

# M62211P/FP

## General Purpose Multi Function DC/DC Converter

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Rev.2.01  
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### Description

M62211FP is designed as a general purpose multi-function DC/DC converter. This small 10-pin package contains many functions allowing simpler peripheral circuits and compact set design.

The output circuit is designed OPEN-COLLECTOR output. This makes the application for STEP-UP, STEP-DOWN and INVERTING.

The input of this unit has two channels containing priority control circuit. This makes the control a simple matter when the back-light is on and during the stable state.

### Feature

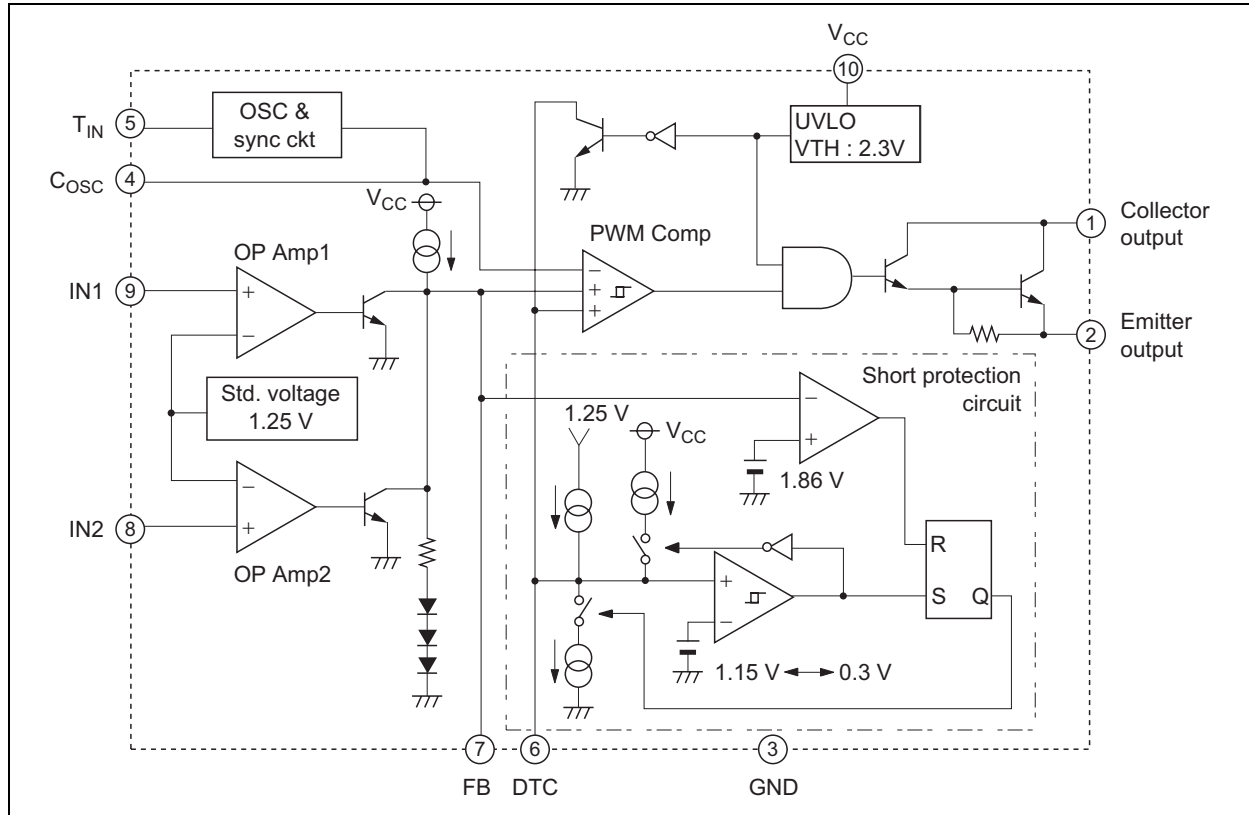
- Wide operation power supply voltage range..... 2.5 to 35 V
- Operation can be synchronized by the external sync signal.
- Operation can be controlled using two prioritized systems. (High input has priority)
- High speed switching is possible. (500 kHz max)
- Output short protection circuit and ON/OFF control are used.
- The dead-time control and the soft-start operation are possible.
- Small size 10-pin SOP package.

### Applications

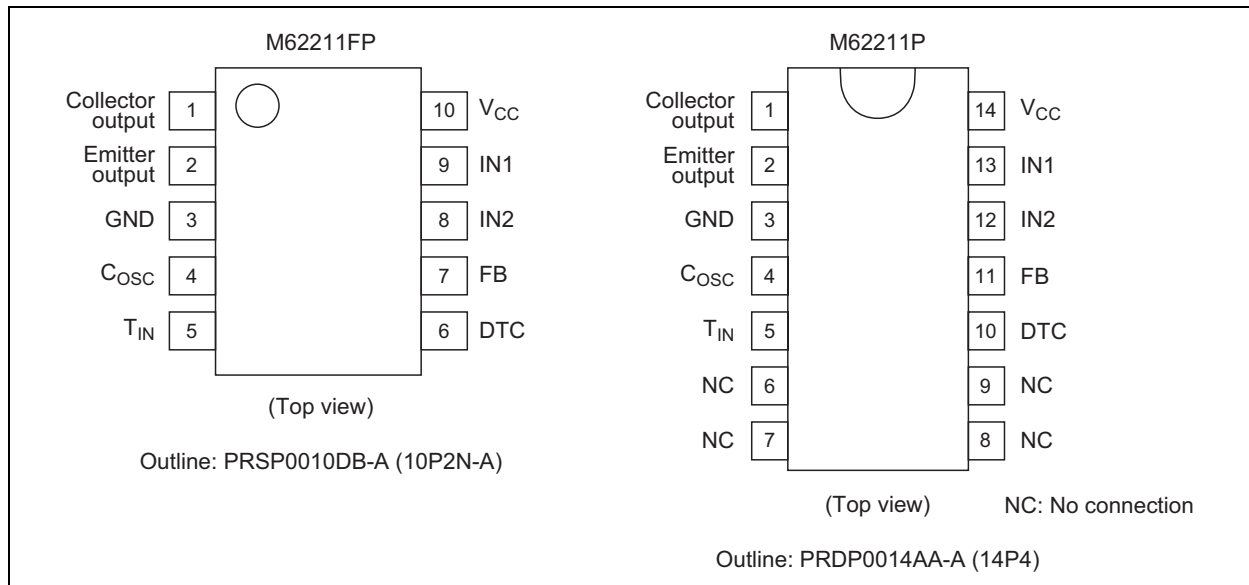
Back-light control of personal computers and word processors

General electric products

### Block Diagram



### Pin Arrangement



## Absolute Maximum Ratings

(Ta = 25°C, unless otherwise noted)

Item	Symbol	Ratings	Units	Conditions
Power supply voltage	V <sub>CC</sub>	36	V	
Output voltage	V <sub>O</sub>	36	V	
Output current	I <sub>O</sub>	150	mA	
Power dissipation	P <sub>d</sub>	1500 (P) 450 (FP)	mW	Ta = 25°C
Thermal derating ratio	K <sub>θ</sub>	1.2 (P) 3.6 (FP)	mW/°C	Ta > 25°C
Operating ambient temperature	Topr	-20 to +85	°C	
Storage temperature	Tstg	-40 to +150	°C	

## Electrical Characteristics

(Ta = 25°C, V<sub>CC</sub> = 12 V, C<sub>OSC</sub> = 390 pF, unless otherwise noted)

Block	Item	Symbol	Limits			Units	Test Condition
			Min	Typ	Max		
All device	Power supply voltage range	V <sub>CC</sub>	2.5	—	35	V	
	Circuit current	I <sub>CC</sub>	—	2.4	3.5	mA	No load
Std. voltage section	Standard voltage	V <sub>REF</sub>	1.19	1.25	1.31	V	Voltage follower
	Line regulation	L <sub>INE</sub>	—	5	12	mV	V <sub>CC</sub> = 2.5 to 3.5 V
Error Amp. section	Input bias current	I <sub>B</sub>	—	—	500	nA	
	Open loop gain	A <sub>V</sub>	—	80	—	dB	
	Unity gain bandwidth	G <sub>B</sub>	—	0.6	—	MHz	
	Output high voltage	V <sub>OM+</sub>	1.7	—	2.5	V	V <sub>FB</sub> = 1.86 V
	Output low voltage	V <sub>OM-</sub>	—	—	400	mV	V <sub>FB</sub> = 1.86 V
	Output sink current	I <sub>OM+</sub>	—	6	—	mA	V <sub>FB</sub> = 1.86 V
Oscillator section	Output source current	I <sub>OM-</sub>	—	-100	-50	μA	V <sub>IN1</sub> = 1 V, V <sub>IN2</sub> = 1 V
	Oscillation frequency	f <sub>OSC</sub>	—	110	—	kHz	
	Upper limit voltage of oscillation waveform	V <sub>OSCH</sub>	—	1.0	—	V	
	Lower limit voltage of oscillation waveform	V <sub>OSCL</sub>	—	0.45	—	V	
	Cosc charge current	I <sub>OSC CH</sub>	—	-120	—	μA	
	Cosc discharge current 1	I <sub>OSC DIS1</sub>	—	30	—	μA	
	Cosc discharge current 2	I <sub>OSC DIS2</sub>	—	120	—	μA	
	T <sub>IN</sub> "H" level	V <sub>TINH</sub>	2.2	—	V <sub>CC</sub>	V	
T <sub>IN</sub> "L" level	V <sub>TINL</sub>	—	—	1.0	V		

## Electrical Characteristics

(Ta = 25°C, V<sub>CC</sub> = 12 V, C<sub>OSC</sub> = 390 pF, unless otherwise noted)

Block	Item	Symbol	Limits			Units	Test Condition
			Min	Typ	Max		
UVLO section	Start-up threshold voltage	V <sub>TH ON</sub>	2.2	2.3	2.4	V	
	Shut-down threshold voltage	V <sub>TH OFF</sub>	—	2.25	—	V	
	Hysteresis	V <sub>HYS</sub>	20	50	80	mV	
Short protection circuit	FB threshold voltage	V <sub>TH FB</sub>	—	1.86	—	V	V <sub>IN1</sub> = 1 V, V <sub>IN2</sub> = 1 V, V <sub>DTC</sub> = 0.7 V
	Latch mode "H" threshold voltage	V <sub>TH DTC</sub>	—	1.15	—	V	V <sub>IN1</sub> = 1 V, V <sub>IN2</sub> = 1 V, V <sub>FB</sub> = 2.11 V
	Latch mode "L" threshold voltage	V <sub>TL DTC</sub>	—	0.3	—	V	V <sub>IN1</sub> = 1 V, V <sub>IN2</sub> = 1 V, V <sub>FB</sub> = 2.11 V
	DTC charge current when start-up	I <sub>CH1</sub>	—	-35	—	μA	V <sub>DTC</sub> = 0.7 V, V <sub>FB</sub> = 2.11 V
	DTC discharge current 1	I <sub>DIS1</sub>	—	45	—	μA	V <sub>DTC</sub> = 0.7 V, V <sub>FB</sub> = 2.11 V
	DTC charge current when stable state	I <sub>CH2</sub>	—	-15	—	μA	V <sub>DTC</sub> = 0.7 V, V <sub>FB</sub> = 0.7 V
	DTC discharge current 2	I <sub>DIS2</sub>	—	20	—	μA	V <sub>DTC</sub> = 0.2 V, V <sub>FB</sub> = 2.11 V
Output section	Collector output leak current	I <sub>CL</sub>	-1	—	1	μA	V <sub>CE</sub> = 35 V, V <sub>CC</sub> = 35 V
	Collector output saturation voltage	V <sub>SAT1</sub>	—	1.6	—	V	Emitter follower, I <sub>E</sub> = 50 mA, V <sub>C</sub> = 12 V

## Explanation of Back Light Control Circuit

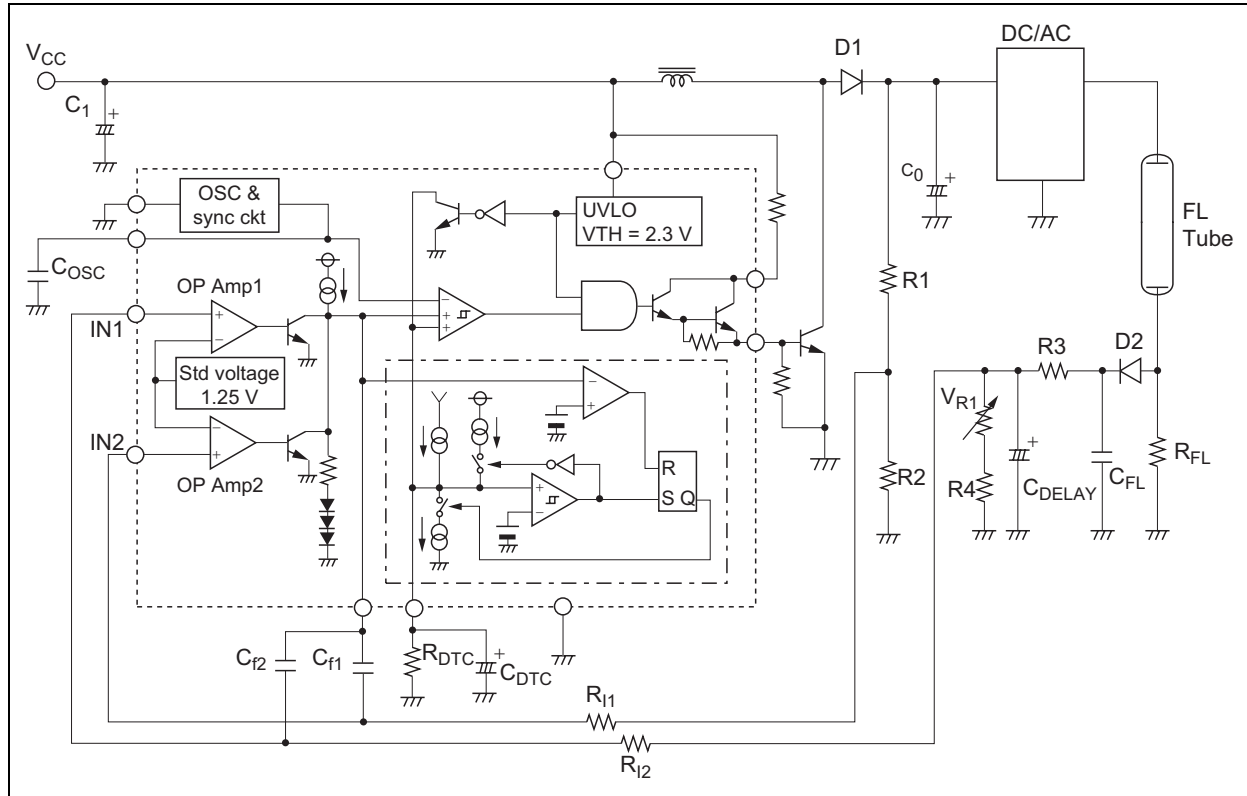


Figure 1 An Application of the Back Light Control Circuit

### 1. Priority Control Operation

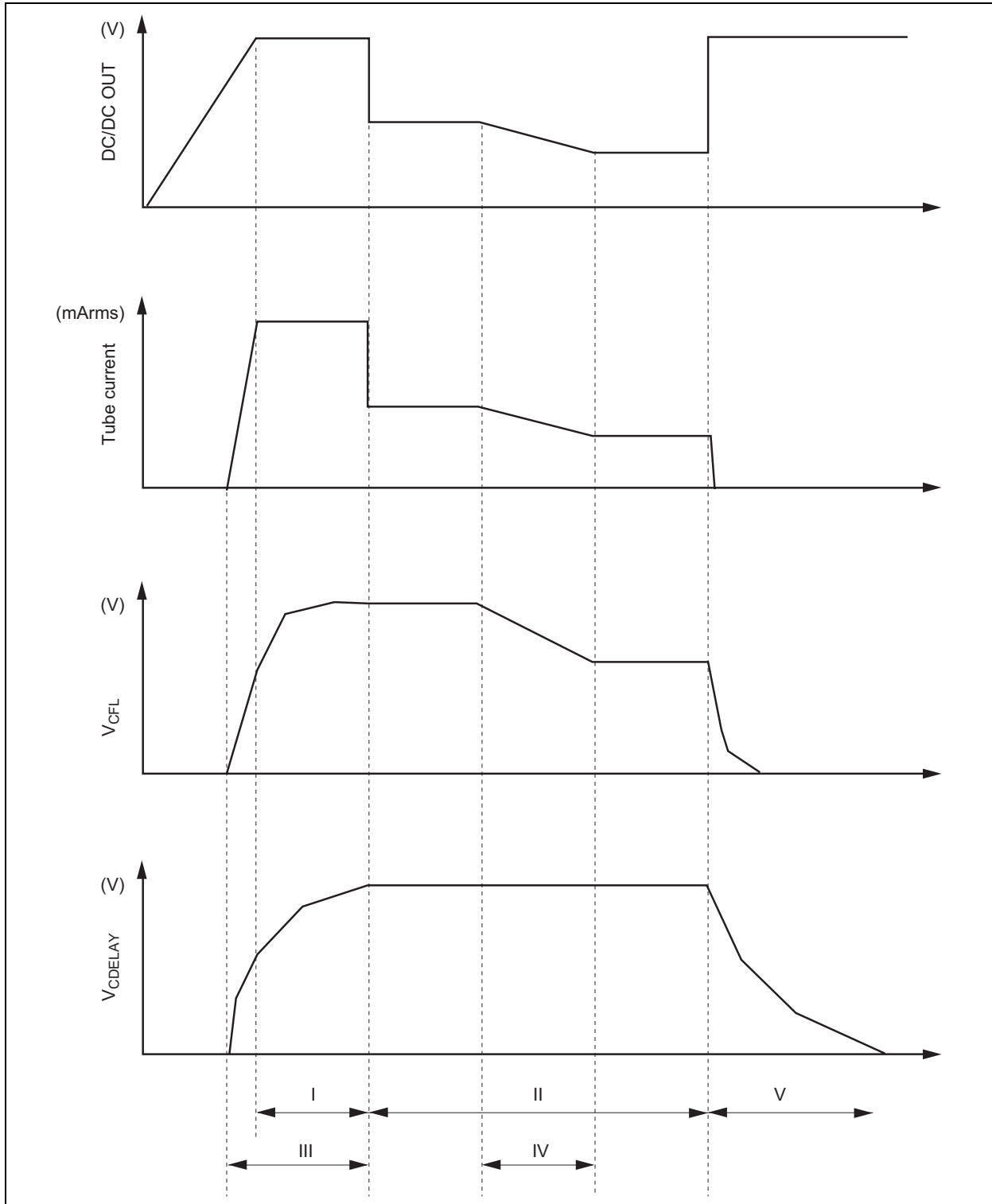
As far as OP Amp1 and OP Amp2 are concerned, there is no problem when either IN1 or IN2 is used to control current, since the setting up to lower the output voltage of the DC/DC converter is prioritized. (The above figure uses IN1 to control current)

- (1) When starting, the output voltage "V<sub>O</sub>" is determined by the feedback to IN2 via R1 and R2 and the following equation:

$$V_O = V_{REF} \times (R1 + R2) / R2 \quad (V_{REF} = 1.25 \text{ V typ}) \quad (\text{Area of the Timing Chart 1})$$

- (2) Next, this output voltage "V<sub>O</sub>" is used to discharge the FL tube by the inverter and causes the tube current to flow. The tube current is filtered and smoothed by R<sub>FL</sub>, D2, and C<sub>FL</sub> so that the DC voltage (V<sub>CFL</sub>) corresponding to the tube current is generated at C<sub>FL</sub>. The voltage of V<sub>CFL</sub> is divided by R3, V<sub>R1</sub>, and R4, and feedback to IN1, it can control tube current. (Area of the Timing Chart 2)
- (3) Here, C<sub>DELAY</sub> is inserted between R3 and V<sub>R1</sub> + R4 in order to regulate the timing to switch from the voltage control to the current control. (Area of the Timing Chart 3)
- (4) When in the current control state, it is possible to adjust brightness by changing the amount of feedback of the tube current using V<sub>R1</sub>. (Area of the Timing Chart 4)
- (5) If the feedback used for controlling current is lost due to irregularities in the FL tube. etc. The control returns to the voltage control mode. (Area of the Timing Chart 5)

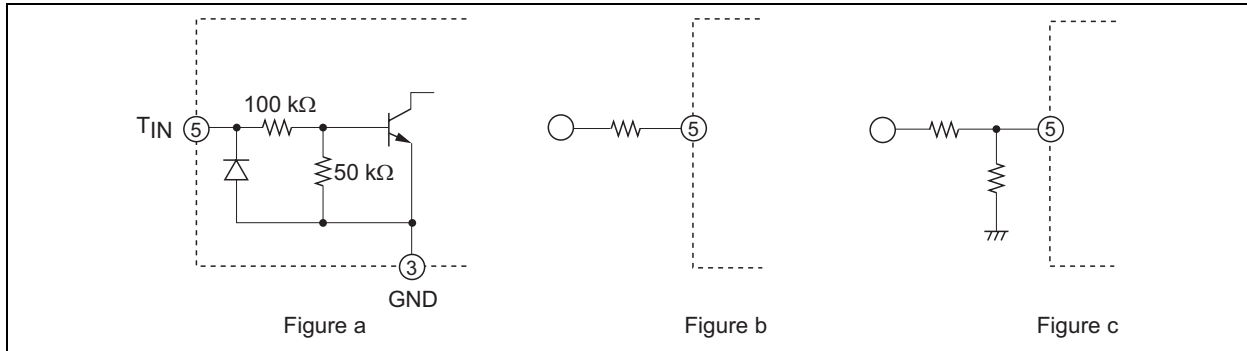
## Timing Chart



## 2. Setting up T<sub>IN</sub>

### 1) Setting up the level

The T<sub>IN</sub> terminal is shown in Figure a. In order for the level of T<sub>IN</sub> to satisfy the conditions shown in the table below, the external circuits shown in Figure b or Figure c should be used when the external voltage level of the input is high.



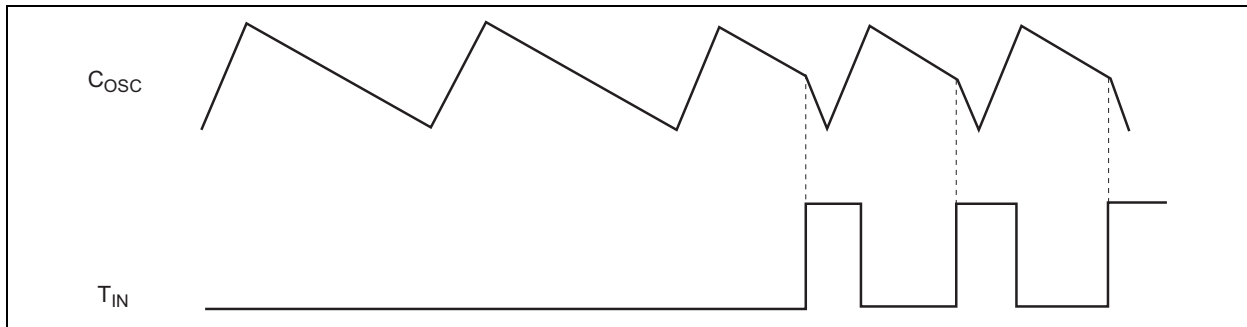
Items	Symbols	Min	Typ	Max	Unit
T <sub>IN</sub> "H" level	V <sub>TINH</sub>	2.2	—	V <sub>CC</sub>	V
T <sub>IN</sub> "L" level	V <sub>TINL</sub>	—	—	1.0	V

### 2) Setting up frequency

The periodical change of T<sub>IN</sub> is expected to be +30% to -20%. The f<sub>IN</sub> is set to approximately 1.5 times f<sub>OSC</sub>.

$$f_{IN} = 1.5 \cdot f_{OSC}$$

$$f_{OSC} \approx \frac{1}{1.3 \mu s + (23 \times 10^3 \times C_{OSC})} \quad (\text{Hz})$$



### 3. Soft Start, DTC, and Short Protection

#### 1) Soft Start (The peripheral circuit is shown in Figure 1)

When the power is turned ON, IN1 and IN2 are at 0 V level. Therefore, the FB terminal is fixed to High level. The DTC terminal goes up gradually starting from 0 V due to the internal charge current and the external  $C_{DTC}$ .

When the level of DTC terminal reaches the lower limit of the triangular wave of the oscillator, PWM comparator and the output circuit go into operation causing the output voltage, " $V_O$ " of the DC/DC converter to rise. The charge current is designed to be approximately 35  $\mu\text{A}$ .

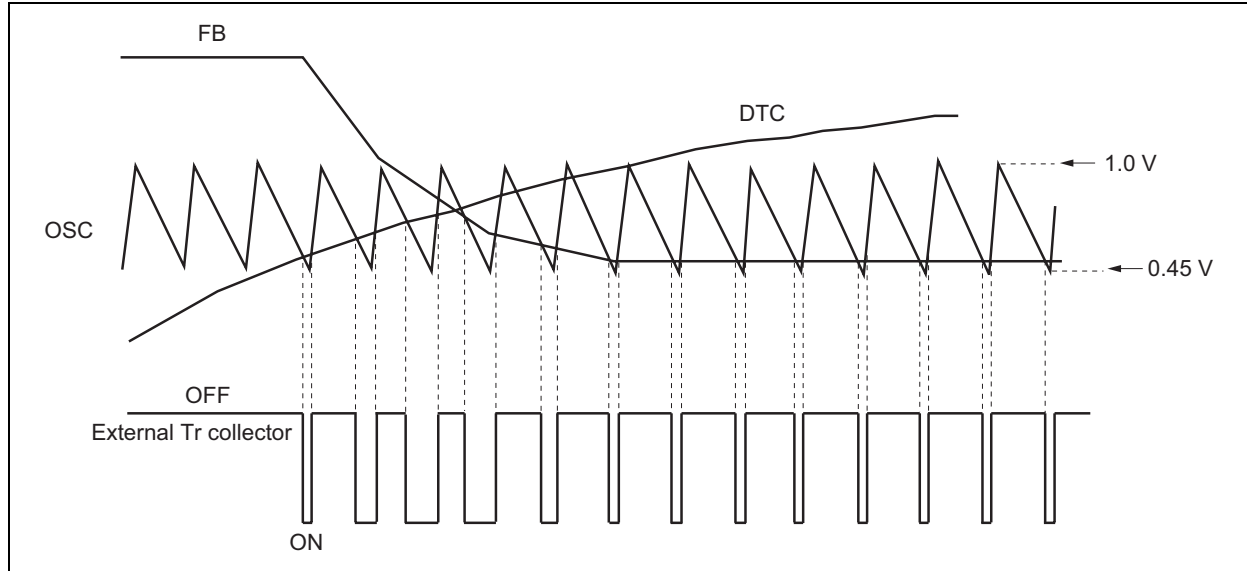


Figure 2

#### 2) DTC

The dead time control is set by installing a resistor between the DTC terminal and GND. However, the DTC terminal serves as the short protection circuit also. Therefore, its set up depends on whether the short protection circuit is used and not.

— When the short protection circuit is used

At this time, the charge current for DTC is approximately 10  $\mu\text{A}$ . Therefore,  $R_{DTC}$  should be set to 40 k $\Omega$  to 110 k $\Omega$ .

— When the short protection circuit is not used

At this time, the charge current for DTC is approximately 45  $\mu\text{A}$ . Therefore,  $R_{DTC}$  is set to 12 k $\Omega$  to 25 k $\Omega$ .

#### 3) Short protection circuit

The short protection circuit used the timer latch system. It is determined by setting the capacity used for the soft start connected to the DTC terminal.

Figure 3 shows the short protection circuit and the timing chart for various modes.

When the power is turned on, the FB terminal goes high (approx. 2.4 V) and the DTC terminal goes low. (goes up slowly from 0 V) Thus, approximately 35  $\mu\text{A}$  current will flow when SW1: ON and SW2: OFF. The potential, namely the potential of the FB terminal is in the amplitude of the triangular wave, SW1 will be OFF and SW2 will be ON and approximately 45  $\mu\text{A}$  will flow into the DTC terminal. This discharge current will cause the DTC terminal to drop from 1.15 V.

At this time, if the potential of the FB terminal goes to the control potential before the potential at the DTC terminal goes lower than 0.45 V which is the lower limit value of the triangular wave and if the potential of the FB terminal is lower than the potential of the DTC terminal, then the system is activated.

When the output is shorted, the system is either activated or latched depending on whether the time for the high potential of the FB terminal reaches the potential of the control state is long or short. (For detail, see [II] and [IV] of the Mode)

There are two ways to go back to operation after the latch to shut off output. Either method can restart with soft start.

1. Turning on the  $V_{CC}$ .
2. Make the FB terminal to go to the low potential of 1.25 V or less. Then, it is cancelled.



[Mode Explained]

[I] Mode.....Activation

This is used when the FB terminal goes down to the control state potential when the DTC terminal is in up slope. In order for the activation to occur when the DTC terminal is in down slope, the FB terminal potential must go below the DTC terminal before the DTC terminal goes to 0.45 V.

[II] Mode..... Output short → Activation

The system is activated if the FB terminal potential goes below the DTC terminal potential before the DTC terminal goes to 0.45 V. If there is not enough time, the output is turned OFF. (Latched)

[III] Mode..... ON/OFF Control → Activation

This mode turns off the output by forcing the DTC terminal to go down. (The system) returns as in the case of the activation.

[IV] Mode..... Output short (Latch)

The output is turned OFF when the FB terminal potential did not go down to the control state before the DTC terminal went down to 0.45 V.

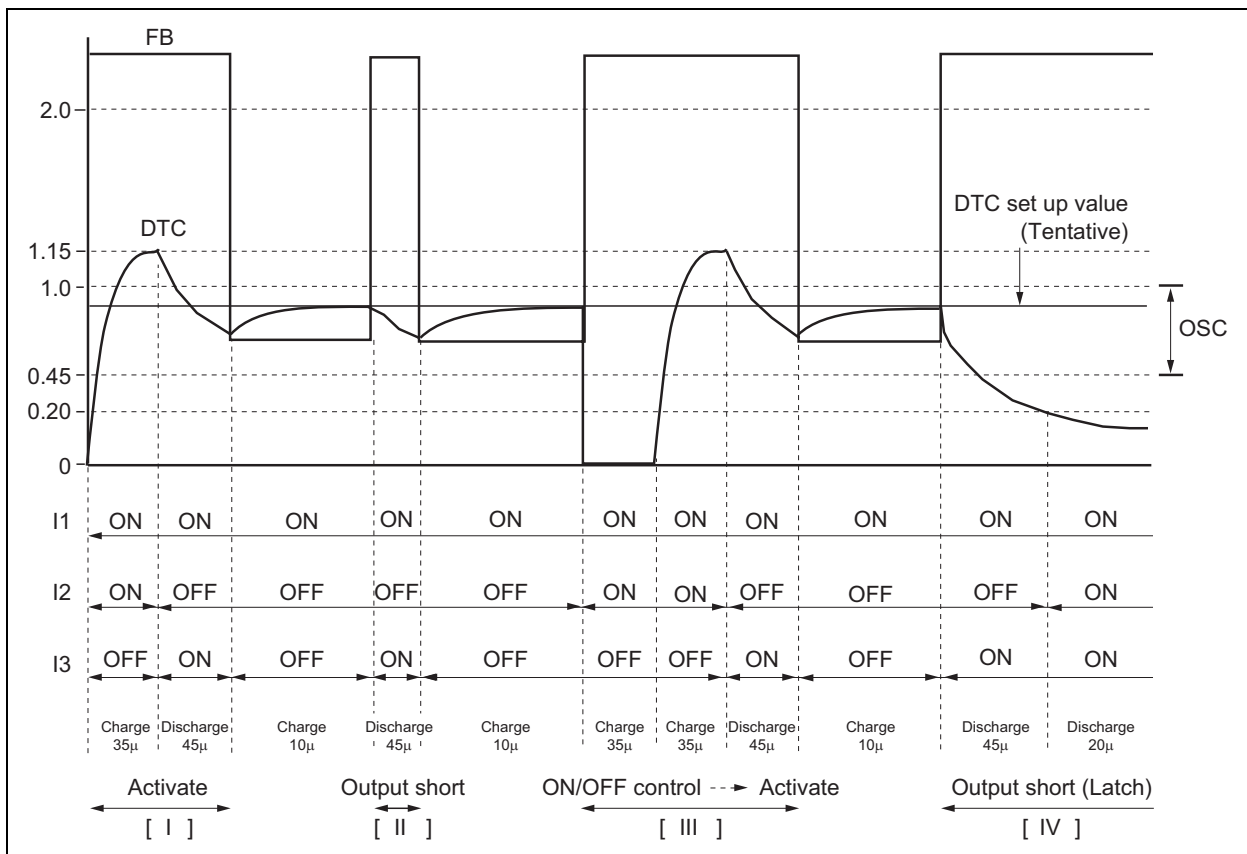
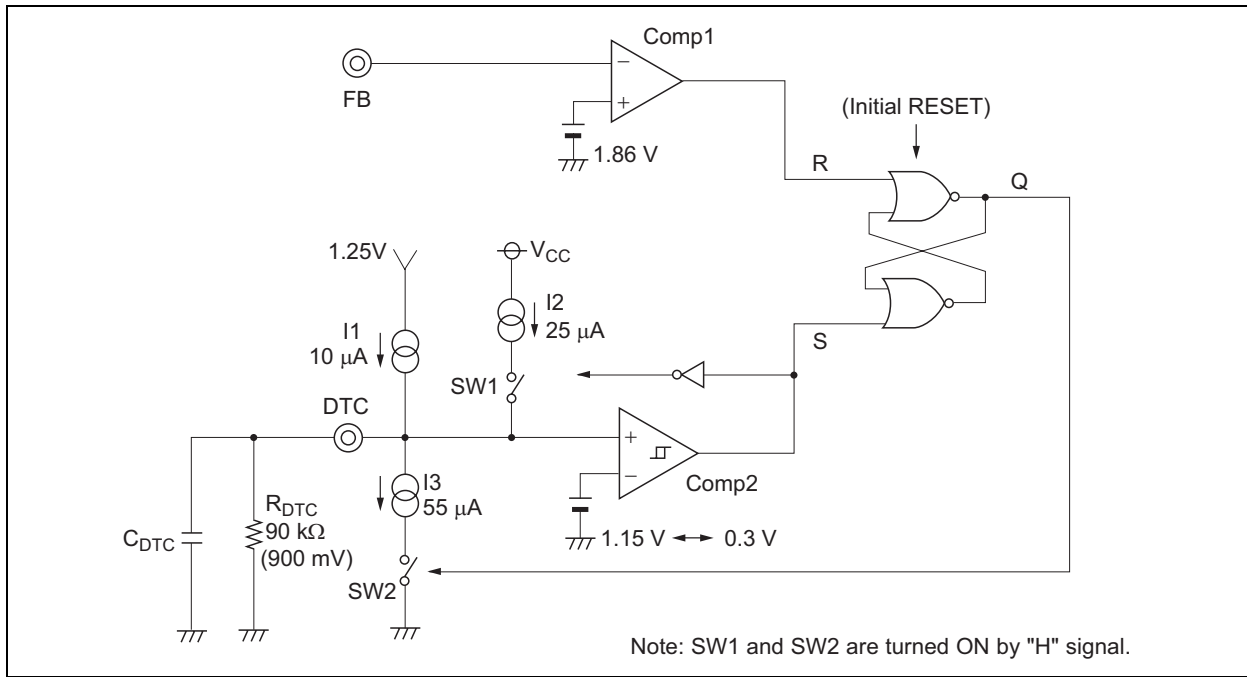
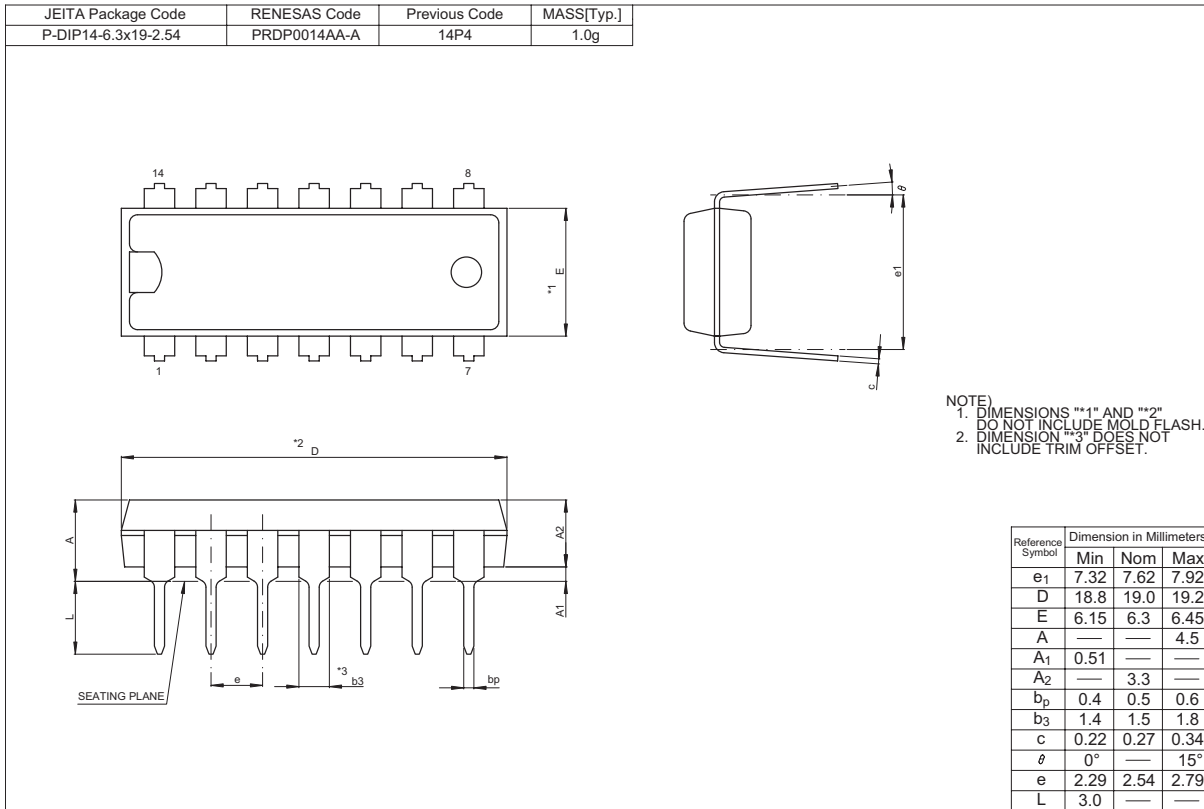
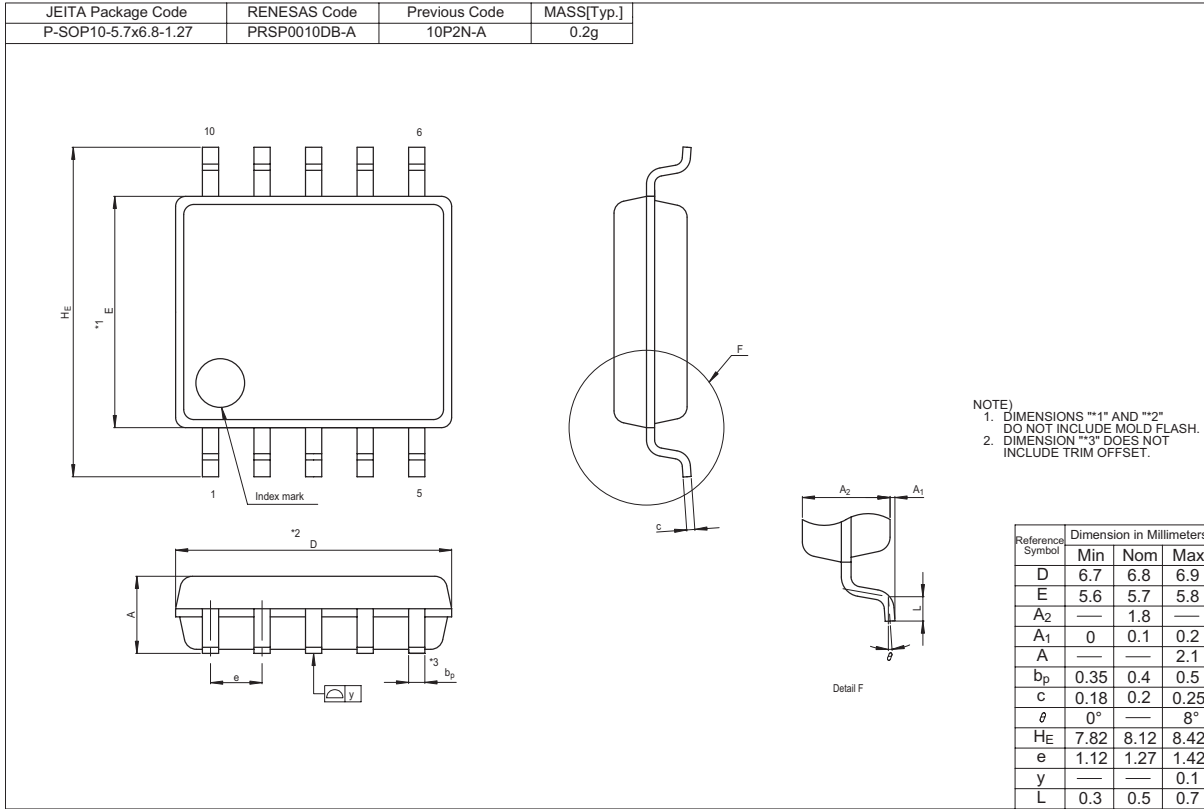


Figure 3 Short Protection Circuit and the Timing Chart of the Modes

Package Dimensions



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