The MB3800 is a single-channel switching regulator control IC for low voltage applications incorporating a soft start function and short circuit detection function. The device has a low minimum operating voltage of 1.8 V and is ideal for the power supply of battery-operated electronic equipment.

Features

■ Wide supply voltage operating range: 1.8 V to 15 V

■ Low current consumption: Typically 5.5 mA in operation, 1 μA or less in stand-by

■ High speed operation is possible: Maximum 1 MHz

■ The error amplifier gain is set inside the IC, so peripheral components are minimized.

■ Incorporates a soft start circuit.

■ Incorporates a timer-latch type short circuit detection circuit (SCP).

■ Totem-pole type output with adjustable on/off current (for NPN transistors)

■ Incorporates a stand-by function.
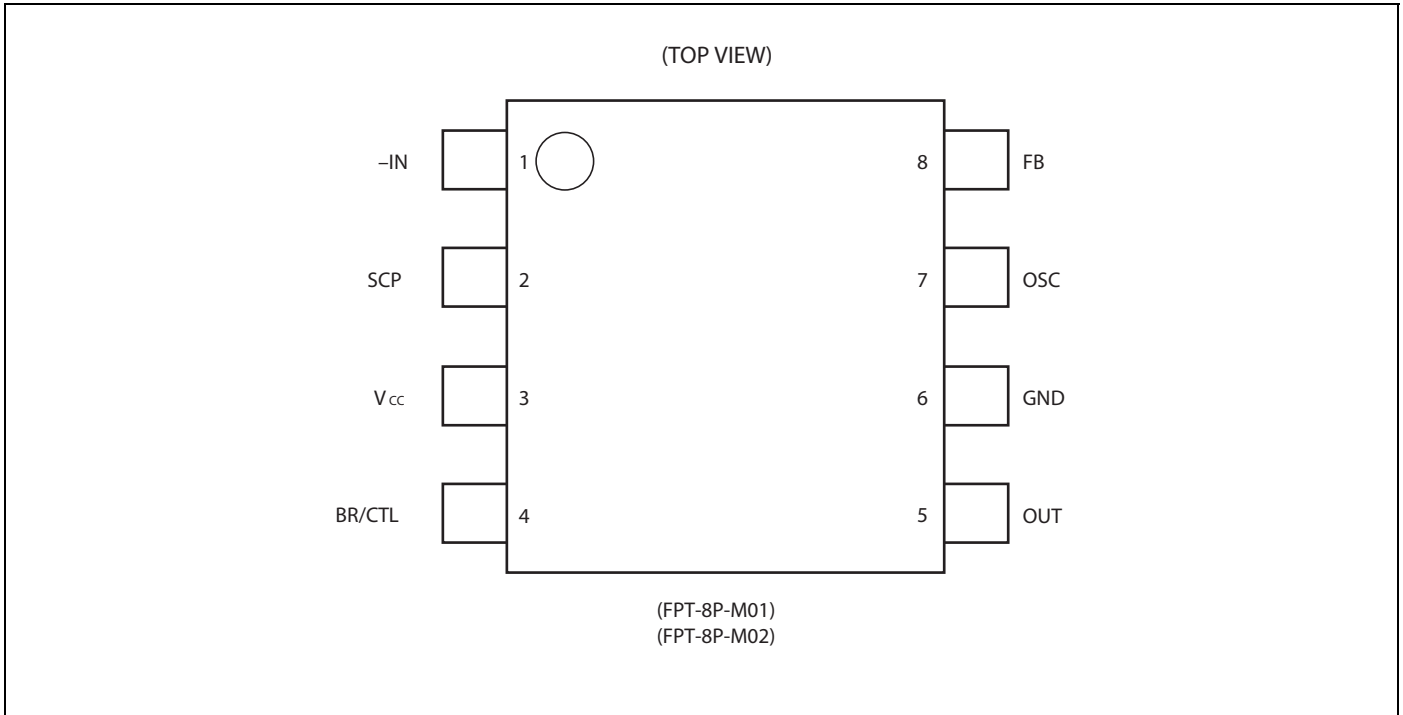
■ Two types of packages (SOP-8 : 2 types)

Application

■ LCD monitor/panel

■ Power supply module

■ Portable apparatus etc.

Contents

1. Pin Assignment

(TOP VIEW)

```
        ┌─────────────────────────┐
 −IN ──┤ 1 ◯                    8 ├── FB
        │                         │
 SCP ──┤ 2                     7 ├── OSC
        │                         │
 V_CC ──┤ 3                     6 ├── GND
        │                         │
BR/CTL ─┤ 4                     5 ├── OUT
        └─────────────────────────┘
```

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

2. Pin Description

Pin No.	Symbol	I/O	Description
1	−IN	I	Error amplifier inverting input pin
2	SCP	—	Soft start and SCP setting capacitor connection pin
3	V_{CC}	—	Power supply pin
4	BR/CTL	I	Output current setting and control pin
5	OUT	O	Totem-pole type output pin
6	GND	—	Ground pin
7	OSC	—	Capacitor and resistor connection pin for setting the oscillation frequency
8	FB	O	Error amplifier output pin

3. Block Diagram
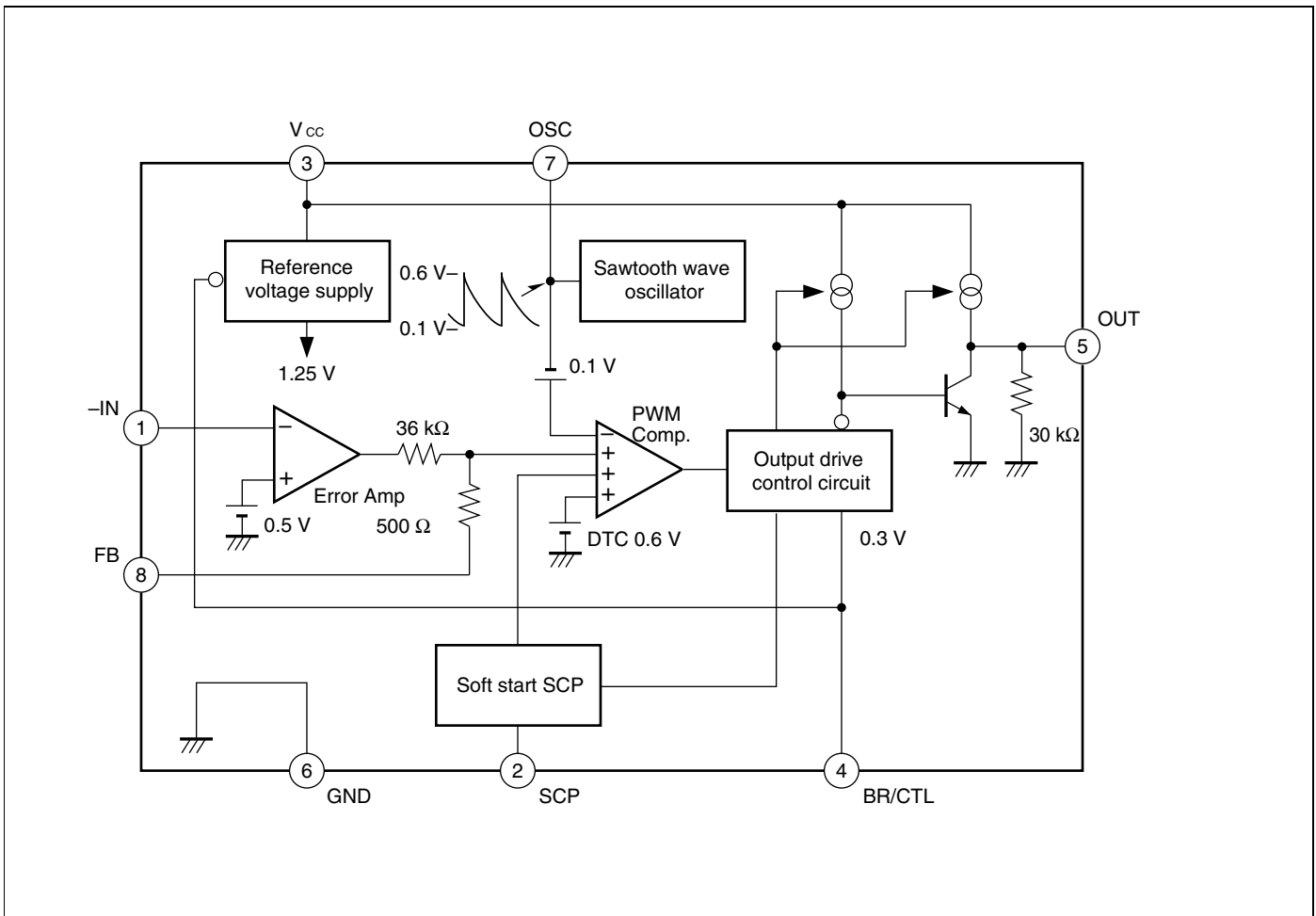
4. Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating		Unit
			Min	Max	
Power supply voltage	V_{CC}	—	—	16	V
Output source current	$I_O{}^+$		—	−50	mA
Output sink current	$I_O{}^-$		—	50	mA
Allowable dissipation	P_D	FPT-8P-M01, Ta $\leq$ +25°C	—	570*	mW
		FPT-8P-M02, Ta $\leq$ +25°C	—	430*	mW
		SSOP-8, Ta $\leq$ +25°C	—	580*	mW
Storage temperature	T_{stg}	—	−55	+125	°C

*: When mounted on a 10 cm square double-sided epoxy board.

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.

5. Recommended Operating Conditions

(Ta = +25°C)

Parameter	Symbol	Value			Unit
		Min	**Typ**	**Max**	
Power supply voltage	V_{CC}	1.8	—	15	V
Error amplifier input voltage	V_I	–0.2	—	+1.0	V
BR/CTL pin input voltage	V_{BR}	–0.2	—	V_{CC}	V
Output source current	I_O^+	–40	—	—	mA
Output sink current	I_O^-	—	—	40	mA
SCP pin capacitance	C_{PE}	—	0.1	—	µF
Phase compensation capacitance	C_P	—	0.1	—	µF
Output current setting resistance	R_B	150	390	5000	W
Timing resistance	R_T	1.0	3.0	10.0	kΩ
Timing capacitance	C_T	100	270	10000	pF
Oscillation frequency	f_{OSC}	10	500	1000	kHz
Operating Ambient temperature	Ta	–30	+25	+85	°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 representatives beforehand.

6. Electrical Characteristics

(VCC = +2 V, Ta = +25°C)

Parameter		Symbol	Condition	Value			Unit
				Min	Typ	Max	
Circuit to prevent malfunction at low input voltage (U.V.L.O.)	Reset voltage	V_R	—	—	—	0.9	V
	Threshold voltage	V_{TH}		1.1	1.3	1.5	V
Soft start	Charging current	I_{CS}	V_{SCP} = 0 V	−1.5	−1.0	−0.7	μA
	Voltage at soft start completion	V_{tS}	—	0.7	0.8	0.9	V
Short circuit detection (S.C.P.)	Charging current	I_{CPC}	V_{SCP} = 0 V	−1.5	−1.0	−0.7	μA
	Threshold voltage	V_{tPC}	—	0.7	0.8	0.9	V
Sawtooth wave oscillator (OSC)	Oscillation frequency	f_{OCS}	R_T = 3.0 kΩ, C_T = 270 pF	400	500	600	kHz
	Frequency input stability	f_{dV}	V_{CC} = 2 V to 15 V	—	2	10	%
	Frequency variation with temperature	f_{dT}	Ta = −30°C to +85°C	—	5	—	%
Error amplifier	Input threshold voltage	V_T	V_{FB} = 450 mV	480	500	520	mV
	V_T input stability	V_{TdV}	V_{CC} = 2 V to 15 V	—	5	20	mV
	V_T variation with temperature	V_{TdT}	Ta = −30°C to +85°C	—	1	—	%
	Input bias current	I_B	V_{IN} = 0 V	−1.0	−0.2	+1.0	μA
	Voltage gain	A_V	—	70	100	145	V/V
	Frequency bandwidth	BW	A_V = 0 dB	—	6	—	MHz
	Maximum output voltage range	V_{OM}^+	—	0.78	0.87	—	V
		V_{OM}^-		—	0.05	0.2	V
	Output source current	I_{OM}^+	V_{FB} = 0.45 V	—	−40	−24	μA
	Output sink current	I_{OM}^-		24	40	—	μA
Idle period adjustment section	Maximum duty cycle	t_{DUTY}	R_T = 3.0 kΩ, C_T = 270 pF V_{FB} = 0.8 V	65	75	85	%

(Continued)

(Continued)

Parameter		Symbol	Condition	Value			Unit
				Min	**Typ**	**Max**	
Output section	Output voltage	V_{OH1}	$R_B = 390\ \Omega$, $I_O = -15$ mA	1.0	1.2	—	V
		V_{OH2}	$R_B = 750\ \Omega$, $V_{CC} = 1.8$ V $I_O = -10$ mA	0.8	1.0	—	V
		V_{OL1}	$R_B = 390\ \Omega$, $I_O = 15$ mA	—	0.1	0.2	V
		V_{OL2}	$R_B = 750\ \Omega$, $V_{CC} = 1.8$ V $I_O = 10$ mA	—	0.1	0.2	V
	Output source current	I_O^+	$R_B = 390\ \Omega$, $V_O = 0.9$ V	—	−30	−20	mA
	Output sink current	I_O^-	$R_B = 390\ \Omega$, $V_O = 0.3$ V	30	60	—	mA
	Pull down resistance	R_O	—	20	30	40	kΩ
Output current setting section/ Control section	Pin voltage	V_{BR}	$R_B = 390\ \Omega$	0.2	0.3	0.4	V
	Input off condition	I_{OFF}	—	−20	—	0	μA
	Input on condition	I_{ON}		—	—	−45	μA
	Pin current range	I_{BR}		−1.8	—	−0.1	mA
Entire device	Stand-by current	I_{CCS}	BR/CTL pin open or V_{CC}	—	—	1	μA
	Average supply current	I_{CC}	$R_B = 390\ \Omega$	—	5.5	9.3	mA

7. Diagram
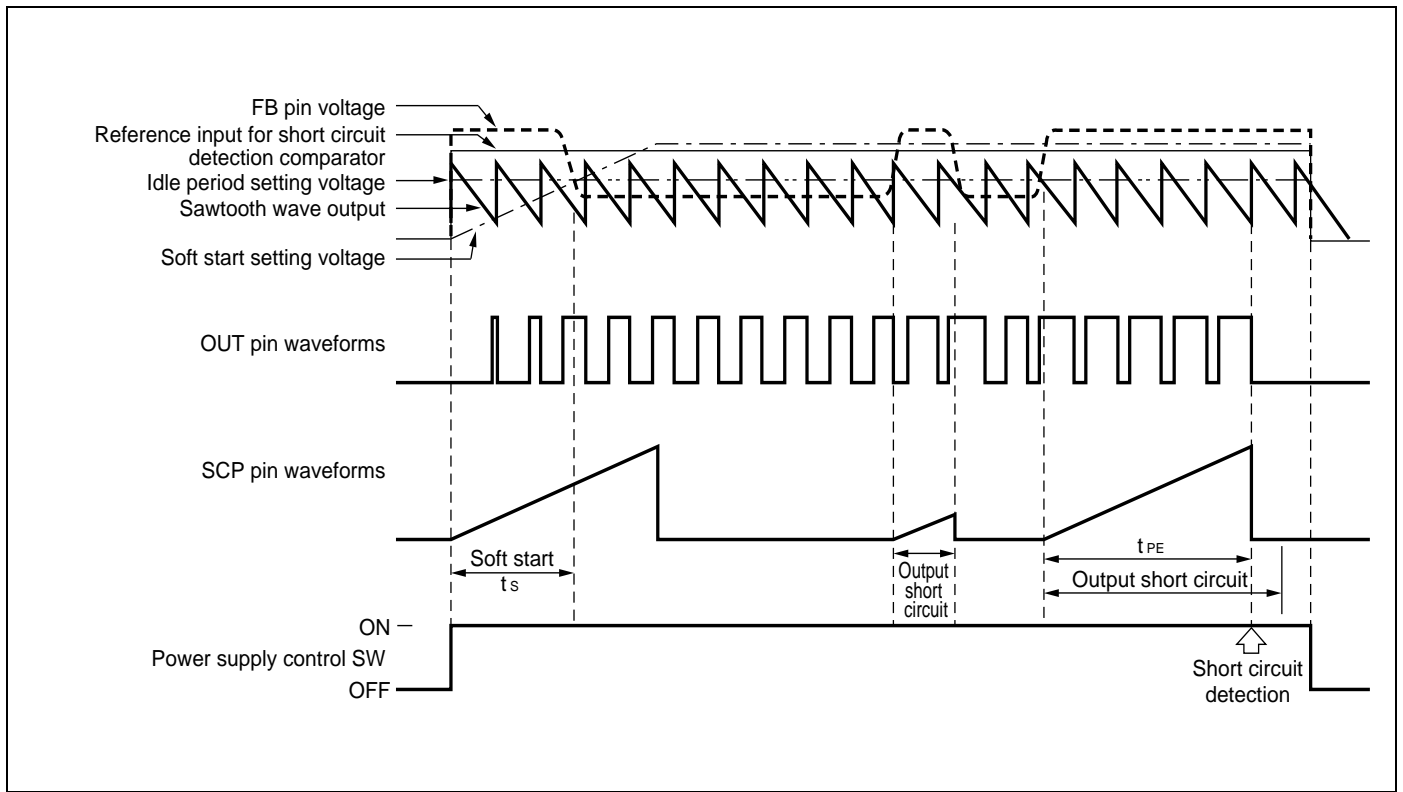
8. How to Set the Time Constant for Soft Start and Short Circuit Detection

8.1 Soft Start

At power on, the capacitor C_{PE} connected to the SCP pin (pin 2) starts charging. The PWM comparator compares the soft start setting voltage as a proportion of the voltage at the SCP pin with the sawtooth waveform.

The comparison controls the ON duty of the OUT pin (pin 5), causing the soft start operation. On completion of soft start operation, the voltage at the SCP pin stays low, the soft start setting voltage stays high, and the circuit enters the output short circuit detection wait state.

Soft start time (The time until the output ON duty reaches approximately 50%)

$$t_S \text{ [s]} \cong 0.35 \times C_{PE} \text{ [}\mu\text{F]}$$
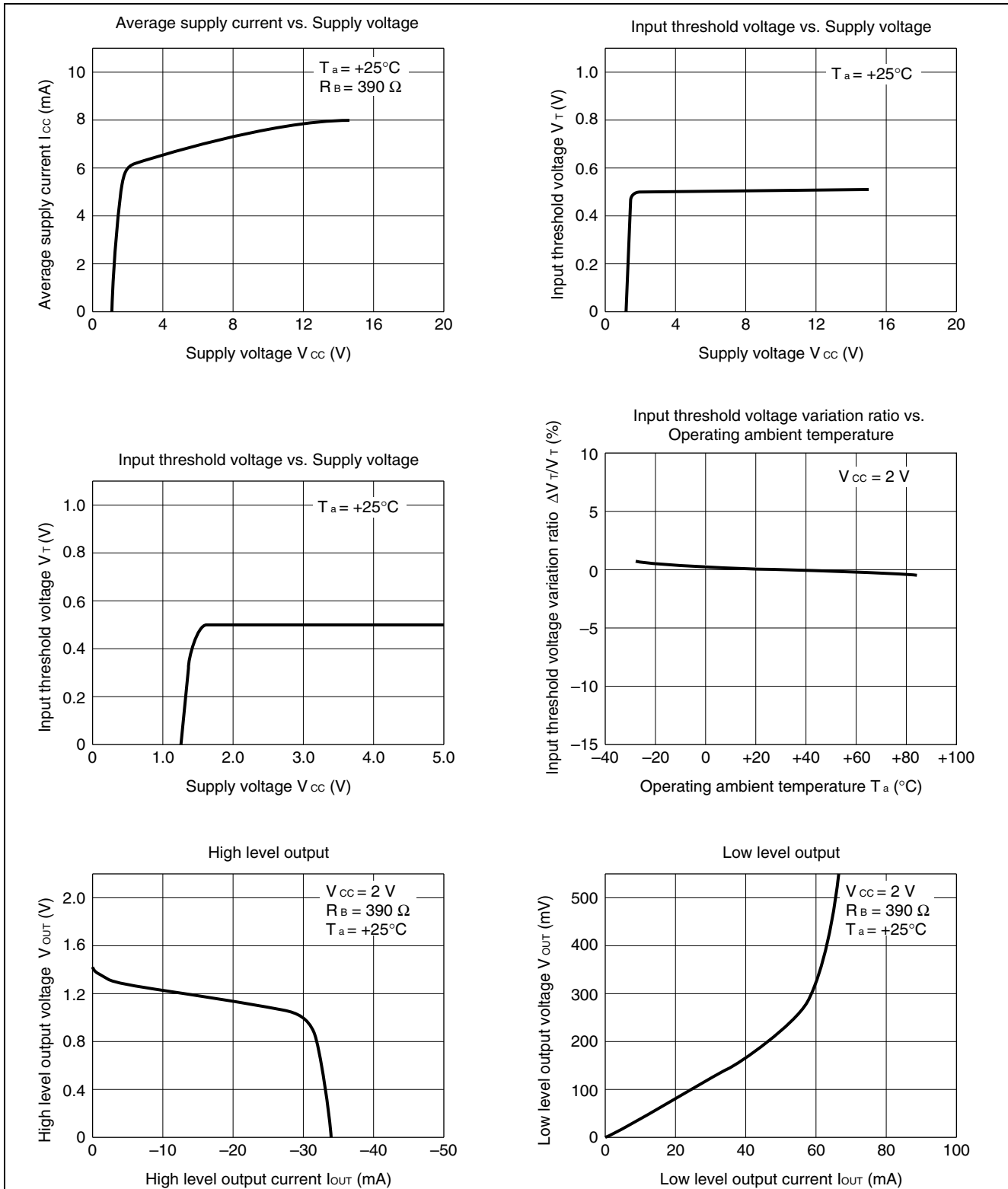
8.2 Short Circuit Protection

If the switching regulator output suddenly drops due to load effect, the error amplifier output (FB pin (pin 8)) is fixed at VOM^+ and capacitor C_{PE} starts charging. When the voltage at the SCP pin reaches approximately 0.8 V, the OUT pin (pin 5) is set low and the SCP pin (pin 2) stays low.

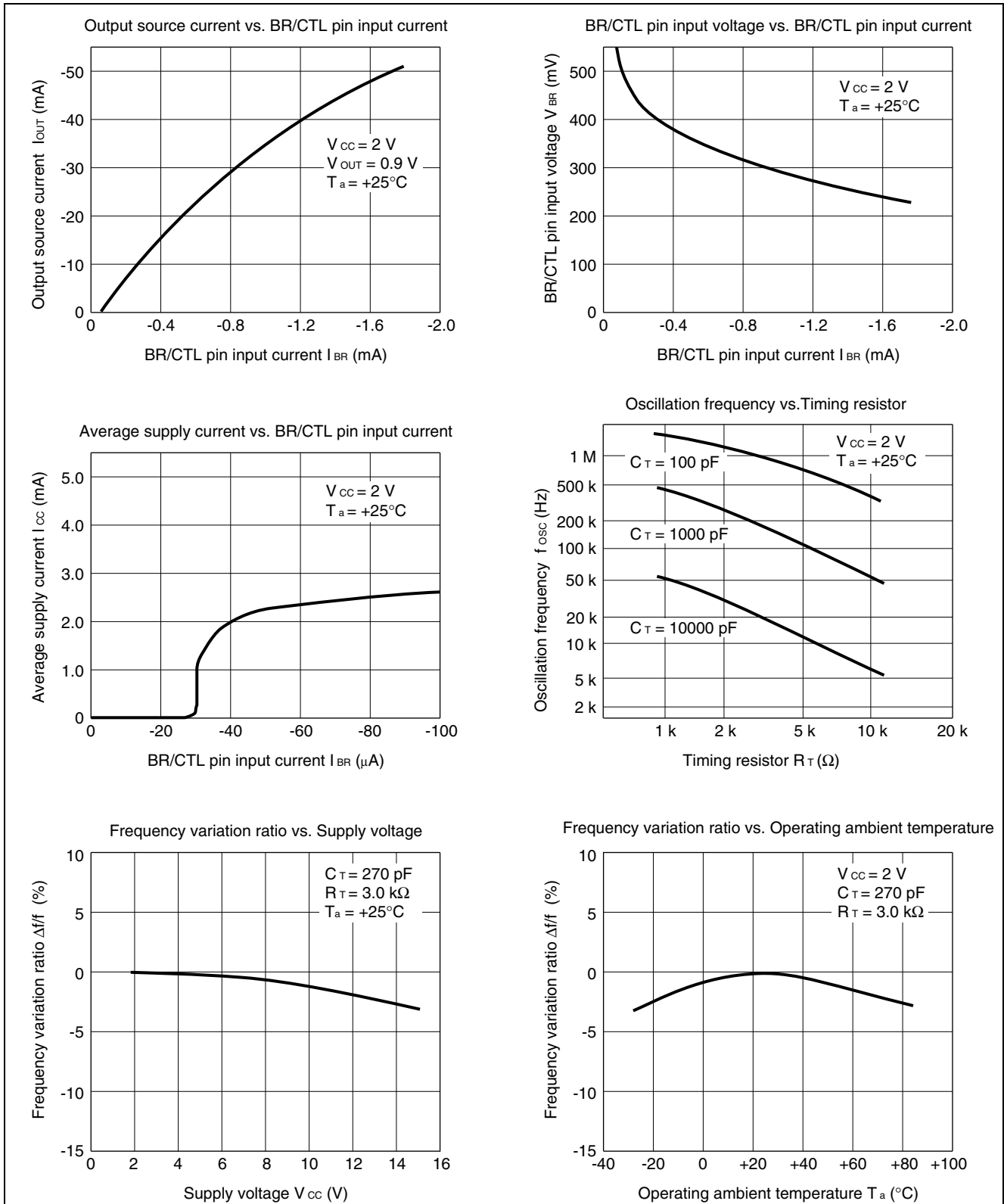Once the protection circuit operates, the circuit can be restored by resetting the power supply.

• Short circuit detection time

$$t_{PE} \text{ [s]} \cong 0.8 \times C_{PE} \text{ [}\mu\text{F]}$$

9. Typical Characteristics

Average supply current vs. Supply voltage

$T_a = +25°C$
$R_B = 390 Ω$

Average supply current I_{CC} (mA) vs. Supply voltage V_{CC} (V)

Input threshold voltage vs. Supply voltage

$T_a = +25°C$

Input threshold voltage V_T (V) vs. Supply voltage V_{CC} (V)

Input threshold voltage vs. Supply voltage

$T_a = +25°C$

Input threshold voltage V_T (V) vs. Supply voltage V_{CC} (V)

Input threshold voltage variation ratio vs. Operating ambient temperature

$V_{CC} = 2 V$

Input threshold voltage variation ratio $ΔV_T/V_T$ (%) vs. Operating ambient temperature T_a (°C)

High level output

$V_{CC} = 2 V$
$R_B = 390 Ω$
$T_a = +25°C$

High level output voltage V_{OUT} (V) vs. High level output current I_{OUT} (mA)

Low level output

$V_{CC} = 2 V$
$R_B = 390 Ω$
$T_a = +25°C$

Low level output voltage V_{OUT} (mV) vs. Low level output current I_{OUT} (mA)

(Continued)

Output source current vs. BR/CTL pin input current

Output source current I_{OUT} (mA) vs. BR/CTL pin input current I_{BR} (mA)

$V_{CC} = 2$ V
$V_{OUT} = 0.9$ V
$T_a = +25°C$

BR/CTL pin input voltage vs. BR/CTL pin input current

BR/CTL pin input voltage V_{BR} (mV) vs. BR/CTL pin input current I_{BR} (mA)

$V_{CC} = 2$ V
$T_a = +25°C$

Average supply current vs. BR/CTL pin input current

Average supply current I_{CC} (mA) vs. BR/CTL pin input current I_{BR} (μA)

$V_{CC} = 2$ V
$T_a = +25°C$

Oscillation frequency vs.Timing resistor

Oscillation frequency f_{OSC} (Hz) vs. Timing resistor R_T (Ω)

$C_T = 100$ pF
$C_T = 1000$ pF
$C_T = 10000$ pF

$V_{CC} = 2$ V
$T_a = +25°C$

Frequency variation ratio vs. Supply voltage

Frequency variation ratio $\Delta f/f$ (%) vs. Supply voltage V_{CC} (V)

$C_T = 270$ pF
$R_T = 3.0$ kΩ
$T_a = +25°C$

Frequency variation ratio vs. Operating ambient temperature

Frequency variation ratio $\Delta f/f$ (%) vs. Operating ambient temperature T_a (°C)

$V_{CC} = 2$ V
$C_T = 270$ pF
$R_T = 3.0$ kΩ

(Continued)

(Continued)

Maximum duty cycle vs. Oscillation frequency

$V_{CC} = 2\ V$
$C_T = 270\ pF$
$T_a = +25°C$

(Maximum duty cycle t_{DUTY} (%) vs. Oscillation frequency f_{OSC} (Hz))
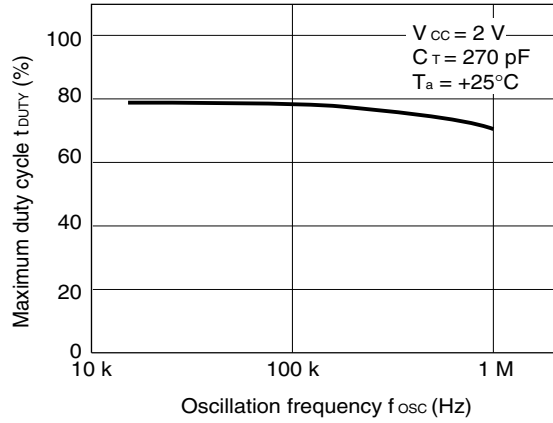
Output pin voltage and current waveforms
(reference data)

$V_{CC} = 2\ V$
$C_T = 270\ pF$
$R_T = 1.0\ k\Omega$
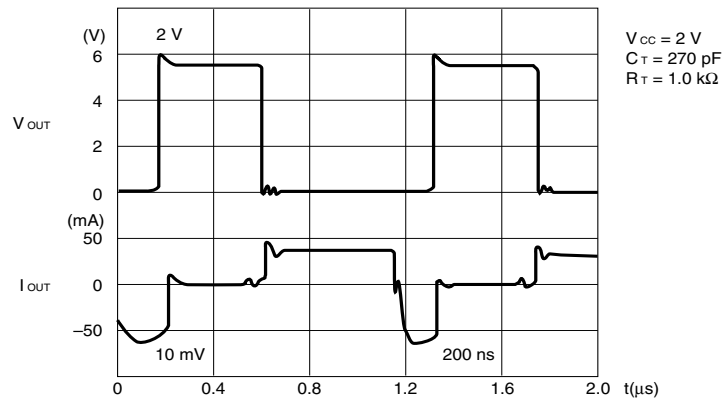
Note: The OFF delay time of V_{OUT} depends on the
characteristics of the external transistor.

Measurement circuit diagram
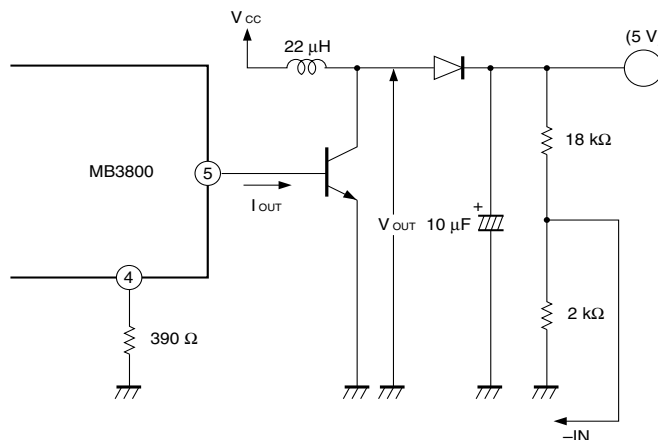
10. Functional Description

10.1 Switching Regulator Function

10.1.1 Reference voltage circuit

The reference voltage circuit generates a temperature-compensated reference voltage ($\cong$1.25V) from voltage supplied from the V_{CC} pin (pin 3). In addition to providing the reference voltage for the switching regulator, the circuit also sets the idle period.

10.1.2 Sawtooth wave oscillator

The sawtooth oscillator generates a sawtooth wave (up to 1 MHz) that is stable with respect to the supply voltage and temperature. The capacitor and resistor that set the oscillation frequency are connected to the OSC pin (pin 7).

10.1.3 Error amplifier (Error Amp)

The error amplifier detects the output voltage of the switching regulator and outputs the PWM control signal. The voltage gain is fixed, and connecting a phase compensation capacitor to the FB pin (pin 8) provides stable phase compensation for the system.

10.1.4 PWM comparator (PWM Comp.)

The voltage comparator has one inverting and three non-inverting inputs. The comparator is a voltage/pulse width converter that controls the ON time of the output pulse depending on the input voltage. The output level is high (H) when the sawtooth wave is lower than the error amplifier output voltage, soft start setting voltage, and idle period setting voltage.

10.1.5 Output circuit

The output circuit has a totem pole type configuration and can drive an external NPN transistor directly. The value of the ON/OFF current can be set by a resistor connected to the BR/CTL pin (pin 4).

10.2 Power Supply Control Function

Stand-by mode (supply current 1 μA or less) can be set by connecting the BR/CTL pin (pin 4) to V_{CC} or by making the pin open circuit.

SW	Mode
OFF	Stand-by mode
ON	Operating mode
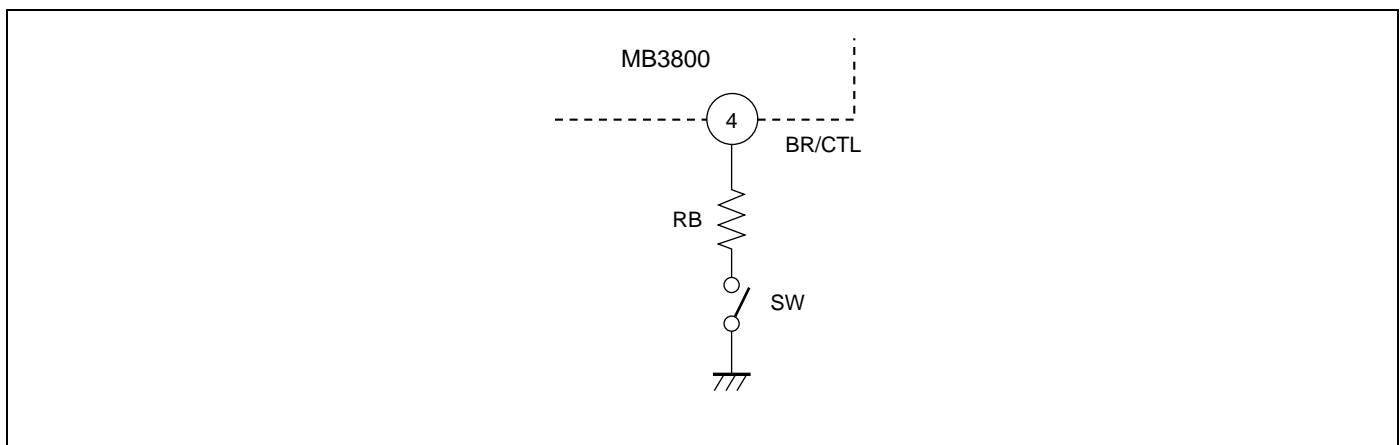
10.3 Other Functions

10.3.1 Soft start and short circuit detection

Soft start operation is set by connecting capacitor C_{PE} to the SCP pin (pin 2). Soft start prevents a current spike on start-up.

On completion of soft start operation, the SCP pin (pin 2) stays low and enters the short circuit detection wait state. When an output short circuit occurs, the error amplifier output is fixed at $V_{OM}+$ and capacitor C_{PE} starts charging. After charging to approximately 0.8 V, the OUT pin (pin 5) is set low and the SCP pin (pin 2) stays low.

Once the protection circuit operates, the circuit can be restored by resetting the power supply. (See "How to Set the Time Constant for Soft Start and Short Circuit Detection".)

10.3.2 Circuit to prevent malfunction at low input voltage

Transients when powering on or instantaneous glitches in the supply voltage can lead to malfunction of the control IC and cause system damage or failure. The circuit to prevent malfunction at low input voltage detects a low input voltage by comparing the supply voltage to the internal reference voltage. On detection, the circuit fixes the OUT pin (pin 5) to low.

The system recovers when the supply voltage rises back above the threshold voltage of the malfunction prevention circuit.

11. Application Example
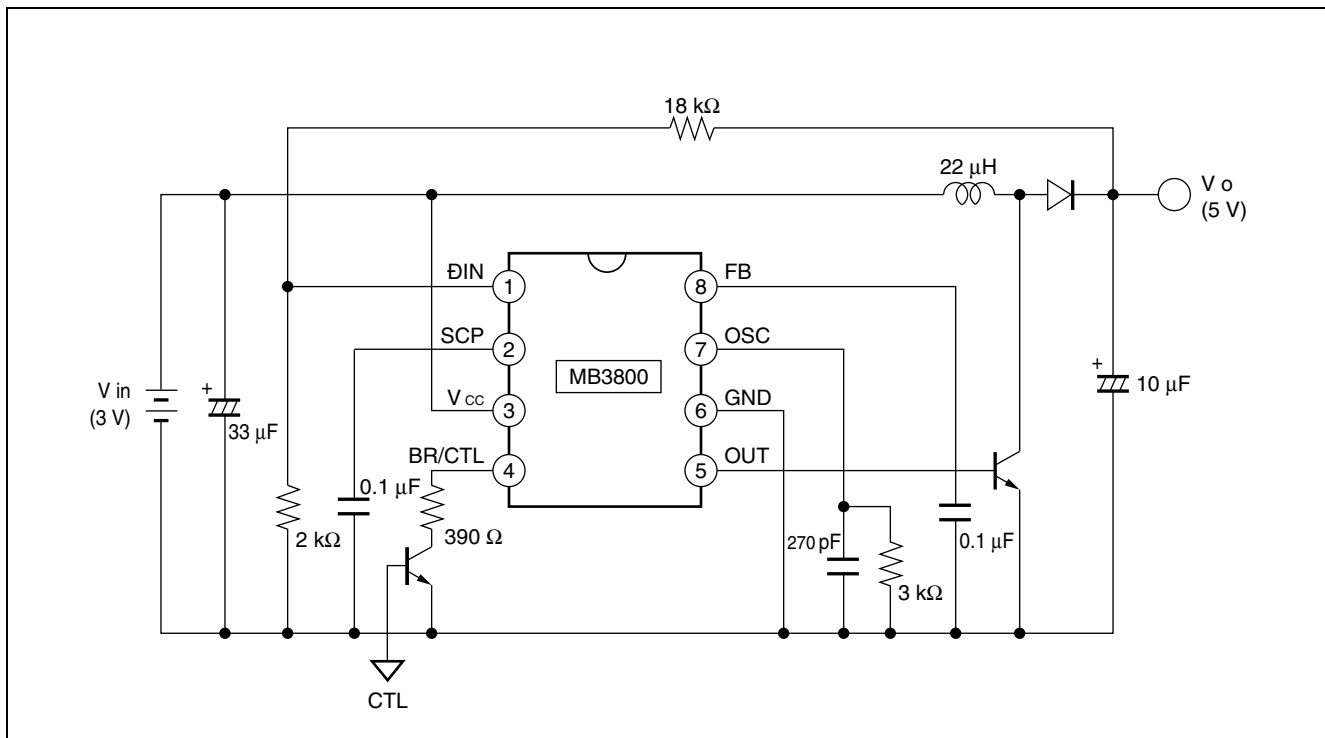
12. Notes On Use

■ 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.

13. Ordering Information

Part number	Package	Remarks
MB3800PF-❏❏	8-pin Plastic SOP (FPT-8P-M01)	Conventional version
MB3800PNF-❏❏	8-pin Plastic SOP (FPT-8P-M02)	Conventional version
MB3800PF-❏❏❏E1	8-pin Plastic SOP (FPT-8P-M01)	Lead Free version
MB3800PNF-❏❏❏E1	8-pin Plastic SOP (FPT-8P-M02)	Lead Free version

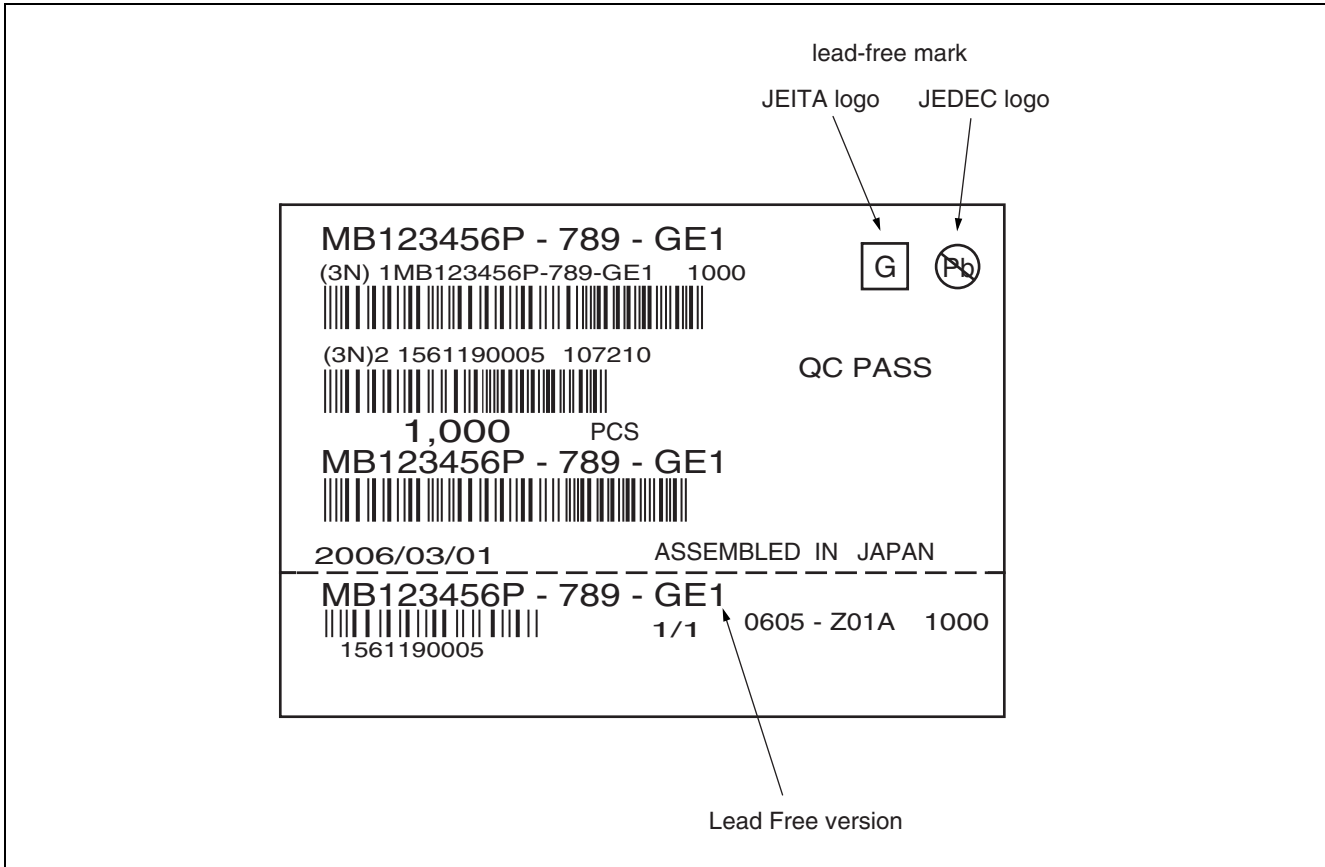## 14. RoHS Compliance Information of Lead (Pb) Free version

The LSI products of Cypress with "E1" are compliant with RoHS Directive , and has observed the standard of lead, cadmium, mercury, Hexavalent chromium, polybrominated biphenyls (PBB) , and polybrominated diphenyl ethers (PBDE) .

The product that conforms to this standard is added "E1" at the end of the part number.

15. Marking Format (Lead Free version)

Lead Free version

3800
E1XXXX
XXX

INDEX

SOP-8
(FPT-8P-M01)

Lead Free version

3800
XXXX
E1 XXX

SOP-8
(FPT-8P-M02)
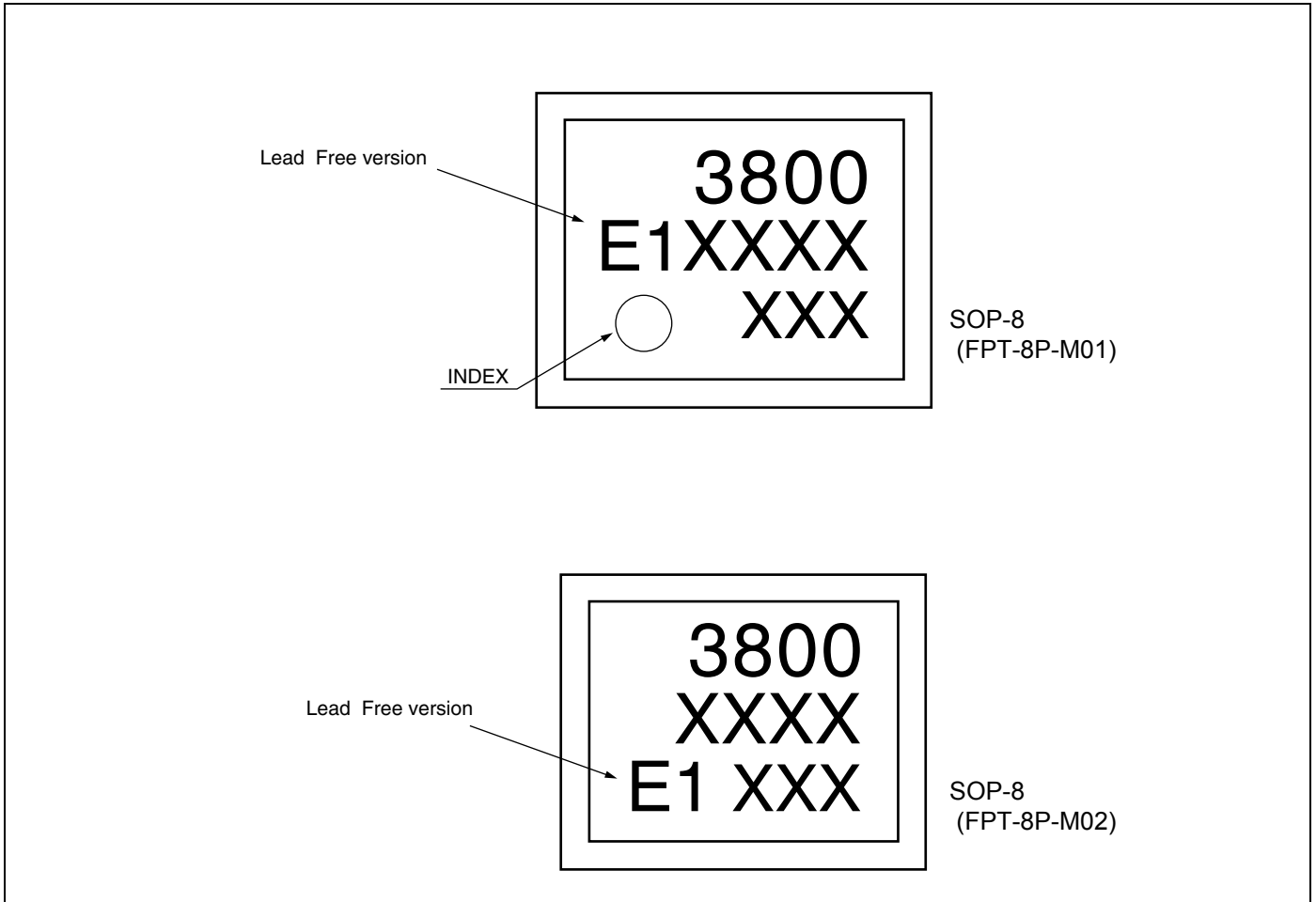
16. Labeling Sample (Lead free version)

lead-free mark

JEITA logo   JEDEC logo

MB123456P - 789 - GE1

(3N) 1MB123456P-789-GE1   1000

[barcode]

(3N)2 1561190005 107210

[barcode]

1,000   PCS

MB123456P - 789 - GE1

[barcode]

2006/03/01   ASSEMBLED IN JAPAN

MB123456P - 789 - GE1

[barcode]

1561190005   1/1   0605 - Z01A   1000

G   (Pb)

QC PASS

Lead Free version

17. MB3800PF-☐☐☐E1, MB3800PNF-☐☐☐E1
Recommended Conditions of Moisture Sensitivity Level

Item	Condition	
Mounting Method	IR (infrared reflow) , Manual soldering (partial heating method)	
Mounting times	2 times	
Storage period	Before opening	Please use it within two years after Manufacture.
	From opening to the 2nd reflow	Less than 8 days
	When the storage period after opening was exceeded	Please processes within 8 days after baking (125°C, 24H)
Storage conditions	5°C to 30°C, 70%RH or less (the lowest possible humidity)	

[Temperature Profile for FJ Standard IR Reflow]

1. **IR** (**infrared reflow**)

H rank : 260°C Max

(a) Temperature Increase gradient　: Average 1°C/s to 4°C/s
(b) Preliminary heating　: Temperature 170°C to 190°C, 60s to 180s
(c) Temperature Increase gradient　: Average 1°C/s to 4°C/s
(d) Actual heating　: Temperature 260°C Max; 255°C or more, 10s or less
(d')　: Temperature 230°C or more, 40s or less
　　　　　　　　　　　　　　　　or
　　　　　Temperature 225°C or more, 60s or less
　　　　　　　　　　　　　　　　or
　　　　　Temperature 220°C or more, 80s or less
(e) Cooling　: Natural cooling or forced cooling

  Note : Temperature : the top of the package body

2. **Manual soldering (partial heating method)**

    Conditions   : Temperature 400°C Max

    Times   : 5 s max/pin

18. Package Dimensions

8-pin plastic SOP	Lead pitch	1.27 mm
	Package width × package length	5.3 × 6.35 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	2.25 mm MAX
	Weight	0.10 g
(FPT-8P-M01)	Code (Reference)	P-SOP8-5.3×6.35-1.27

8-pin plastic SOP
(FPT-8P-M01)
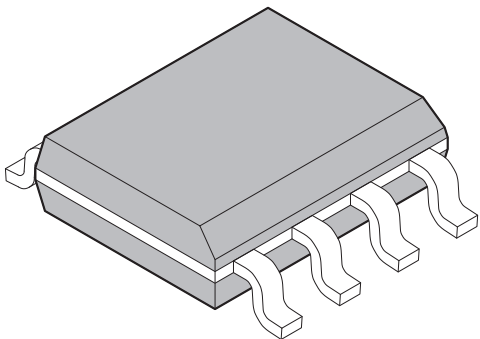
Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.

*1 6.35 $^{+0.25}_{-0.20}$ (.250 $^{+.010}_{-.008}$)

0.17 $^{+0.03}_{-0.04}$
(.007 $^{+.001}_{-.002}$)

INDEX

*2 5.30±0.30   7.80±0.40
(.209±.012) (.307±.016)

1.27(.050)

0.47±0.08
(.019±.003)   ⊕ 0.13(.005) Ⓜ

"A"

Details of "A" part

2.00 $^{+0.25}_{-0.15}$ (Mounting height)
(.079 $^{+.010}_{-.006}$)

0.25(.010)

0~8°

0.50±0.20
(.020±.008)

0.60±0.15
(.024±.006)

0.10 $^{+0.10}_{-0.05}$
(.004 $^{+.004}_{-.002}$)
(Stand off)

0.10(.004)

© 2002 FUJITSU LIMITED F08002S-c-6-7
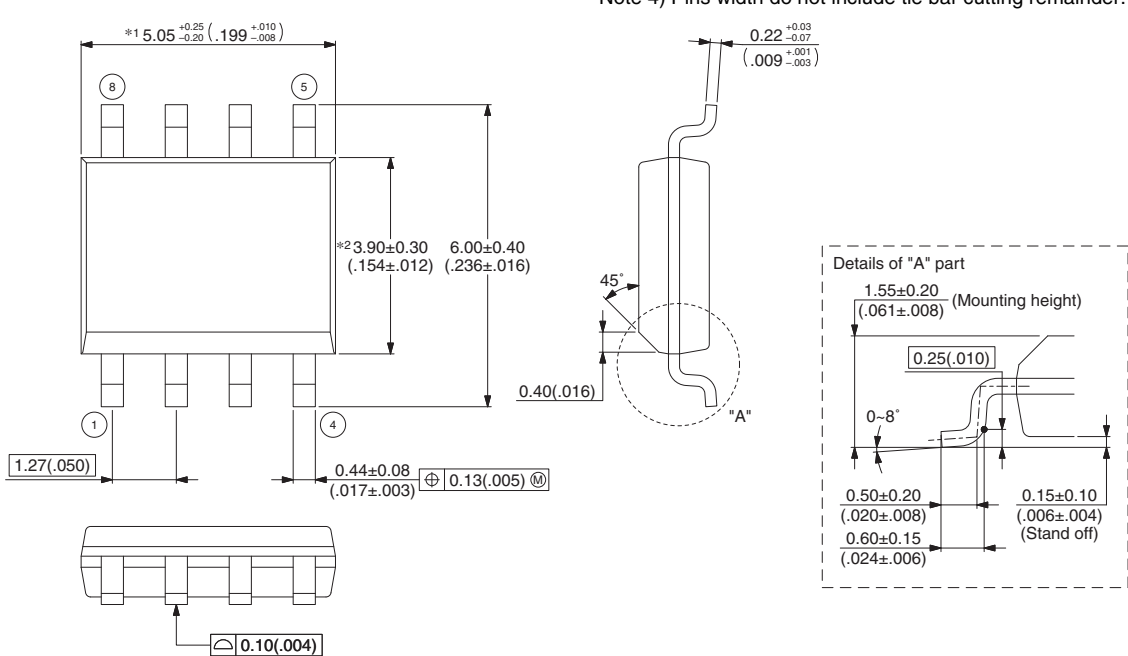
Dimensions in mm (inches).
Note: The values in parentheses are reference values.

(Continued)

8-pin plastic SOP	Lead pitch	1.27 mm
	Package width × package length	3.9 × 5.05 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.75 mm MAX
	Weight	0.06 g
(FPT-8P-M02)		

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.

$*1\ 5.05\,^{+0.25}_{-0.20}\,(.199\,^{+.010}_{-.008})$

$*2\ 3.90\pm0.30$
$(.154\pm.012)$

6.00 ± 0.40
$(.236\pm.016)$

1.27(.050)

0.44 ± 0.08
$(.017\pm.003)$ ⊕ 0.13(.005) Ⓜ

0.10(.004)

$0.22\,^{+0.03}_{-0.07}$
$(.009\,^{+.001}_{-.003})$

45°

0.40(.016)

"A"

Details of "A" part

$\dfrac{1.55\pm0.20}{(.061\pm.008)}$ (Mounting height)

0.25(.010)

0~8°

$\dfrac{0.50\pm0.20}{(.020\pm.008)}$

$\dfrac{0.60\pm0.15}{(.024\pm.006)}$

$\dfrac{0.15\pm0.10}{(.006\pm.004)}$ (Stand off)

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

© 2002 FUJITSU LIMITED F08004S-c-4-7

(Continued)

Document History

Spansion Publication Number: DS04-27212-4Ea

Document Title:MB3800 Switching Regulator Controller **Document Number: 002-08716**				
Revision	**ECN**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	–	TAOA	05/10/2006	Migrated to Cypress and assigned document number 002-08716. No change to document contents or format.
*A	5171075	TAOA	03/15/2016	Updated to Cypress format. Deleted FPT-8P-M03.

Sales, Solutions, and Legal Information

Worldwide Sales and Design Support

Cypress maintains a worldwide network of offices, solution centers, manufacturer's representatives, and distributors. To find the office closest to you, visit us at Cypress Locations.

Products		PSoC® Solutions
ARM® Cortex® Microcontrollers	cypress.com/arm	cypress.com/psoc
Automotive	cypress.com/automotive	PSoC 1 | PSoC 3 | PSoC 4 | PSoC 5LP
Clocks & Buffers	cypress.com/clocks	
Interface	cypress.com/interface	**Cypress Developer Community**
Lighting & Power Control	cypress.com/powerpsoc	Community | Forums | Blogs | Video | Training
Memory	cypress.com/memory	
PSoC	cypress.com/psoc	**Technical Support**
Touch Sensing	cypress.com/touch	cypress.com/support
USB Controllers	cypress.com/usb	
Wireless/RF	cypress.com/wireless	