FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-27601-1E

*ASSP*

# POWER MANAGEMENT SWITCH

# MB3802

## ■ DESCRIPTION

The MB3802 is a power management switch incorporating two switch circuits with extremely low ON resistance.

NO diode is required because the switch block is configured with an N-ch MOS to prevent reverse current at swich OFF.

The MB3802 starts at a very low voltage (typical $V_{IN}$ > 2.2V) and a stable ON resistance is obtained irrespective of the switching voltage because the intermal DC/DC converter applies the optimum voltage for the N-ch MOS gate at swith ON.

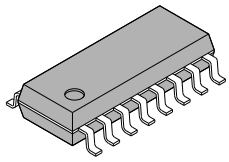
Moreover, the load-side capacitor is discharged at switch OFF, and the power supply for various power supply systems is switched efficiently.

## ■ FEATURES

- Extremely low ON resistance:
  $R_{ON}$ = 0.12Ω (typical)
  $R_{ON}$ = 0.06Ω (typical at parallel connection)
- Reverse current protection at load side at switch OFF
- Operation start at low input voltage: $V_{IN}$ > 2.2V (typical)
- Low power consumption
  At switch OFF: $I_{IN}$ (input voltage) = 0 µA, $V_{IN}$ = 0V
  At switch ON: $I_{IN}$ = 230 µA, $V_{IN}$ = 5V
- Load discharge function
- External control of ON/OFF time
- Break-before-make operation

## ■ PACKAGE

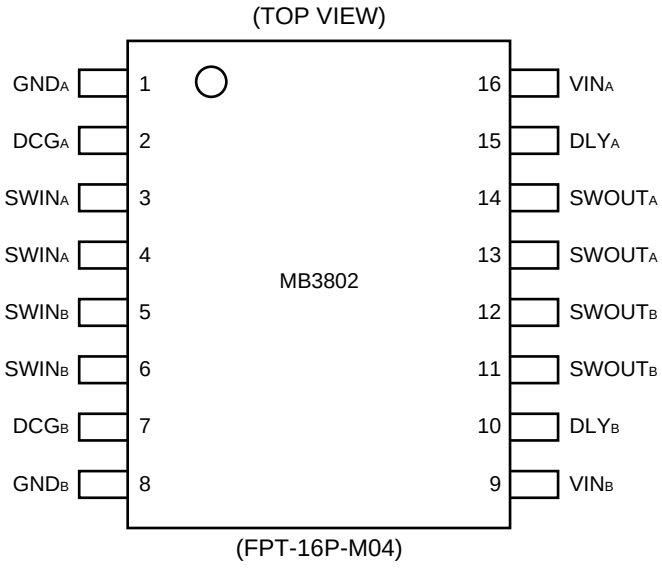
Plastic SOP, 16 pin



(FPT-16P-M04)

# MB3802

## ■ PIN ASSIGNMENT

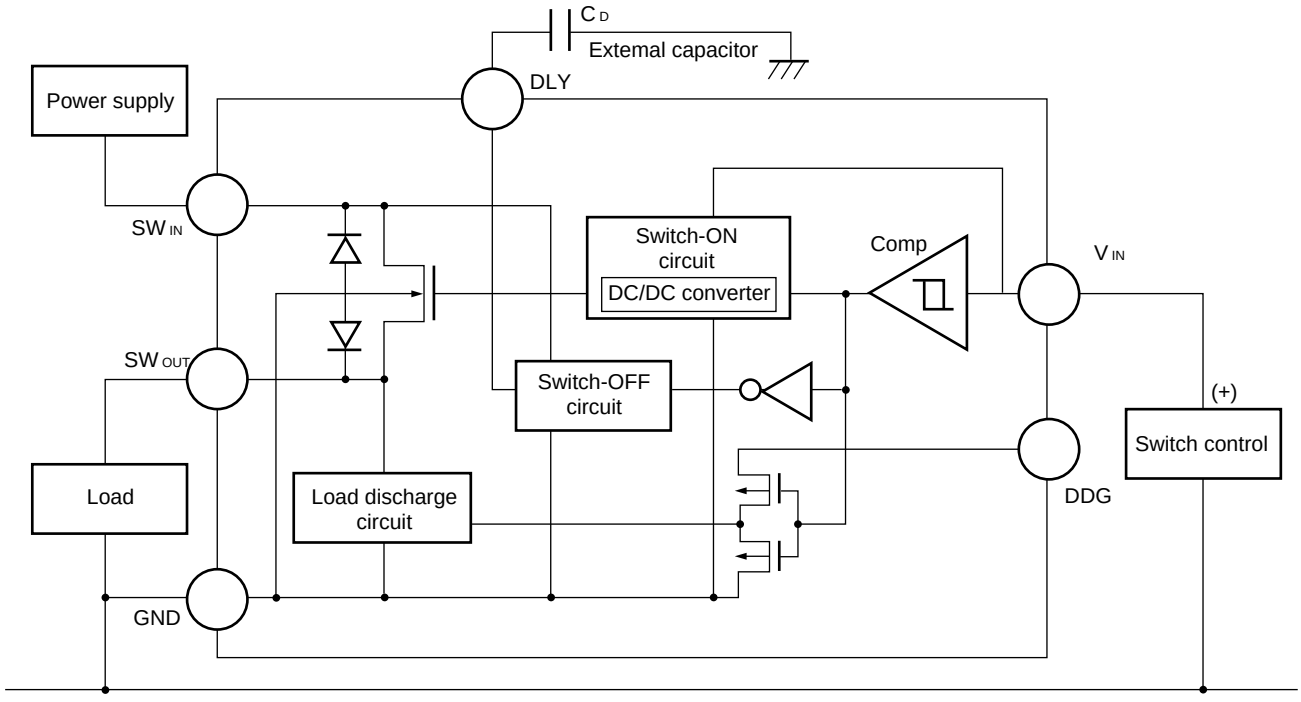



## ■ PIN DESCRIPTION (SCSI Interface)

| Pin No. | Pin symbol | Description |
|---|---|---|
| 16 | $V_{INA}$ | These pins switch ON at High level and OFF at Low level. They serve as power-supply pins for the DC/DC converter to generate the switch gate voltage. |
| 9 | $V_{INB}$ | |
| 3, 4 | $SWIN_A$ | **Switch Input pins:** Two common pins are assigned to $SWIN_A$ and $SWIN_B$. They serve as power-supply pins for the switch-OFF circuit which starts at 1.5V min. |
| 5, 6 | $SWIN_B$ | |
| 13, 14 | $SWOUT_A$ | **Switch output pins:** Two common pins are assigned to $SWOUT_A$ and $SWOUT_B$. When DCGA and DCGB are High level, the load-discharge circuit starts discharge via these pins. |
| 11, 12 | $SWOUT_B$ | |
| 2 | $DCG_A$ | **$SWOUT_A$/$SWOUT_B$-side discharge control pins:** These pins are used to discharge from the load-side capacitor at switch OFF. Connect them to GND when discharge is not required. |
| 7 | $DCG_B$ | |
| 15 | $DLY_A$ | **Switch-ON/OFF control pins:** The ON/OFF time can be delayed by connecting an external capacitor. Both times are delayed about three fold by installing a 500-pF capacitor between these pins and GND. Leave these pins open when they are not used. 10V may be generated when these pins are open. To keep these pins at high impedance, take care to mount the device so that no current leaks (less than 0.1 μA). |
| 10 | $DLY_B$ | |
| 1 | $GND_A$ | **Ground pins for input threshold reference voltage and load discharge:** When two switching circuits are used, ground both GND pins. |
| 8 | $GND_B$ | |

# MB3802

## ■ BLOCK DIAGRAM AND EXTERNAL CONNECTIONS




Note: The MB3802 incorporates two switch blocks as shown above. However, GND is common to both blocks.

## ■ BLOCK DESCRIPTION

When $V_{IN}$ exceeds 2.2V, the Comp. starts driving the DC/DC converter to switch the N-ch MOS and applies the optimum voltage for the switch gate.

The DC/DC converter boosts the $V_{IN}$ voltage.

When VIN is below 2.1V, the Comp. stops the DC/DC converter, starts the switch-OFF circuit, and discharges the voltage from the switch gate to GND. The switch-OFF circuit is powered from the $SW_{IN}$ and consumes 0.4µA at 5V.

Since the N-ch MOS back gate is connected to GND, switch-OFF reverse current is prevented irrespective of the High level state between $SW_{IN}$ and $SW_{OUT}$.

The load discharge circuit installed between $SW_{OUT}$ and GND is powered by the DCG pin, and discharges the load-side capacitor at switch OFF. When it is not necessary to discharge the load, connect the DCG pin to GND.

The DLY pins are for connection to an external capacitor to delay the switch-ON/OFF time. The surge current at the load side is cut at power-on by controlling the switch-ON time. The switch-ON time depends on the boot time of the DC/DC converter. Consequently, when the VIN level is high and the $SW_{IN}$ level is low, the switch-ON time is small; when the $SW_{IN}$ level is high, the switch-OFF time is small.

# MB3802

## ■ ABSOLUTE MAXIMUM RATING

(Ta = +25°C)

| Parameter | Symbol | Condition | Ratings | Unit |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | — | –0.3 to 7.0 | V |
| Switching voltage | $V_{SW}$ | At switch OFF | –0.3 to 7.0 | V |
| | | At switch ON | –0.3 to 7.0 | |
| Switching current | $I_{SW}$ | At switch-ON peak | 3.6 | A |
| Pemissible loss | $P_D$ | Ta ≤ + 75°C | 290 | mW |
| Strage Temperature | $P_{STG}$ | — | –55 to +125 | °C |

## ■ RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typical | Max. | |
| Input voltage | $V_{IN}$ | — | 0 | — | 6.0 | V |
| Switching level | $V_{SWIN}$ | At switch ON | 0 | — | 6.0 | V |
| | | At switch OFF | 0 | — | 6.0 | |
| Switching current | $I_{SW}$ | At switch on (for single switch) | — | — | 1.2 | A |
| Gate-pin connection capacitance | $C_D$ | — | — | — | 10 | nF |
| Gate-pin mounting leak current | $I_{DLY}$ | — | –0.1 | — | 0.1 | µA |
| Input voltage to load discharge circuit | $V_{DCG}$ | $V_{IN}$ = 3V, 5V | 2.5 | — | 6.0 | V |
| Operating temperature | $T_{op}$ | — | –40 | — | +7.5 | °C |

## ■ ELECTRICAL CHARACTERISTICS

### 1. DC Characteristics

(Ta = +25°C)

| Parameter | Symbol | Condition | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Input current | $I_{IN1}$ | $V_{IN}$ = 0V | — | 0 | — | µA |
| | $I_{IN2}$ | $V_{IN}$ = 3V | — | 100 | 200 | µA |
| | | $V_{IN}$ = 5V | — | 230 | 460 | µV |
| Swiching resistance | $R_{ON1}$ | $V_{IN}$ = 3V, $I_{SW}$ = 0.5A, $V_{SWIN}$ = 3V | — | 120 | 160 | mΩ |
| | $R_{ON2}$ | $V_{IN}$ = 5V, $I_{SW}$ = 0.5A, $V_{SWIN}$ = 3V | — | 130 | 175 | mΩ |
| Switch-OFF leak current | $I_L$ | $V_{IN}$ = 0V, $V_{SWIN}$ = 6V | — | 0.5 | 2.0 | µA |
| Input threshold voltage | $V_{TH1}$ | At switch ON | 2.0 | 2.2 | 2.4 | V |
| | $V_{TH2}$ | At switch OFF | 1.9 | 2.1 | 2.3 | V |
| Input hysteresis width | $V_{HYS}$ | — | 50 | 100 | — | mV |
| Switch resistance | $R_{ON}$ | $V_{IN}$ = 3V, 5V, $I_{SW}$ = 0.5A Ta = –40° to +75°C | — | — | 210 | mΩ |
| Switch charge resistance | $R_{DCG1}$ | $V_{SWOUT}$ = 3V, $V_{DCG}$ = 3V | — | 750 | 1500 | Ω |
| | $R_{DCG2}$ | $V_{SWOUT}$ = 5V, $V_{DCG}$ = 5V | — | 500 | 1000 | Ω |
| Input voltage to switch charge circuit | $I_{DCG}$ | $V_{DCG}$ = 5V | — | 0 | 2 | µA |

### 2. AC Characteristics

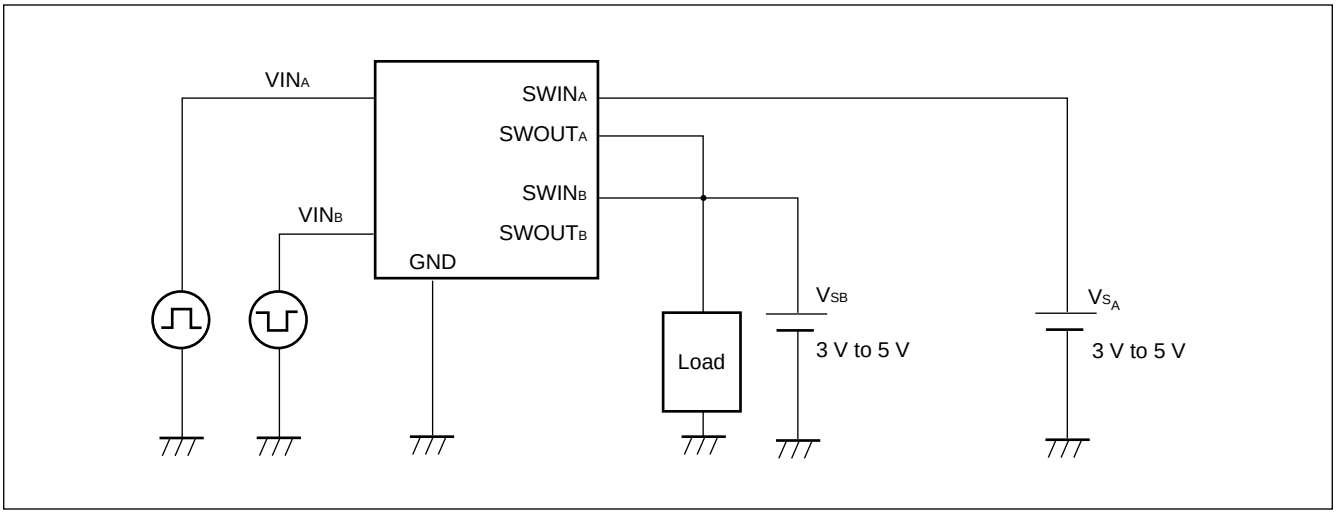
(Ta = +25°C)

| Parameter | Symbol | Condition | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Switch-ON time | $t_{ON1}$ | $V_{IN}$ = 0V → 3V, $V_{SWIN}$ = 3V | 100 | 300 | 900 | µs |
| | $t_{ON2}$ | $V_{IN}$ = 0V → 5V, $V_{SWIN}$ = 5V | 50 | 150 | 450 | µs |
| Switch OFF time | $t_{OFF1}$ | $V_{IN}$ = 3V → 0V, $V_{SWIN}$ = 3V | 20 | 60 | 180 | µs |
| | $t_{OFF2}$ | $V_{IN}$ = 5V → 0V, $V_{SWIN}$ = 5V | 10 | 30 | 150 | µs |
| Switch ON/OFF time lag | $t_{HYS1}$ | $V_{IN}$ = 3V → 0V, $V_{SWIN}$ = 3V | 80 | 240 | 720 | µs |
| | $t_{HYS2}$ | $V_{IN}$ = 5V → 0V, $V_{SWIN}$ = 5V | 40 | 120 | 300 | µs |

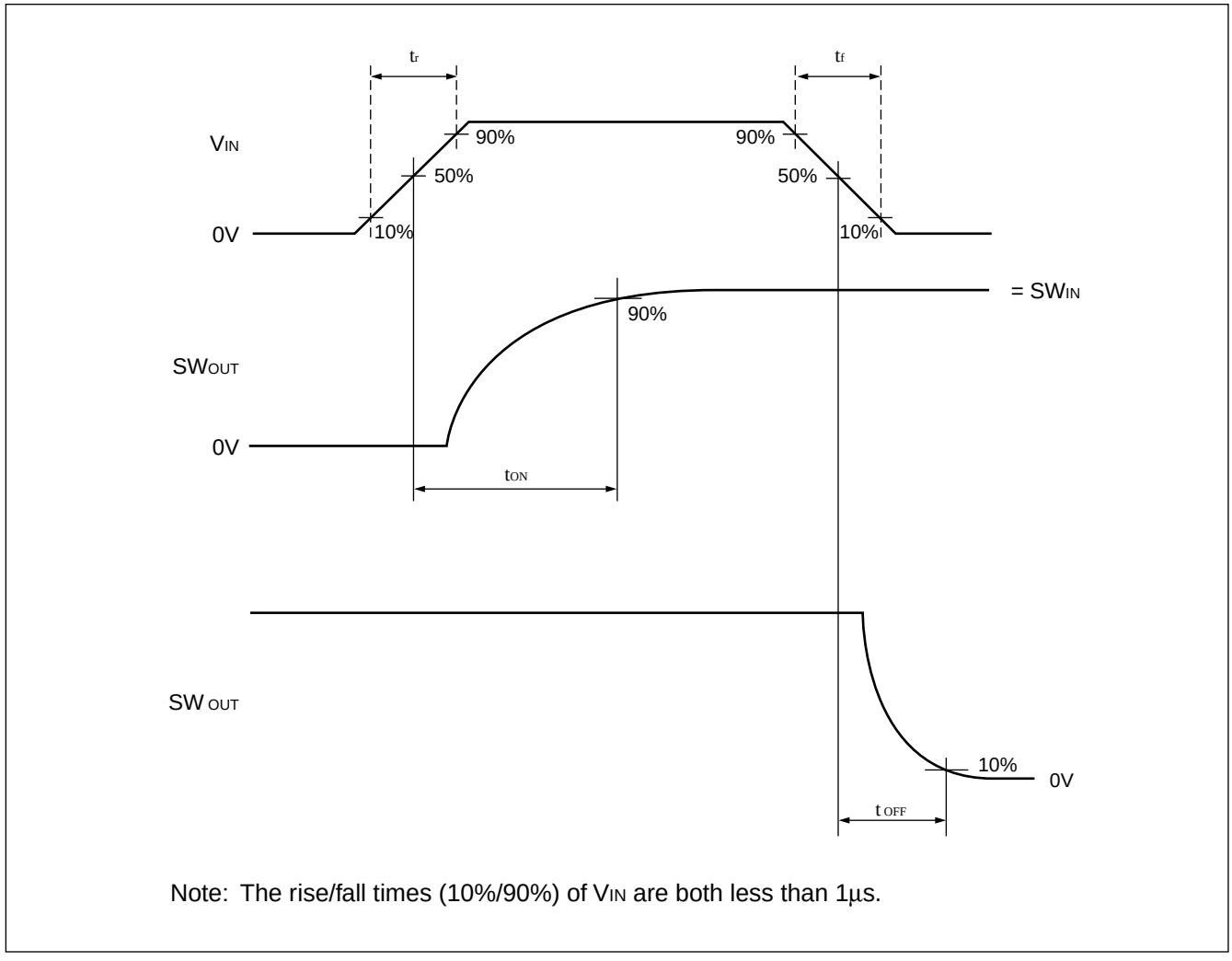
# MB3802

## ■ AC CHARACTERISTIC TEST DIAGRAMS

### 1. Test Condition



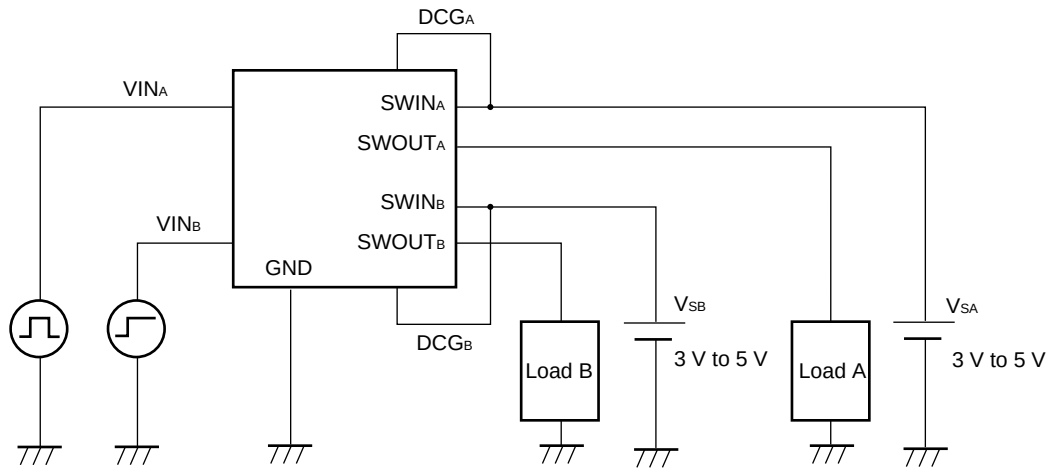

### 2. Switch-ON/OFF Timing Chart




Note: The rise/fall times (10%/90%) of $V_{IN}$ are both less than 1µs.

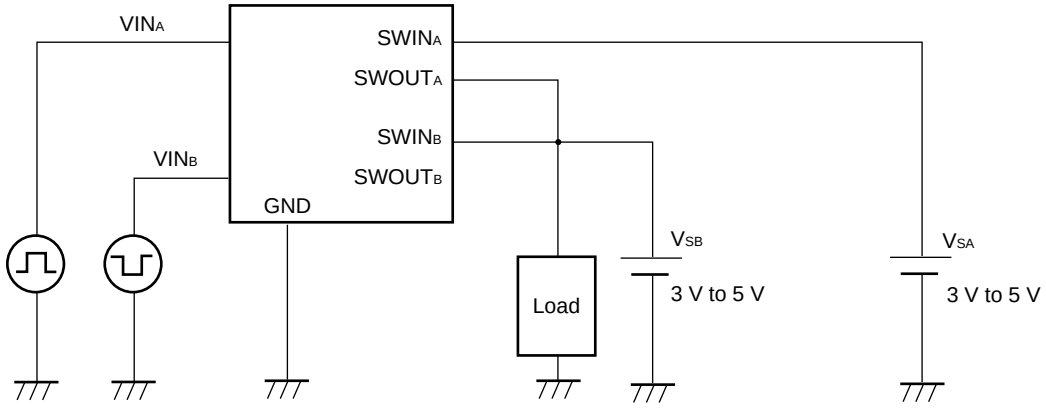
## ■ APPLICATIONS

### 1. Separate Use of Two Switching Circuits



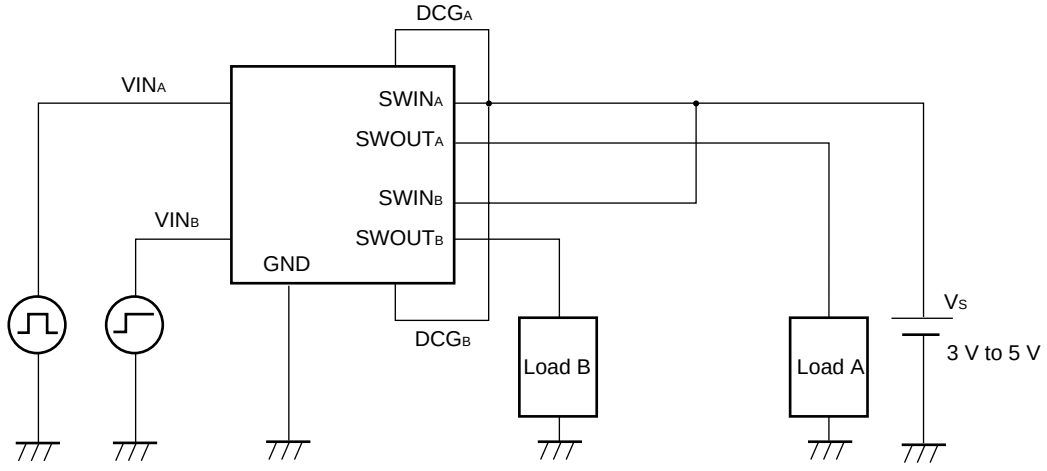

Notes:
1. The two power supplies $V_{SA}$ and $V_{SB}$ can be used separated by controlling the voltages $V_{INA}$ and $V_{INB}$>
2. Connect the DCD pin to GND when it is not used.

### 2. Switching Two Power Supplies



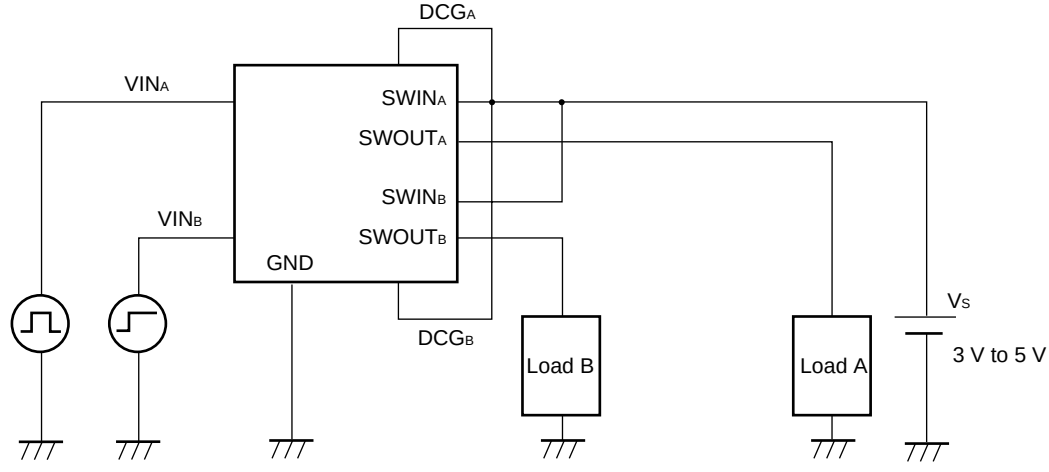

Note: When using different power supplies for a single load, control them by connecting an external capacitor so that both switches are not ON at the same time.

### 3. Switching Two Loads



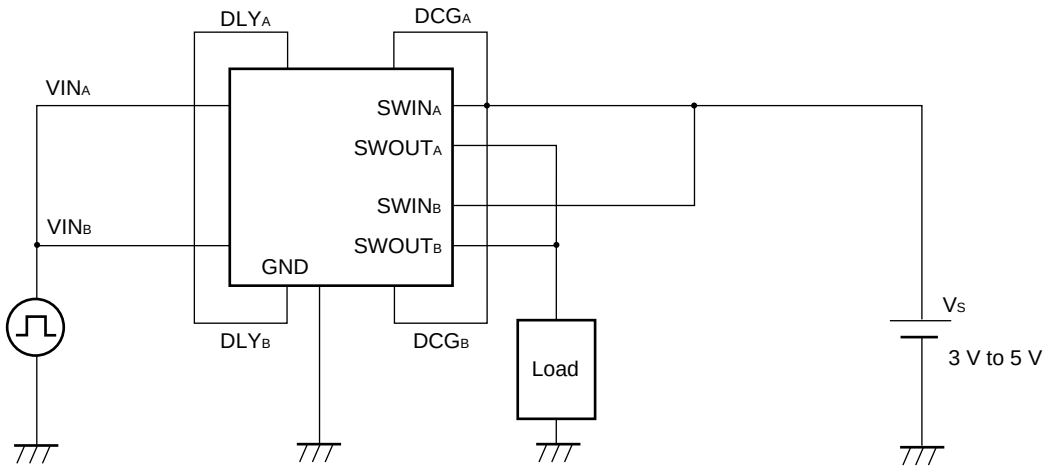

Note: Make this connection to control two different loads separately for a single power supply.

### 4. Connecting Serial Switches



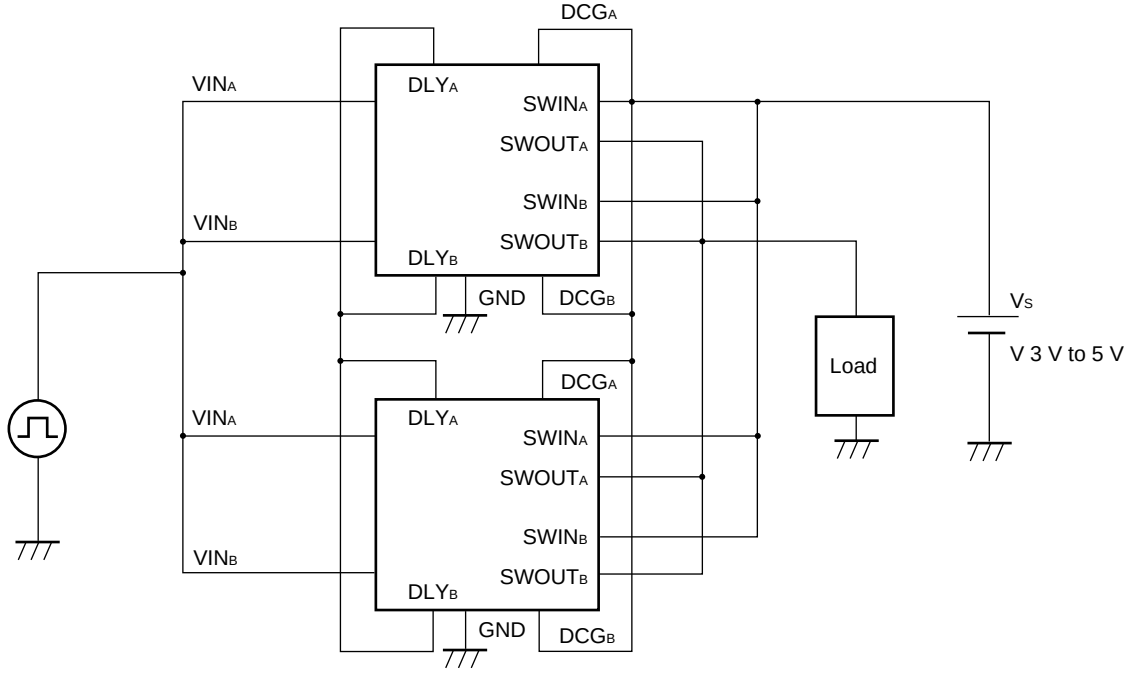

Note: Make this connection to supply power from $V_S$ to load B via load A.

## 5. Connecting Parallel Switches



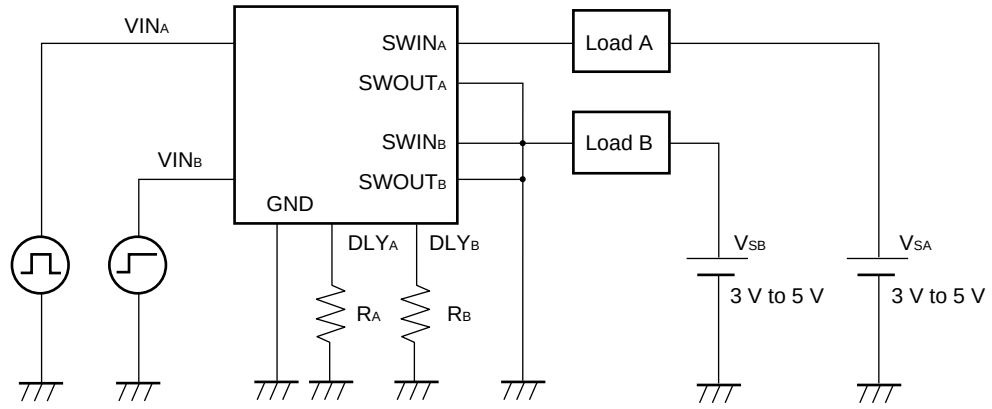

Note: Connect the circuits A and B in parallel to produce a low ON resistance ($R_{ON}$ = 0.06Ω). In this case, connect the DLYA and DLYB pins in common to give synchronous ON/OFF between both switches.

## 6. 25% ON Resistance




Notes:
1. Make this connection to produce an ON resistance that is much lower than the above connection. Also, connect the DLY pins in common.
2. Consider the difference between the ON resistances and the switch-ON/OFF times between two devices (MB3802) and insure that load control is not offset at one device.

## 7. Low-side Switch



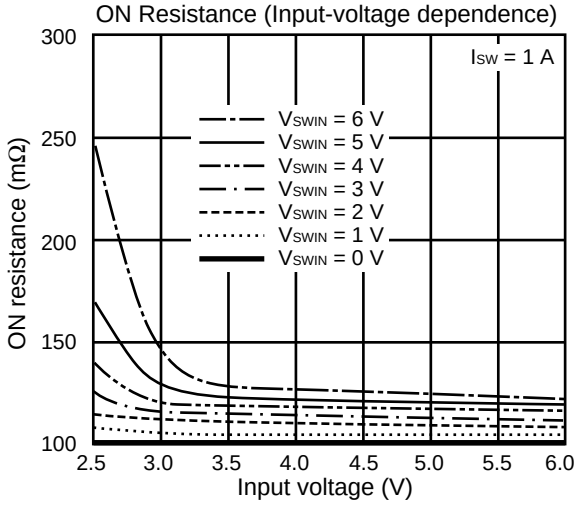

| | $V_{IN}$ = 3 V, $V_S$ = 3 V | $V_{IN}$ = 5 V, $V_S$ = 5 V |
|---|---|---|
| Switch-ON time<br>Switch-OFF time | 80 µs<br>5.0 ms | 45 µs<br>3.5 ms |

$R_A$ and $R_B$ = 10 MΩ

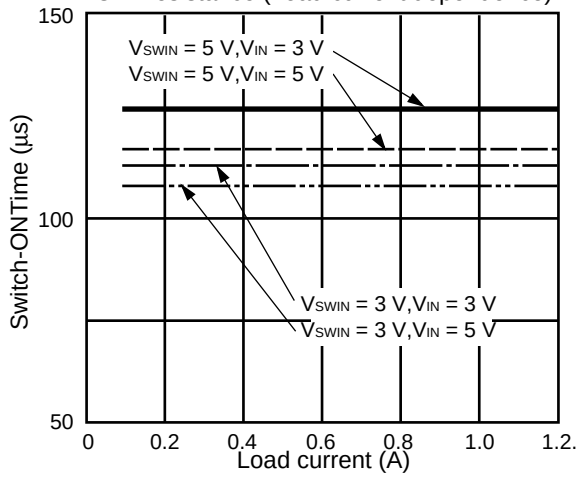
Notes:
1. Make this connection to control the switch ON/OFF at the lower load side.
2. To assist the switch-OFF circuit operation driven by the $SW_{IN}$ power supply, connect high resistances ($R_A$ and $R_B$ = 5 to 10 MΩ) to the DLY pins without overloading the DC/DC converter.
3. At this connection, the switch-OFF time is longer than the switch-ON time.

## ■ TYPICAL PERFORMANCE CHARACTERISTICS

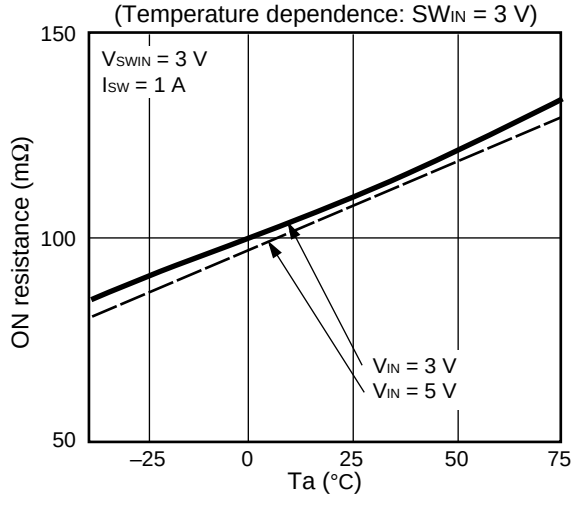
ON Resistance (Input-voltage dependence)



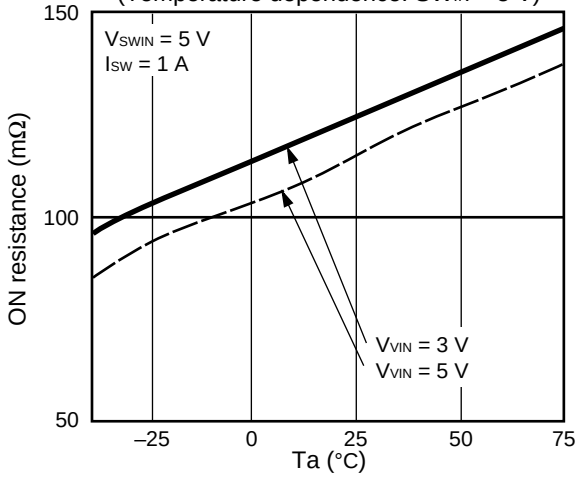

ON Resistance (Load current dependence)



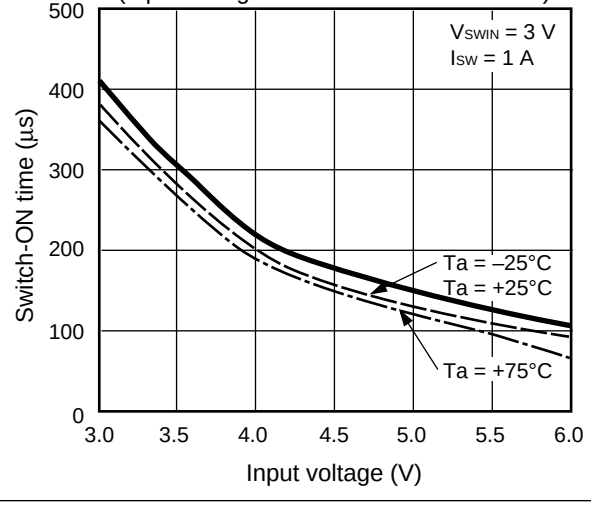

ON Resistance
(Temperature dependence: $SW_{IN}$ = 3 V)



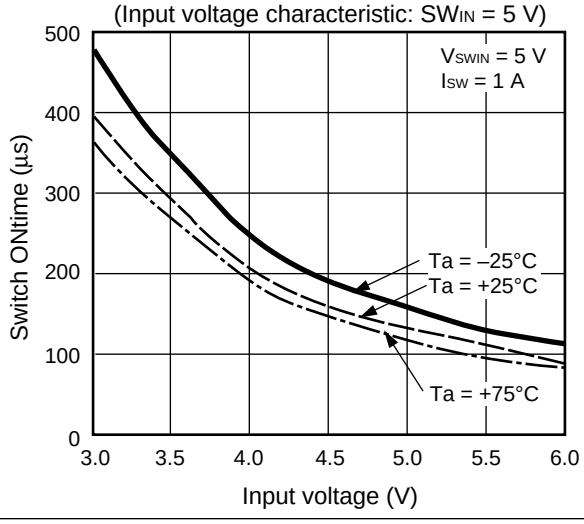

ON Resistance
(Temperature dependence: $SW_{IN}$ = 5 V)




Switch-ON time
(Input voltage characteristic: $SW_{IN}$ = 3 V)




Switch-ON time
(Input voltage characteristic: $SW_{IN}$ = 5 V)

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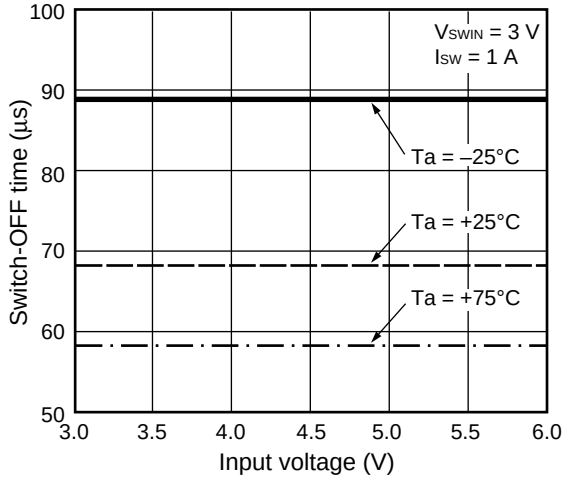
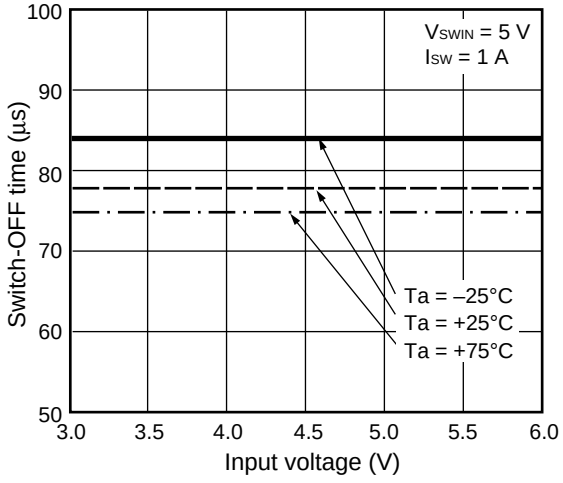
# MB3802

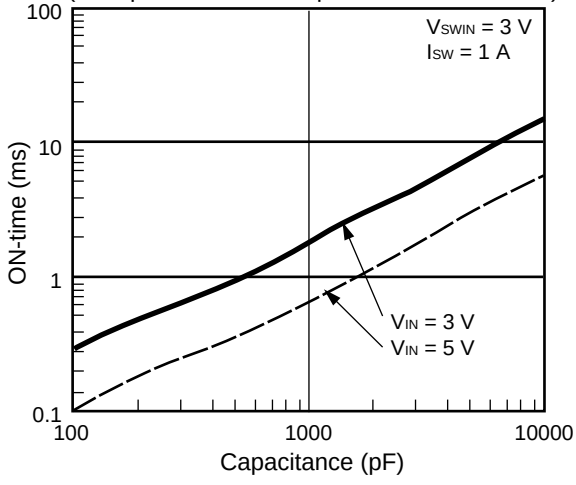
Switch-OFF Time
(Input voltage characteristic: $SW_{IN}$ = 3 V)



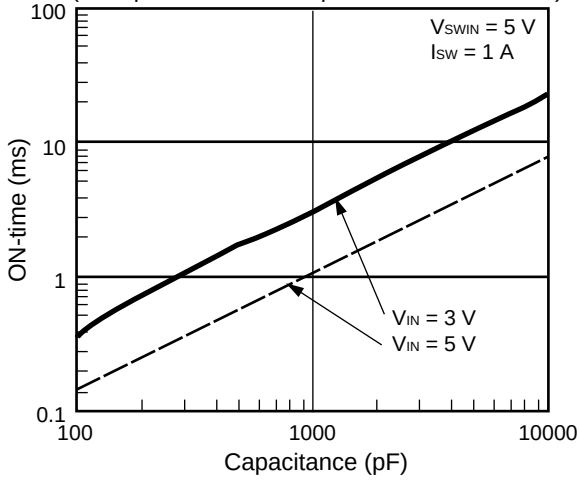

Switch-OFF Time
(Input voltage characteristic: $SW_{IN}$ = 5 V)



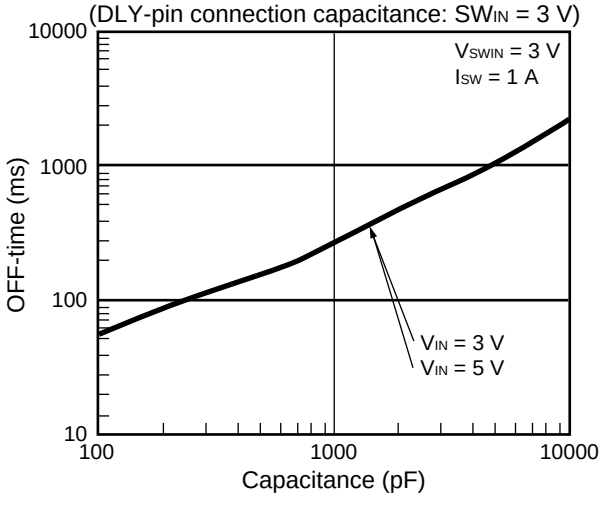

Switch-ON Time
(DLY-pin connection capacitance: $SW_{IN}$ = 3 V)



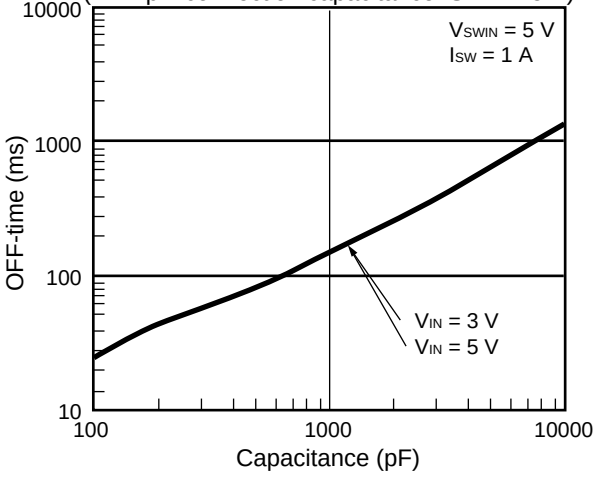

Switch-ON Time
(DLY-pin connection capacitance: $SW_{IN}$ = 5 V)




Switch-OFF Time
(DLY-pin connection capacitance: $SW_{IN}$ = 3 V)




Switch-OFF Time
(DLY-pin connection capacitance: $SW_{IN}$ = 5 V)

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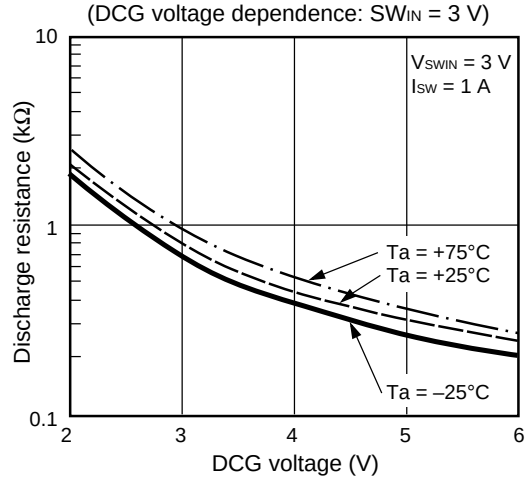
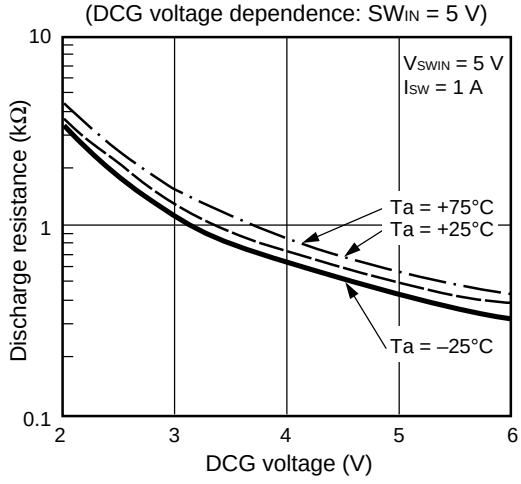
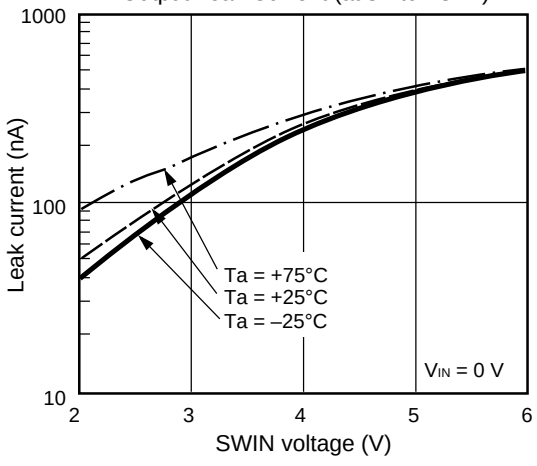
Discharge Resistance
(DCG voltage dependence: $SW_{IN}$ = 3 V)



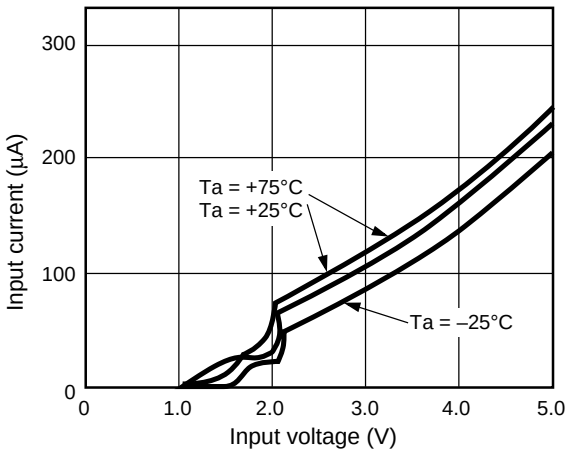

Discharge Resistance
(DCG voltage dependence: $SW_{IN}$ = 5 V)



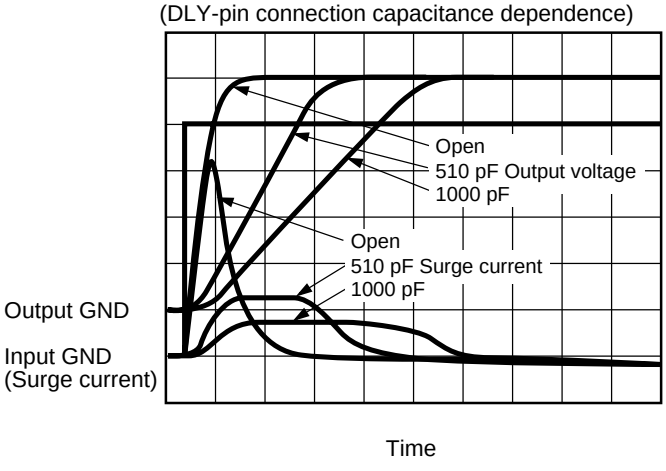

Output Leak Current (at switch OFF)



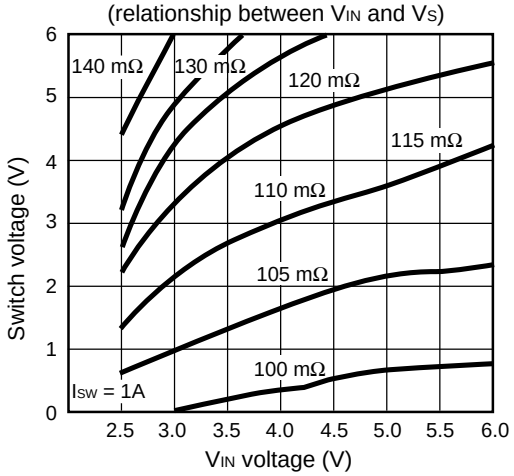

Input Current (Input voltage dependence)




Surge Current and Output Voltage Boot
(DLY-pin connection capacitance dependence)




Switch-On resistance
(relationship between $V_{IN}$ and $V_S$)



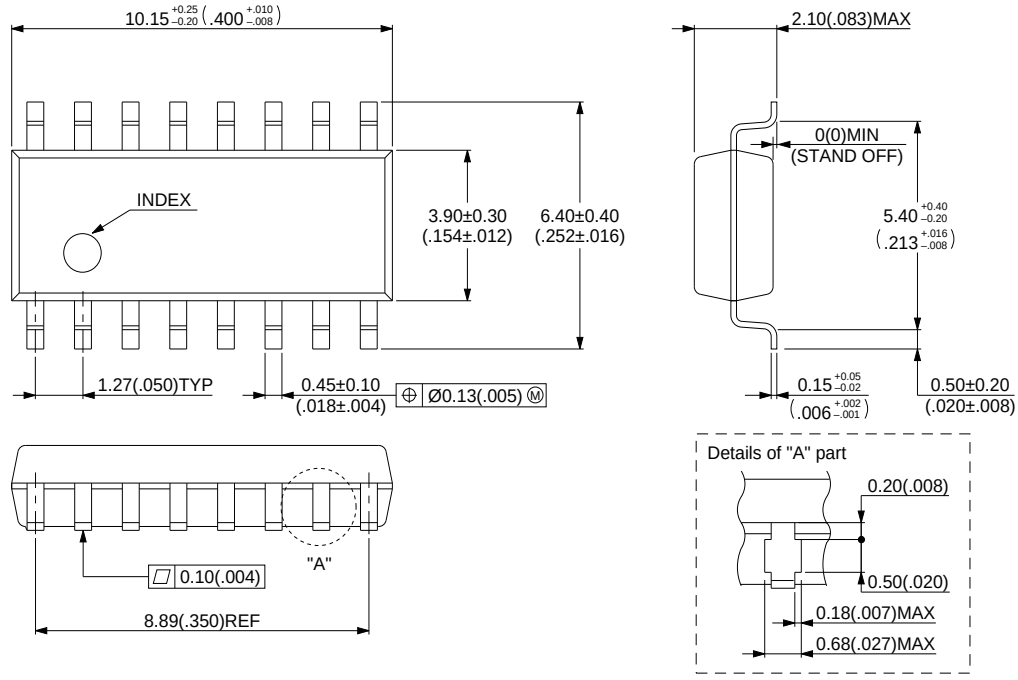

$V_{IN}$ = 0 → 5V
$SW_{IN}$ = 5V
Load capacitance = 47 µF

V: 200 mA/div. (surge current)
V: 1.0 V/div. (output voltage)
H: 200 µs/div. (time axis)

# MB3802

## ■ PACKAGE DIMENSIONS

16 pins, Plastic SOP
(FPT-16P-M04)






Dimensions in mm(inches).

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