

Dual H-bridge Driver for actuator

□ GENERAL DESCRIPTION

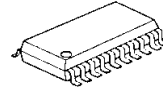
The NJU7385 is a dual H-bridge driver IC that has general versatility for a compact actuator.

The Mode Select Function in the control part can select two types of control systems, "Two-input" and "Phase & Enable". Input part has a Schmitt inverter circuit with a high resistance to noise. And it has a transition sequence which automatically transits to standby mode with no input signal. Output part has two circuit configurations of independent H-bridge. Protection circuit contains an under voltage lockout (UVLO) circuit and a thermal shutdown circuit and outputs alarm signal if an error is detected. Supply /interface voltage corresponds to the logic, 3.3V/5.0V.

The NJU7385 is superior to performance compared to conventional products. It has the low current consumption and improved standby function (Auto/Manual). Especially, it is suitable for battery equipment. And it has versatility and a wide range of applications for various actuators, such as a compact step motor, DC motor, and solenoid.

- Supply Voltage $V_{DD}=2.5$ to $5.5V$
 $V_{MM}=3.0$ to $8.0V$
- Output Current $I_o=400mA$
- Low Quiescent Current $I_{DD}=200\mu A$ typ.
- Input Control Mode Select Function
 - 2-Input Control
 - Phase & Enable Control
- Standby Function
 - At No Signal
 - At using STB terminal
- Under Voltage Lock Out (UVLO) Circuit
- Thermal Shutdown (TSD) Circuit
- Alarm Output Function (At the protection circuit operates)
- CMOS Technology
- Package Outline SSOP20-C3

□ PACKAGE OUTLINE



NJU7385VC3

□ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

| PARAMETER | SYMBOL | RATINGS | UNIT |
|------------------------------|--------------------|---------------------------------|------|
| Logic Supply Voltage | V _{DD} | 7 | V |
| Motor Supply Voltage | V _{MM} | 9 | V |
| Motor Output Voltage | V _O | 9 | V |
| SENSE Terminal Voltage | V _{SENSE} | 7 | V |
| Logic Input Terminal Voltage | V _{IN} | 7 | V |
| Alarm Output Voltage | V _{ALARM} | 7 | V |
| Motor Output Current | I _o | 700 | mA |
| Alarm Output Current | I _{ALARM} | 20 | mA |
| Operating Temperature | T _{opr} | -40 to +85 | °C |
| Junction Temperature | T _j | -40 to +150 | °C |
| Storage Temperature | T _{stg} | -50 to +150 | °C |
| Power Dissipation | P _D | 1.0 (*1) Mounted on 2Layers PCB | W |
| | | 1.5 (*1) Mounted on 4Layers PCB | |

(*1): Mounted on glass epoxy board based on EIA/JEDEC. (114.3x76.2x1.6mm: 2Layers/4Layers)

□ RECOMMENDED OPERATING CONDITIONS

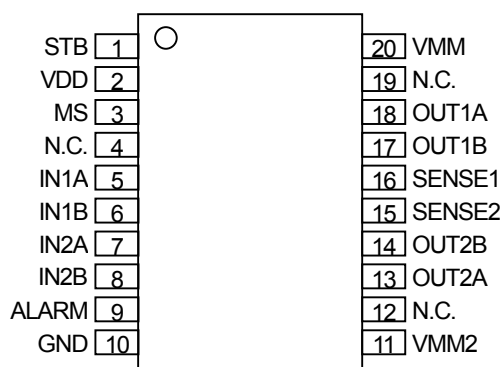
(Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|----------------------|-----------------|----------------|------|------|------|------|
| Logic Supply Voltage | V _{DD} | | 2.5 | 3.3 | 5.5 | V |
| Motor Supply Voltage | V _{MM} | | 3.0 | 7.2 | 8.0 | V |

□ ELECTRICAL CHARACTERISTICS
 $(V_{DD}=V_{STB}=3.3V, V_{MM1}=V_{MM2}=7.2V, V_{SENSE1}=V_{SENSE2}=0V, T_a=25^{\circ}C)$

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|--|-------------------|---|------|------|------|-------------|
| □ GENERAL | | | | | | |
| Logic block quiescent current | I_{DD} | Except I_{IH} | - | 200 | 300 | μA |
| Motor block quiescent current | I_{MM} | Per each channel | - | 100 | 150 | μA |
| Standby current | I_{STB} | $V_{STB}=0V$ | - | 0.1 | 1 | μA |
| □ INPUT BLOCK | | | | | | |
| H level input voltage 1 | V_{IH1} | | 20 | - | - | V |
| H level input voltage 2 | V_{IH2} | $V_{DD}=5.0V$ | 26 | - | - | V |
| L level input voltage 1 | V_{IL1} | | - | - | 0.8 | V |
| L level input voltage 2 | V_{IL2} | $V_{DD}=5.0V$ | - | - | 1.0 | V |
| H level input current | I_{IH} | $V_{IN}=3.3V$, per each channel | 22 | 33 | 55 | μA |
| L level input current | I_{IL} | $V_{IN}=0V$, per each channel | - | 100 | 200 | nA |
| Input pull down resistance | R_{INDN} | | 60 | 100 | 140 | $k\Omega$ |
| Input pulse widths | t_p | | 2 | - | - | μs |
| Auto switched time to Standby Mode | t_{STB} | $V_{IN1A}/V_{IN1B}/V_{IN2A}/V_{IN2B}=0V$ | 12 | - | 20 | μs |
| □ ALARM OUTPUT | | | | | | |
| L level output voltage | V_{ALARM} | $R_{ALARM}=5k\Omega$ | - | 0.2 | 0.3 | V |
| Leak current | $I_{LEAKALARM}$ | $V_{ALARM}=5.5V$ | - | - | 1.0 | μA |
| □ MOTOR OUTPUT BLOCK | | | | | | |
| High side output ON resistance | R_{OH} | $I_o=400mA$ | - | 0.5 | 1.0 | Ω |
| Low side output ON resistance | R_{OL} | $I_o=400mA$ | - | 0.5 | 1.0 | Ω |
| High side leak current | I_{OLEAKH} | $V_{MM1}=V_{MM2}=8.0V, V_{STB}=0V$ | - | - | 1.0 | μA |
| Low side leak current | I_{OLEAKL} | $V_{MM1}=V_{MM2}=8.0V, V_{STB}=0V$ | - | - | 1.0 | μA |
| Sense terminal leak current | $I_{SENSELEAK}$ | $V_{SENSE}=1V$ (SENSE→GND), $V_{STB}=0V$ | - | - | 1.0 | μA |
| Delay time 1 | t_{DELAY1} | At Normal operates | - | 500 | - | ns |
| Delay time 2 | t_{DELAY2} | At Release from standby mode | - | 400 | - | ns |
| □ THERMAL SHUTDOWN BLOCK | | | | | | |
| Thermal shutdown operating temperature | T_{DTSD} | | - | 170 | - | $^{\circ}C$ |
| Thermal shutdown recovery temperature | T_{RTSD} | | - | 140 | - | $^{\circ}C$ |
| Thermal shutdown hysteresis | ΔT_{TSD} | | - | 30 | - | $^{\circ}C$ |
| □ UNDER VOLTAGE LOCK OUT BLOCK | | | | | | |
| UVLO operating voltage | V_{DUVLO} | | 1.4 | 1.8 | 2.1 | V |
| UVLO recovery voltage | V_{RUVLO} | | 1.6 | 2.0 | 2.4 | V |
| UVLO hysteresis voltage | ΔV_{UVLO} | | 0.1 | 0.2 | 0.4 | V |

□ PIN CONNECTION

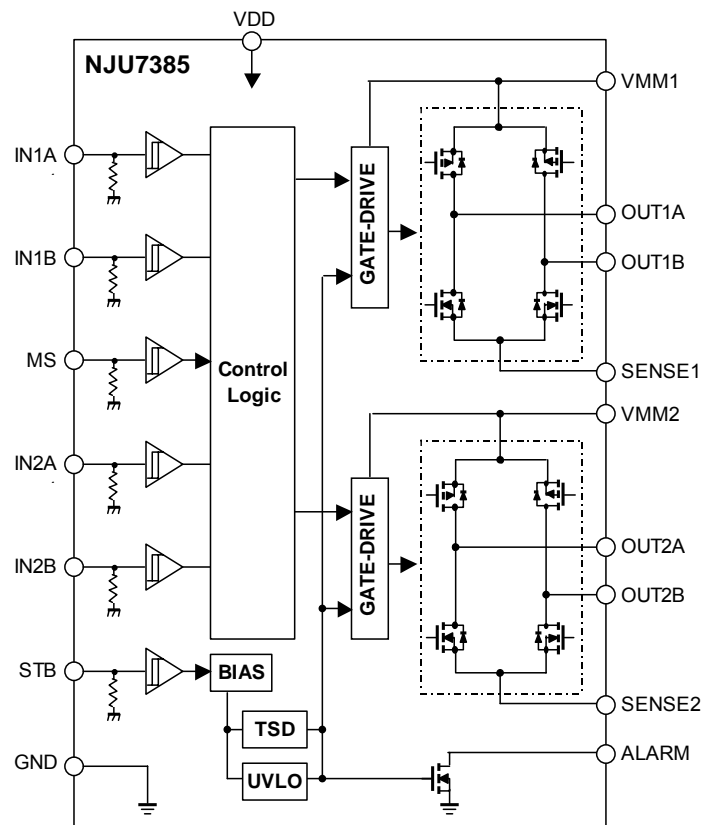


SSOP20-C3

□ PIN FUNCTION LIST

| Pin# | Terminal Name | Function | Remark |
|------|---------------|---|--|
| 1 | STB | Power Saving State Setting Terminal | H= Normal Operation, L=Standby |
| 2 | VDD | Logic Voltage Supply Terminal | Logic Voltage Supply |
| 3 | MS | Input Control Method Setting Input Terminal | L=2-Input Control Type. H=PHASE&ENABLE Control Type |
| 4 | N.C. | No Connection | No Connection |
| 5 | IN1A | 1ch Output Phase Switch Input Terminal A | It works as IN1A at MS Terminal=L, PHASE1 at MS Terminal=H. |
| 6 | IN1B | 1ch Output Phase Switch Input Terminal B | It works as IN1B at MS Terminal=L, ENABLE1 at MS Terminal=H. |
| 7 | IN2A | 2ch Output Phase Switch Input Terminal A | It works as IN2A at MS Terminal=L, PHASE2 at MS Terminal=H. |
| 8 | IN2B | 2ch Output Phase Switch Input Terminal B | It works as IN2B at MS Terminal=L, ENABLE2 at MS Terminal=H. |
| 9 | ALARM | Internal Protection Operation Detection Output Terminal | When the internal protection operation is detected, L level is output |
| 10 | GND | Logic Ground Terminal | Logic Ground |
| 11 | VMM2 | Motor Voltage Supply Terminal 2 | Motor Voltage Supply |
| 12 | N.C. | No Connection | No Connection |
| 13 | OUT2A | 2ch Output Terminal A | - |
| 14 | OUT2B | 2ch Output Terminal B | - |
| 15 | SENSE2 | Current Detection Resistance Connection Terminal 2 | It connects resistance for the detection of the electric current of the side of 2ch. At the unused time, it connects with GND. |
| 16 | SENSE1 | Current Detection Resistance Connection Terminal 1 | It connects resistance for the detection of the electric current of the side of 1ch. At the unused time, it connects with GND. |
| 17 | OUT1B | 1ch Output Terminal B | - |
| 18 | OUT1A | 1ch Output Terminal A | - |
| 19 | N.C. | No Connection | No Connection |
| 20 | VMM1 | Motor Voltage Supply Terminal 1 | Motor Voltage Supply |

□ BLOCK DIAGRAM



□ **THERMAL RESISTANCE CHARACTERISTICS**

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|--|------------------|---|------|------|------|------|
| Junction - Ambient Thermal Resistance 1 | θ_{ja_1} | Mounted on glass epoxy board based on EIA/JEDEC. (114.3x76.2x1.6mm: 2Layers) | - | - | 125 | °C/W |
| Junction - Case Surface Thermal Resistance 1 | Ψ_{jt_1} | Mounted on glass epoxy board based on EIA/JEDEC. (114.3x76.2x1.6mm: 2Layers) | - | 10.8 | - | °C/W |
| Junction-Ambient Thermal Resistance 2 | θ_{ja_2} | Mounted on glass epoxy board based on EIA/JEDEC. (114.3x76.2x1.6mm: 4Layers) | - | - | 83.3 | °C/W |
| Junction - Case Surface Thermal Resistance 2 | Ψ_{jt_2} | Mounted on glass epoxy board based on EIA/JEDEC. (114.3x76.2x1.6mm: 4Layers) | - | 9.4 | - | °C/W |

□ **TRUTH TABLE**

| ALARM Logic | Input Logic | | | | Output Logic | | State | Remark |
|-------------|-------------|-------|---------|---------|--------------|--------------|---|--|
| ALARM | STB | MS | IN1A/2A | IN1B/2B | OUT1A/2A | OUT1B/2B | | |
| H | H | L | L | L | OFF | OFF | ALL Turn OFF | 2-Input Control |
| | | | H | L | H | L | CW | |
| | | | L | H | L | H | CCW | |
| | | | H | H | H | H | Brake | |
| | H | H | H/L | L | OFF | OFF | ALL Turn OFF | PHASE&ENABLE Control |
| | | | L | H | L | H | CCW | It works as INA1/B1=PHASE, INA2/B2=ENABLE |
| | | | H | H | H | L | CW | |
| | L | H/L | H/L | H/L | OFF | OFF | ALL Turn OFF | Standby State1 |
| H/L | H/L | ALL L | ALL L | OFF | OFF | ALL Turn OFF | Standby State2 (INA1/A2/B1/B2=L) | |
| L | H/L | H/L | H/L | OFF | OFF | ALL Turn OFF | State of Internal Protection Function Operating | |

*OFF=Hi-Z

□ FUNCTION DESCRIPTION

◆ Auto Standby Function

The device can be used for mobile equipments that require batteries. When STB terminal turns to “L”, Standby State1 is achieved. On the other hand, 4 terminals (IA1A/1B,IN2A/2B) are set to “L”, Standby State2 is achieved, which is unique from other devices. When in Standby State, the device stands by under minimum power consumption.

◆ UVLO Function

UVLO function goes into action when VDD is less than 1.8V (typ.). In the event of low VDD, UVLO circuit disables the drivers (OUT1A/2A & OUT1B/2B), and simultaneously sets the ALARM output terminal to “L”.

◆ TSD Function

TSD function goes into action when Tj is more than 170°C (typ.). In the event of high Tj, TSD circuit disables the drivers (OUT1A/2A & OUT1B/2B), and simultaneously sets the ALARM output terminal to “L”.

◆ ALARM Output Function

In the event of fault conditions (UVLO, or TSD active), the device sets the ALARM output terminal to “L” to provide indication of fault conditions.

At the same time, output terminals for Motor (OUT1A/2A & OUT1B/2B) are disabled to prevent damage and unpredictable device operation.

◆ STB: Power Saving State Setting Terminal

STB set to “L” puts the device in Standby State1. It is a similar condition with Auto Standby State (Standby State2).

◆ MS: Input Control Mode Setting Input Terminal

| | |
|----|------------------------------|
| MS | Input Control Mode |
| L | 2-Input Control |
| H | Phase & Enable Input Control |

MS is used to toggle between 2-Input Control and Phase & Enable Input Control.

<The features of 2-Input Control>

When MS terminal turns to “L”, 2-Input Control is selected.

One of the features is: 4 Half-Bridges are controlled independently because the input and output is in a one-to-one ratio. (IN1A-OUT1A, IN1B-OUT1B, IN2A-OUT2A, IN2B-OUT2B)

This input mode is relatively suitable for DC Motor applications.

In case of one-way rotation and braking control, it is possible to control 4 DC Motors at the same time.

Additionally, in case of using of H-Bridge control, it is available to be achieved precision current control around Zero cross current area by using complementary PWM with PWM-duty control at IA1A/1B&IN2A/2B terminals.

<The features of Phase & Enable Input Control>

When MS terminal turns to “H”, Phase & Enable Input Control is selected.

The logic level of IN1A/IN2A corresponding to Phase-function decides current direction in H-Bridge control.

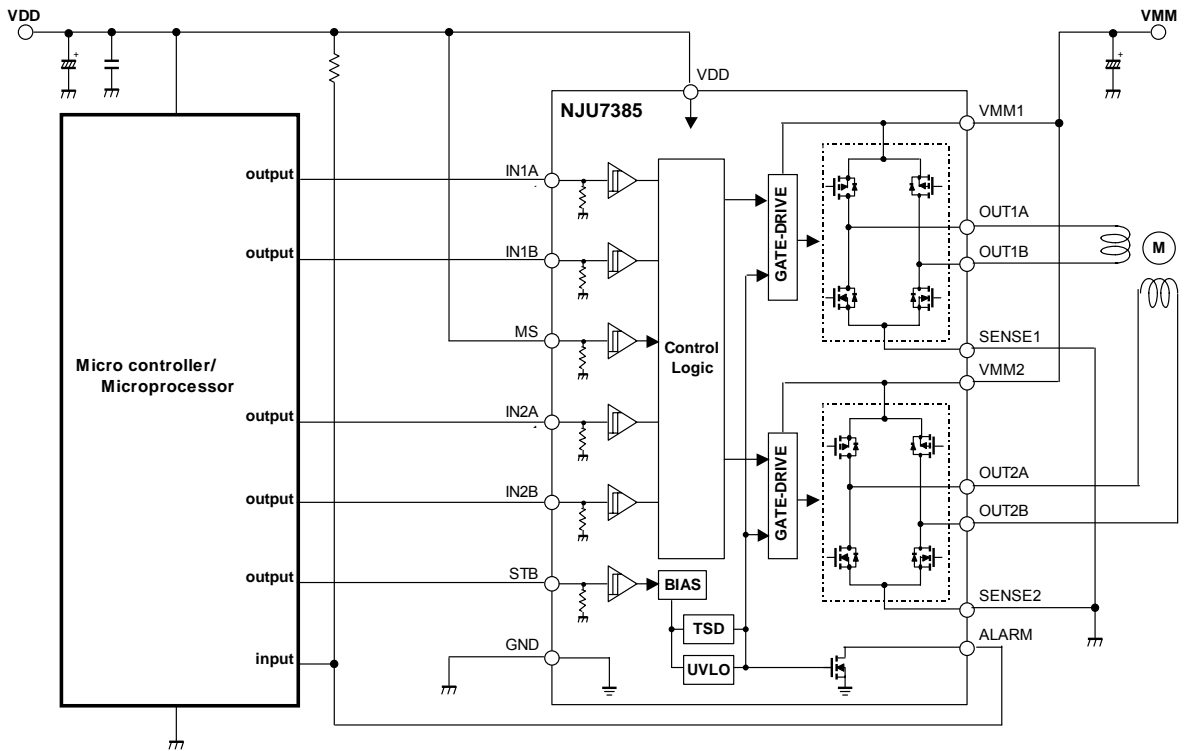
IN1B/IN2B correspond to Enable-function. When IN1B/IN2B are set to “L”, the drivers (OUT1A/2A & OUT1B/2B) are disabled.

This input mode is relatively suitable for Stepper Motor applications. It is possible to control Half-Step-Mode that needs making the drivers disabled.

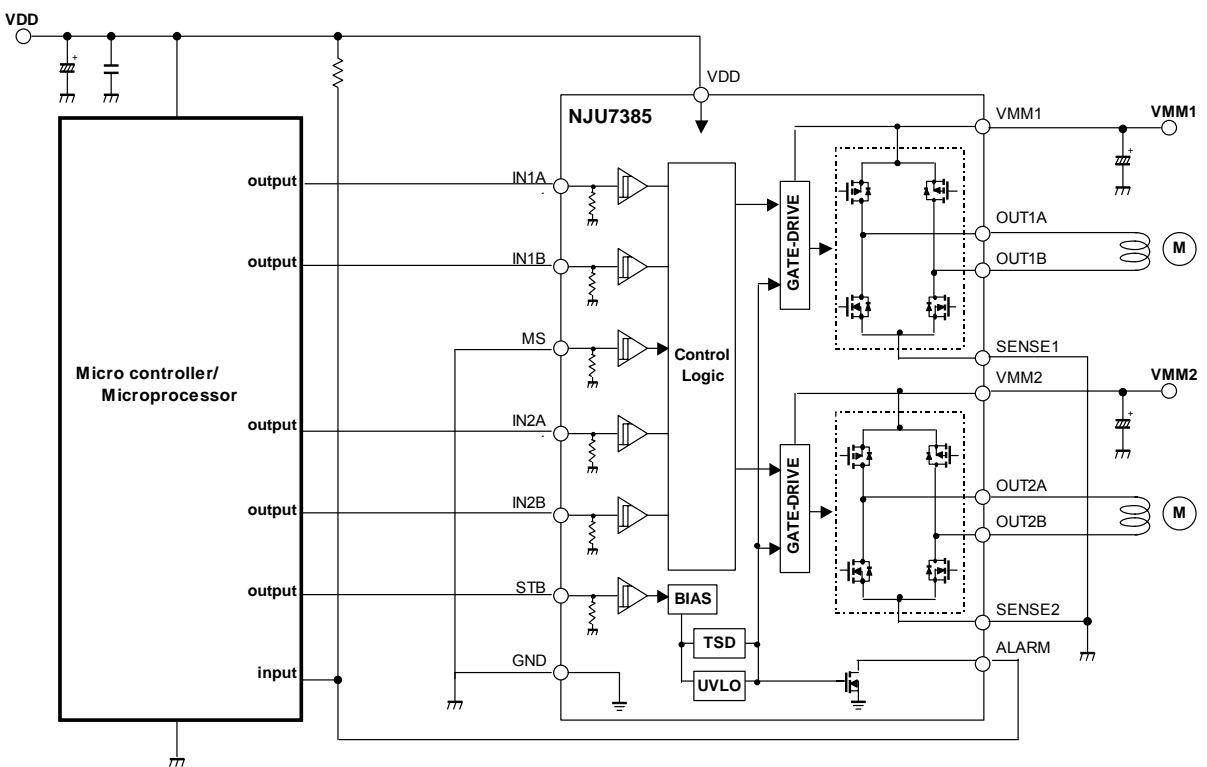
Additionally, in case of Full-Step-Mode, it is available to be achieved a simple control of Stepper Motor using only 2 wires to IN1A/IN2A.

APPLICATION CIRCUIT

◆ For Stepper Motor



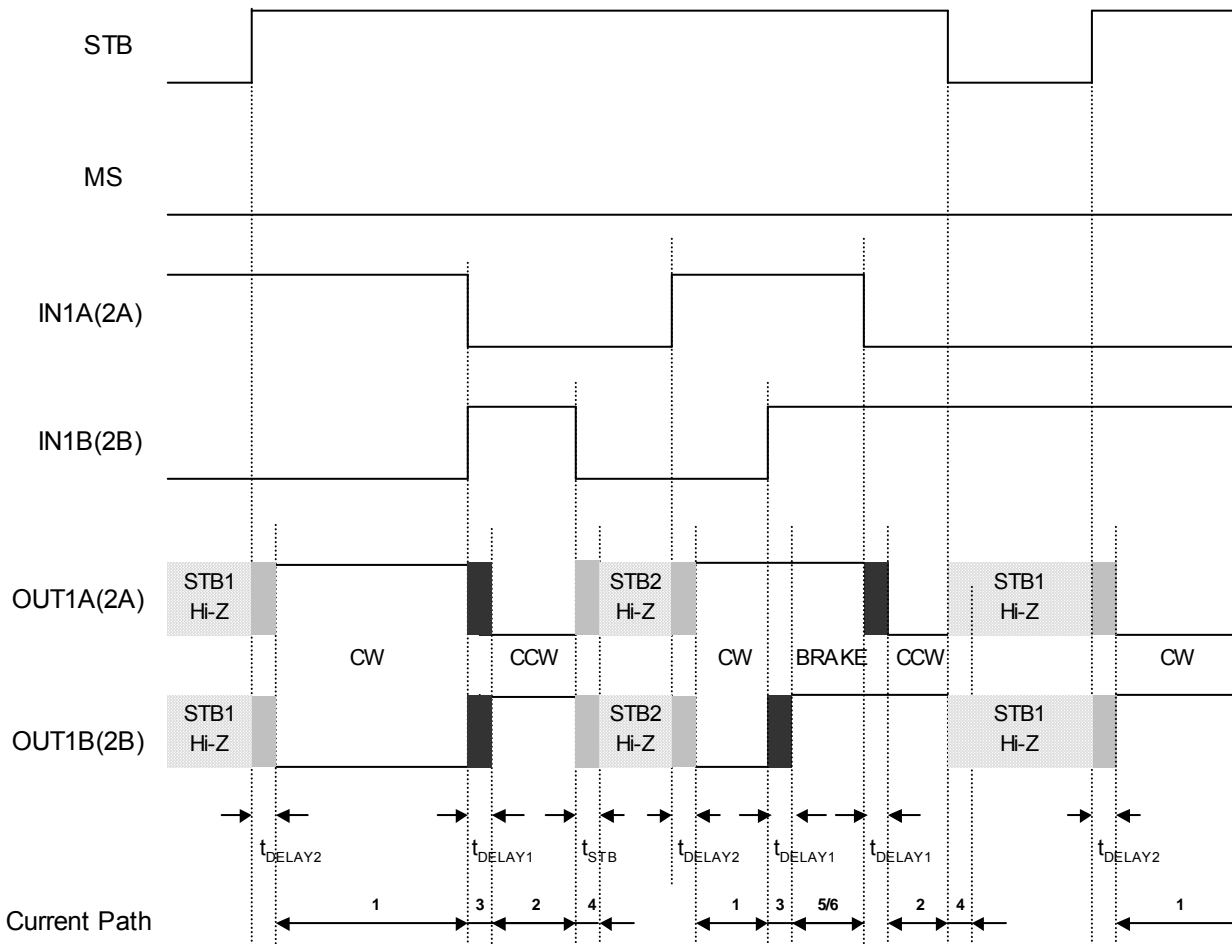
◆ For DC Motor / Solenoid



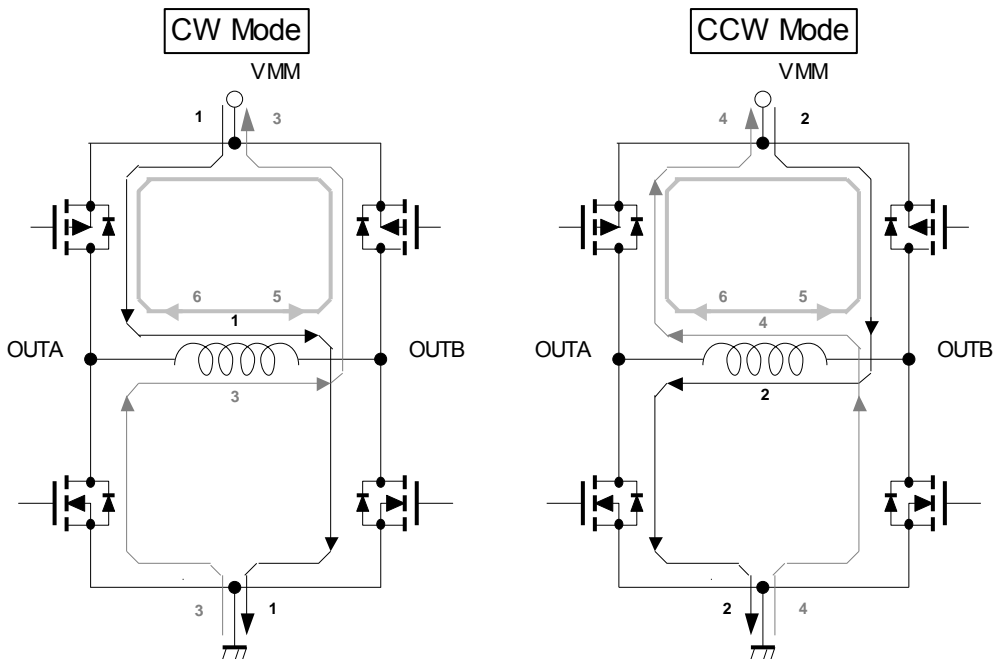
□ TIMING CHART

◆ 2-INPUT CONTROL MODE

2-INPUT CONTROL MODE

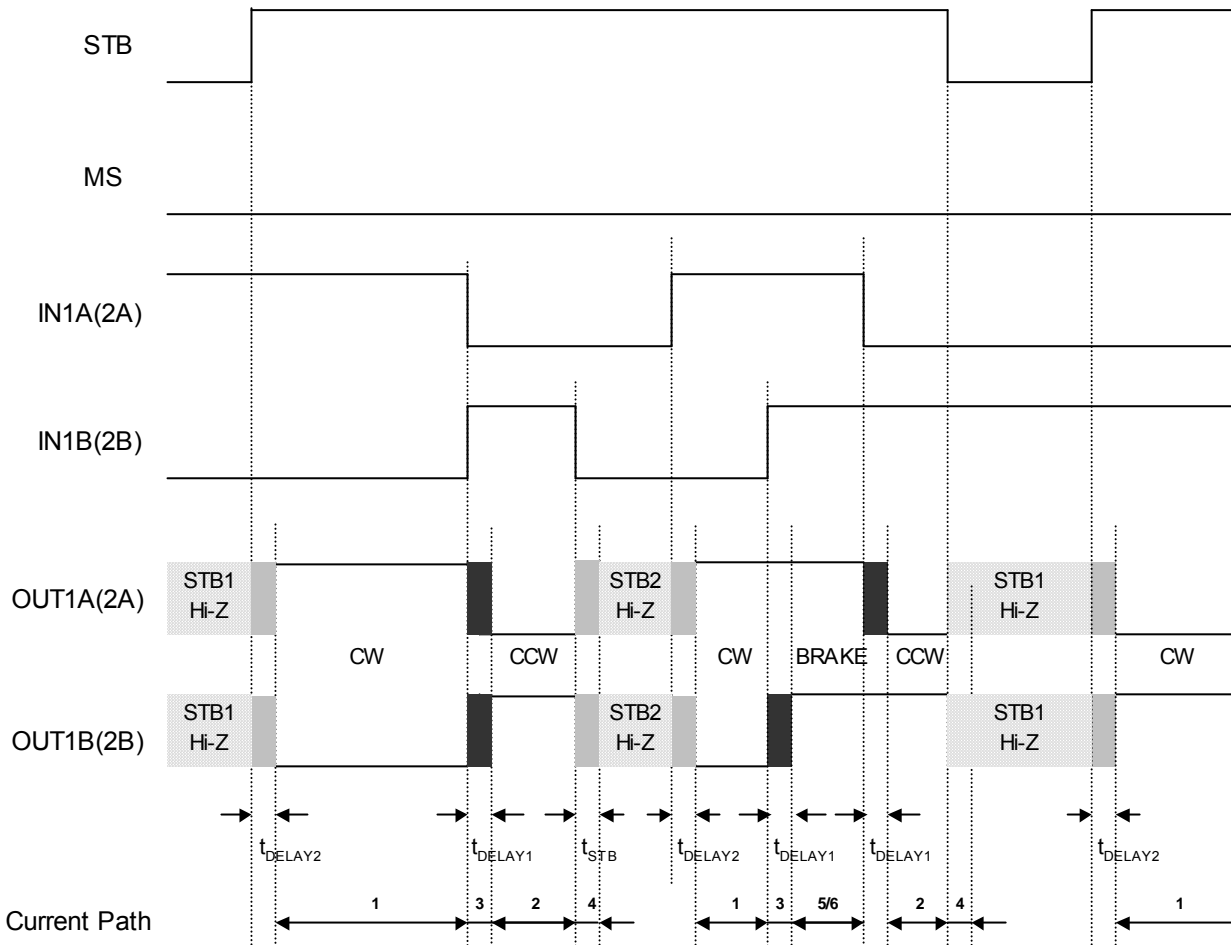


Output stage with current paths during turn-on, turn off.

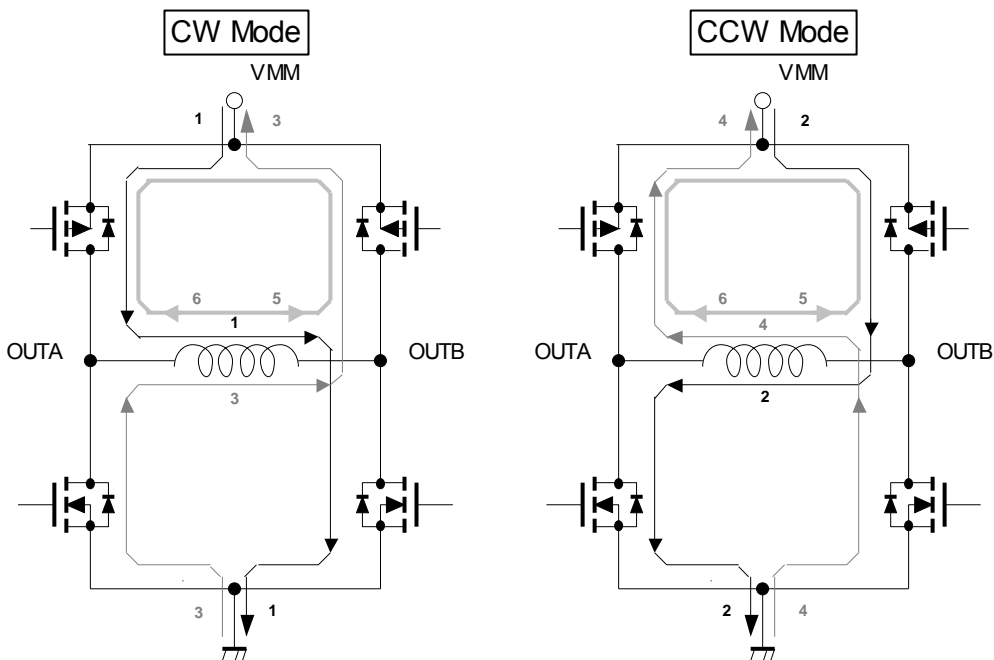


◆ PHASE-ENABLE CONTROL MODE

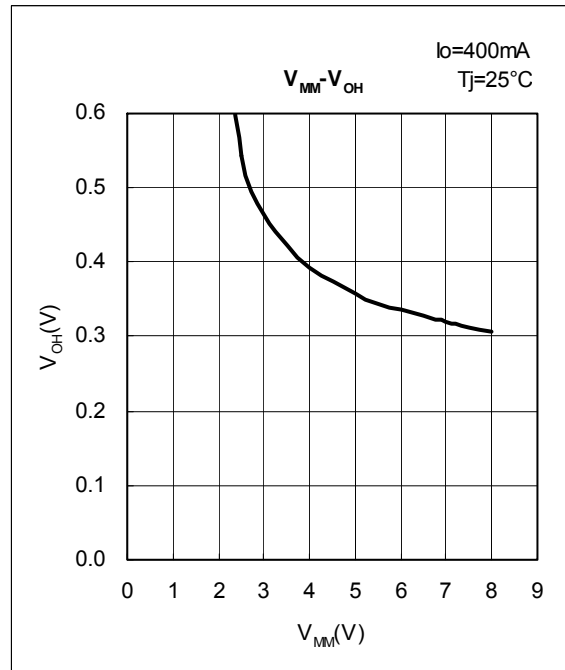
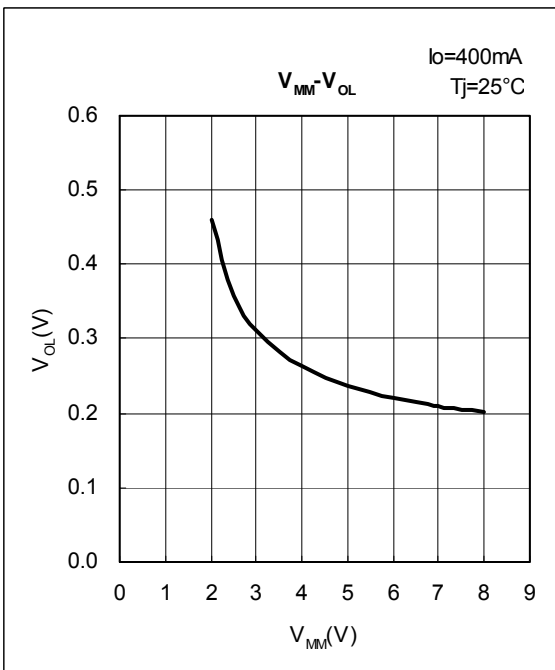
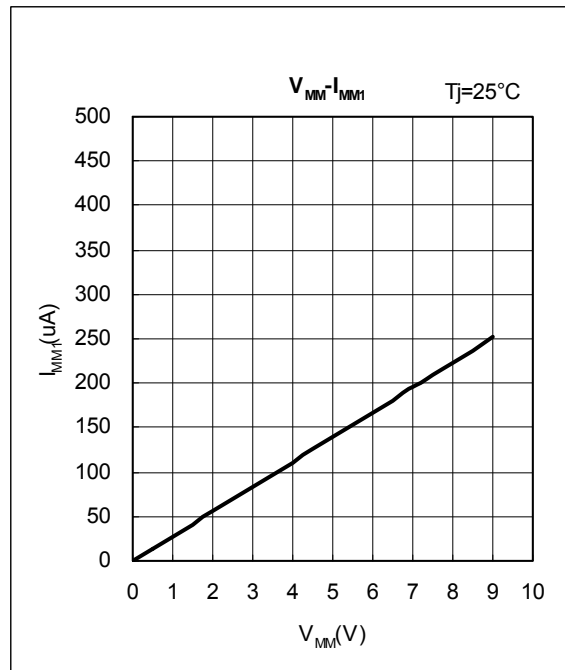
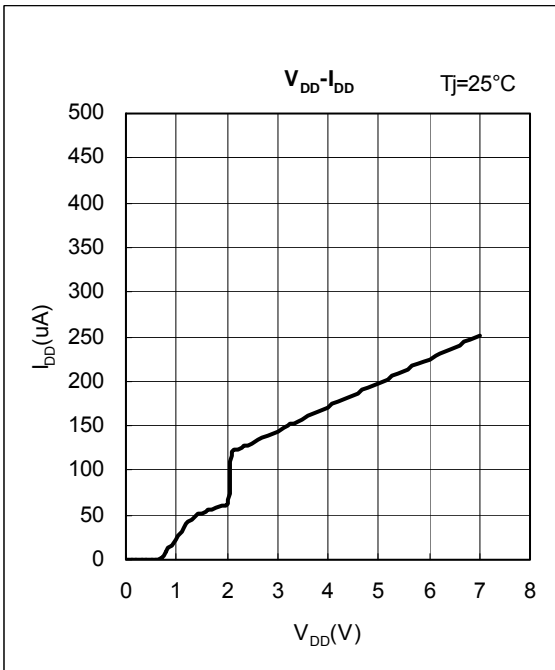
2-INPUT CONTROL MODE



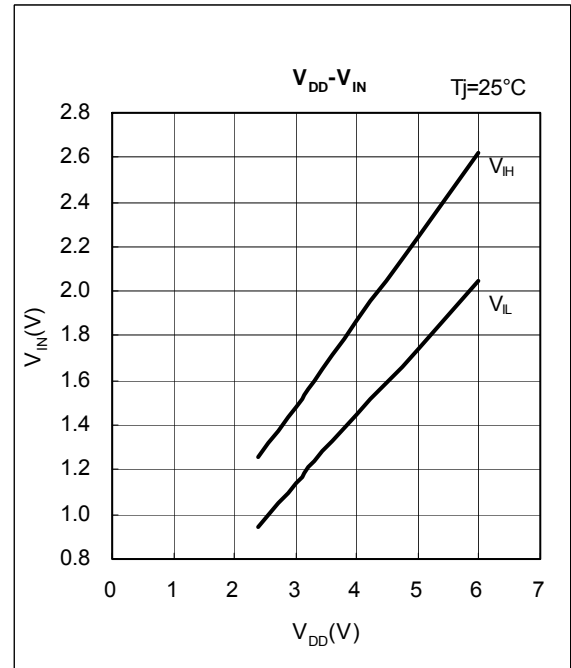
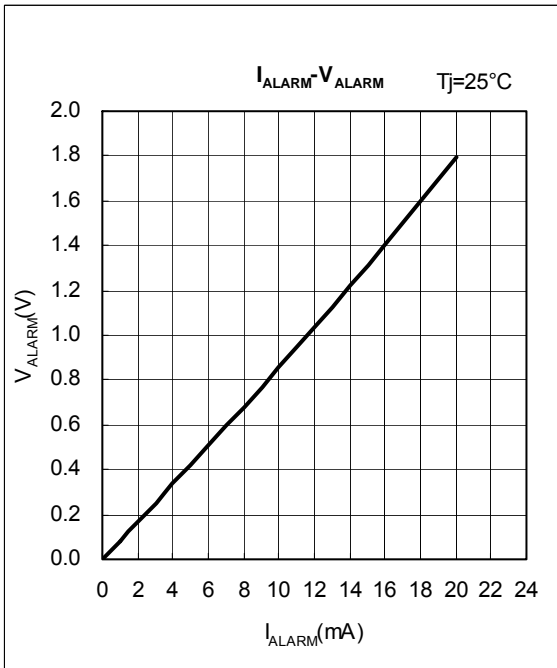
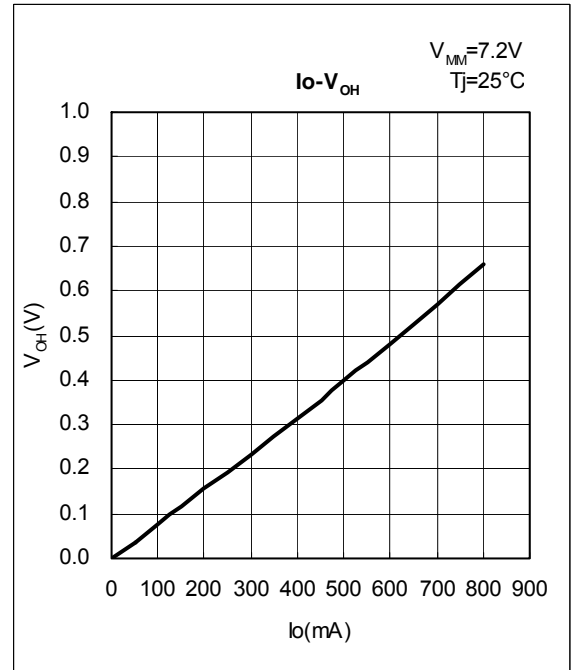
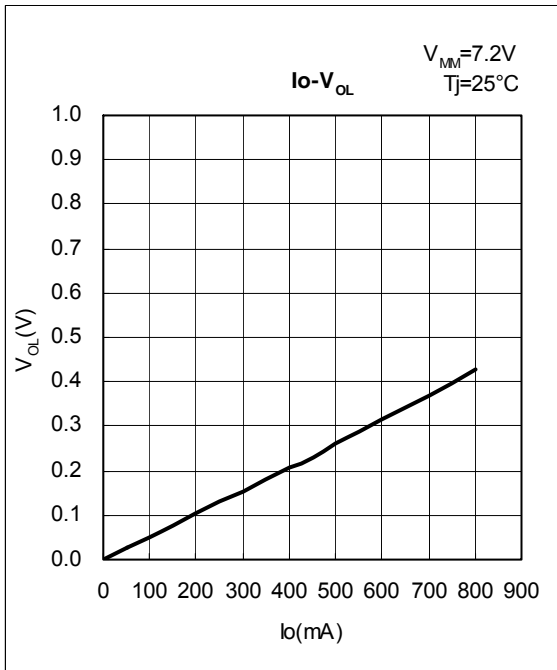
Output stage with current paths during turn-on, turn off.



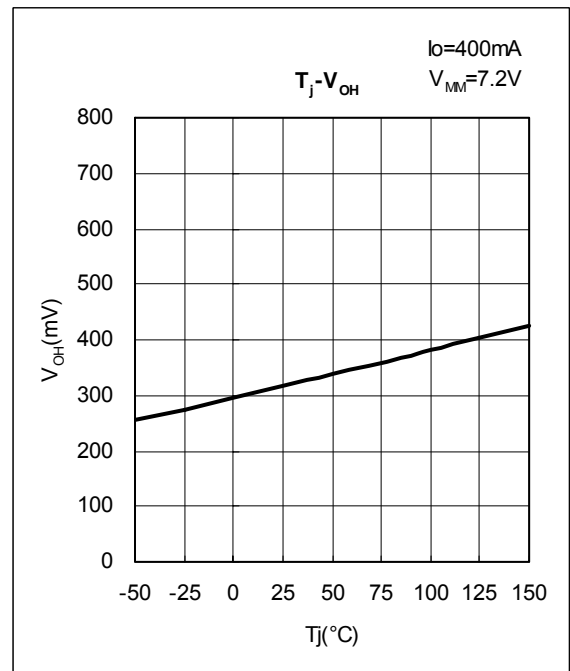
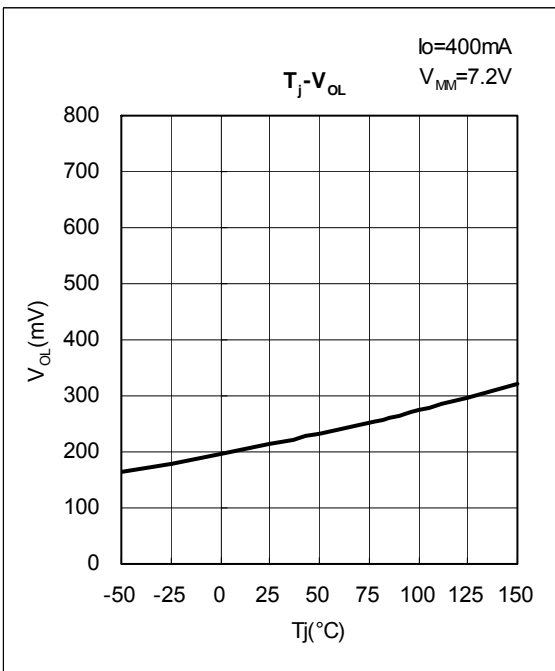
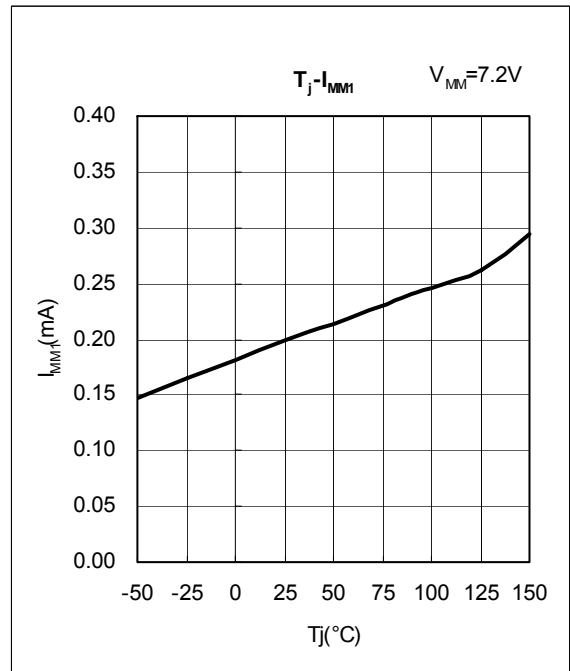
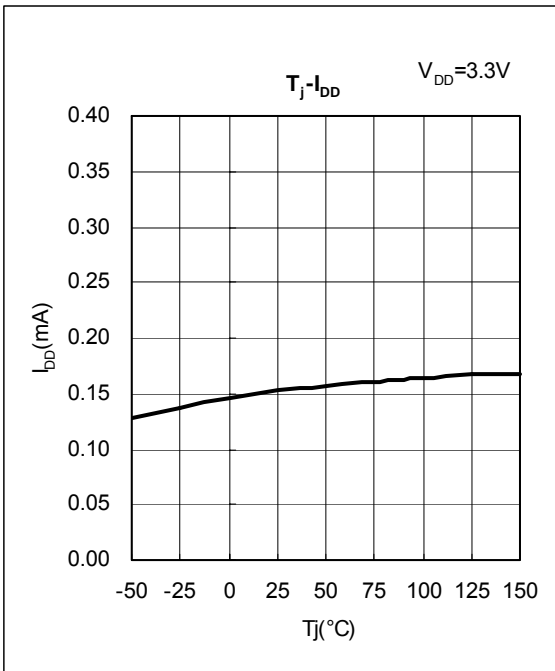
TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS



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