M62211FP

GENERAL PURPOSE MULTI FUNCTION DC-DC CONVERTER

DESCRIPTION

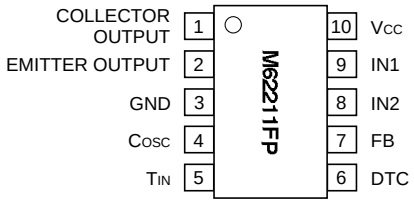
The M62211FP is designed as a general purpose multi-function DC-DC converter. This small 10 pin package contains many functions allowing simpler peripheral circuits and compact set design.

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.

PIN CONFIGURATION (TOP VIEW)



Outline 10P2N-A

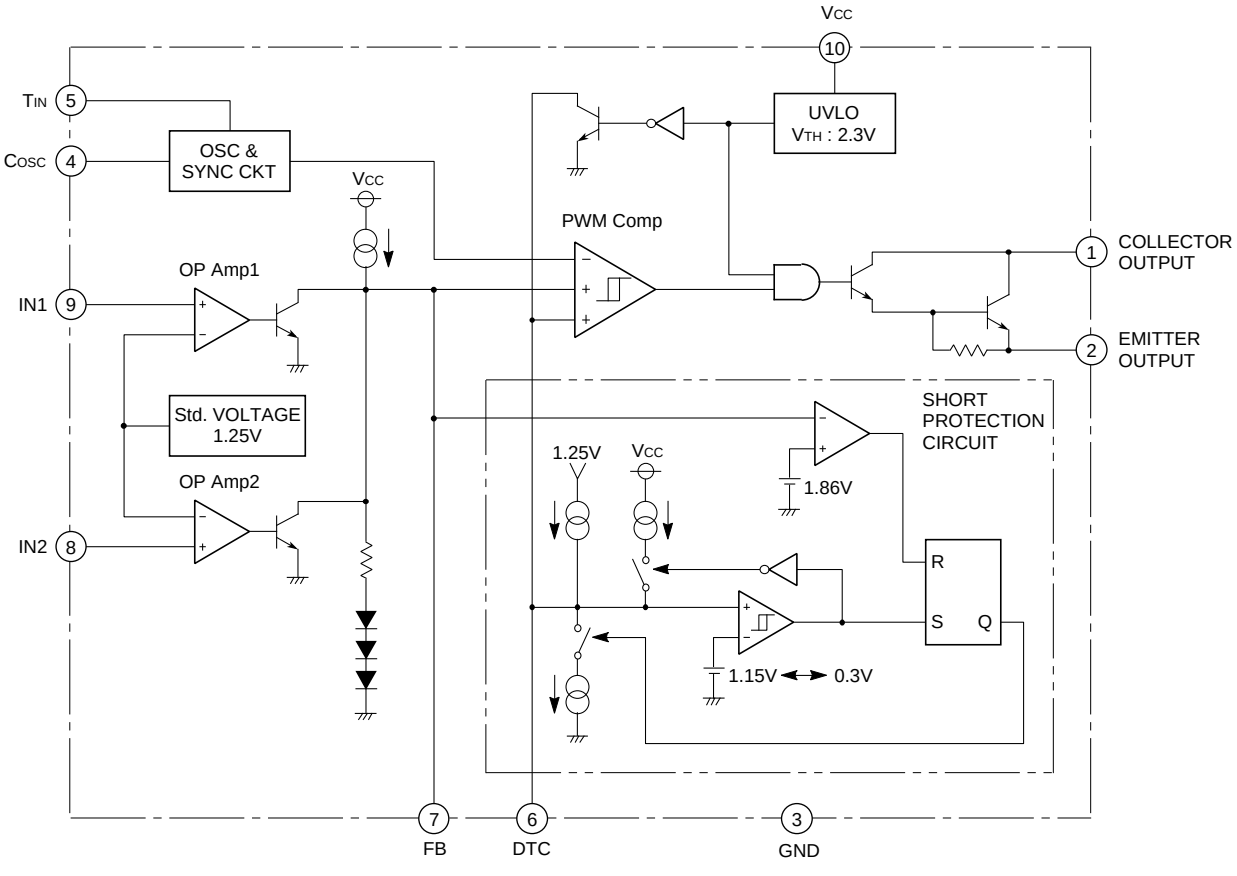
FEATURES

- Wide operation power supply voltage range..... 2.5 to 35V
- 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. (500kHzmax)
- 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.

APPLICATION

Back-light control of personal computers and word processors
General electric products

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Ta=25˚C, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		36	V
V_O	Output voltage		36	V
I_O	Output current		150	mA
P_d	Power dissipation	Ta=25˚C	450	mW
K_θ	Thermal derating	Ta>25˚C	3.6	mW/˚C
T_{opr}	Operating temperature		-20 to +85	˚C
T_{stg}	Storage temperature		-40 to +150	˚C

ELECTRICAL CHARACTERISTICS (Ta=25˚C, V_{CC}=12V, C_{OSC}=390pF, unless otherwise noted)

Block	Symbol	Parameter	Test conditions	Limits			Unit
				Min.	Typ.	Max.	
All device	V_{CC}	Range of power supply voltage		2.5		35	V
	I_{CC}	Circuit current	No Load		2.4	3.5	mA
Std. voltage section	V_{REF}	Standard voltage	Voltage follower	1.19	1.25	1.31	V
	L_{INE}	Line regulation	V_{CC}=2.5 to 35V		5	12	mV
Error amp. section	I_B	Input bias current				500	nA
	A_V	Open loop gain			80		dB
	G_B	Unity gain bandwidth			0.6		MHz
	V_{OM}^+	Output high voltage		1.7		2.5	V
	V_{OM}^-	Output low voltage				400	mV
	I_{OM}^+	Output sink current	V_{FB}=1.86V		6		mA
	I_{OM}^-	Output source current	V_{IN1}=1V, V_{IN2}=1V		-100	-50	µA
Oscil-later section	f_{OSC}	Oscillation frequency			110		kHz
	V_{OSCH}	Upper limit voltage of oscillation waveform			1.0		V
	V_{OSCL}	Lower limit voltage of oscillation waveform			0.45		V
	$I_{OSC\ CH}$	Cosc charge current			-120		µA
	$I_{OSC\ DIS1}$	Cosc discharge current 1			30		µA
	$I_{OSC\ DIS2}$	Cosc discharge current 2			120		µA
	V_{TINH}	T_{IN} "H" level		2.2		V_{CC}	V
	V_{TINL}	T_{IN} "L" level				1.0	V
UVLO section	$V_{TH\ ON}$	Start-up threshold voltage	V_{IN1}=1V, V_{IN2}=1V	2.2	2.3	2.4	V
	$V_{TH\ OFF}$	Shut-down threshold voltage	V_{IN1}=1V, V_{IN2}=1V		2.25		V
	V_{HYS}	Hysteresis	V_{HYS}=V_{THON}-V_{THOFF}	20	50	80	mV
Short prove-cation circuit	$V_{TH\ FB}$	FB threshold voltage	V_{IN1}=1V, V_{IN2}=1V, V_{DTC}=0.7V		1.86		V
	$V_{TH\ DTC}$	Latch mode "H" threshold voltage	V_{IN1}=1V, V_{IN2}=1V, V_{FB}=2.11V		1.15		V
	$V_{TL\ DTC}$	Latch mode "L" threshold voltage	V_{IN1}=1V, V_{IN2}=1V, V_{FB}=2.11V		0.3		V
	I_{CH1}	DTC charge current when start-up	V_{DTC}=0.7V, V_{FB}=2.11V		-35		µA
	I_{DIS1}	DTC discharge current 1	V_{DTC}=0.7V, V_{FB}=2.11V		45		µA
	I_{CH2}	DTC charge current when stable state	V_{DTC}=0.7V, V_{FB}=0.7V		-10		µA
	I_{DIS2}	DTC discharge current 2	V_{DTC}=0.2V, V_{FB}=2.11V		20		µA
Output section	I_{CL}	Collector output leak current	V_{CE}=35V , V_{CC}=35V	-1		1	µA
	V_{SAT1}	Collector output saturation voltage 1	Emitter follower, I_E=50mA, V_C=12V		1.6		V

1. EXPLANATION OF BACK LIGHT CONTROL CIRCUIT

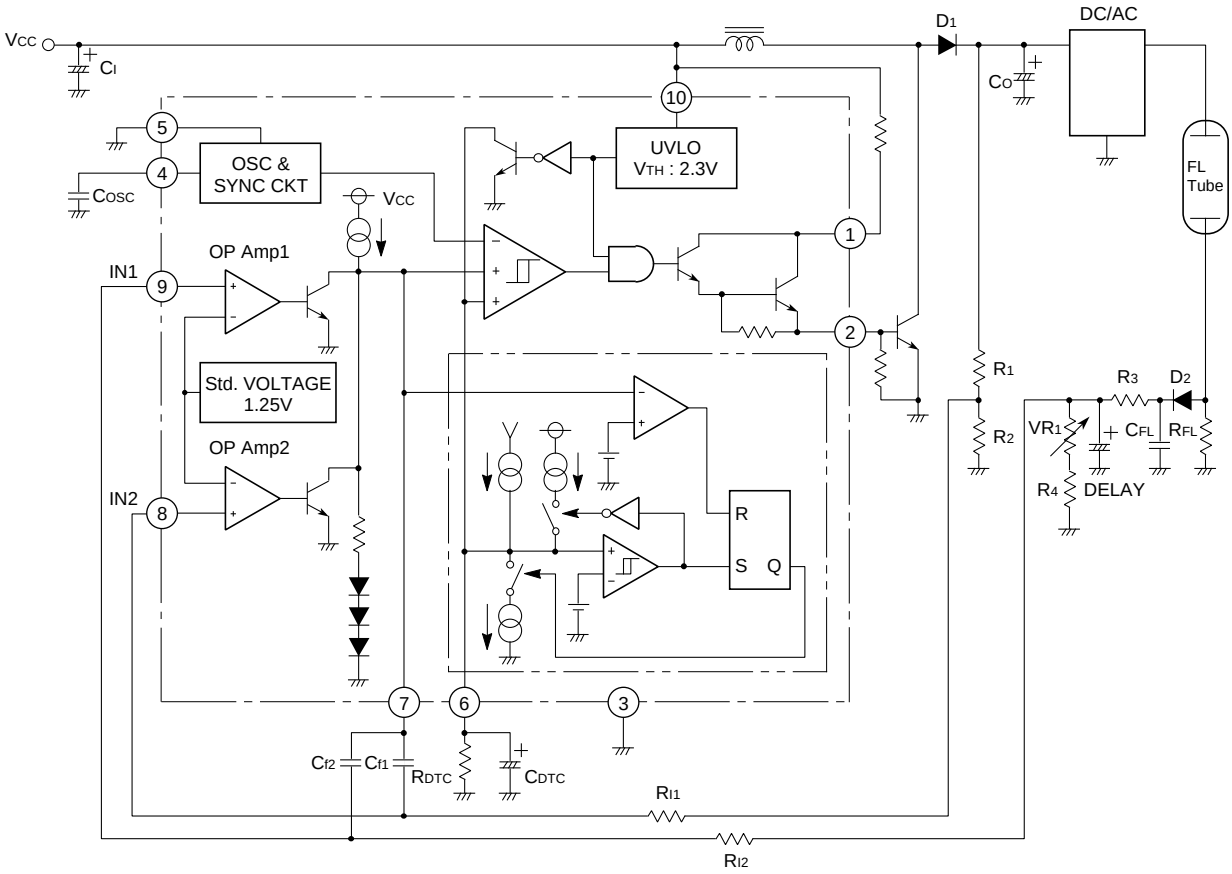


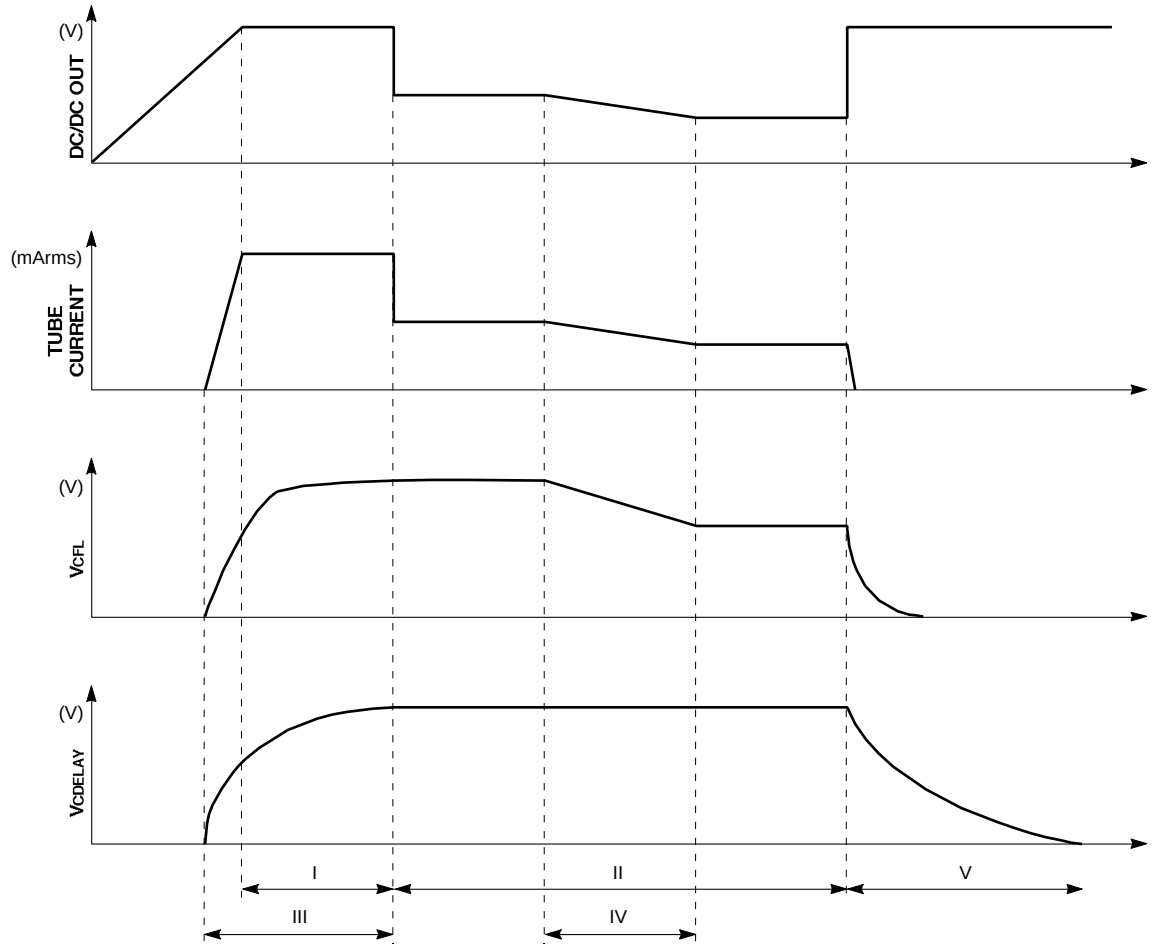
Fig.1 An application of the back light control circuit

1-1. Priority control operation

As far as OPAmp1 and OPAmp2 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 "Vo" is determined by the feedback to IN2 via R1 and R2 and the following equation:
   $Vo=V_{REF}X(R1+R2)/R2$ (V_{REF}=1.25Vtyp)
   (Area of the Timing Chart 1)
2) Next, this output voltage "Vo" 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_{FL}, D2, and C_{FL} so that the DC voltage (V_{CFL}) corresponding to the tube current is generated at C_{FL}.
   The voltage of V_{CFL} is divided by R3, V_{R1}, and R4, and feedback to IN1, it can control tube current. (Area of the Timing Chart 2)
3) Here, CDELAY is inserted between R3 and V_{R1}+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_{R1}. (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



1-2. Setting up TIN

1)Setting up the level

The TIN terminal is shown in Fig.a. In order for the level of TIN to satisfy the conditions shown in the table below, the external circuits shown in Fig.b or Fig.c should be used when the external voltage level of the input is high.

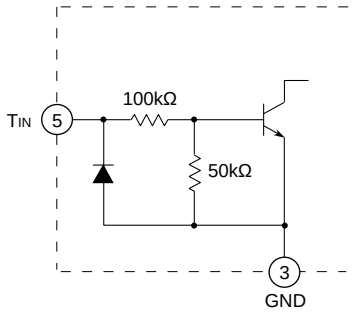


Fig. a

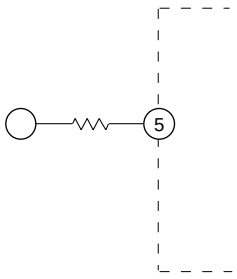


Fig. b

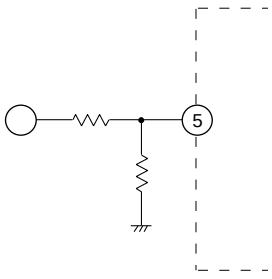


Fig. c

Symbol	Parameter	Min.	Typ.	Max.	Unit
VTINH	TIN "H" level	2.2	–	VCC	V
VTINL	TIN "L" level	–	–	1.0	V

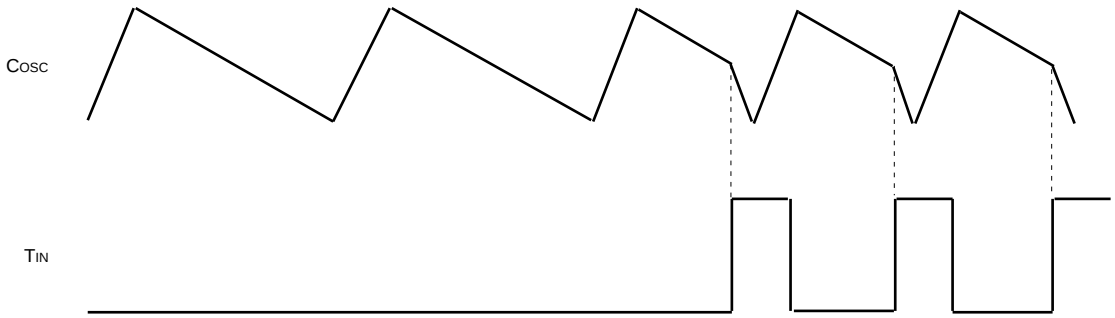
2) Setting up frequency

The periodical change of T_{IN} is expected to be +30% to -20%.

The f_{IN} is set to approximately 1.5 times f_{OSC}

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

$$f_{OSC} \fallingdotseq \frac{1}{1.3\mu s + (23X10^{3}XC_{OSC})} \text{ (Hz)}$$



1-3 Soft start, DTC, and short protection

1) Soft Start (The peripheral circuit is shown in Fig.1)

When the power is turned ON, IN1 and IN2 are at 0V level. Therefore, the FB terminal is fixed to High level. The DTC terminal goes up gradually starting from 0V 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, "Vo" of the DC-DC converter to rise. The charge current is designed to be approximately 35µA.

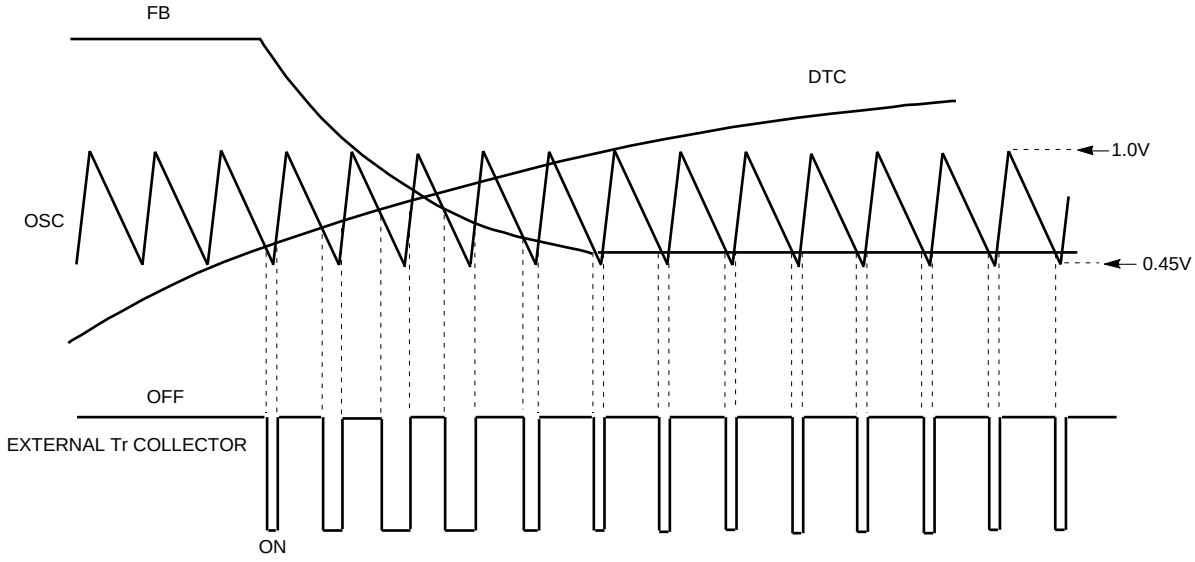


Fig. 2

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 10μA. Therefore, R_{DTC} should be set to 40kΩ to 110kΩ.

(When the short protection circuit is not used)

At this time, the charge current for DTC is approximately 45μA. Therefore, R_{DTC} is set to 12kΩ to 25kΩ.

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.

Fig.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. 2.4V) and the DTC terminal goes low (goes up slowly from 0V). Thus, approximately 35μA 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 45μA will flow into the DTC terminal. This discharge current will cause the DTC terminal to drop from 1.15V.

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 0.45V 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 Vcc.

2. Make the FB terminal to go to the low potential of 1.25V or less. Then, it is cancel led.

[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 0.45V.

[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 0.45V. 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 0.45V.

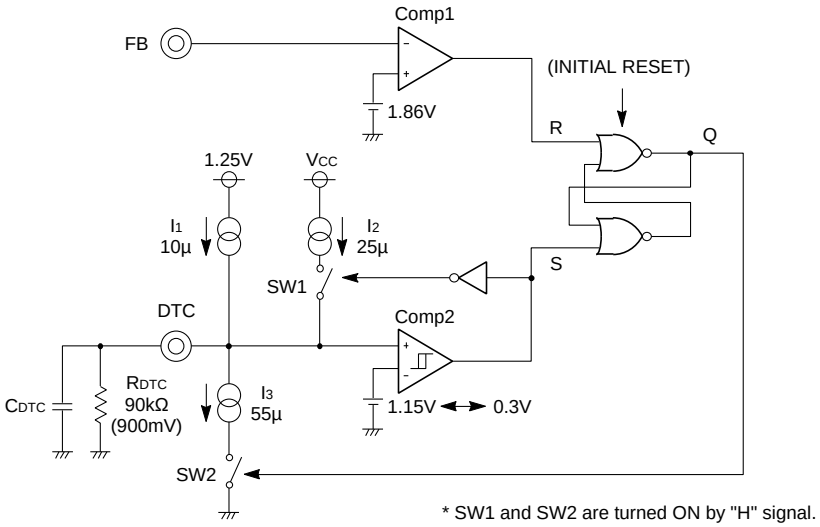


Fig.3 Output short protection circuit

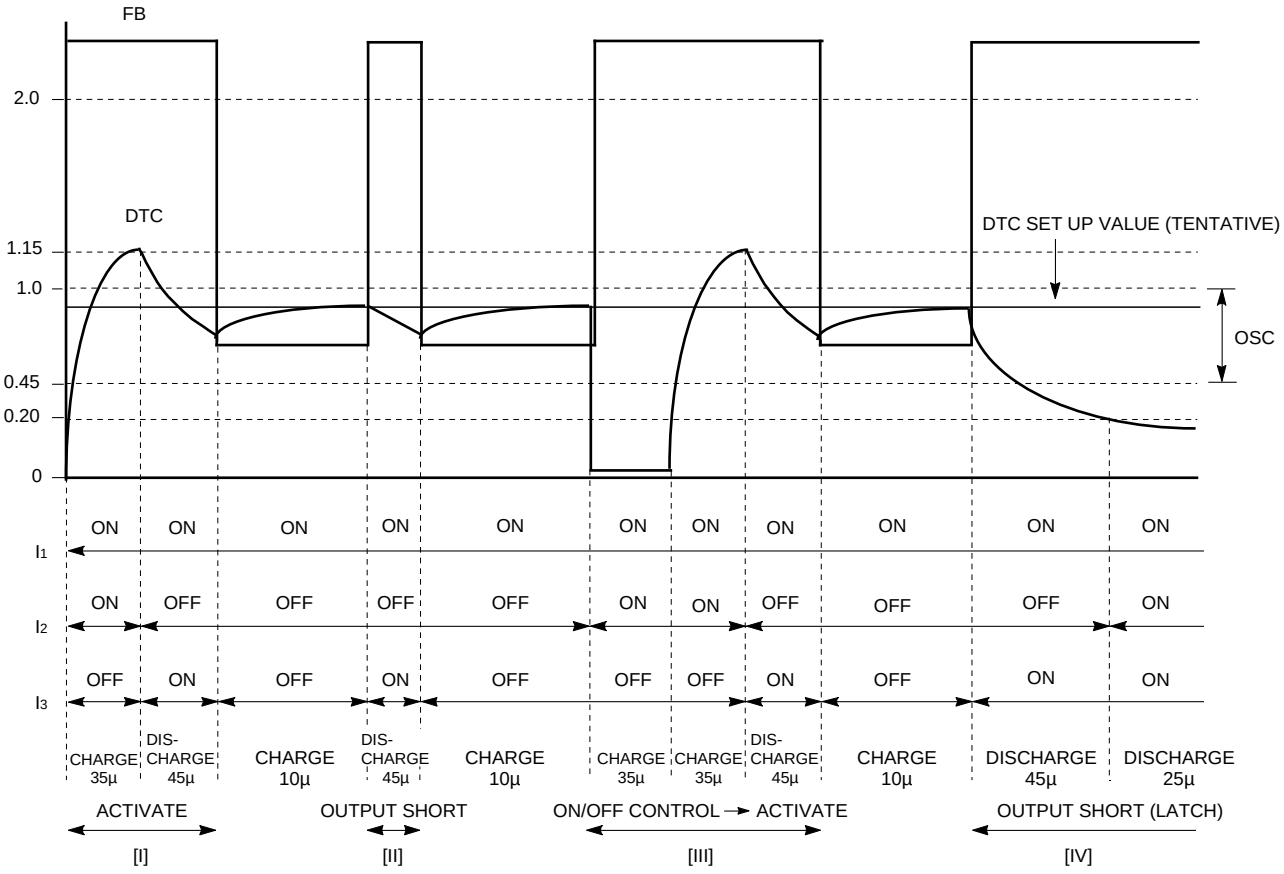


Fig. 4 Short protection circuit and the timing chart of the modes

CONSTANT DEFINITION

Constant		Step-down converter	Step-up converter	Inverting converter
$\frac{T_{ON}}{T_{OFF}}$		$\frac{V_O+V_F}{V_{IN}-V_{CE\,(sat)}-V_O}$	$\frac{V_O+V_F-V_{IN}}{V_{IN}-V_{CE\,(sat)}}$	$\frac{\lvert V_O\rvert+V_F}{V_{IN}-V_{CE\,(sat)}}$
$T_{ON}+T_{OFF}$		$\frac{1}{f_{OSC}}$	$\frac{1}{f_{OSC}}$	$\frac{1}{f_{OSC}}$
$T_{OFF\,(MAX)}$		$\frac{T_{ON}+T_{OFF}}{1+\frac{T_{ON}}{T_{OFF}}}$	$\frac{T_{ON}+T_{OFF}}{1+\frac{T_{ON}}{T_{OFF}}}$	$\frac{T_{ON}+T_{OFF}}{1+\frac{T_{ON}}{T_{OFF}}}$
$T_{ON\,(MAX)}$		$\frac{1}{f_{OSC}}-T_{OFF}$	$\frac{1}{f_{OSC}}-T_{OFF}$	$\frac{1}{f_{OSC}}-T_{OFF}$
$D_{(MAX)}$		$\frac{T_{ON\,(MAX)}}{T_{ON}+T_{OFF}}$	$\frac{T_{ON\,(MAX)}}{T_{ON}+T_{OFF}}$	$\frac{T_{ON\,(MAX)}}{T_{ON}+T_{OFF}}$
C_{OSC}		$\frac{1}{23.0\times10^{3}\times f_{OSC}}-56\times10^{-12}$	$\frac{1}{23.0\times10^{3}\times f_{OSC}}-56\times10^{-12}$	$\frac{1}{23.0\times10^{3}\times f_{OSC}}-56\times10^{-12}$
I_{pk}		$2\times I_O$	$2\times\left(1+\frac{T_{ON}}{T_{OFF}}\right)\times I_O$	$2\times\left(1+\frac{T_{ON}}{T_{OFF}}\right)\times I_O$
$L_{(MIN)}$	(Note1)	$\frac{(V_{IN}-V_{CE\,(sat)}-V_O)\times T_{ON\,(MAX)}}{\Delta I_O}$	$\frac{(V_{IN}-V_{CE\,(sat)})^2\times T_{ON\,(MAX)}^2\times f_{OSC}}{2\times V_O\times I_O}$	$\frac{(V_{IN}-V_{CE\,(sat)})^2\times T_{ON\,(MAX)}^2\times f_{OSC}}{2\times V_O\times I_O}$
R_1	(Note2, 3)	$\left(\frac{V_O}{V_{REF}}-1\right)\times R_2$	$\left(\frac{V_O}{V_{REF}}-1\right)\times R_2$	$\left(\frac{\lvert V_O\rvert}{V_{REF}}-1\right)\times R_2$
R_{DTC} (Note4)	not use short protection	$\frac{V_{DTC(MAX)}}{\lvert I_{CH1}\rvert}$	$\frac{V_{DTC(MAX)}}{\lvert I_{CH1}\rvert}$	$\frac{V_{DTC(MAX)}}{\lvert I_{CH1}\rvert}$
	use short protection	$\frac{V_{DTC(MAX)}}{\lvert I_{CH2}\rvert}$	$\frac{V_{DTC(MAX)}}{\lvert I_{CH2}\rvert}$	$\frac{V_{DTC(MAX)}}{\lvert I_{CH2}\rvert}$
C_{DTC} (Note4)	calculate from start-up time	$\frac{\lvert I_{CH1}\rvert\times t_{start}}{V_{DTC(MAX)}}$	$\frac{\lvert I_{CH1}\rvert\times t_{start}}{V_{DTC(MAX)}}$	$\frac{\lvert I_{CH1}\rvert\times t_{start}}{V_{DTC(MAX)}}$
	calculate from shut down time	$\frac{I_{DIS1}\times t_{start}}{V_{DTC(MAX)}-V_{OSCL}}$	$\frac{I_{DIS1}\times t_{start}}{V_{DTC(MAX)}-V_{OSCL}}$	$\frac{I_{DIS1}\times t_{start}}{V_{DTC(MAX)}-V_{OSCL}}$

V_F:Forward Voltage of outer Diode.
$V_{CE\,(sat)}$:Saturation Voltage of M62211 or Saturation Voltage of Current buffer Transistor.
* Please setting the Oscillation frequency first and calculate each constant value.

Note1. Please setting ΔI_O about 1/3 to 1/5 of maximum output current.

2. $\lvert V_O\rvert=(1+\frac{R_1}{R_2})\times V_{REF}$
3. Please setting R2 about few kΩ to score of kΩ because output voltage don't undergo a influence of input current (Terminal 8 or 9).
4. Please setting $V_{DTC\,(MAX)}$ to satisfy $D_{(MAX)}$, fixed from characteristics of $D_{(MAX)}$-$V_{DTC\,(MAX)}$.
   I_{CH1} means DTC charge current when start-up (-35μA typ), I_{CH2} means DTC charge current when stable state (-10μA typ), V_{OSCL} means lower limit voltage of oscillation waveform (0.45V typ), and I_{DIS1} means DTC discharge current 1 (45μA typ).
   t_{start} means time interval when terminal voltage of DTC increase to V_{OSCL} from lower voltage and to start switching at first.
   t_{short} means time interval when output is shut down after output is shorted.
5. Choose an external transistor, diode and inductor with peak current rating approximately greater than “Ipk”.