FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-27201-4E

*ASSP For Power Supply Applications*

# Switching Regulator Controller

# MB3776A

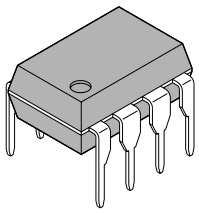
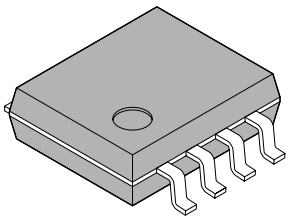
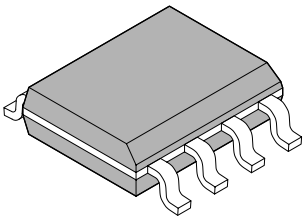
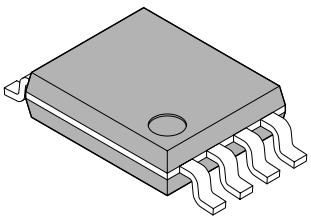
## ■ DESCRIPTION

MB3776A is a PWM system switching regulator controller. Because of its low operating supply voltage and power-down, the MB3776A is ideal for use in DC/DC converters for battery-powered portable equipment.

## ■ FEATURES

- Wide supply voltage range: (2 V to 15 V)
- Wide oscillation frequency range, high-frequency oscillation: (10 kHz to 500 kHz)
- Push-pull output. Drive current set with external resistor
- Bulit-in idle period circuit
- Internally set error amplifier gain, few external components
- Bulit-in power-down function

## ■ PACKAGES

| 8-pin Plastic DIP | 8-pin Plastic SOP | 8-pin Plastic SOP | 8-pin Plastic SSOP |
|---|---|---|---|
|  |  |  |  |
| (DIP-8P-M01) | (FPT-8P-M01) | (FPT-8P-M02) | (FPT-8P-M03) |

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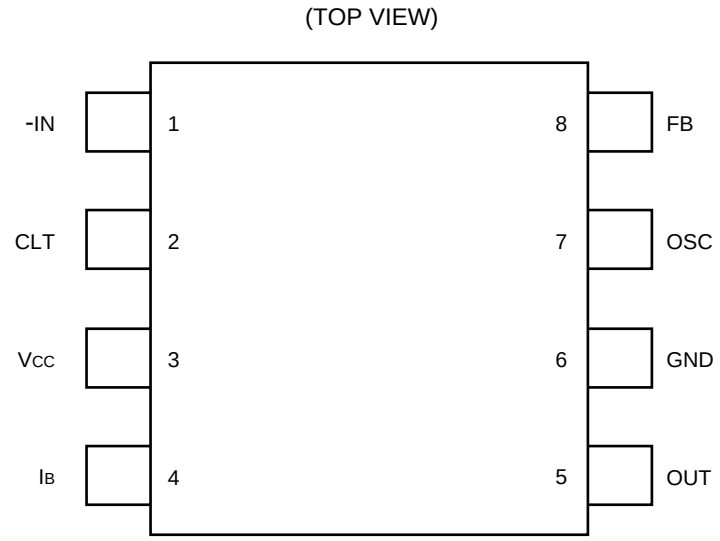
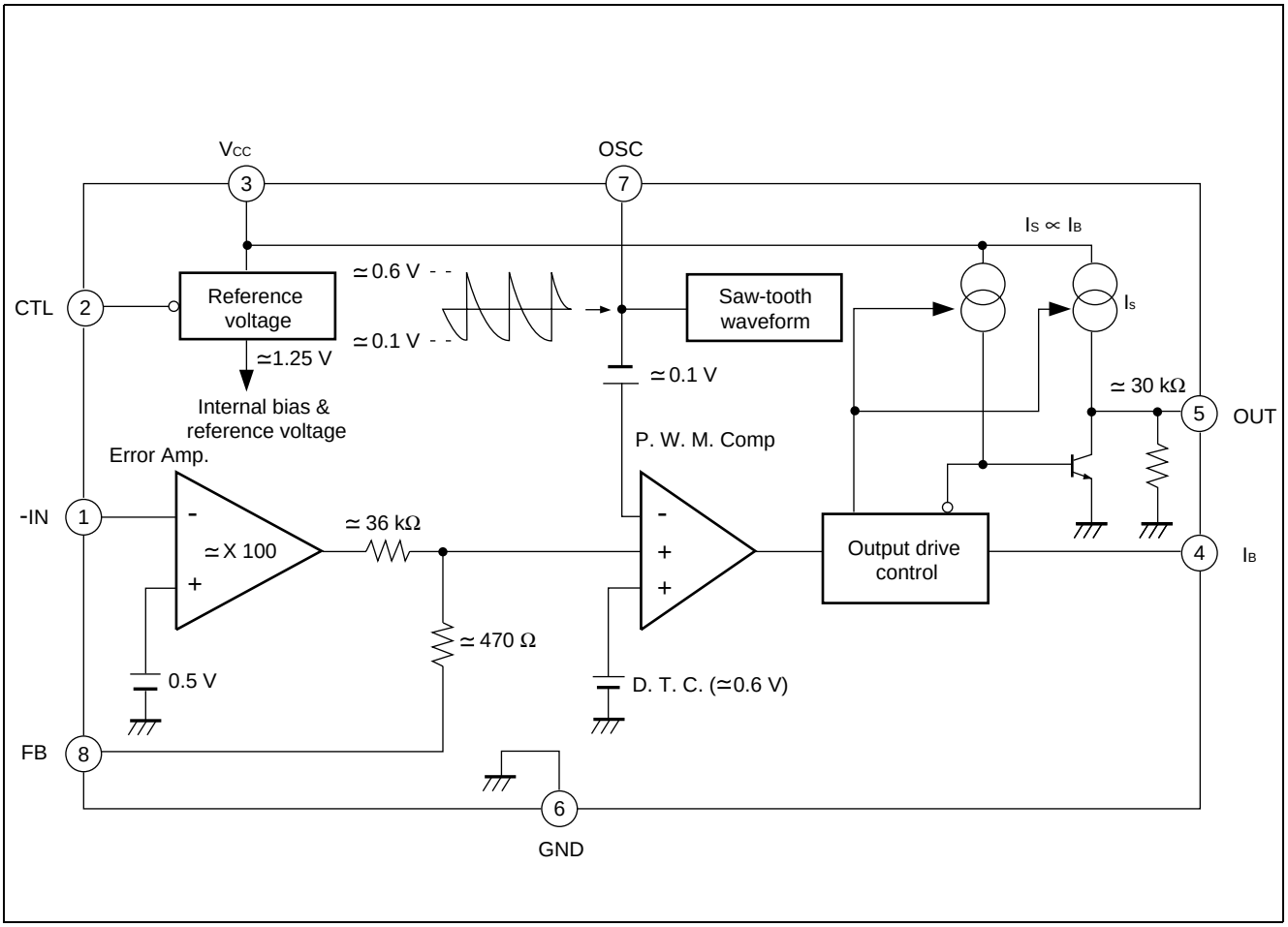
## ■ PIN ASSIGNMENT




(DIP-8P-M01)
(FPT-8P-M01)
(FPT-8P-M02)
(FPT-8P-M03)

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

(Ta = +25°C)

| Parameter | Symbol | Condition | | Rating | | Unit |
|---|---|---|---|---|---|---|
| | | | | Min | Max | |
| Power supply voltage | $V_{CC}$ | — | | — | 16 | V |
| Error amp. input voltage | $V_I$ | — | | –0.3 | +10 | V |
| Output source current | $I_{SOURCE}$ | — | | — | –50 | mA |
| Output sink current | $I_{SINK}$ | — | | — | 50 | mA |
| Power dissipation | $P_D$ | Ta ≤ +25°C (DIP) | | — | 550 | mW |
| | | Ta ≤ +25°C (SOP) | EIAJ | — | *570 | mW |
| | | | JEDEC | — | *430 | mW |
| | | Ta < +25°C (SSOP) | | — | *580 | mW |
| Operating temperature | Top | — | | –30 | +75 | °C |
| Storage temperature | Tstg | — | | –55 | +125 | °C |

*: The packages are mounted on the epoxy board (10 cm × 10 cm × 1.5 mm)

**WARNING:** Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Value | | | Unit |
|---|---|---|---|---|---|
| | | Min | Typ | Max | |
| Power supply voltage | $V_{CC}$ | 2.0 | — | 15 | V |
| Error amp. input voltage | $V_I$ | –0.2 | — | 1.0 | V |
| Output source current | $I_{SOURCE}$ | –40 | — | — | mA |
| Output sink current | $I_{SINK}$ | — | — | 40 | mA |
| Phase compensation capacitor | $C_P$ | — | 0.1 | — | µF |
| Timing capacitor | $C_T$ | 100 | 1000 | 10000 | pF |
| Timing resistor | $R_T$ | 1.0 | 3.0 | 5.0 | kΩ |
| Oscillator frequency | $f_{OSC}$ | 10 | 200 | 500 | kHz |
| Operating temperature | $T_{OP}$ | –30 | 25 | 75 | °C |

**WARNING:** The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

## ■ ELECTRICAL CHARACTERISTICS

### 1. Reference Section and Error Amp. Section

(Ta = +25°C, $V_{CC}$ = 3 V)

| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Input threshold voltage | $V_T$ | $V_{FB}$ = 450 mV | 487 | 507 | 527 | mV |
| $V_T$ input stability | $V_{TdV1}$ | $V_{CC}$ = 2.0 V to 6.0 V | –5 | — | 5 | mV |
| | $V_{TdV2}$ | $V_{CC}$ = 6.0 V to 15 V | –5 | — | 5 | mV |
| $V_T$ temp. stability | $V_{TdT}$ | Ta = –30 °C to +75 °C | –3 | — | 3 | % |
| Input bias current | $I_B$ | $V_{IN}$ = 0 V to 0.6 V | –1.0 | –0.2 | 1.0 | µA |
| Voltage gain | $A_V$ | — | 70 | 100 | 145 | V/V |
| Frequency band width | BW | $A_V$ = 0 dB | — | 6 | — | MHz |

### 2. Saw-tooth Waveform Oscillator Section

(Ta = +25°C, $V_{CC}$ = 3 V)

| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Oscillator frequency | $f_{OSC}$ | $R_T$ = 3.0 kΩ<br>$C_T$ = 1000 pF | 160 | 200 | 240 | kHz |
| Frequency input stability | $f_{dV}$ | $V_{CC}$ = 2.0 V to 15 V | — | ±2 | — | % |
| Frequency temp. stability | $f_{dT}$ | Ta = –30°C to +75°C | — | ±10 | — | % |

### 3. Under Lockout Protection

(Ta = +25°C, $V_{CC}$ = 3 V)

| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Threshold voltage | $V_{TH}$ | — | — | 1.4 | — | V |

### 4. Dead-time Control Section

(Ta = +25°C, $V_{CC}$ = 3 V)

| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Max duty cycle | $t_{DUTY}$ | $C_T$ = 1000 pF<br>$R_T$ = 3.0 kΩ<br>$V_{FB}$ = 0.9 V | 60 | 70 | 85 | % |

## 5. Output Section

(Ta = +25°C, $V_{CC}$ = 3 V)

| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Output source current | $I_{SOURCE}$ | $R_B$ = 820 Ω, $V_O$ = 1 V | –40 | –30 | –20 | mA |
| Output sink current | $I_{SINK}$ | $R_B$ = 820 Ω, $V_O$ = 0.3 V | 30 | 60 | — | mA |
| High-level output voltage | $V_{OH}$ | $R_B$ = 820 Ω, $V_O$ = 7 V<br>$I_O$ = –15 mA | 5.5 | 6.0 | — | V |
| Output voltage | $V_{OL}$ | $V_{CTL}$ = $V_{CC}$, $I_O$ = 3 μA | — | 0.1 | 0.2 | V |

## 6. Control Section

(Ta = +25°C, $V_{CC}$ = 3 V)

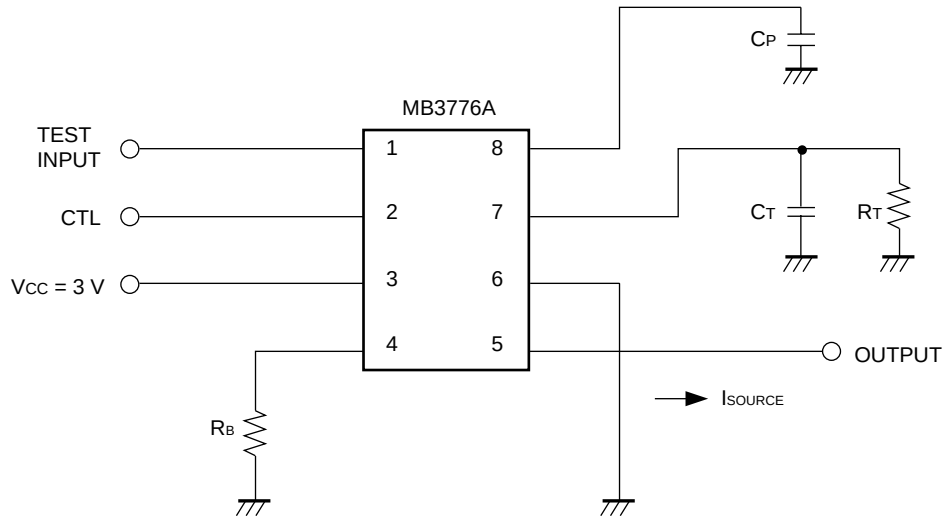
| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Input off condition | $I_{OFF}$ | — | –300 | — | — | μA |
| Input on condition | $I_{ON}$ | — | — | — | –700 | μA |
| Control terminal current | $I_{CTL}$ | $V_{CC}$ = 7 V, $V_{CTL}$ = 0 V | –1.3 | –1 | — | mA |

## 7. All Device

(Ta = +25°C, $V_{CC}$ = 3 V)

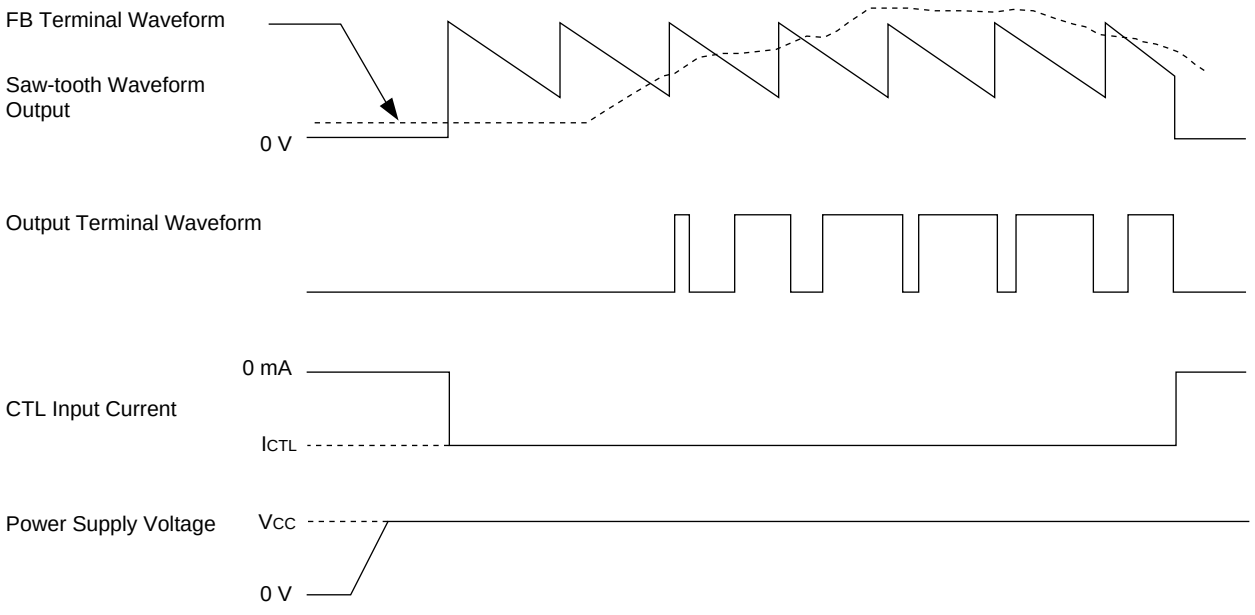
| Parameter | Symbol | Condition | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Stand by current | $I_{CCS}$ | $V_{CTL}$ = $V_{CC}$ or<br>CTL terminal open | — | — | 0.5 | μA |
| Average supply current | $I_{CC}$ | $I_{CTL}$ = –700 μA<br>$R_B$ = 820 Ω | — | 4.5 | 8 | mA |

## ■ MEASURMENT CIRCUIT



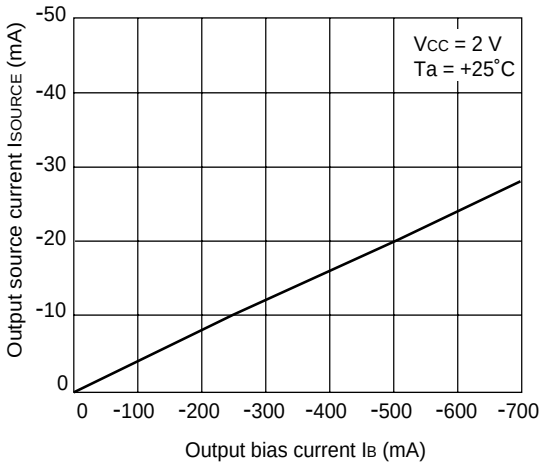

$C_T$ = 1000 pF
$C_P$ = 0.1 µF
$R_T$ = 3 kΩ
$R_B$ =820 Ω
$I_{SOURCE} \simeq 25000/R_B$ (mA)

## ■ DIAGRAM

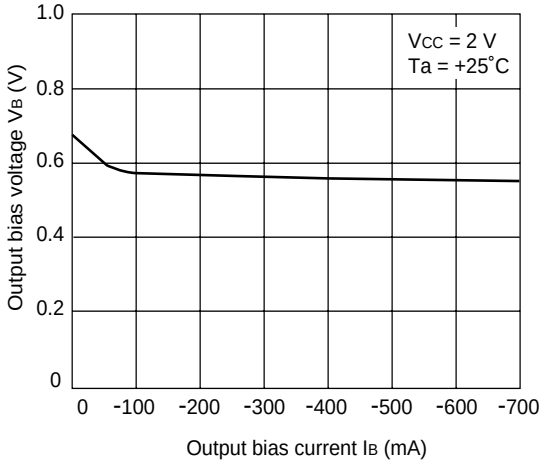


## ■ TYPICAL CHARACTERISTIC

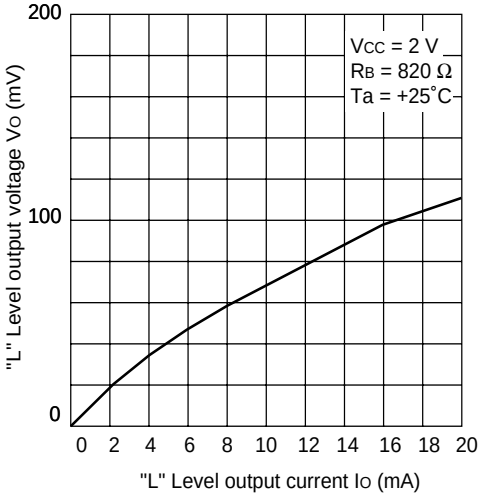
Output bias current vs. Output source current



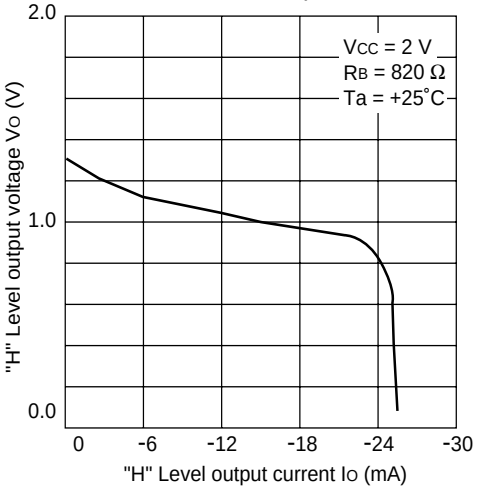

Output bias current vs. Output bias voltage



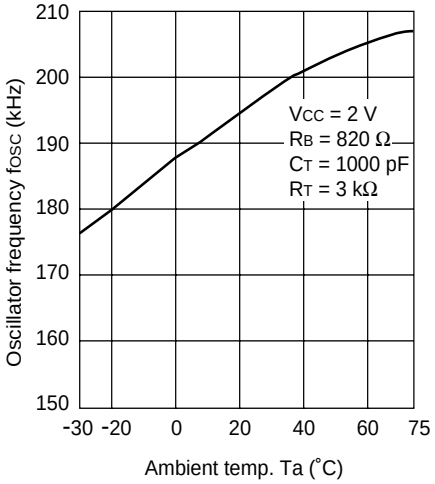

"L" Level output



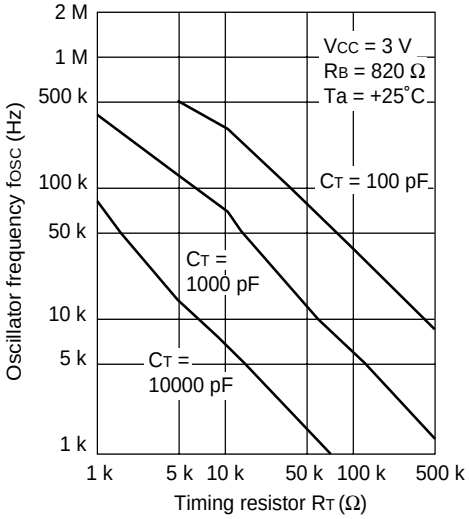

"H" Level output




Ambient temp. vs. Oscillator frequency




Timing resistor vs. Oscillator frequency

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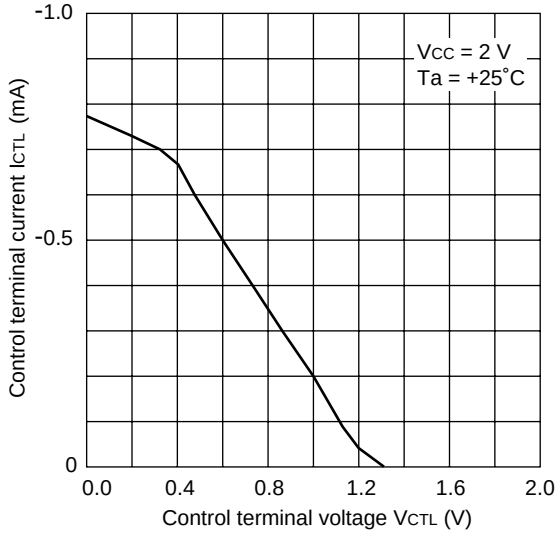
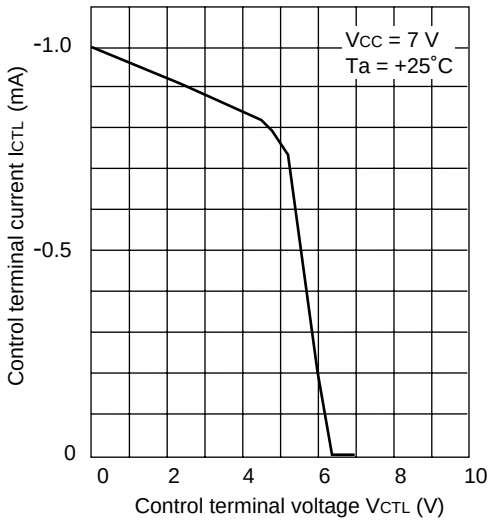
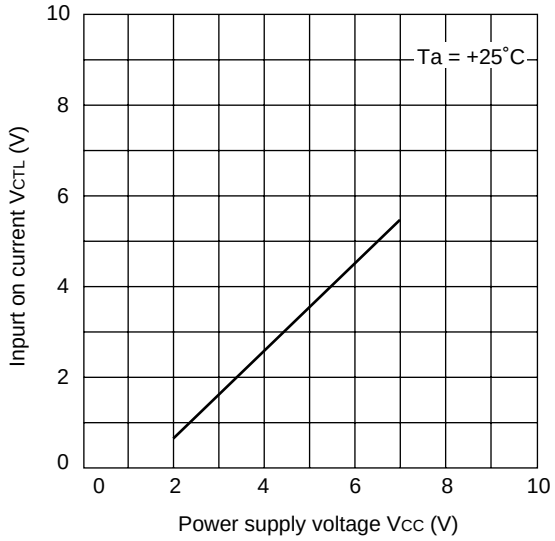
Control terminal voltage vs. Control terminal current



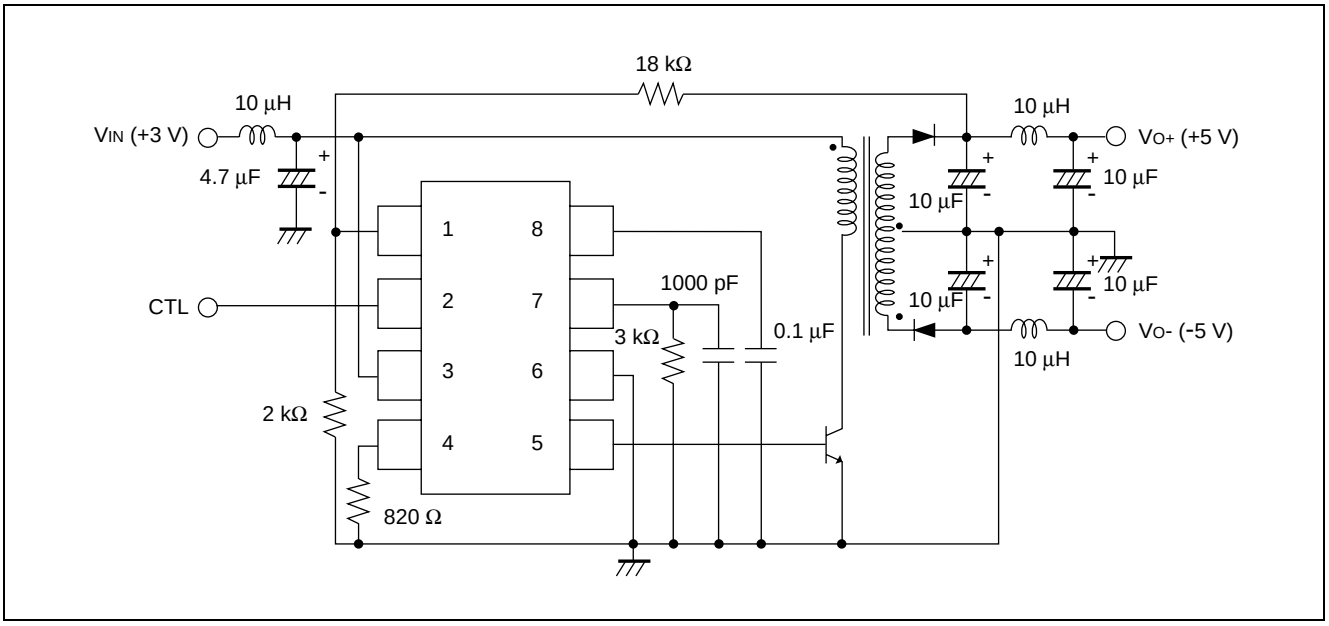

Control terminal voltage vs. Control terminal current




Power supply voltage vs. Input on voltage

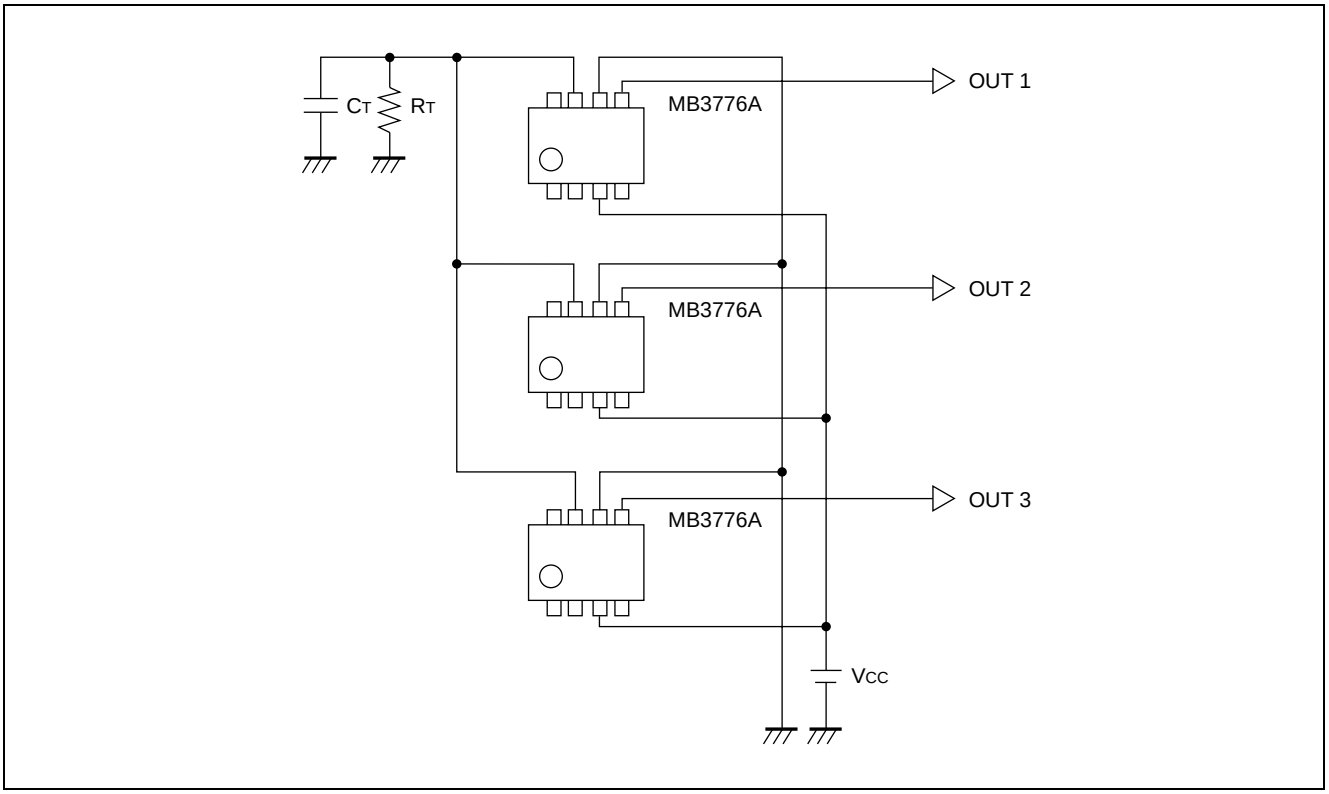


## ■ APPLICATION EXAMPLE




### Synchronization

To synchronize MB3776A controllers, the OSC terminal of each IC is shared and the same specified capacitor and resistor used on a signal IC application is connected for self-excitation oscillation. The CTL terminal controls power on/off of each IC.



## ■ NOTES ON USE

- Take account of common impedance when designing the earth line on a printed wiring board.

- Take measures against static electricity.
  - For semiconductors, use antistatic or conductive containers.
  - When storing or carrying a printed circuit board after chip mounting, put it in a conductive bag or container.
  - The work table, tools and measuring instruments must be grounded.
  - The worker must put on a grounding device containing 250 kΩ to 1 MΩ resistors in series.

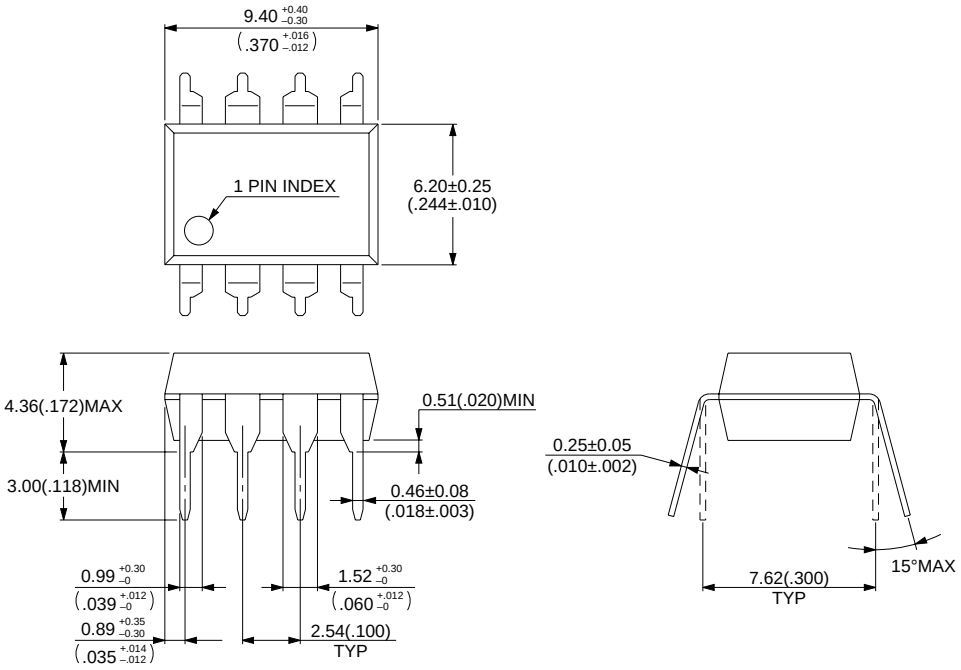
- Do not apply a negative voltage
  - Applying a negative voltage of –0.3 V or less to an LSI may generate a parasitic transistor, resulting in malfunction.

## ■ ORDERING INFORMATION

| Part number | Package | Remarks |
|---|---|---|
| MB3776A-P | 8-pin Plastic DIP<br>(DIP-8P-M01) | |
| MB3776APF | 8-pin Plastic SOP<br>(FPT-8P-M01) | |
| MB3776APNF | 8-pin Plastic SOP<br>(FPT-8P-M02) | |
| MB3776APFV | 8-pin Plastic SSOP<br>(FPT-8P-M03) | |

## ■ PACKAGE DIMENSIONS

8-pin Plastic DIP
(DIP-8P-M01)




Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

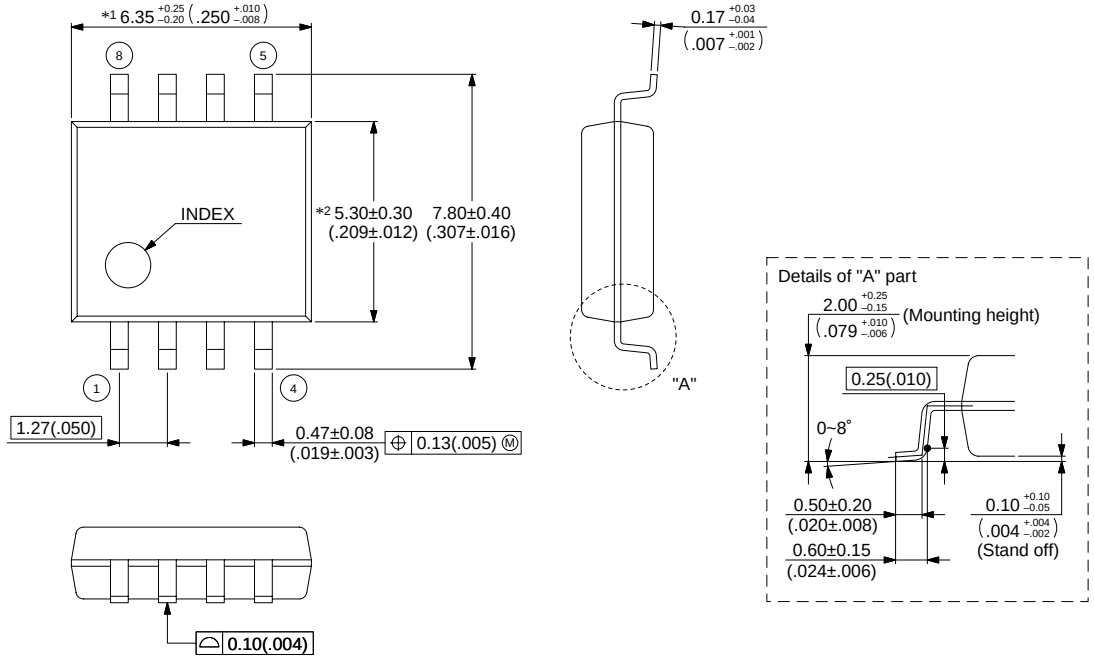


*(Continued)*

*(Continued)*

8-pin Plastic SOP
(FPT-8P-M01)

Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.






Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

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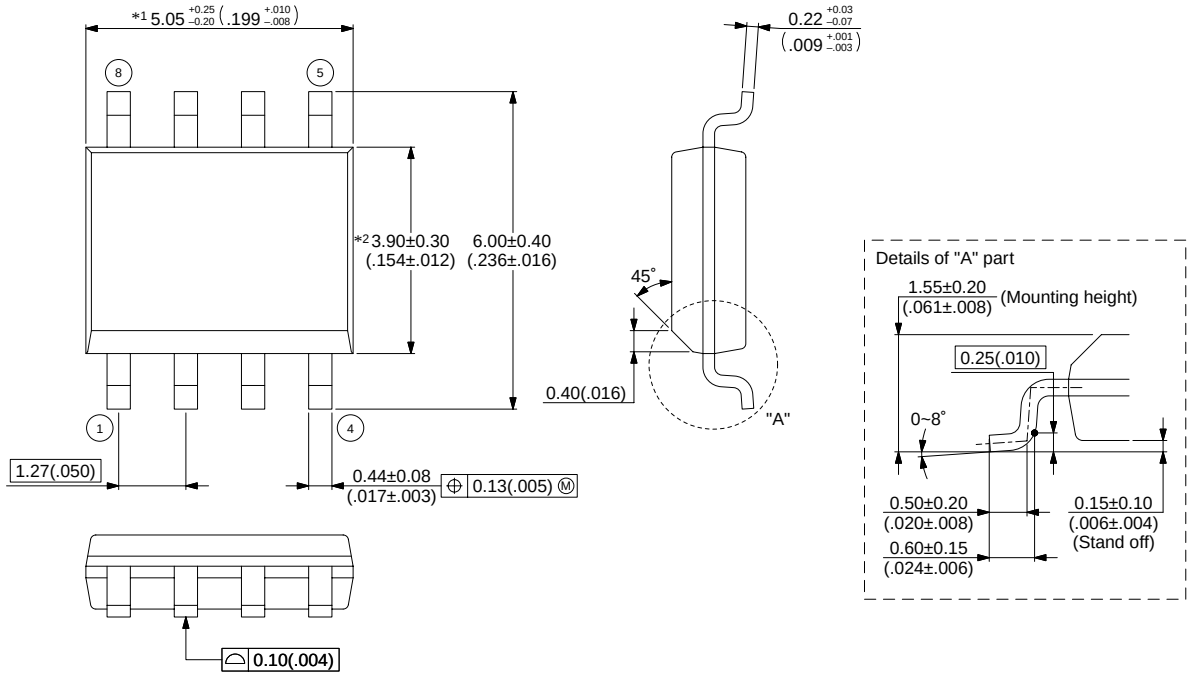
8-pin Plastic SOP
(FPT-8P-M02)

Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.






Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

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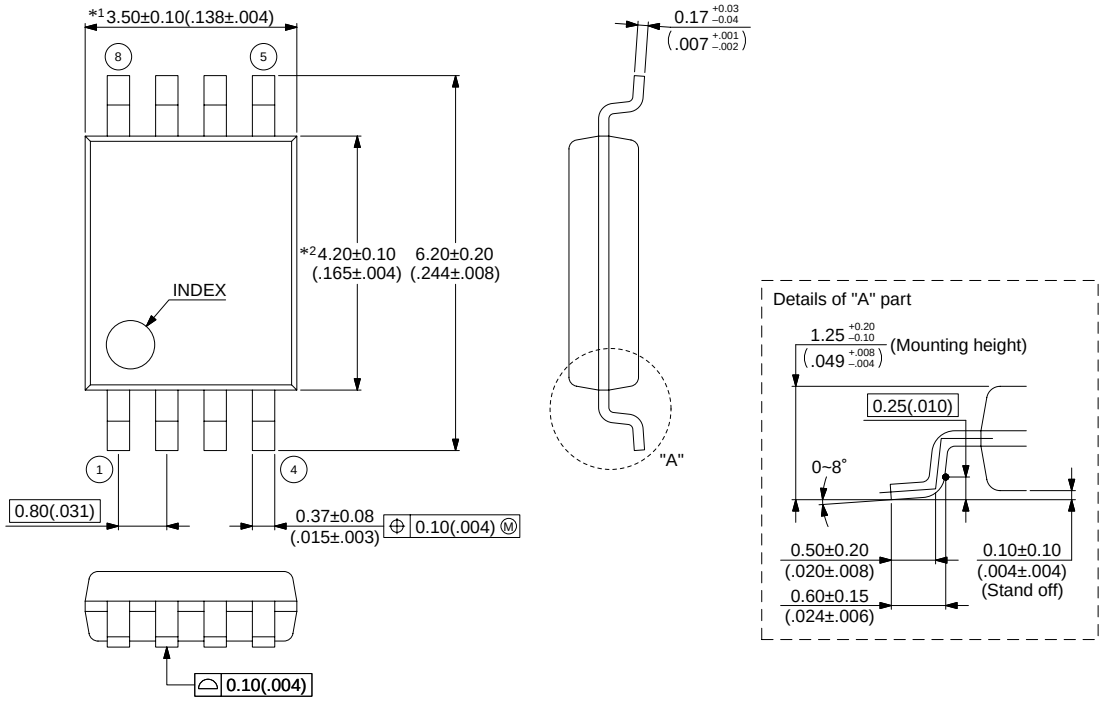
8-pin Plastic SSOP
(FPT-8P-M03)

Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.






Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

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