FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-27221-2E

*ASSP For Power Supply Applications*

**With Power Mode Switching Function**

# 2-ch DC/DC Converter IC With Synchronous Rectifier

# MB3821

## ■ DESCRIPTION

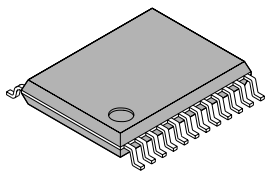
The MB3821 is a pulse width modulation (PWM) type 2-channel DC/DC converter IC with synchronous rectification designed for low voltage, high efficiency operation in high precision and high frequency applications, ideal for down conversion.
A normal/low-power mode selection is provided, ideal for an internal power supply (3.3V, 5V) in applications with substantial load current variation, such as notebook computers.

## ■ FEATURES

- Synchronous rectification
- High efficiency : 93 % (normal power mode, VIN = 6 V, load 1 A)
  : 84 % (low power mode, VIN = 6 V, load 20 mA)
- Built-in power mode selector circuit
- Reference voltage accuracy : 2.5V ± 2 %
- Built-in error amp input control type soft start circuit
- Totem pole type output for N-ch MOSFET applications
- Built-in timer-latch type short protection circuit

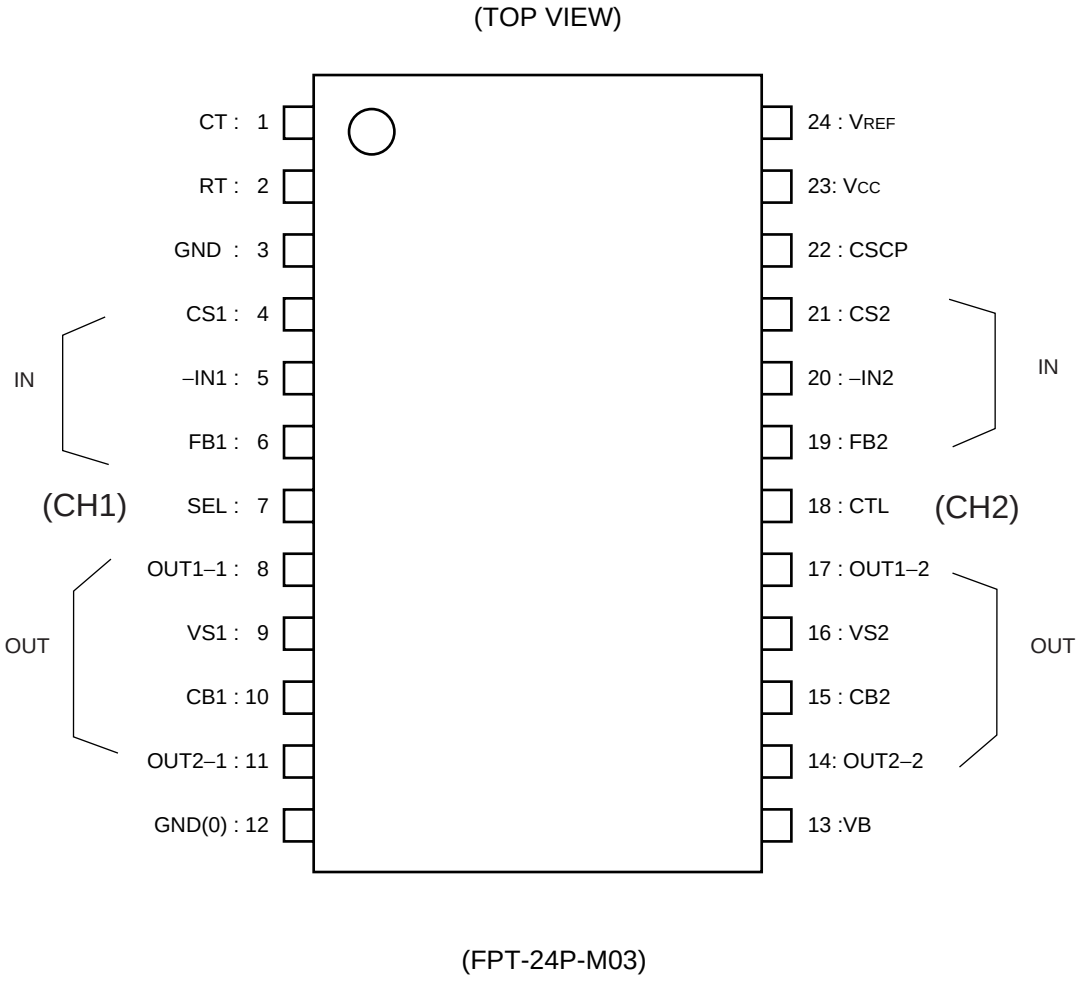
## ■ PACKAGE

24-pin, Plastic SSOP



(FPT-24P-M03)

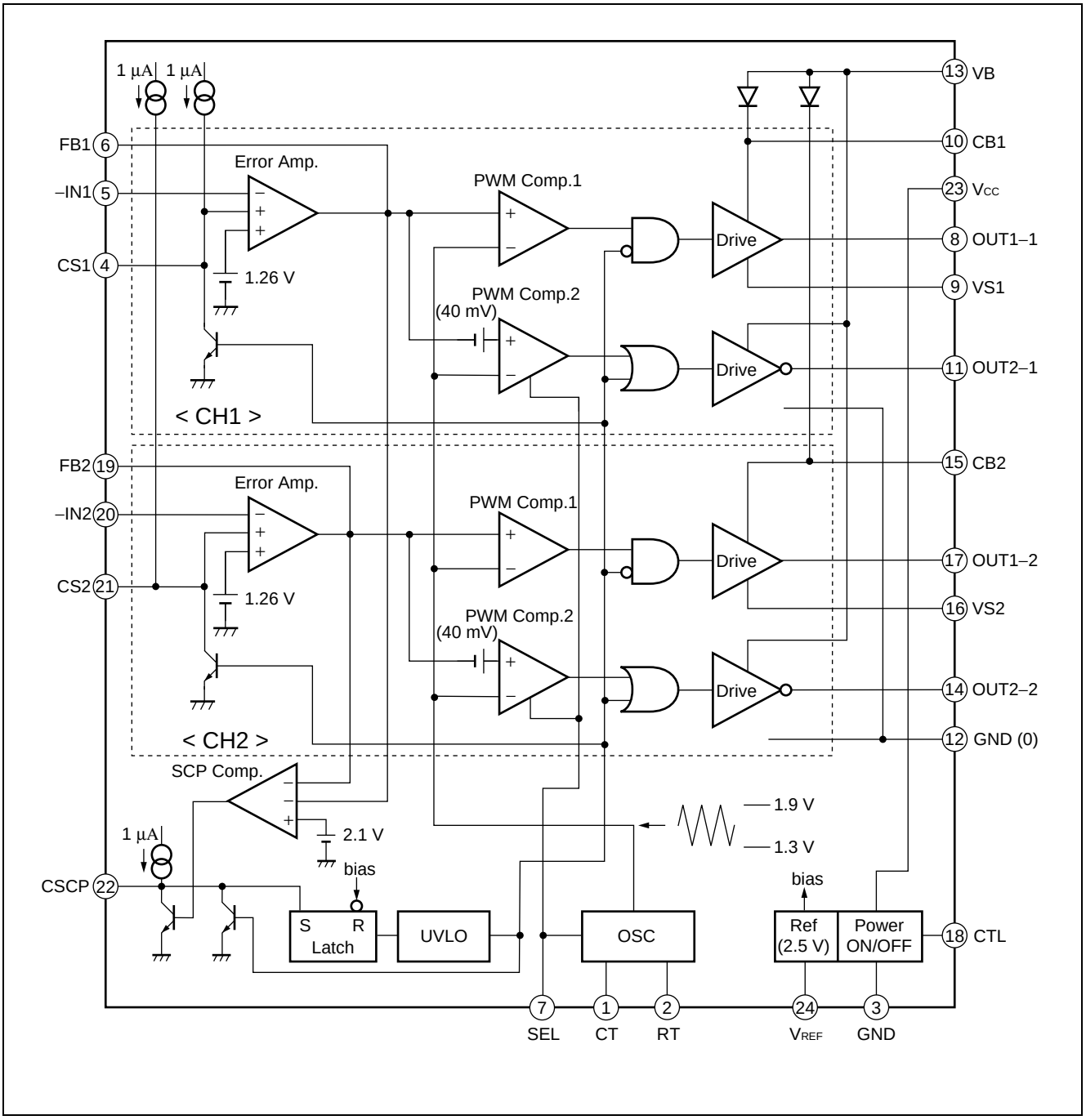
## ■ PIN ASSIGNMENT



## ■ PIN DESCRIPTION

| Pin No. | Symbol | I/O | Descriptions |
|---|---|---|---|
| 1 | CT | — | Triangular wave oscillator frequency setting capacitance connection pin. |
| 2 | RT | — | Triangular wave oscillator frequency setting resistance connection pin. |
| 3 | GND | — | Ground pin. |
| 4 | CS1 | — | Capacitor connection pin for Channel 1 soft start (also channel control). |
| 5 | –IN1 | I | Channel 1 error amplifier inverted input pin. |
| 6 | FB1 | O | Channel 1 error amplifier output pin |
| 7 | SEL | I | Mode select pin. Set the SEL pin to “H” level to switch the IC to low power mode. |
| 8 | OUT1-1 | I | Totem pole type output pin (external main side FET gate drive). |
| 9 | VS1 | — | Channel 1 external main side FET source connection pin. |
| 10 | CB1 | — | Channel 1 boot capacitance connection pin. |
| 11 | OUT2-1 | O | Channel 1 totem pole output pin (external main side FET gate drive). |
| 12 | GND(0) | — | Ground pin for output circuit. |
| 13 | VB | — | Power supply pin for output circuit. |
| 14 | OUT2-2 | O | Channel 2 totem pole output pin (external synchronous rectifier side FET gate drive). |
| 15 | CB2 | — | Channel 2 boot capacitance connection pin. |
| 16 | VS2 | — | Channel 2 external main side FET source connection pin. |
| 17 | OUT1-2 | O | Channel 2 totem pole output pin (external main side FET gate drive). |
| 18 | CTL | I | Power supply control pin. Set CTL pin to “L” to switch the IC to standby mode. |
| 19 | FB2 | O | Channel 2 error amplifier output pin. |
| 20 | –IN2 | I | Channel 2 error amplifier inverted input pin. |
| 21 | CS2 | — | Channel 2 soft start capacitance connection pin(also channel control). |
| 22 | CSCP | — | Timer-latch short circuit protection capacitance connection pin. |
| 23 | $V_{CC}$ | — | Reference power supply, control circuit power supply pin. |
| 24 | $V_{REF}$ | O | Reference voltage output pin. |

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RAGINGS

| Parameter | Symbol | Conditions | Rating | | Unit |
|---|---|---|---|---|---|
| | | | Min. | Max. | |
| Power supply voltage | $V_{CC}$ | — | — | 32 | V |
| Bias voltage | $V_B$ | — | — | 17 | V |
| Output current | Io | — | — | 50 | mA |
| Output peak current | Io | Duty ≤ 5 % | — | 500 | mA |
| Power dissipation | $P_D$ | Ta ≤ +25°C | — | 740* | mW |
| Storage temperature | $T_{stg}$ | — | –55 | +125 | °C |

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

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 | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Power supply voltage | $V_{CC}$ | — | 4.5 | 16 | 30 | V |
| Bias voltage | $V_B$ | — | — | 6 | 16 | V |
| Reference voltage output current | $I_{OR}$ | — | –1 | — | 0 | mA |
| Input voltage | $V_{IN}$ | -IN pin | 0 | — | $V_{CC}$ – 1.8 | V |
| | | SEL, CTL pin | 0 | — | 30 | V |
| Output current | $I_O$ | OUT pin | –30 | — | 30 | mA |
| Output peak current | Io | Duty ≤ 5 % | –300 | — | 300 | mA |
| Timing capacitance | $C_T$ | — | 150 | 500 | 15000 | pF |
| Timing resistance | $R_T$ | — | 6.8 | 10 | 12 | kΩ |
| Oscillator frequency | $f_{OSC}$ | SEL = 0 V (Normal mode) | 10 | 200 | 500 | kHz |
| | | SEL = 5 V (Low power mode) | 1 | 20 | 50 | kHz |
| Soft-start capacitance | $C_S$ | — | — | 0.1 | 1.0 | µF |
| Short detection capacitance | $C_{SCP}$ | — | — | 0.01 | 1.0 | µF |
| Boot capacitance | $C_B$ | — | — | 0.1 | 1.0 | µF |
| 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 FUJITSU representatives beforehand.

## ■ ELECTRICAL CHARACTERISTICS

($V_{CC}$ = 16 V, SEL =0 V, Ta = +25°C)

| Parameter | | Symbol | Pin No. | Conditions | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min. | Typ. | Max. | |
| Reference voltage block | Output voltage | $V_{REF}$ | 24 | $V_{REF}$ =0 mA | | 2.45 | 2.50 | 2.55 | V |
| | Output voltage temperature variation | $\Delta V_{REF}/V_{REF}$ | 24 | Ta = –30°C to +85°C | | — | 0.5* | — | % |
| | Input stability | Line | 24 | $V_{CC}$ = 4.5 V to 30 V | | — | — | 15 | mV |
| | Load stability | Load | 24 | $V_{REF}$ = 0 mA to –1.0 mA | | — | — | 15 | mV |
| | Short-circuit output current | $I_{OS}$ | 24 | $V_{REF}$ = 1 V | | –60 | –25 | — | mA |
| Under voltage lockout protection circuit block(U.V.L.O.) | Threshold voltage | $V_{TH}$ | 4,21 | $V_{CC}$ = ↓ | | 3.2 | 3.5 | 3.8 | V |
| | Hysteresis width | $V_H$ | 4,21 | — | | — | 0.18 | — | V |
| | Reset voltage | $V_{RST}$ | 4,21 | — | | 2.4 | 2.8 | — | V |
| Soft-start block | Charge current | $I_{CS}$ | 4,21 | — | | –1.4 | –1.0 | –0.6 | µA |
| | Input standby voltage | $V_{STB}$ | 4,21 | — | | — | 50 | 100 | mV |
| Short circuit detection block | Threshold voltage | $V_{TH}$ | 4,21 | — | | 0.63 | 0.68 | 0.73 | V |
| | Input source current | $I_{CSCP}$ | 22 | — | | –1.4 | –1.0 | –0.6 | µA |
| | Short detection time | $t_{SCP}$ | 22 | $C_{SCP}$ = 0.01 µF | | 4.5 | 6.8 | 12.2 | ms |
| | Input standby voltage | $V_{STB}$ | 22 | — | | — | 50 | 100 | mV |
| | Input latch voltage | $V_I$ | 22 | — | | — | 50 | 100 | mV |
| Triangular wave oscillator block | Oscillator frequency | $f_{OSC}$ | 8,11, 14,17 | $C_T$ = 500pF, $R_T$ = 10 kΩ | SEL = 0 V | 180 | 200 | 220 | kHz |
| | | | | | SEL = 5 V | 16 | 20 | 24 | kHz |
| | Mode select voltage | $V_{LOW}$ | 7 | Low power mode | | 2.0 | — | — | V |
| | | $V_{HI}$ | 7 | Normal mode | | — | — | 1.0 | V |
| | Input current | $I_{SEL}$ | 7 | SEL = 5 V | | — | 50 | 80 | µA |
| | Frequency stability for voltage | $\Delta f/fdv$ | 8,11, 14,17 | $C_T$ = 500pF, $R_T$ = 10 kΩ, $V_{CC}$ = 4.5V to 30V | SEL = 0 V | — | 1 | 10 | % |
| | | | | | SEL = 5 V | — | 1 | 10 | % |
| | Frequency stability for temperature | $\Delta f/fdt$ | 8,11, 14,17 | $C_T$ = 500pF, $R_T$ = 10 kΩ, Ta = –30°C to +85°C | SEL = 0 V | — | 1* | — | % |
| | | | | | SEL = 5 V | — | 1* | — | % |

*: Standard design value.

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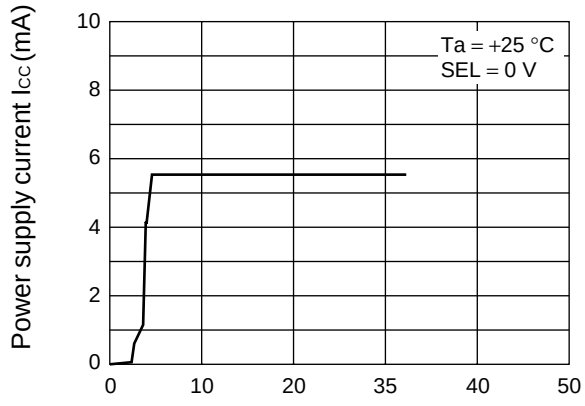
($V_{CC}$ = 16 V, SEL =0 V, Ta = +25°C)

| Parameter | | Symbol | Pin No. | Conditions | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min. | Typ. | Max. | |
| Error amplifier block | Threshold voltage | $V_{TH}$ | 6,19 | FB = 1.6 V | | 1.235 | 1.260 | 1.285 | V |
| | $V_T$ temperature stability | $\Delta V_T / V_T$ | 6,19 | Ta = –30°C to +85°C | | — | 0.5* | — | % |
| | Input bias current | $I_B$ | 5,20 | –IN = 0 V | | –200 | –50 | — | nA |
| | Voltage gain | $A_V$ | 6,19 | DC | | 60 | 100 | — | dB |
| | Frequency bandwidth | BW | 6,19 | $A_V$ = 0 dB | | — | 800* | — | kHz |
| | Output voltage | $V_{OH}$ | 6,19 | — | | $V_{REF}$ – 0.3 | — | — | V |
| | | $V_{OL}$ | 6,19 | — | | — | 0.8 | 1.0 | V |
| | Output source current | $I_{SOURCE}$ | 6,19 | FB = 1.6 V | | — | –90 | –45 | µA |
| | Output sink current | $I_{SINK}$ | 6,19 | FB = 1.6 V | | 1.5 | 6.0 | — | mA |
| PWM Comp. block | Threshold voltage | $V_{TL}$ | 8,11 14,17 | Duty cycle = 0 % | | 1.2 | 1.3 | — | V |
| | | $V_{TH}$ | | Duty cycle = Dtr | | — | 1.9 | 2.0 | V |
| Dead time control block | Maximum duty cycle | Dtr | 8,11, 14,17 | $C_T$ = 500 pF $R_T$ = 10 kΩ | SEL = 0 V | 85 | 90 | 95 | % |
| | | | | | SEL = 5 V | 89 | 94 | 99 | % |
| Output block (Drive) | Output voltage (Main side) | $V_{OH}$ | 8,17 | VS = 16 V CB = 22 V | $I_O$ = –30 mA | CB – 1.4 | CB – 1.1 | — | V |
| | | $V_{OL}$ | 8,17 | | $I_O$ = 30 mA | — | VS + 1.1 | VS + 1.4 | V |
| | Output voltage (Synchronous rectifier side) | $V_{OH}$ | 11,14 | $I_O$ = –30 mA | | VB – 1.4 | VB – 1.1 | — | V |
| | | $V_{OL}$ | 11,14 | $I_O$ = 30 mA | | — | 0.1 | 0.5 | V |
| | Diode voltage | $V_{DIODE}$ | 13 | $I_O$ = 10 mA | | — | 1.0 | 1.1 | V |
| Control block | CTL input voltage | $V_{IH}$ | 18 | IC active mode | | 2.0 | — | — | V |
| | | $V_{IL}$ | 18 | IC standby mode | | — | — | 1.0 | V |
| | Input current | $I_{CTL}$ | 18 | CTL = 5 V | | — | 50 | 80 | µA |
| General | Standby current | $I_{CCS}$ | 23 | CTL = 0 V | | — | — | 10 | µA |
| | Power supply current | $I_{CC}$ | 23 | SEL = 0 V (Normal mode) | | — | 5.2 | 7.8 | mA |
| | | | 23 | SEL = 5 V (Low power mode) | | — | 1.0 | 1.5 | mA |

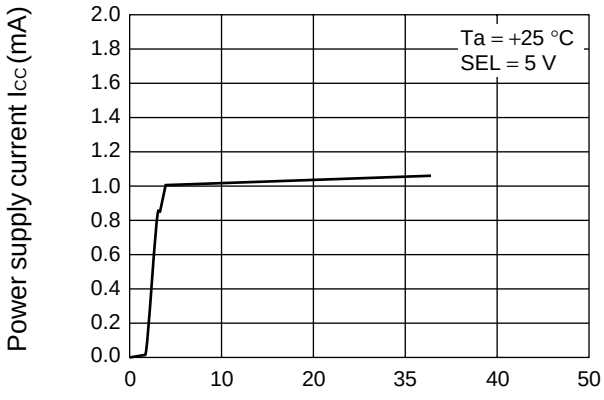
*: Standard design value.

## ■ TYPICAL CHARACTERISTICS

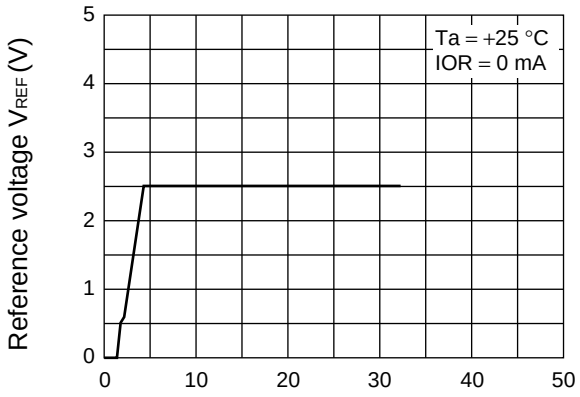
Power supply current vs. power supply voltage



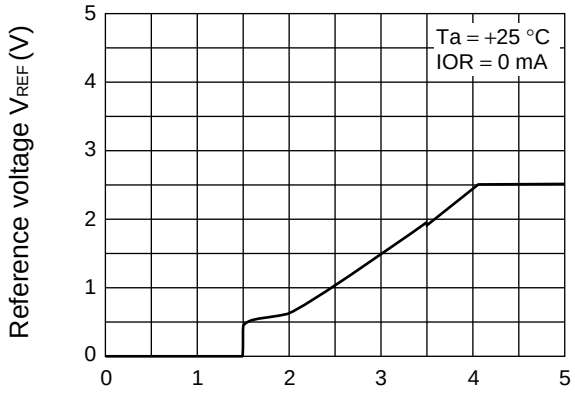

Power supply current vs. power supply voltage



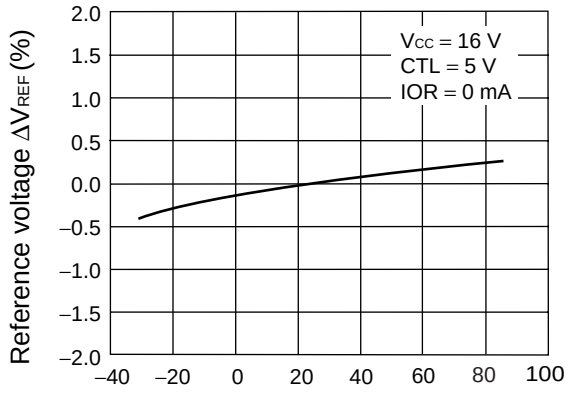

Reference voltage vs. power supply voltage



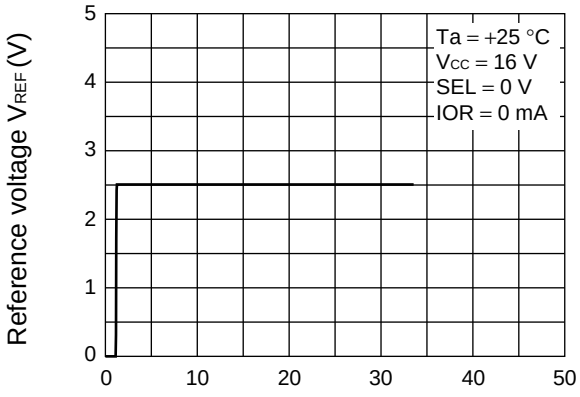

Reference voltage vs. power supply voltage




Reference voltage vs. ambient temperature



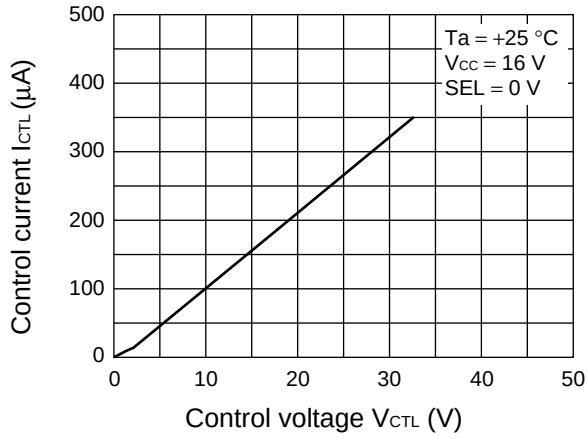

Reference voltage vs. control voltage



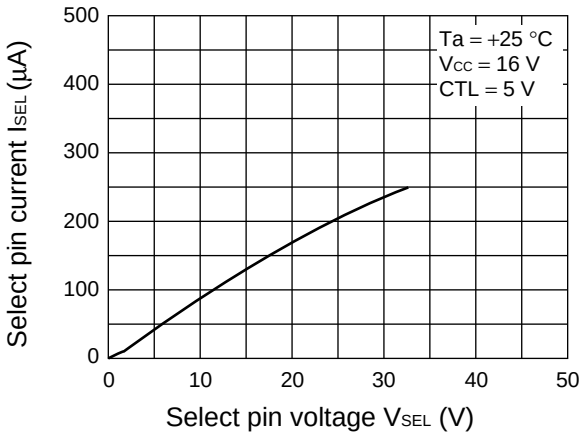

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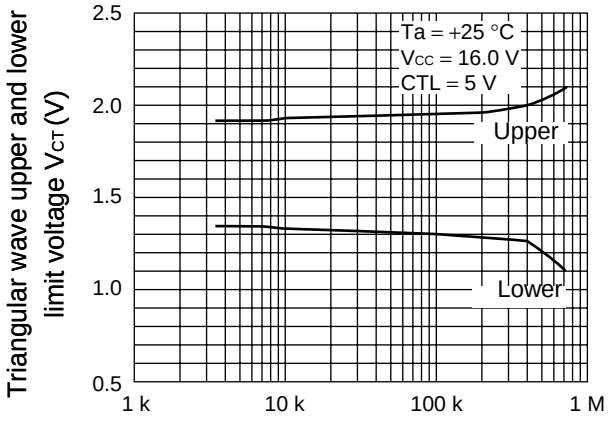
Control current vs. control voltage



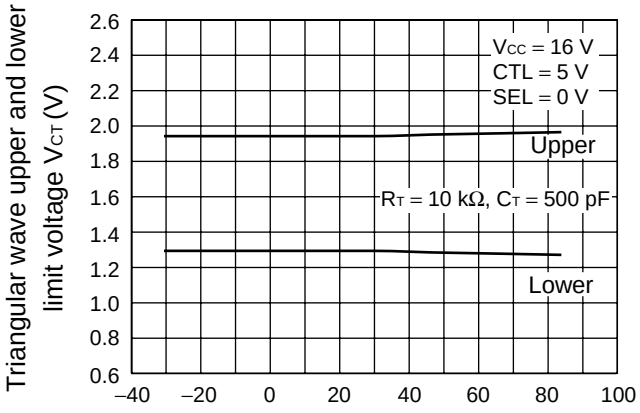

Select pin current vs. select pin voltage



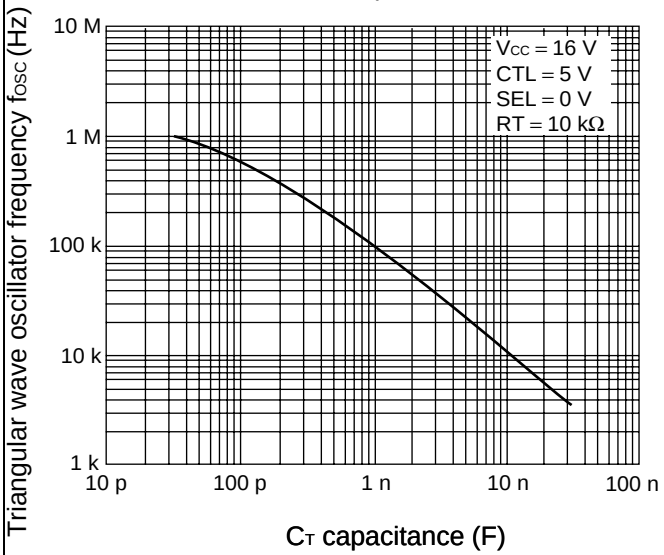

Triangular wave upper and lower limit voltage vs. triangular wave oscillator frequency



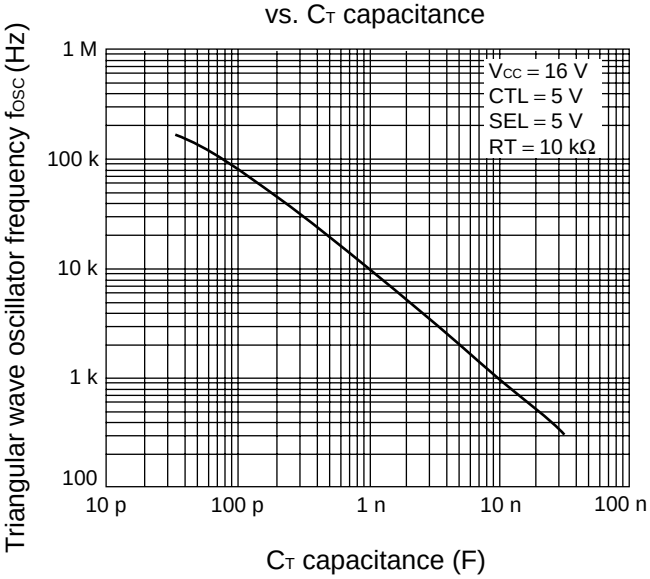

Triangular wave upper and lower limit voltage vs. ambient temperature




Triangular wave oscillator frequency vs. $C_T$ capacitance

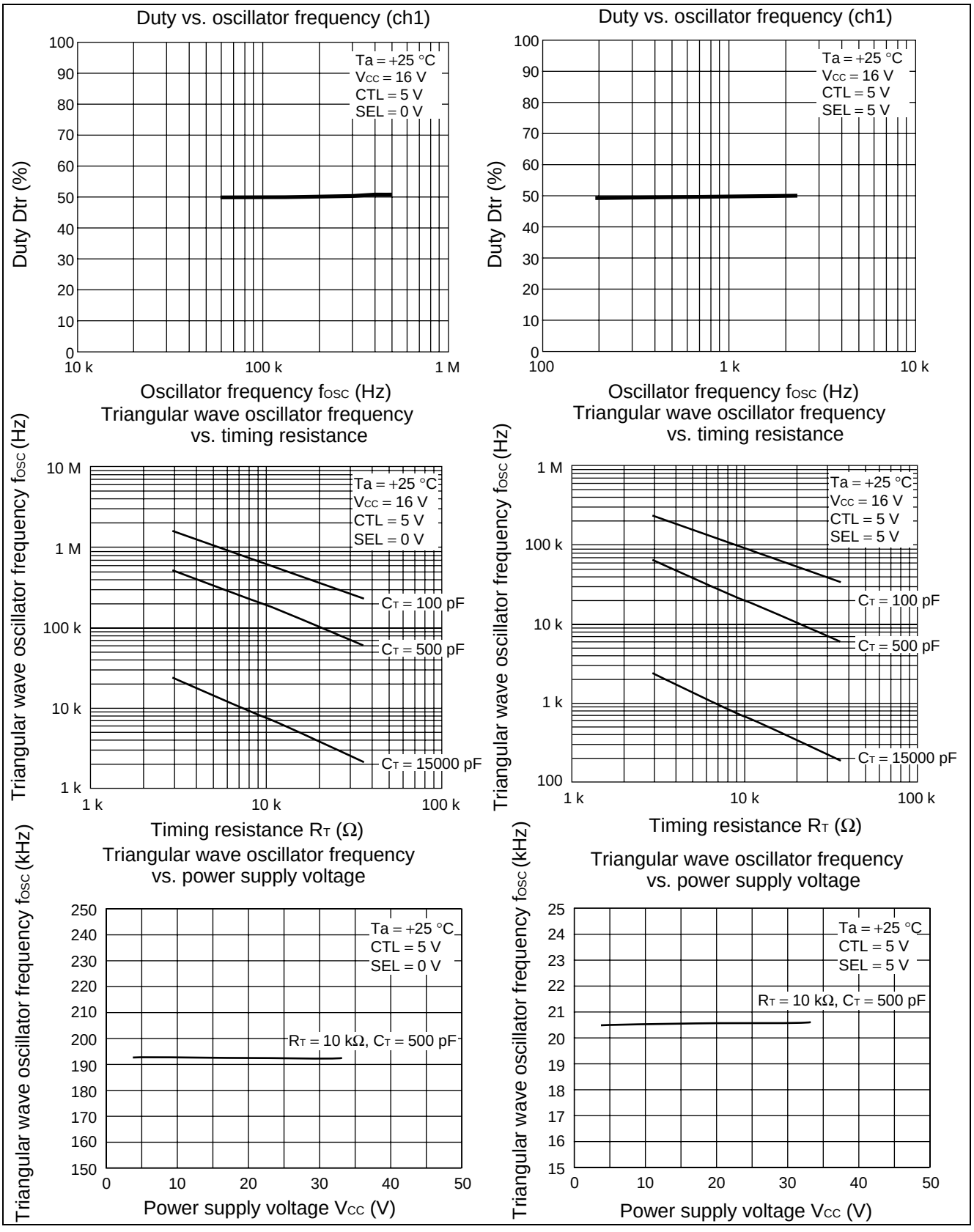



Triangular wave oscillator frequency vs. $C_T$ capacitance



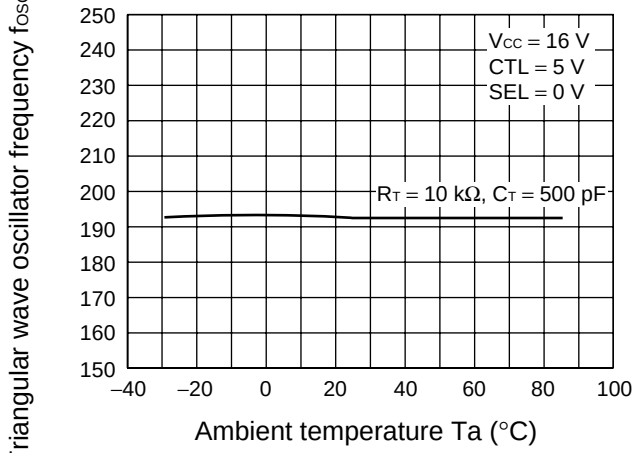

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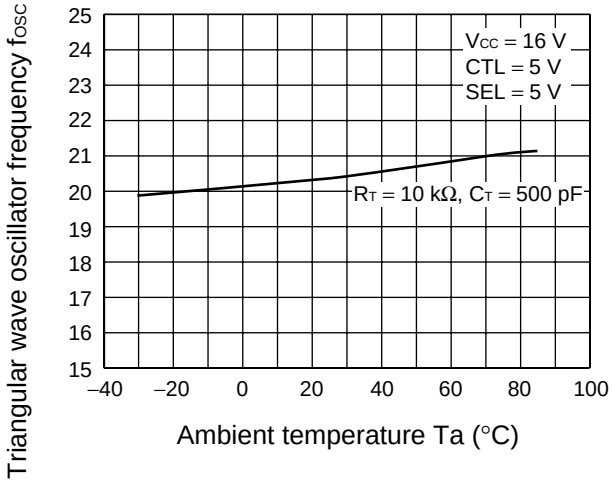

Duty vs. oscillator frequency (ch1)
Ta = +25 °C
VCC = 16 V
CTL = 5 V
SEL = 0 V
Duty Dtr (%)
100
90
80
70
60
50
40
30
20
10
0
10 k
100 k
1 M
Oscillator frequency fOSC (Hz)
Duty vs. oscillator frequency (ch1)
Ta = +25 °C
VCC = 16 V
CTL = 5 V
SEL = 5 V
Duty Dtr (%)
100
1 k
10 k
Oscillator frequency fOSC (Hz)
Triangular wave oscillator frequency
vs. timing resistance
Ta = +25 °C
VCC = 16 V
CTL = 5 V
SEL = 0 V
CT = 100 pF
CT = 500 pF
CT = 15000 pF
Triangular wave oscillator frequency fOSC (Hz)
10 M
1 M
100 k
10 k
1 k
Timing resistance RT (Ω)
Triangular wave oscillator frequency
vs. timing resistance
Ta = +25 °C
VCC = 16 V
CTL = 5 V
SEL = 5 V
CT = 100 pF
CT = 500 pF
CT = 15000 pF
Triangular wave oscillator frequency fOSC (Hz)
1 M
100 k
10 k
1 k
100
Timing resistance RT (Ω)
Triangular wave oscillator frequency
vs. power supply voltage
Ta = +25 °C
CTL = 5 V
SEL = 0 V
RT = 10 kΩ, CT = 500 pF
Triangular wave oscillator frequency fOSC (kHz)
250
240
230
220
210
200
190
180
170
160
150
0
10
20
30
40
50
Power supply voltage VCC (V)
Triangular wave oscillator frequency
vs. power supply voltage
Ta = +25 °C
CTL = 5 V
SEL = 5 V
RT = 10 kΩ, CT = 500 pF
Triangular wave oscillator frequency fOSC (kHz)
25
24
23
22
21
20
19
18
17
16
15
Power supply voltage VCC (V)

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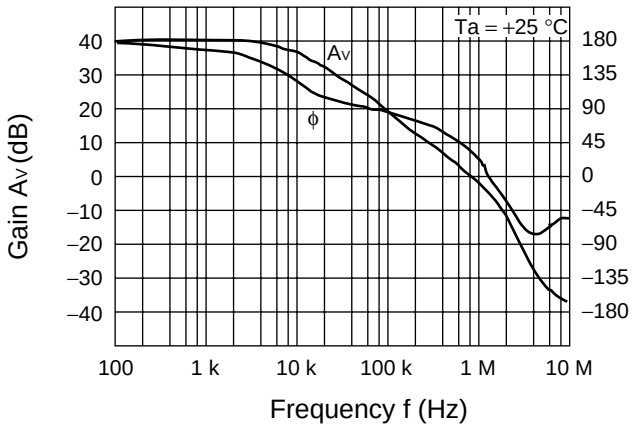
Triangular wave oscillator frequency vs. ambient temperature

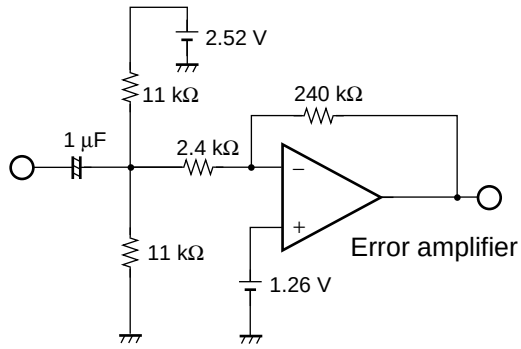



Triangular wave oscillator frequency vs. ambient temperature

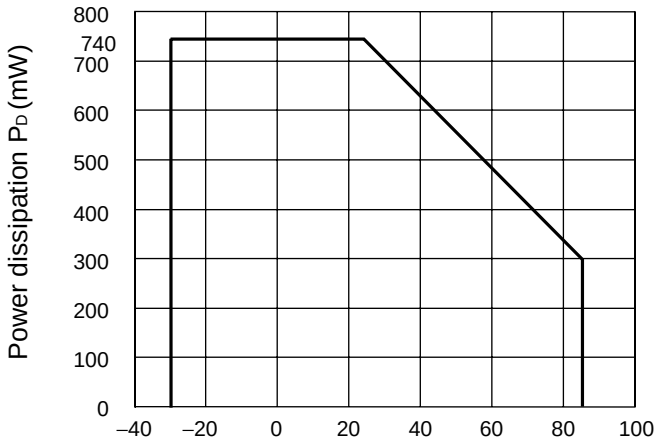



Error amplifier,gain and phase vs. frequency (ch1)




Power dissipation vs. ambient temperature



## ■ FUNCTIONAL DESCRIPTION

### 1. DC/DC Converter Function

#### (1) Reference voltage circuit (Ref)

The reference voltage circuit generates a temperature-compensated reference voltage (≅ 2.50 V) using the voltage supplied from the power supply terminal (pin 23). This voltage is used as the reference voltage for the internal circuits of the IC. The reference voltage can also be supplied to an external device from the $V_{REF}$ terminal (pin 24) up to a maximum current of 1mA.

#### (2) Triangular-wave oscillator circuit (OSC)

By connecting a frequency setting capacitor and a resistor to the $C_T$ (pin 1) and the $R_T$ (pin 2) terminals, it is possible to generate any desired triangular oscillation waveform.
The triangular wave is input to the PWM comparator within the IC.

#### (3) Error amplifier

This amplifier detects the output voltage of the DC/DC converter and outputs a PWM control signal accordingly. The system can be provided with stable phase compensation by connecting a feedback resistor and capacitor between the FB pin and the -IN pin of the error amplifier to create the desired level of loop gain.
Also, by connecting soft start capacitance to the CS terminal, which is the non inverted input pin for the error amplifier, it is possible to prevent current surges when the power supply is started. By using the error amplifier for soft start detection, it is possible to operate with a fixed soft start interval independent of the output load on the DC/DC converter.

#### (4) PWM comparators (PWM Comp.1, PWM Comp.2)

PWM Comp.1 and PWM Comp.2 are voltage-pulse width modulators that control the output duty according to input voltage.
PWM Comp.1 controls the pulse width on the main side output circuit, and PWM Comp.2 controls the pulse width on the synchronous rectifier side output circuit. The triangular wave generated by the triangular wave oscillator is compared to the error amplifier output voltage, and in the intervals when the error amplifier voltage is higher than the triangular wave, the main side output transistor is switched on and the synchronous rectifier side output transistor is switched off.
Also, PWM Comp.1 is set to a maximum duty cycle of approximately 90 % (normal mode).

#### (5) Output circuit (Drive)

The output circuits is comprised of a totem-pole configuration on both the main side and synchronous rectifier side, and can drive an external N-ch MOSFET.

#### (6) Mode select circuit (SEL)

The SEL terminal (pin 7) can set either channel to normal mode or low power mode.
In low power mode the triangular oscillator frequency is set to approximately 1/10 of normal mode, reducing the internal power consumption of the chip and enabling high efficiency power supply at light load levels.

#### (7) Power supply control circuit (CTL)

The CTL terminal (pin 18) is used for power supply on/off control (standby power consumption is 10 μA or less).

### 2. Protection Functions

#### (1) Under Voltage Lockout Circuit (UVLO)

Power-on surge states or sudden drops in supply voltage can cause a control IC to operate abnormally, leading to destruction or damage to system elements. The under voltage lockout circuit detects the internal reference voltage level from the supply voltage, and shuts off the output transistors so that the inactive interval becomes 100%, holding the CSCP terminal (pin 22) voltage at “L” level.
Operation is restored as soon as the supply voltage exceeds the under voltage lockout circuit threshold voltage.

**(2) Timer-Latch Short Circuit Protection Circuit (SCP)**

This circuit detects the output voltage level from the error amplifier. When the error amplifier output voltage exceeds approximately 2.1V, a timer circuit is activated and charges the external capacitor at the CSCP terminal (pin 22). If the error amplifier output does not return to normal range before the capacitor voltage reaches approximately 0.7V, a latch circuit is activated and sets both the main and synchronous rectifier side output pins to “L” level. After the short protection circuit has been activated, it is reset by simply restarting the power supply. (See “METHOD OF SETTING TIME CONSTANT FOR TIMER LATCH SHORT-CIRCUIT PROTECTION CIRCUIT”.)

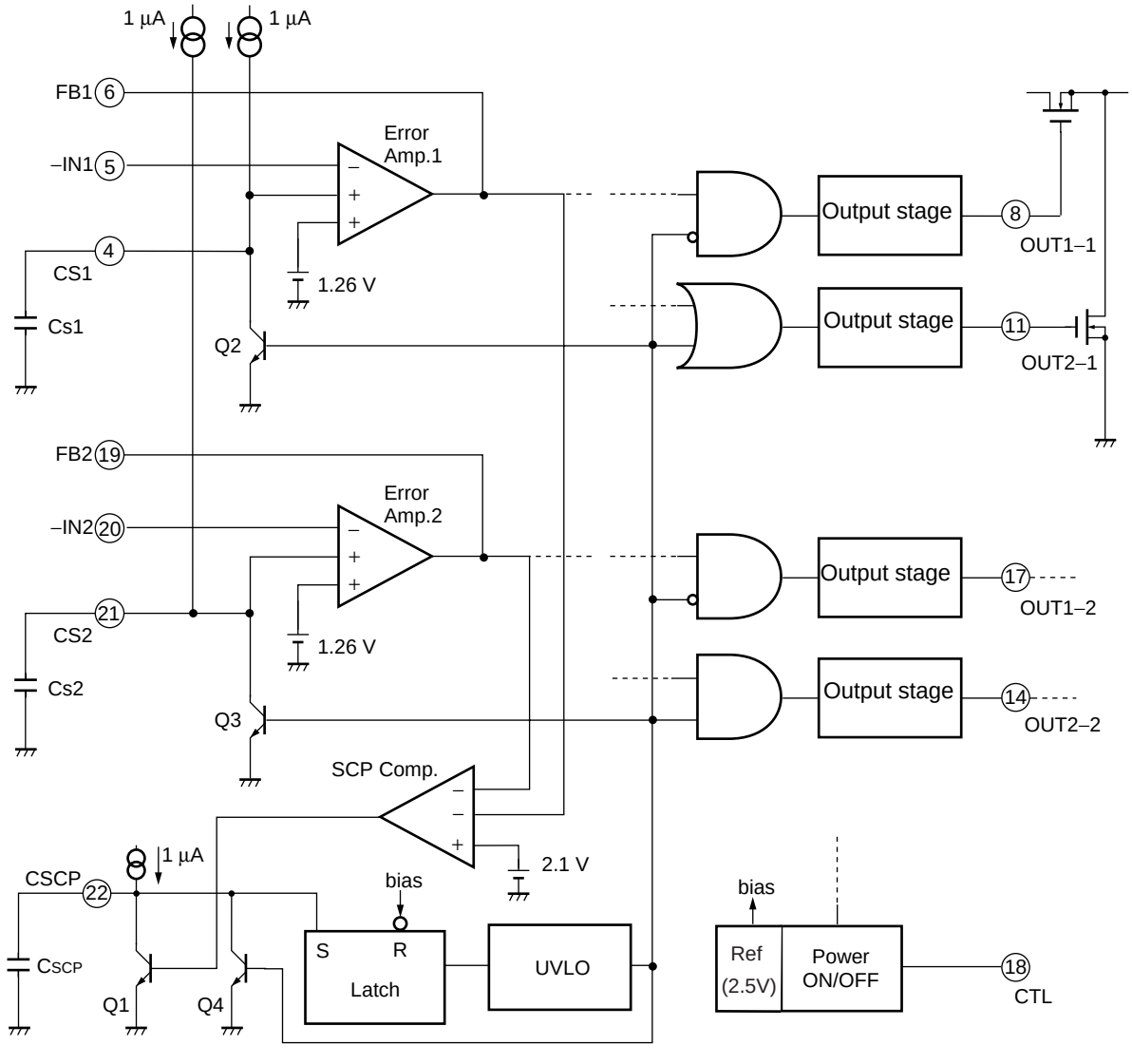
## ■ METHOD OF SETTING SOFT START TIME

To provide a soft start by preventing current surges at power-on, soft start capacitors (Cs1, Cs2) are connected to both channels, the CS1 pin (pin 4) for CH1 and the CS2 pin (pin 21) for CH2.
When the IC is started (when the CTL pin (pin 18) goes to “H” level, and Vcc ≥ UVLO threshold voltage), transistors Q2 and Q3 switch off and the CS1 and CS2 pins begin charging the external soft start capacitors (Cs1, Cs2) at 1 µA. The error amplifier contributes to a soft start with the proportionate output voltage to the CS1 and CS2 pin voltage regardless of the load current on the DC/DC converter.
The soft start time can be calculated by the following formula.

Soft start time (time to 100% output)

$t_S(sec) \fallingdotseq 1.26 \times C_S\ (\mu F)$

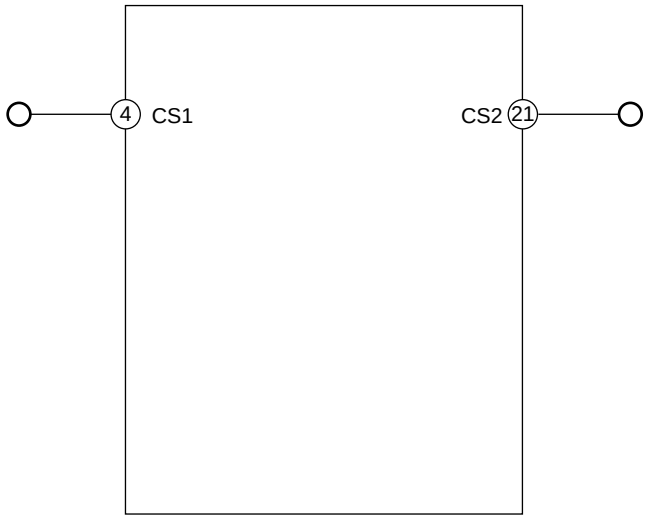
**Soft start circuit**



## ■ TREATMENT WITHOUT USING CS TERMINAL

When you do not use the soft start circuit, open the CS1 terminal (pin 4) and CS2 terminal (pin 22).

**Treatment When Not Using SCP**



## ■ METHOD OF SETTING TIME CONSTANT FOR TIMER-LATCH SHORT-CIRCUIT PROTECTION CIRCUIT

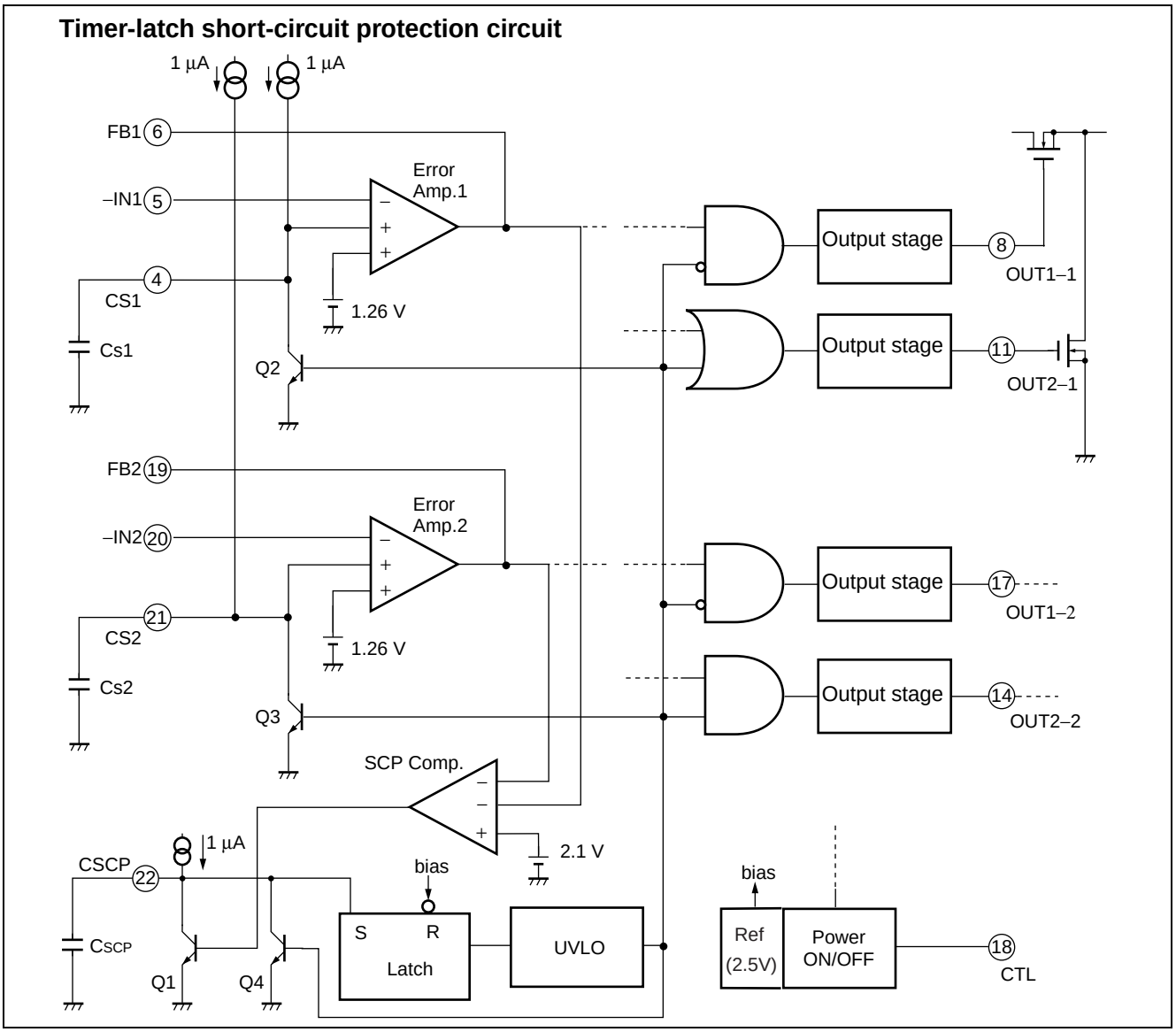
The short detection comparator (SCP comparator) constantly compares the error amplifier output level to the reference voltage.
While the switching regulator load conditions are stable on all channels, the short detection comparator output remains at "H" level, transistor Q1 is on, and the CSCP terminal (pin 22) is held at input standby voltage ($V_{STB} \fallingdotseq 50$mV). If the load conditions change rapidly due to a short-circuiting of load, causing the output voltage to drop, the output from the short detection comparator goes to "L" level. This causes transistor Q1 to turn off and the external short protection capacitor $C_{SCP}$ connected to the CSCP pin to charge at 1.0 μA.

Short Detection Time

$t_{SCP}(sec) \fallingdotseq 0.7 \times C_{SCP}$ (μF)

When the capacitor $C_{SCP}$ is charged to the threshold voltage $V_{TH} \fallingdotseq 0.7$ V, the SR latch is set, and the external FET is turned off (inactive interval is set to 100%). At this point, the SR latch input is closed and the CSCP terminal is held at input latch voltage ($V_I \fallingdotseq 50$ mV).

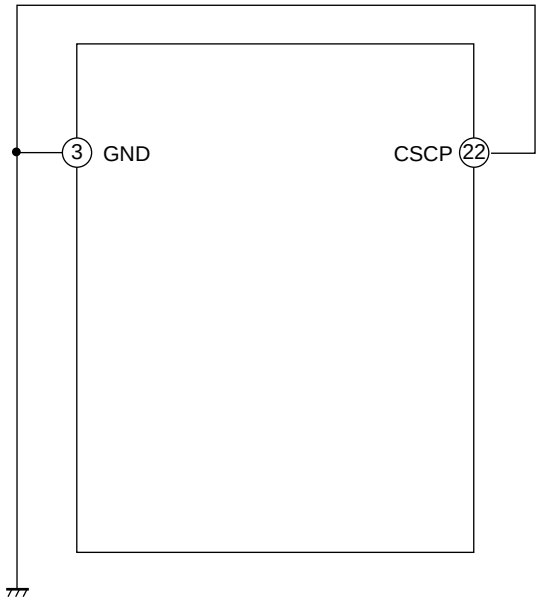
**Timer-latch short-circuit protection circuit**



## ■ TREATMENT WITHOUT USING CSCP TERMINAL

When you do not use the timer latch short-circuit protection circuit, connect the CSCP terminal (pin 22) to GND with the shortest distance.

**Treatment When Not Using SCP**




## ■ Channel Control Method

On/off controls for either channel are enabled by setting the CS pins.

Setting Conditions

| CS pin setting | | Channel output state | |
|---|---|---|---|
| CS1 | CS2 | CH1 | CH2 |
| GND | GND | OFF | OFF |
| GND | Open | OFF | ON |
| Open | GND | ON | OFF |
| Open | Open | ON | ON |

## ■ METHOD OF SETTING OSCILLATOR FREQUENCY

Oscillator Frequency can be set by timing capacitor ($C_T$) connected to CT pin (pin 1) and timing resistor ($R_T$) connected to RT pin (pin 2).

Oscillator frequency

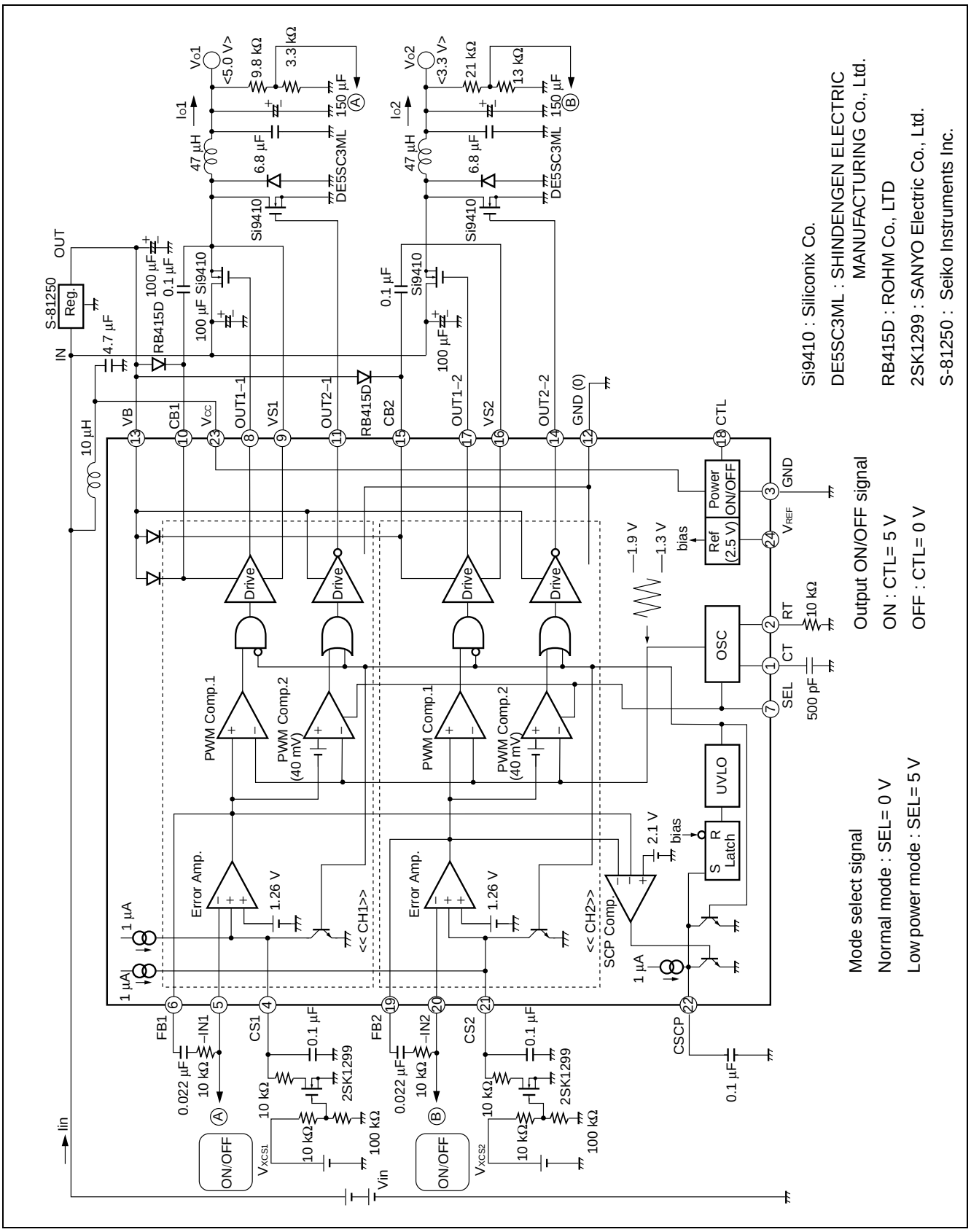
- Normal mode

$$f_{OSC}\ (kHz) \fallingdotseq \frac{1000000}{C_T(pF) \times R_T(k\Omega)}$$

- Low power mode

$$f_{OSC}\ (kHz) \fallingdotseq \frac{100000}{C_T(pF) \times R_T(k\Omega)}$$

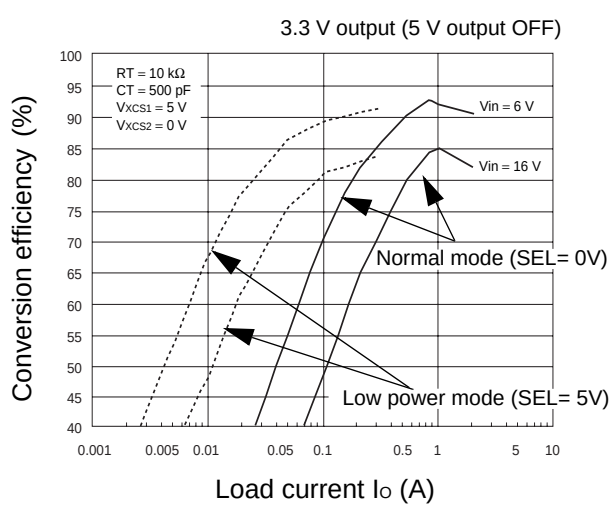
## ■ APPLICATION EXAMPLE



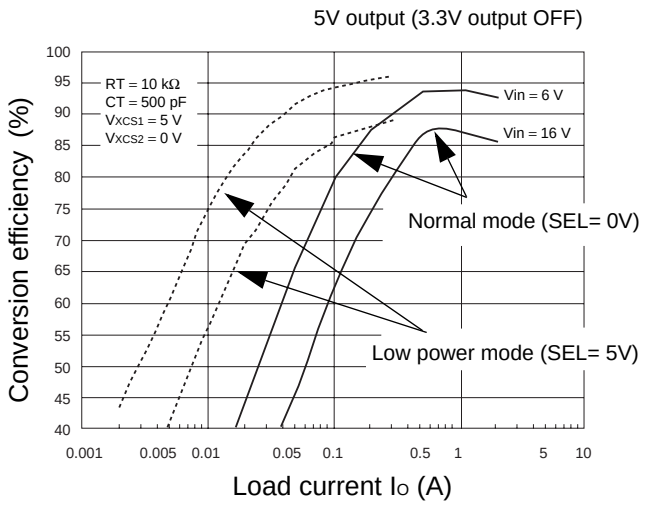
## ■ REFERENCE DATA

- **Load characteristic**

Conversion efficiency vs. load current

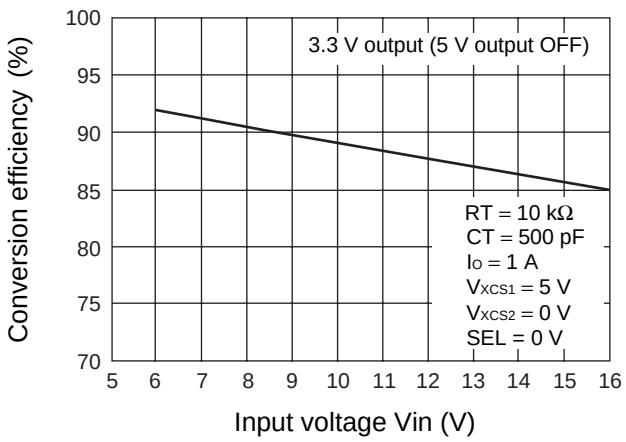



Conversion efficiency vs. load current

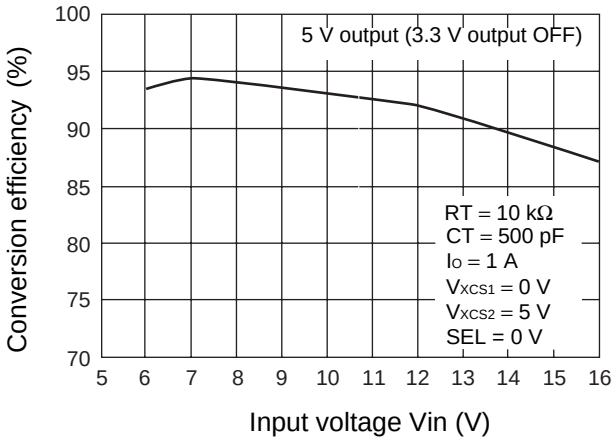



- **Normal mode**

Conversion efficiency vs. Input voltage




Conversion efficiency vs. Input voltage

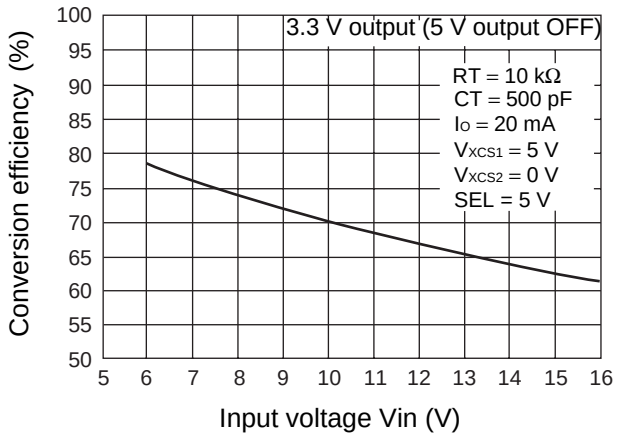



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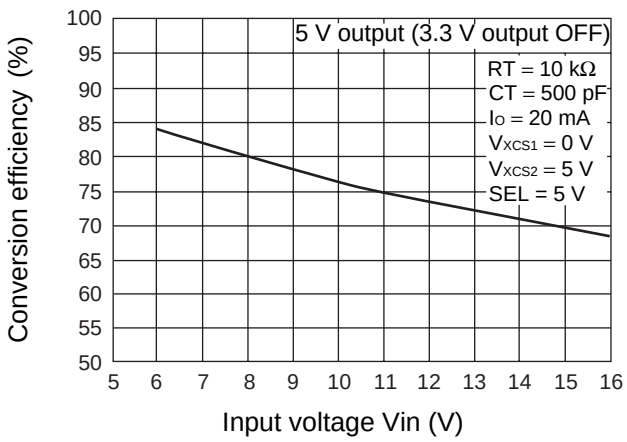
*(Continued))*

- **Low power mode**

Conversion efficiency vs. Input voltage




Conversion efficiency vs. Input voltage



## ■ USAGE PRECAUTIONS

### 1. Never use setting exceeding maximum rated conditions.

Exceeding maximum rated conditions may cause permanent damage to the LSI.

Also, it is recommended that recommended operating conditions be observed in normal use. Exceeding recommended operating conditions may adversely affect LSI reliability.

### 2. Use this device within recommended operating conditions.

Recommended operating conditions are values within which normal LSI operation is warranted.

Standard electrical characteristics are warranted within the range of recommended operating conditions and within the listed conditions for each parameter.

### 3. Printed circuit board ground lines should be set up with consideration for common impedance.

### 4. Take appropriate static electricity measures.

- Containers for semiconductor materials should have anti-static protection or be made of conductive material.
- After mounting, printed circuit boards should be stored and shipped in conductive bags or containers.
- Work platforms, tools, and instruments should be properly grounded.
- Working personnel should be grounded with resistance of 250 kΩ to 1 MΩ between body and ground.

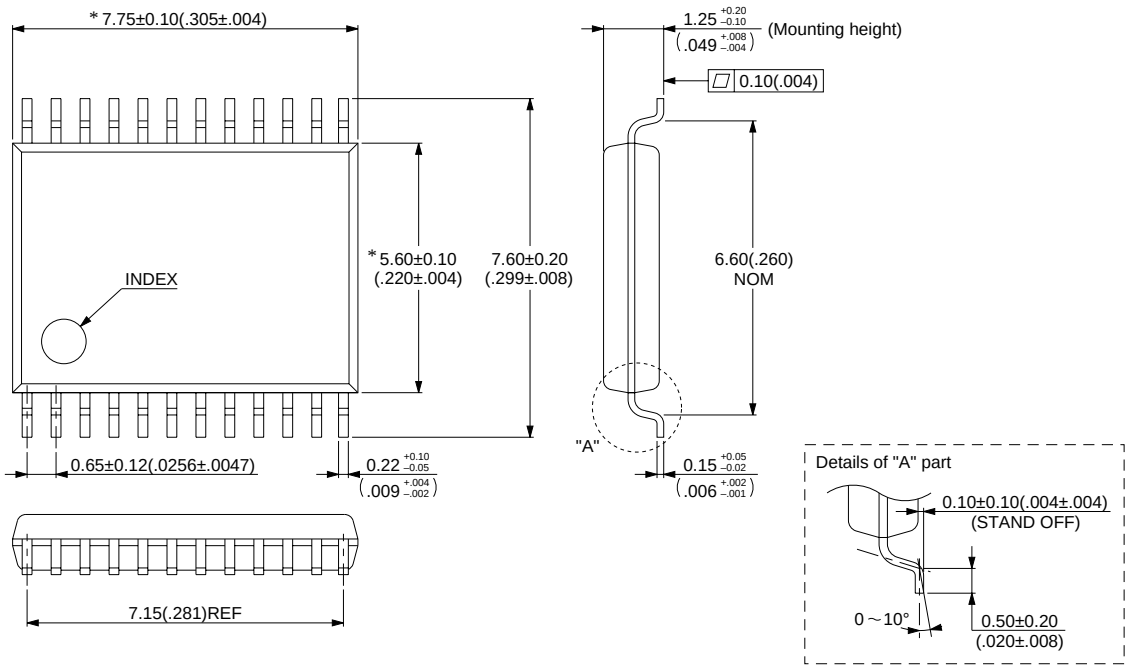
## ■ ORDERING INFORMATION

| Part number | Package | Remarks |
|---|---|---|
| MB3821PFV | 24-pin plastic SSOP<br>(FPT-24P-M03) | |

## ■ PACKAGE DIMENSION

48-pin Plastic LQFP
(FPT-24P-M03)

*: These dimensions do not include resin protrusion.




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Dimensions in: mm (inches)

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