$ | $V_{GATE2}$ - $V_{OUT}$ = 1 V, after $V_{CT}$ = Low, $I_{OUT}$ = 0 mA | — | 36 | — | μs |

## TCK420G

### 11.5. AC Characteristics (Ta = 25°C, $V_{IN}$ = 24 V, $C_{GATE1,2}$ (Note 5) = 4000 pF)

| Characteristics | Symbol | Test Condition (Figure 2,3,4) | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{GS}$ ON time | $t_{ON}$ | Initial startup time<br>$V_{GATE2} - V_{OUT}$ = 1 V after $V_{CT}$ = High, $I_{OUT}$ = 0 mA | — | 2.9 | — | ms |
| $V_{GS}$ OFF time | $t_{OFF}$ | $V_{GATE2}$ - $V_{OUT}$ = 1 V, after $V_{CT}$ = Low, $I_{OUT}$ = 0 mA | — | 32 | — | μs |

## 11.6. AC Characteristics (Ta = 25°C, $C_{GATE1,2}$ (Note 5) = 4000 pF)

| Characteristics | | Symbol | Test Condition (Figure 5,6) | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| OVLO $V_{GS}$ turn OFF time | TCK420G | $t_{OVP}$ | $V_{IN}$ = 24 to 29 V, $V_{IN\ rising}$ = 2 V/μs<br>$V_{GS}$ typ to $V_{GS}$ ($V_{GATE2}$-$V_{IN}$) = 1 V<br>$I_{OUT}$ = 0 mA | — | 31 | — | μs |
| | TCK421G | | $V_{IN}$ = 20 to 25 V, $V_{IN\ rising}$ = 2 V/μs<br>$V_{GS}$ typ to $V_{GS}$ ($V_{GATE2}$-$V_{IN}$) = 1 V<br>$I_{OUT}$ = 0 mA | — | 34 | — | μs |
| | TCK422G | | $V_{IN}$ = 12 to 15 V, $V_{IN\ rising}$ = 2 V/μs<br>$V_{GS}$ typ to $V_{GS}$ ($V_{GATE2}$-$V_{IN}$) = 1 V<br>$I_{OUT}$ = 0 mA | — | 41 | — | μs |
| | TCK423G | | $V_{IN}$ = 12 to 15 V, $V_{IN\ rising}$ = 2 V/μs<br>$V_{GS}$ typ to $V_{GS}$ ($V_{GATE2}$-$V_{IN}$) = 1 V<br>$I_{OUT}$ = 0 mA | — | 16 | — | μs |
| | TCK424G | | $V_{IN}$ = 9 to 12 V, $V_{IN\ rising}$ = 2 V/μs<br>$V_{GS}$ typ to $V_{GS}$ ($V_{GATE2}$-$V_{IN}$) = 1 V<br>$I_{OUT}$ = 0 mA | — | 18 | — | μs |
| | TCK425G | | $V_{IN}$ = 5 to 8 V, $V_{IN\ rising}$ = 2 V/μs<br>$V_{GS}$ typ to $V_{GS}$ ($V_{GATE2}$-$V_{IN}$) = 1 V<br>$I_{OUT}$ = 0 mA | — | 19 | — | μs |

Note 5: $C_{GATE1}$ and $C_{GATE2}$ are input capacitance connected to each VGATE1 and VGATE2 instead of external MOSFET

### 11.7. Timing Chart

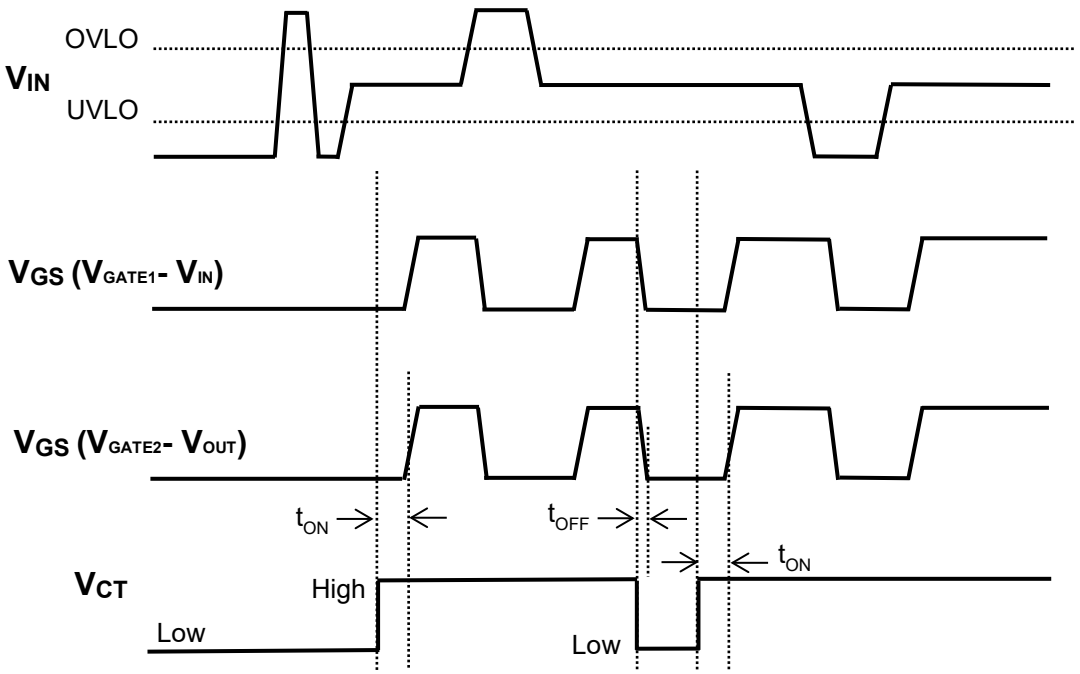



**Fig.1 $t_{ON}$, $t_{OFF}$**

### 11.8. Switching Waveform and Test circuit

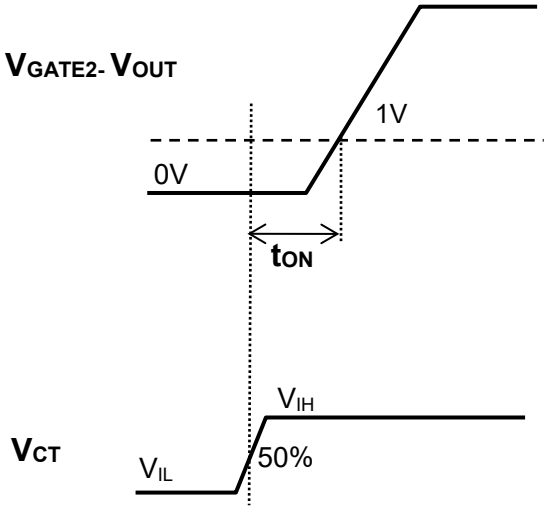



**Fig.2 $V_{GS}$ ON time Waveform**

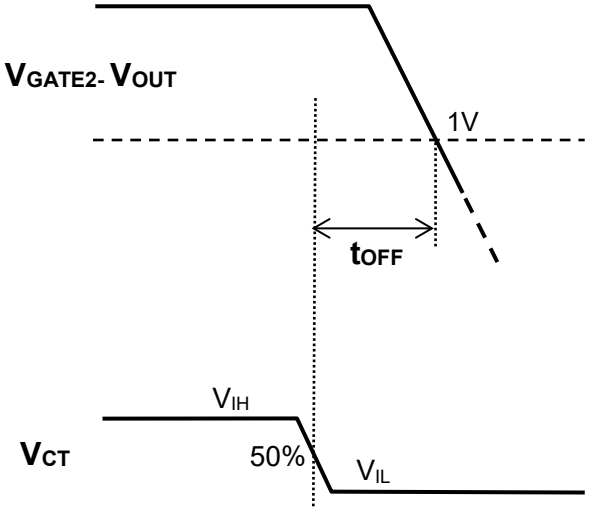



**Fig.3 $V_{GS}$ OFF time Waveform**

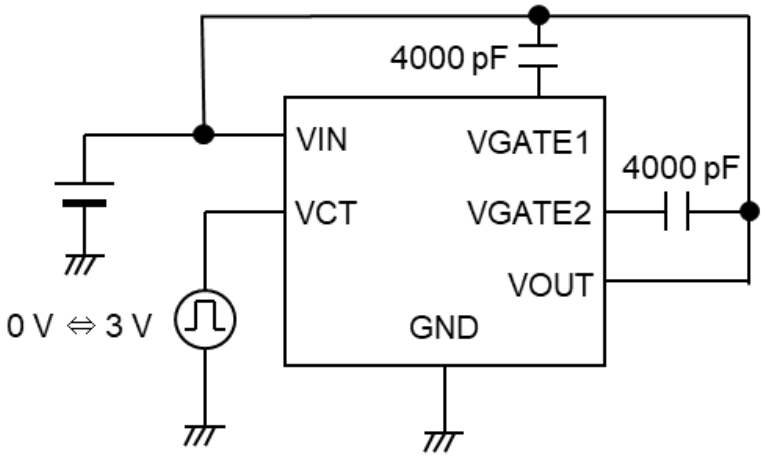



**Fig.4 $V_{GS}$ ON and OFF time test circuit**

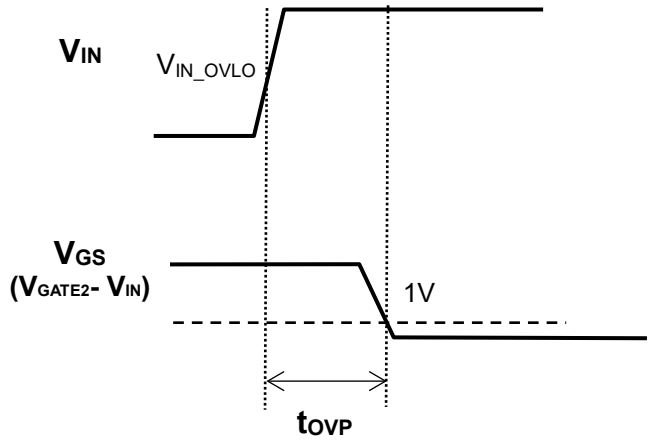



**Fig.5 $t_{OVP}$ Waveform**

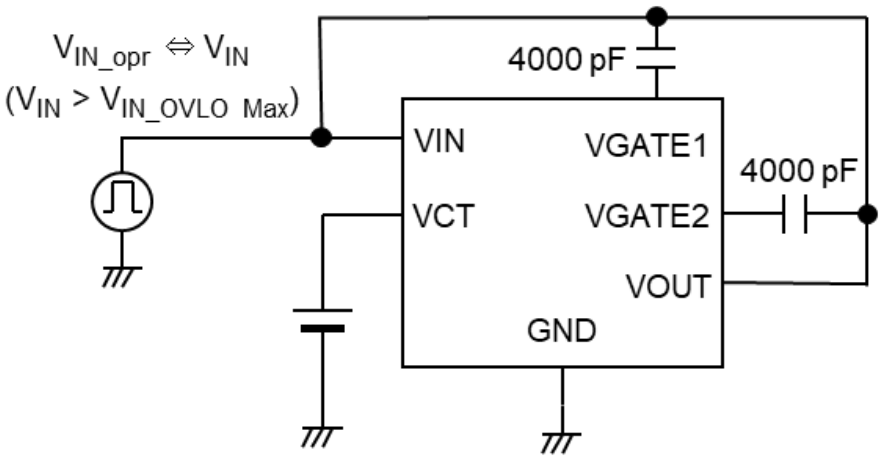
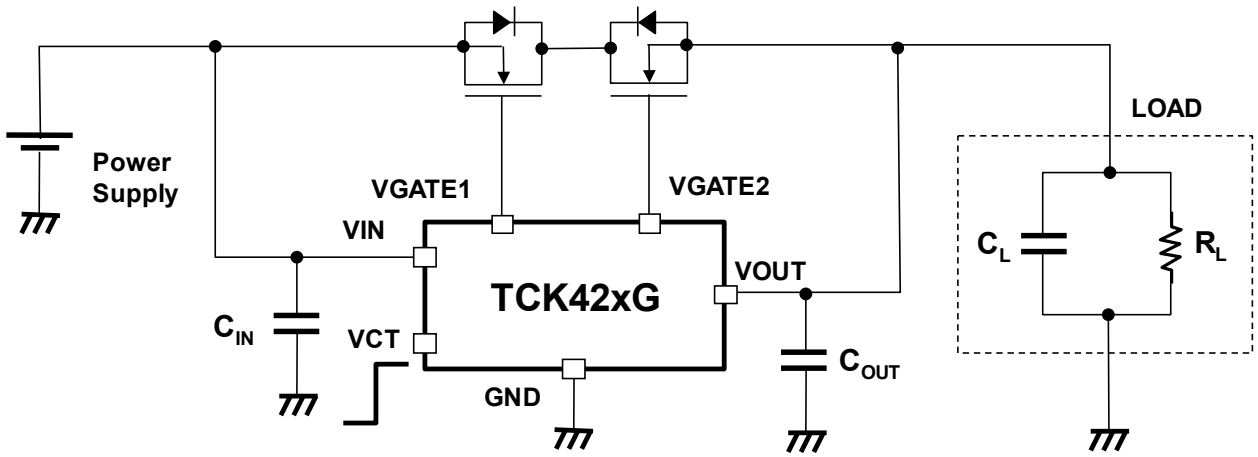



**Fig.6 $t_{OVP}$ test circuit**

# 12. Application Note

## 12.1. Common Drain Connection N-channel MOSFET circuit example




1. Input and Output capacitor
   An input capacitor ($C_{IN}$) and an output capacitor ($C_{OUT}$) are recommended for the stable operation. 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 $C_{OUT}$ as close to VIN pin and VOUT pin to improve stability of the power supply.

2. VCT pin
   VCT pin is pull down connection to GND. VCT High level voltage must be under 5.5V $V_{IH}$ max.

3. VGATE1,2 pin and VOUT pin
   VGATE1 pin is connected to Gate of VIN side MOSFET. VGATE2 pin is connected to Gate of VOUT side MOSFET. VOUT pin is connected to Source of VOUT side MOSFET. When the gate driver IC turns off state, VGATE1 terminal voltage is close to VIN voltage dropped by parasitic diode forward voltage. This circuit works to protect over voltage for VIN side MOSFET Gate-Source terminal. VOUT terminal works to protect VOUT side MOSFET as same circuit.

4. Turn on recovery time after Over Voltage Lock Out (OVLO)
   Once $V_{IN}$ is in normal voltage range after OVLO, the turn on recovery time is similar $V_{GS}$ ON time ($t_{ON}$).

5. Under Voltage Lock Out (UVLO) and Over Voltage Lock Out (OVLO)
   UVLO and OVLO are designed in these products, but these are not designed to constantly ensure the suppression of the gate driver IC and external MOSFETs within operation limits. Depending on the condition during actual usage, it could affect the electrical characteristic specification and reliability. To select external MOSFETs, please consider enough electrical design margin. When using these products, please read through and understand the concept of dissipation 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.

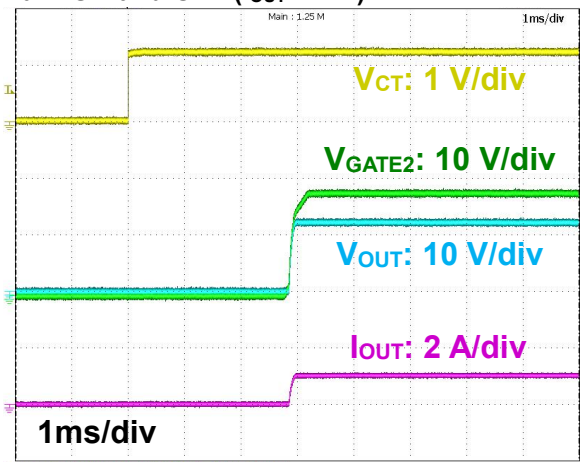
## Common Drain Connection N-channel MOSFET Switching Waveform

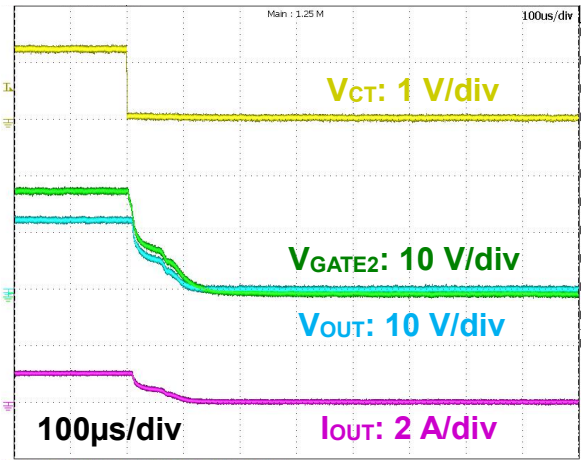
### Typical switching waveforms with TOSHIBA MOSFETs

| OVP Gate Driver IC | MOSFET | | Test conditions | |
|---|---|---|---|---|
| | Part Number | Description | Turn ON and OFF | Over Voltage Lock Out |
| TCK423G ($V_{GS}$ = 5.6 V) | TPN1R603PL | Single N-channel MOSFET<br>$V_{DSS}$: 30 V, $V_{GSS}$: ± 20 V<br>$R_{DS(ON)}$: 1.2 mΩ typ at $V_{GS}$ = 10 V<br>Package: TSON Advance | $V_{IN}$ = 12 V (TCK423G)<br>$V_{IN}$ = 20 V (TCK421G)<br>$I_{OUT}$ = 1 A, 3 A<br>$C_{IN}$ = 1 µF<br>$C_{OUT}$ = 1 µF<br>$V_{CT}$ = 0 V ⇔ 1.2 V<br>Ta = 25 °C | $V_{IN}$ = 12 V ⇔ 15 V (TCK423G)<br>$V_{IN}$ = 20 V ⇔ 25 V (TCK421G)<br>$I_{OUT}$ = 1 A<br>$C_{IN}$ = 1 µF<br>$C_{OUT}$ = 1 µF<br>$V_{CT}$ = 1.2 V<br>Ta = 25 °C |
| TCK421G ($V_{GS}$ = 10 V) | TPHR6503PL1 | Single N-channel MOSFET<br>$V_{DSS}$: 30 V, $V_{GSS}$: ± 20 V<br>$R_{DS(ON)}$: 0.41 mΩ typ at $V_{GS}$ = 10 V<br>Package: SOP Advance(N) | | |

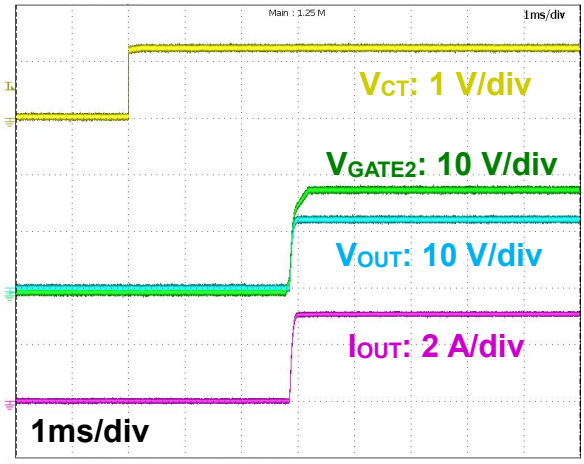
**TCK423G + TPN1R603PL x 2pcs**

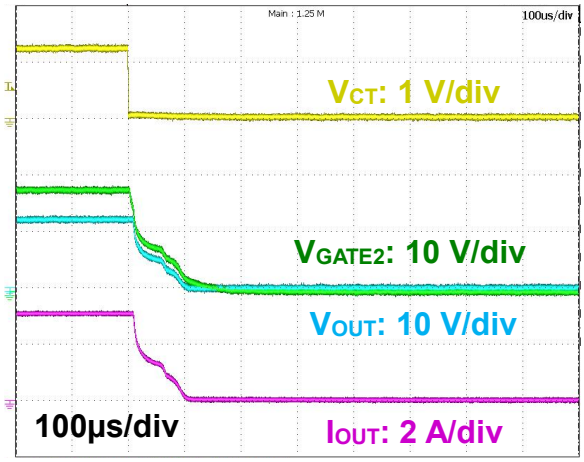
1. **Turn ON and OFF ($I_{OUT}$ = 1 A)**



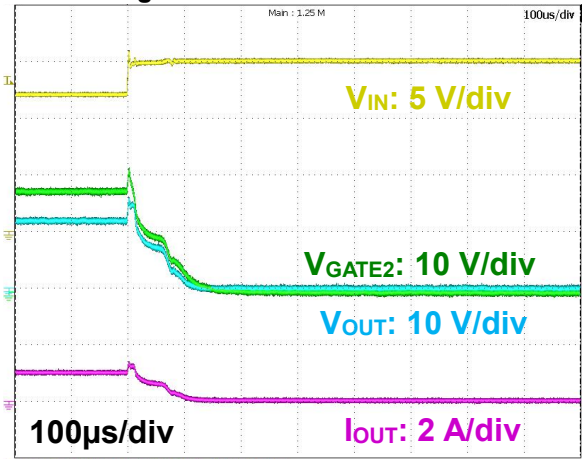



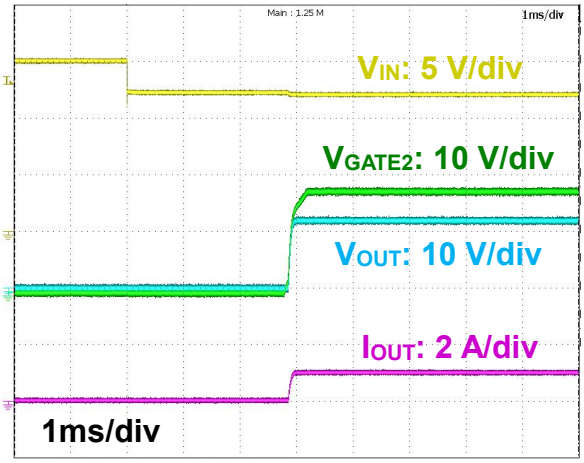

2. **Turn ON and OFF ($I_{OUT}$ = 3 A)**



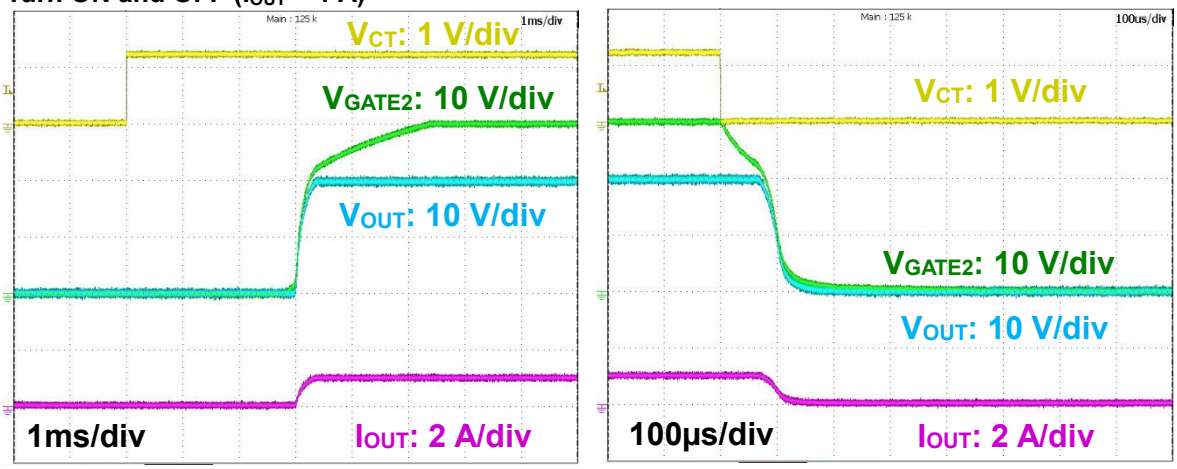

3. **Over Voltage Lock Out**



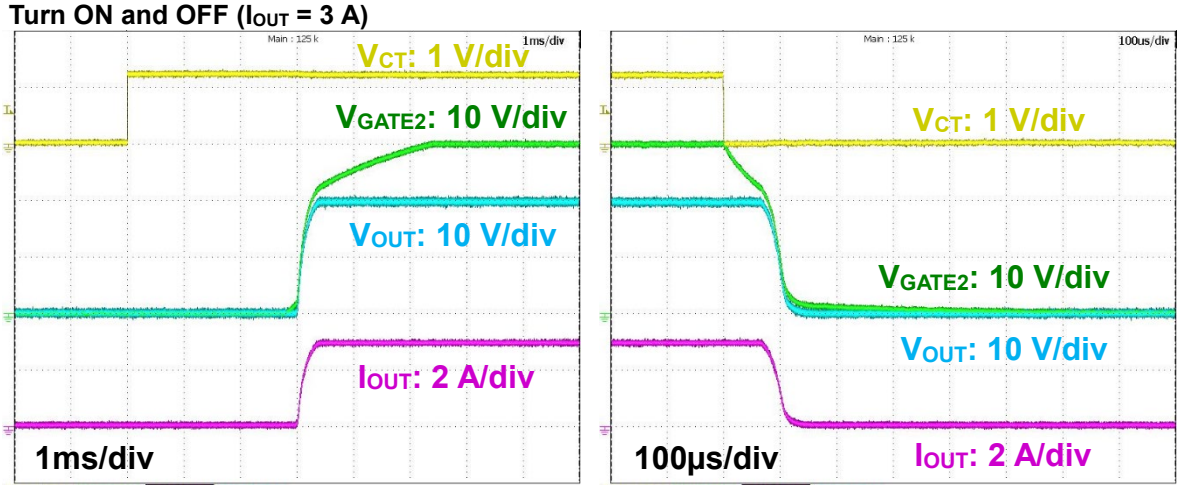



**TCK421G + TPHR6503PL1 x 2pcs**

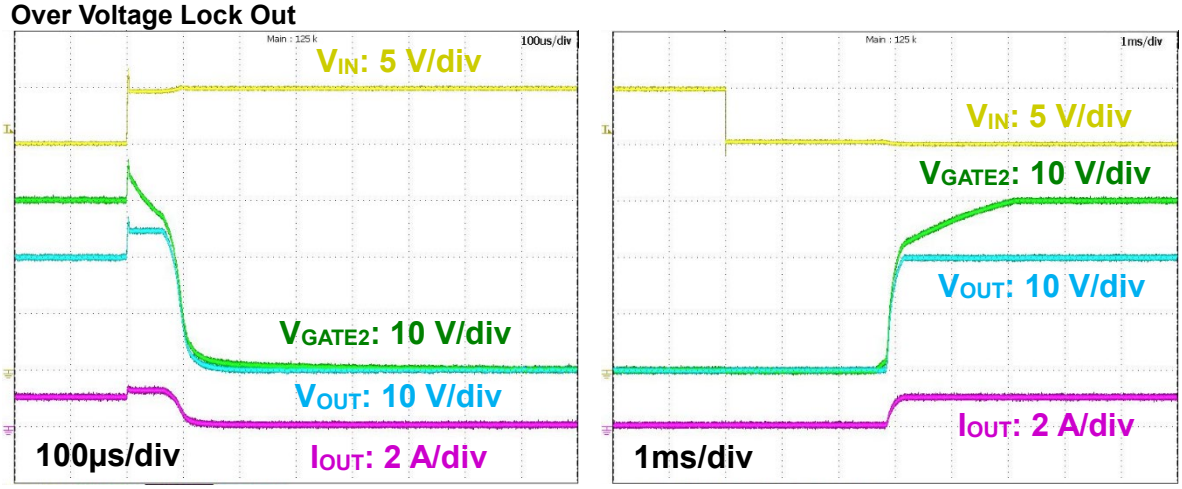
1. Turn ON and OFF ($I_{OUT}$ = 1 A)



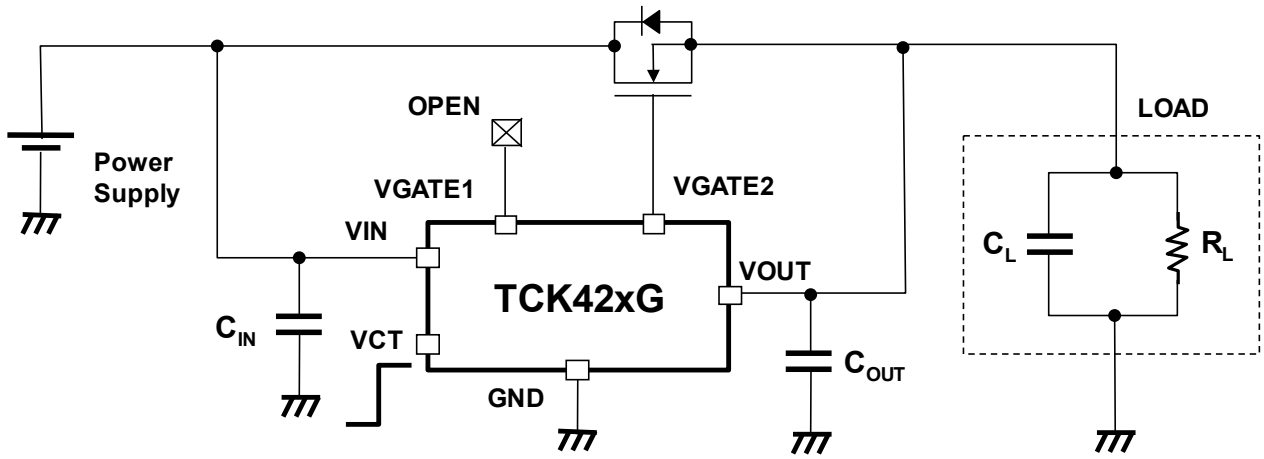

2. Turn ON and OFF ($I_{OUT}$ = 3 A)




3. Over Voltage Lock Out



## 12.2. Single N-channel MOSFET circuit example




1. Input and Output capacitor
   An input capacitor ($C_{IN}$) and an output capacitor ($C_{OUT}$) are recommended for the stable operation. 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 $C_{OUT}$ as close to VIN pin and VOUT pin to improve stability of the power supply.

2. VCT pin
   VCT pin is pull down connection to GND. VCT High level voltage must be under 5.5V $V_{IH}$ max.

3. VGATE1,2 pin and VOUT pin
   VGATE1 pin is OPEN state/Non connection. VGATE2 pin is connected to Gate of MOSFET. VOUT pin is connected to Source of MOSFET. When the gate driver IC turns off state, VGATE2 terminal voltage is close to VOUT voltage dropped by parasitic diode forward voltage. This circuit works to protect over voltage for MOSFET Gate-Source terminal.

4. Turn on recovery time after Over Voltage Lock Out
   Once $V_{IN}$ is in normal voltage range after OVLO, the turn on recovery time is similar $V_{GS}$ ON time ($t_{ON}$).

5. Under Voltage Lock Out (UVLO) and Over Voltage Lock Out (OVLO)
   UVLO and OVLO are designed in these products, but these are not designed to constantly ensure the suppression of the gate driver IC and external MOSFETs within operation limits. Depending on the condition during actual usage, it could affect the electrical characteristic specification and reliability. To select external MOSFETs, please consider enough electrical design margin. When using these products, please read through and understand the concept of dissipation 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.

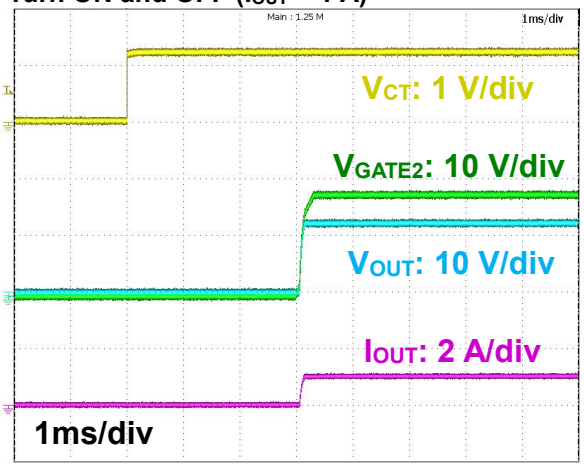
## Single N-channel MOSFET Switching Waveform

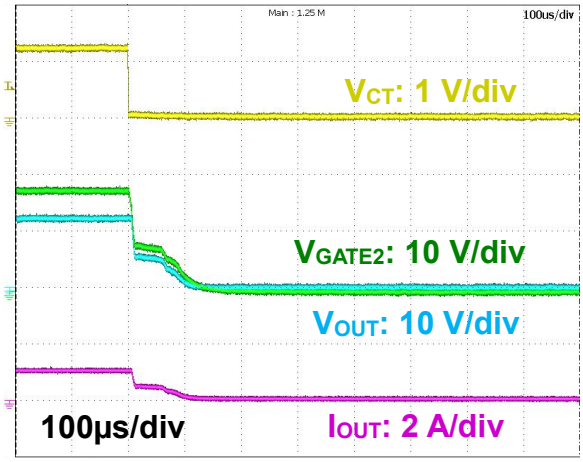
### Typical switching waveforms with TOSHIBA MOSFETs

| OVP Gate Driver IC | MOSFET | | Test conditions | |
|---|---|---|---|---|
| | Part Number | Description | Turn ON and OFF | Over Voltage Lock Out |
| TCK423G ($V_{GS}$ = 5.6 V) | TPN1R603PL | Single N-channel MOSFET<br>$V_{DSS}$: 30 V, $V_{GSS}$: ± 20 V<br>$R_{DS(ON)}$: 1.2 mΩ typ at $V_{GS}$ = 10 V<br>Package: TSON Advance | $V_{IN}$ = 12 V (TCK423G)<br>$V_{IN}$ = 20 V (TCK421G)<br>$I_{OUT}$ = 1 A, 3 A<br>$C_{IN}$ = 1 µF<br>$C_{OUT}$ = 1 µF<br>$V_{CT}$ = 0 V ⇔ 1.2 V<br>Ta = 25 °C | $V_{IN}$ = 12 V ⇔ 15 V (TCK423G)<br>$V_{IN}$ = 20 V ⇔ 25 V (TCK421G)<br>$I_{OUT}$ = 1 A<br>$C_{IN}$ = 1 µF<br>$C_{OUT}$ = 1 µF<br>$V_{CT}$ = 1.2 V<br>Ta = 25 °C |
| TCK421G ($V_{GS}$ = 10 V) | TPHR6503PL1 | Single N-channel MOSFET<br>$V_{DSS}$: 30 V, $V_{GSS}$: ± 20 V<br>$R_{DS(ON)}$: 0.41 mΩ typ at $V_{GS}$ = 10 V<br>Package: SOP Advance(N) | | |

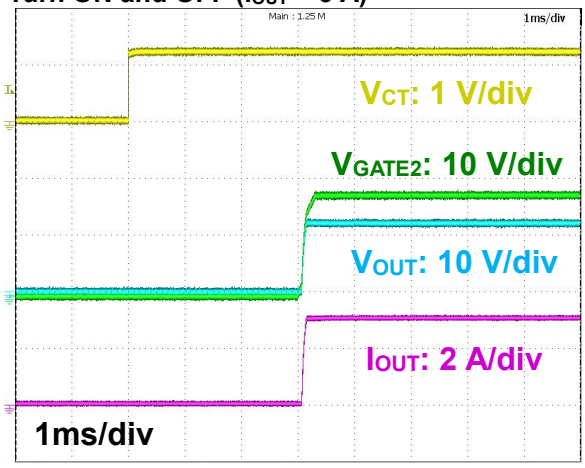
**TCK423G + TPN1R603L**

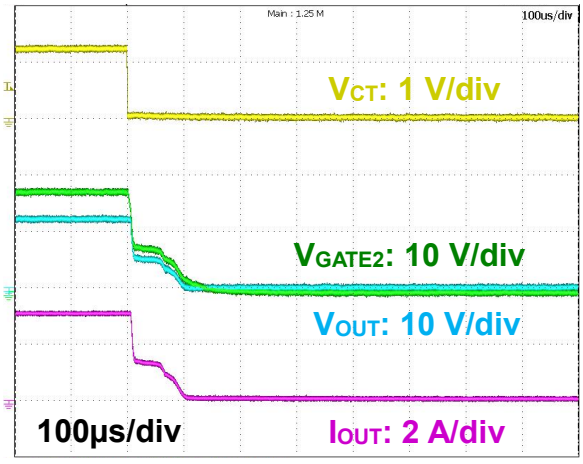
1. **Turn ON and OFF ($I_{OUT}$ = 1 A)**



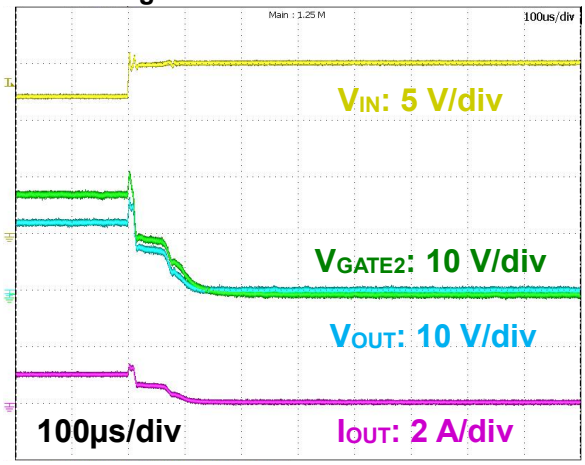



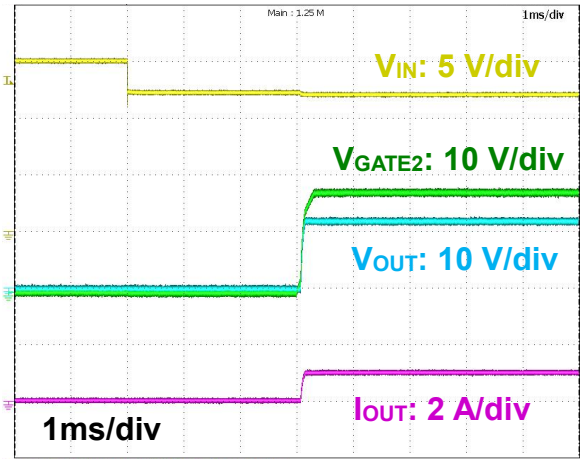

2. **Turn ON and OFF ($I_{OUT}$ = 3 A)**



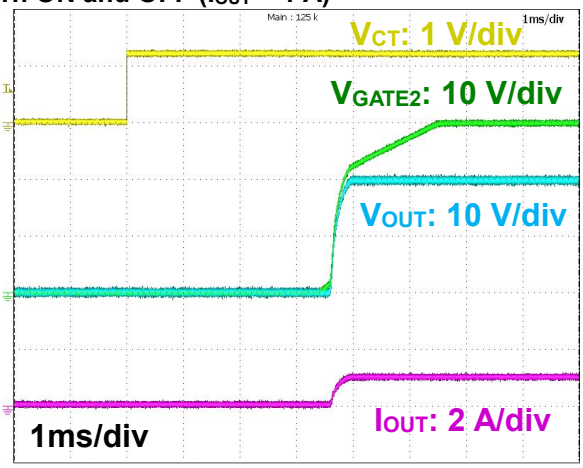

3. **Over Voltage Lock Out**

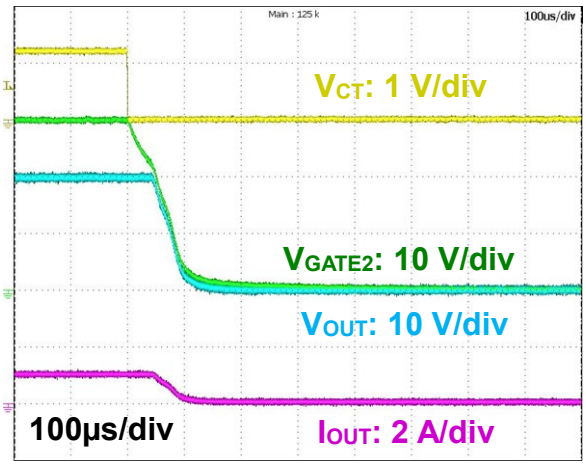


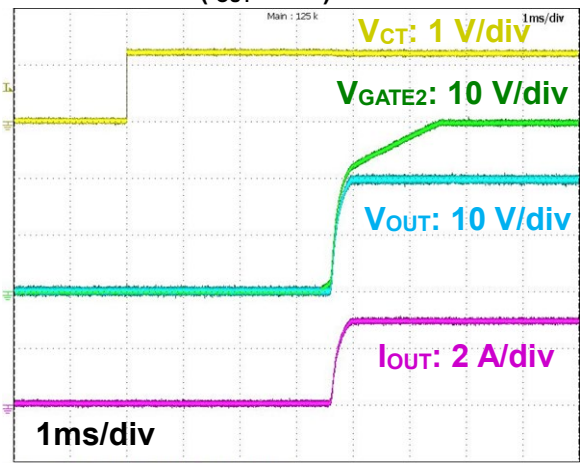
**TCK421G + TPHR6503PL1**

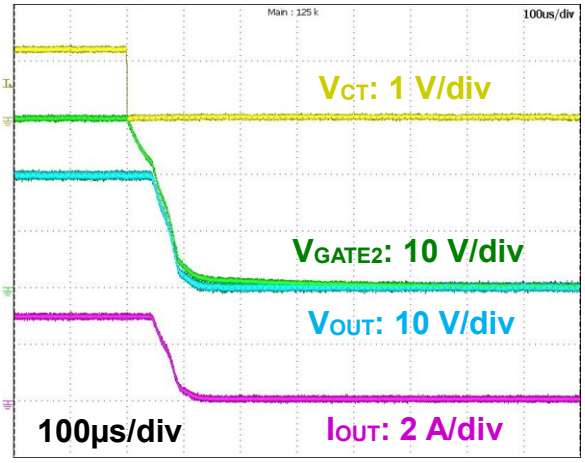
6. **Turn ON and OFF ($I_{OUT}$ = 1 A)**



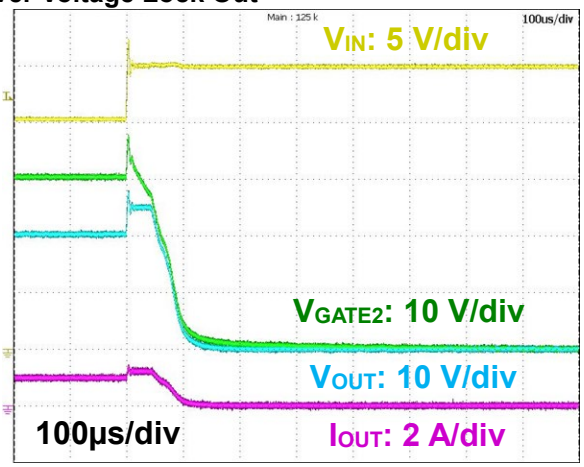



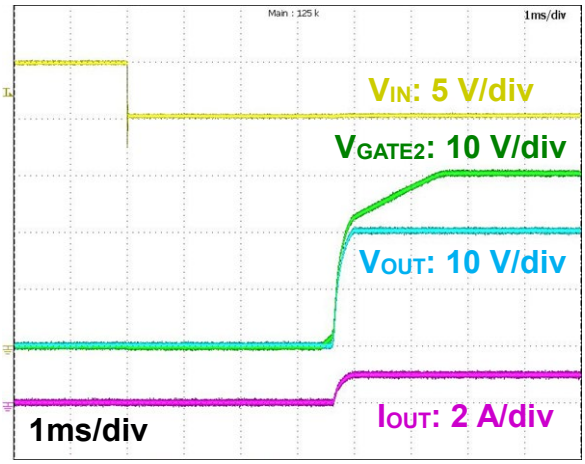

7. **Turn ON and OFF ($I_{OUT}$ = 3 A)**




8. **Over Voltage Lock Out**

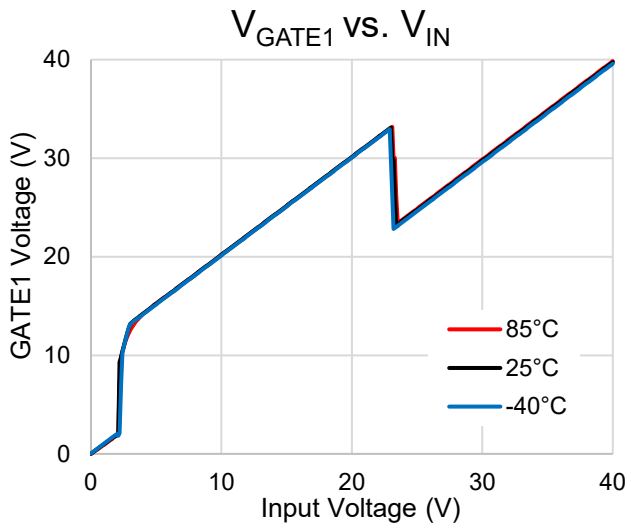


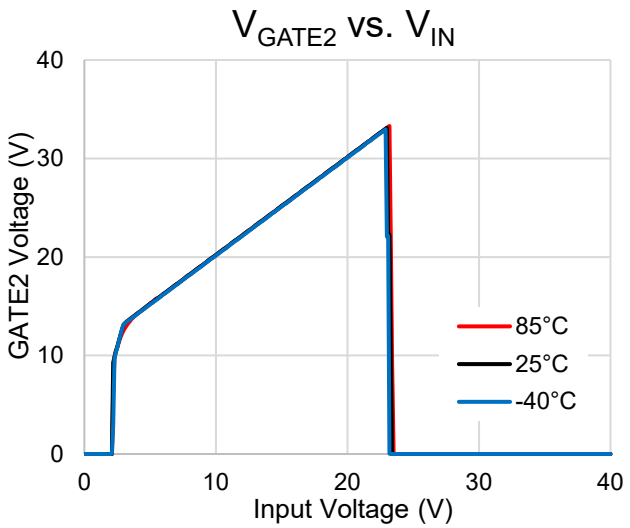



# 13. Representative Typical Characteristics

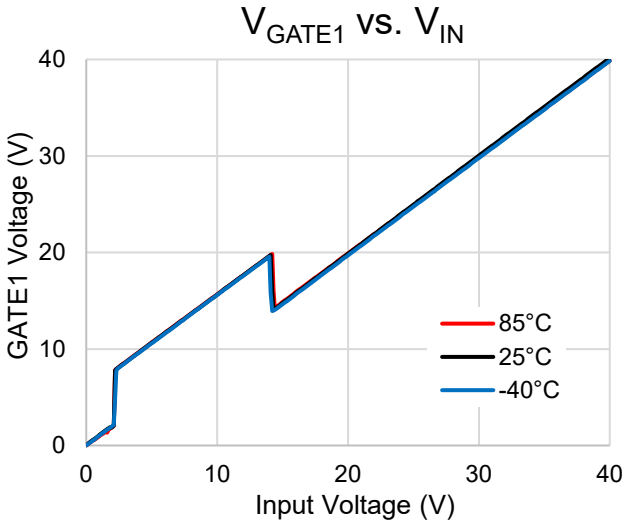
## 13.1. Gate voltage vs. Input voltage

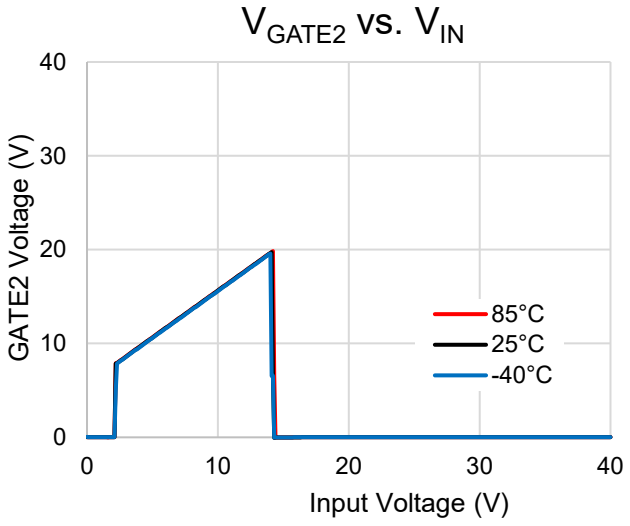
**$V_{GS}$ = 10 V (TCK421G)**




**$V_{GS}$ = 5.6 V (TCK423G)**

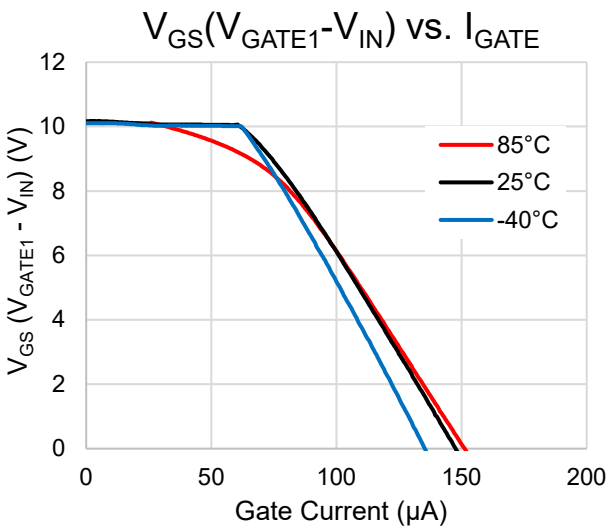


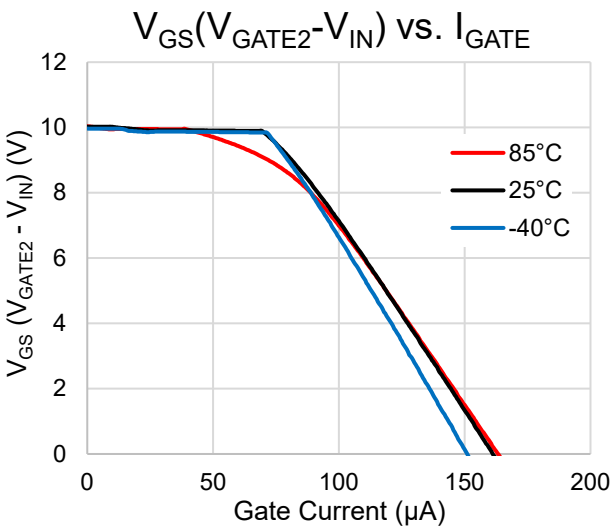



## 13.2. Gate voltage vs. Gate current

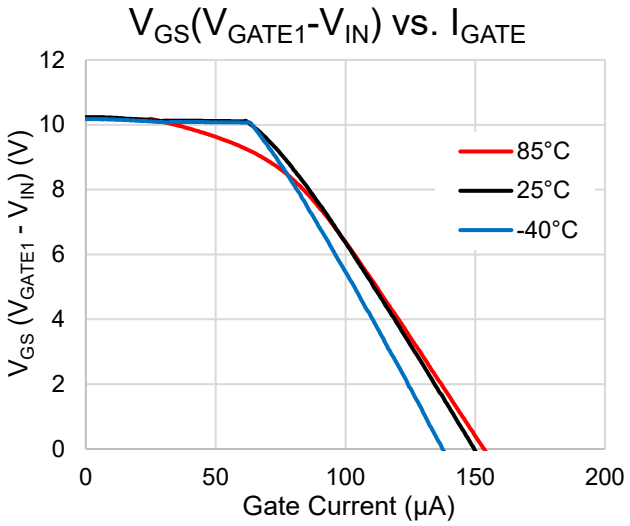
### 1. $V_{GS}$ = 10V (TCK421G)

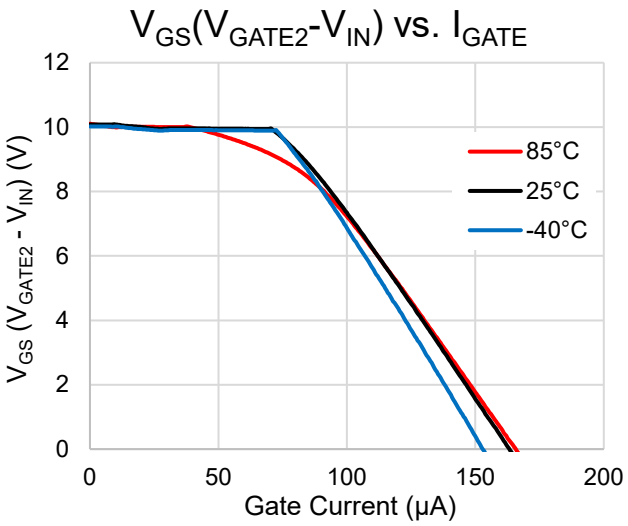
**$V_{IN}$ = 20 V**



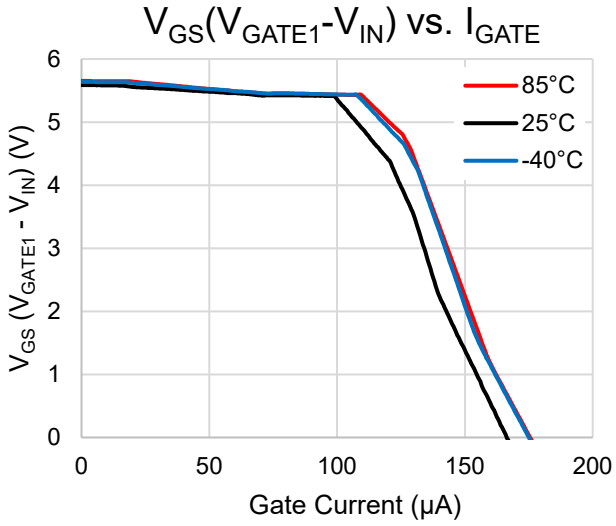

**$V_{IN}$ = 12 V**

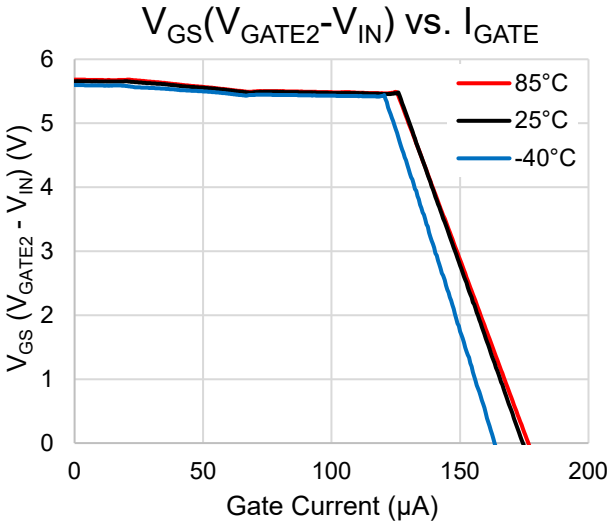


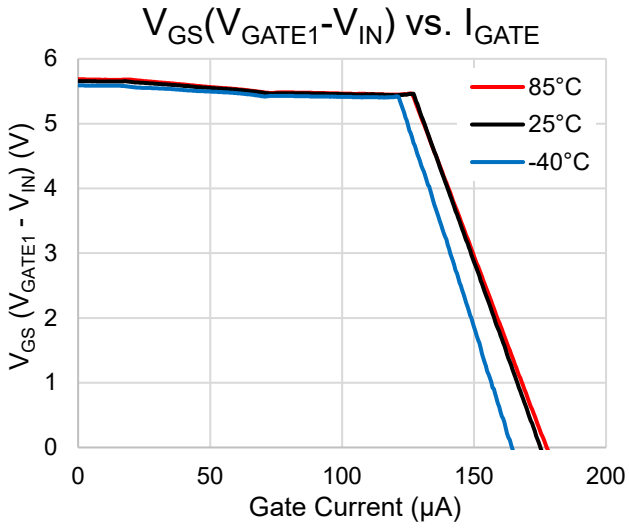
**2. $V_{GS}$ = 5.6 V (TCK423G)**

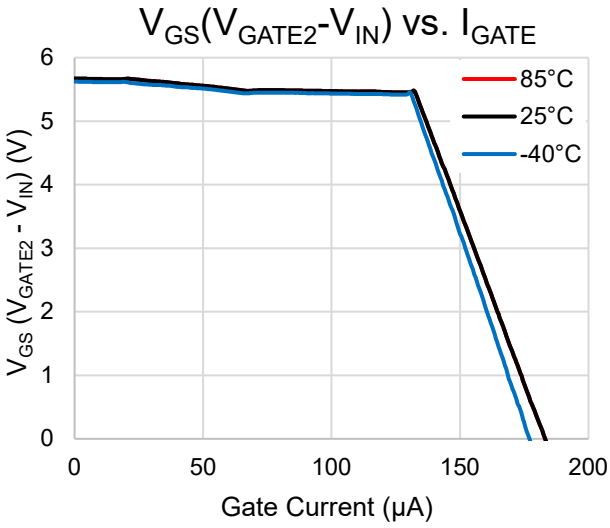
**$V_{IN}$ = 12 V**



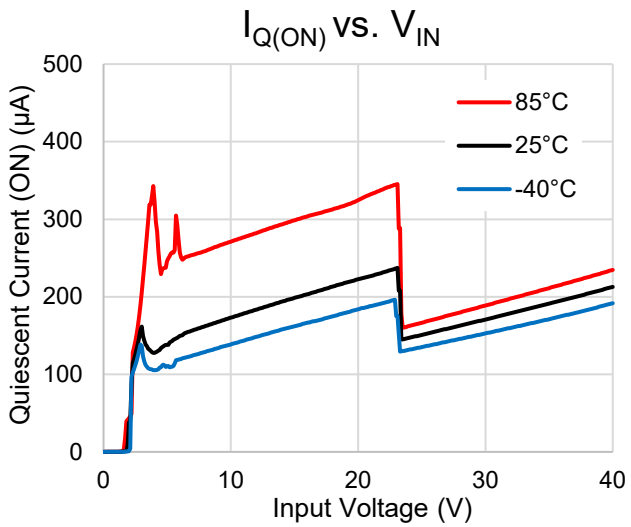

**$V_{IN}$ = 9 V**



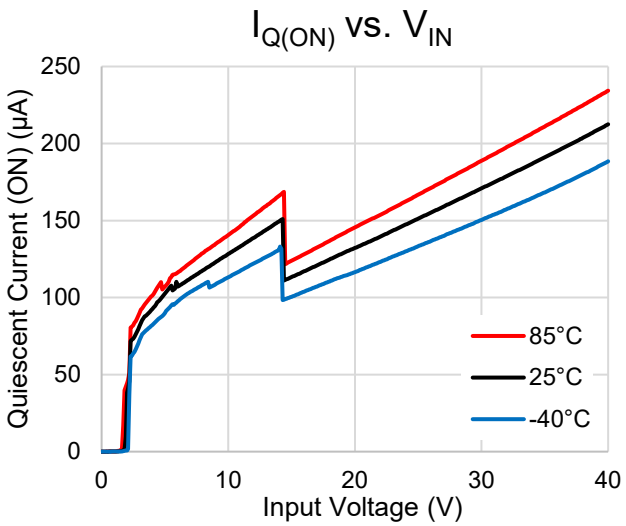



### 13.3. Quiescent current vs. Input voltage

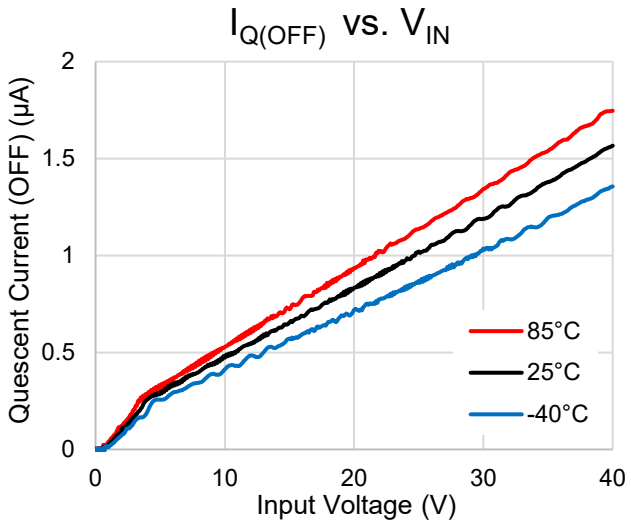
**$V_{GS}$ = 10 V (TCK421G)**




**$V_{GS}$ = 5.6 V (TCK423G)**




### 13.4. Standby current vs. Input voltage (Note 6)

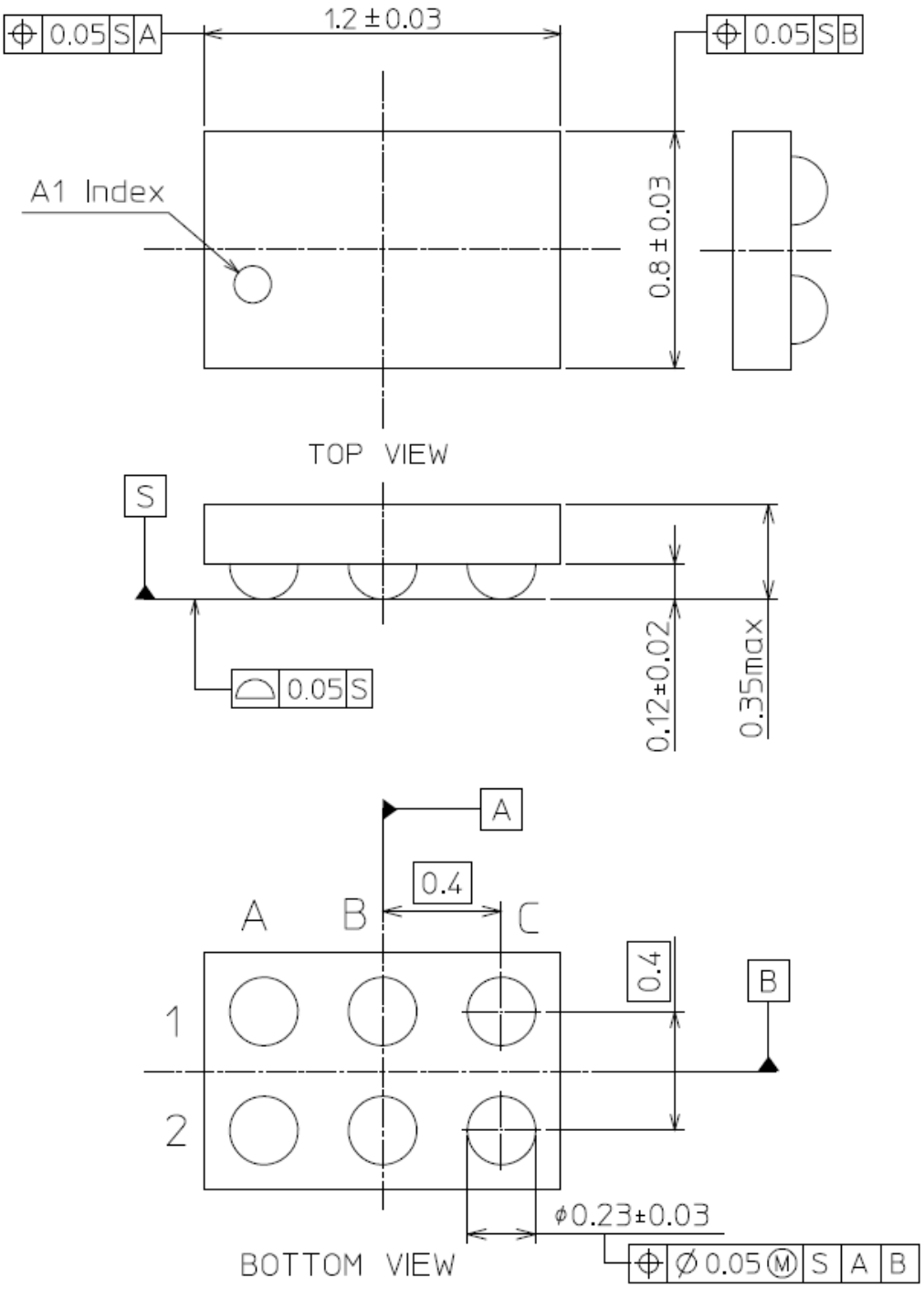



Note 6: Common characteristic of $V_{GS}$ = 10 V and 5.6 V

## 14. Package Information

WCSP6G

Unit: mm

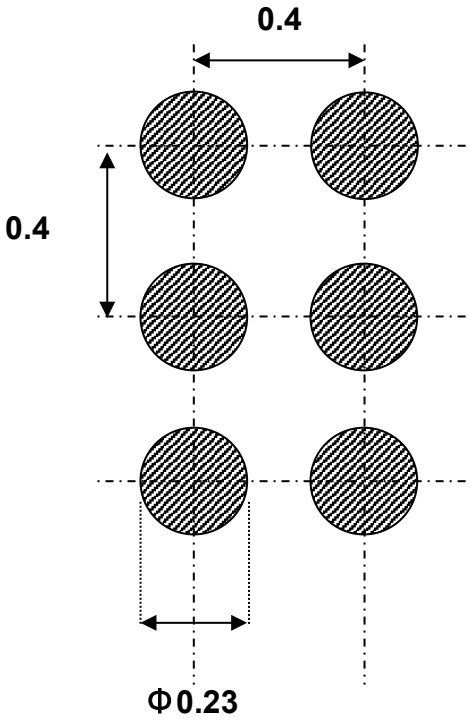



Weight: 0.61 mg (Typ.)

## 15. Land pattern dimensions for reference only

WCSP6G

Unit: mm



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