

To all our customers

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**Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.**

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The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.)

Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.  
Customer Support Dept.  
April 1, 2003

**M62213P/FP**

GENERAL PURPOSE HIGH SPEED PWM CONTROL IC

**DESCRIPTION**

M62213P/FP is designed as a general purpose high-speed PWM control IC.

This small 10 pin package contains many function and protection circuits allowing simpler peripheral circuits and compact set design.

This IC can operate high speed switching (700kHz Max) with high speed PWM comparator and current limiting circuit.

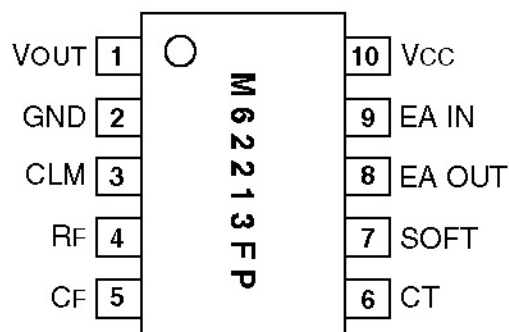
**FEATURES**

- 700kHz operation to MOS- FET
  - Output current  $I_o = \pm 1A$
  - Totem pole output
- Timer type latch protection circuit with OVP
- Soft start operation is possible (with dead time control)
- Built-in OPamp for feedback control (photo coupler can be driven)
- High speed pulse-by-pulse current limiting
- Small size 10-pin SOP package

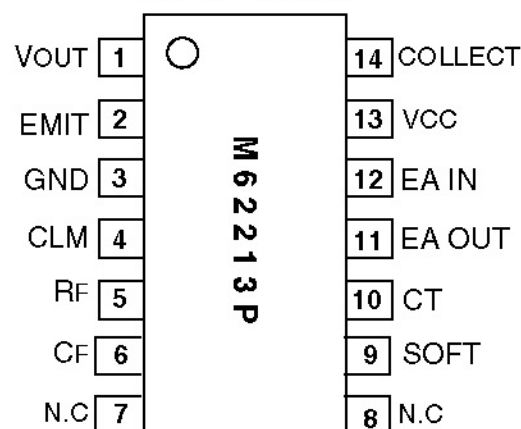
**APPLICATION**

- Switching Regulator
- DC-DC Converter

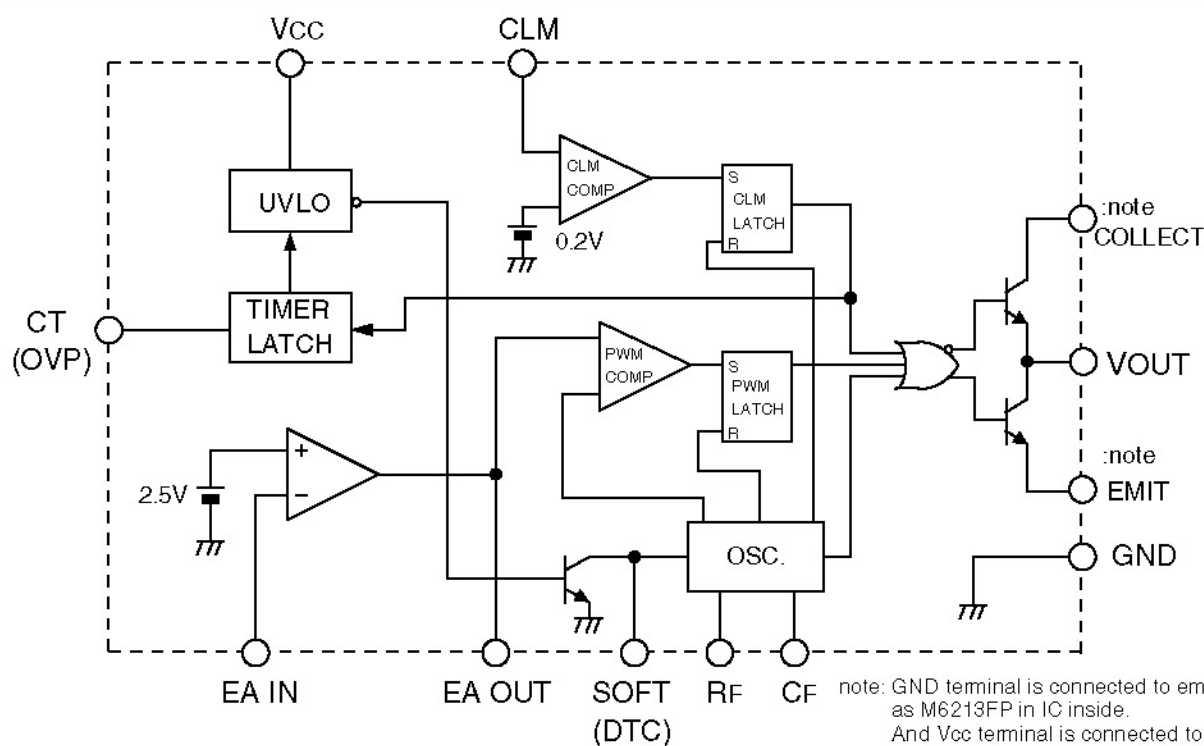
PIN CONFIGURATION (TOP VIEW)



OUTLINE 10P2N-A



OUTLINE 14P4



**M62213P/FP**

GENERAL PURPOSE HIGH SPEED PWM CONTROL IC

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

Symbol	Parameter	Condition	Rating	Unit
Vcc	Supply voltage		36	V
IOUT	Out terminal current	Continuous	150	mA
		Peak	1.0	A
VCT	CT terminal supply voltage		36	V
VEA IN	EA IN terminal supply voltage		10	V
VCLM	CLM terminal supply voltage		-0.3 ~ +4.0	V
Pd	Power dissipation	Ta=25°C	440	mW
Ktheta	Thermal derating	Ta≥25°C	3.52	mW/°C
Topr	Operating temperature		-20 ~ +85	°C
Tstg	Storage temperature		-40 ~ +150	°C

**ELECTRICAL CHARACTERISTICS (Ta=25°C, Vcc=14V, unless otherwise noted)**

Block	Symbol	Parameter	Test condition	Limits			Unit
				Min	Typ	Max	
All device	Vcc	Supply voltage range		Vcc (STOP)	—	35	V
	Vcc(START)	Operation start-up voltage		11.5	12.5	13.5	V
	Vcc(STOP)	Operation stop voltage		7.6	8.3	9.0	V
	ΔVcc	Start-up and stop voltage difference		3.5	4.2	5.1	V
	IccL	Stand-by current		90	180	270	μA
	Icco	Operating current		7.5	13	22	mA
	IccOFF	Timer latch circuit current	Vcc=14V Vcc=Vcc(STOP) + 0.2V	0.9 0.8	2.0 1.8	3.0 2.7	mA
CT	VTHCTH	CT term. "H" threshold voltage		3.5	4.0	4.5	V
	VTHCTL	CT term. "L" threshold voltage		0.4	0.7	1.0	V
	ICTDCHG	CT term. discharge current	In normal operation	70	100	130	μA
	ICTCHG	CT term. charge current	In CLM actuating	-33	-15	-5	μA
Error Amp	VB	Reference voltage		2.4	2.5	2.6	V
	IB	Input bias current		-300	-100	0	nA
	AV	Open loop gain			70		dB
	fT	Unity gain bandwidth			1		MHz
	IOS	Output source current	When VEA IN=0V	-140	-100	-60	μA
	VOm +	Output voltage (High)		4.7	5.25	6.25	V
	VOm -	Output voltage (Low)		0	0.1	0.3	V

# M62213P/FP

GENERAL PURPOSE HIGH SPEED PWM CONTROL IC

## ELECTRICAL CHARACTERISTICS (Ta=25°C, Vcc=14V, unless otherwise noted)

Block	Symbol	Parameter	Test condition	Limits			Unit
				Min	Typ	Max	
CLM	VTHCLM	CLM term. threshold voltage		180	200	220	V
	IOUTCLM	CLM term. output current	VCLM=0V	-270	-200	-140	μA
	TPDCLM	CLM term. delay time	Delay time to output		90		nS
SOFT	VSOFT(0%)	Input voltage range at 0% duty	Soft term. voltage range to set 0% duty	0		0.5	V
	VSOFT(50%)	Input. voltage at 50% duty	Soft term. voltage at 50% duty		2.7		V
	Duty Max	Maximum duty		80	90	99	%
	ISOFT	Soft term. input current		-65	-50	-31	μA
OSC.	fOSCmax	Maximum oscillation frequency				700	KHz
	fOSC	Oscillation frequency	CF=270pF , RF=69 kΩ	150	200	250	KHz
OUTPUT	VOL1	Output low voltage	Vcc=14V, Io=10mA		0.04	0.4	V
	VOL2		Vcc=14V, Io=100mA		0.3	1.4	V
	VOH1	Output high voltage	Vcc=14V, Io=-10mA	12.0	12.7		V
	VOH2		Vcc=14V, Io=-100mA	11.5	12.5		V
	TRISE	Output voltage rise time	No load		50		nS
	TFALL	Output voltage fall time	No load		35		nS

**FUNCTION DESCRIPTION AND APPLICATION****(1) EA IN, EA OUT TERMINAL**

Circuit for EAOUT terminal is connected to constant current load( $100\mu\text{A}$  typ.) shown in Fig.1. Output voltage of error amp. is controlled by the output transistor to provide current-sense comp. with the controlled voltage.

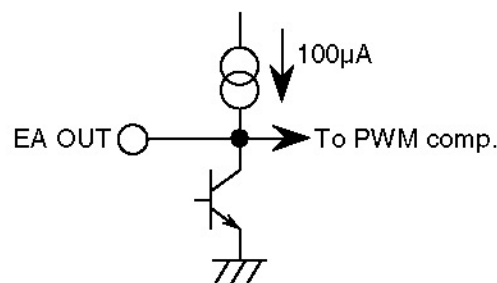


Fig.1 Circuit diagram of EAOUT terminal

**Peripheral circuit of Error Amp**

Detected voltage divided by R1 and R2 is input to EAIN terminal in such case as fly-back system where VCC line voltage is proportional to output voltage, or in the case that the voltage detection is made on the primary side. In this case operating region is set by R1 and R2, and AC gain by  $R1//R2, R_F$ .

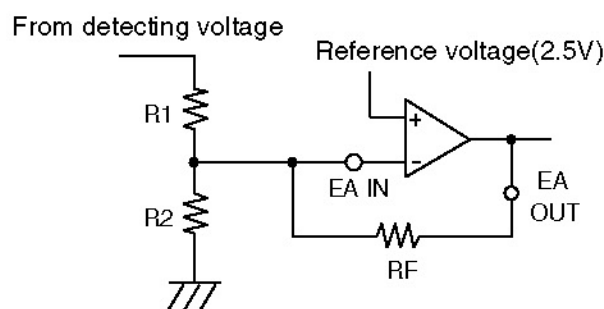


Fig.2 Method to detect the voltage on the primary side

In the case that feedforward system by photo-coupler is applied, following two methods are available. One is the method by error amp. as in Fig.3-1, the other is by the direct connection to photo-coupler as in Fig.3-2.

When photo-coupler is directly connected to EAOUT terminal, input terminal of error amp. is connected to GND, photo-coupler is connected directly to EAOUT terminal.

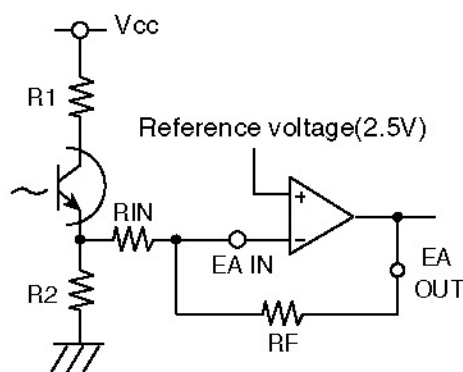


Fig.3-1 Method to use photo-coupler (1)

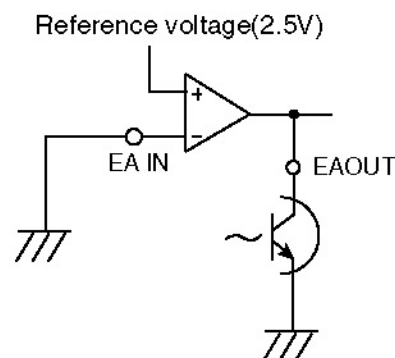


Fig.3-2 Method to use photo-coupler (2)

In Fig. 3-1, AC gain is represented as:

$$|A_v| = |R_F / R_{IN}|$$

Proper gain setting is about 40dB.

$R_F$  should be 52K $\Omega$  or more due to the current source capability of error amp.

$R_1$ ,  $R_2$  should meet the condition as below so that the voltage of EAIN terminal should not be over 5V.

$$R_2 * V_{cc} / (R_1 + R_2) \leq 5V$$

Due to the input impedance of EAIN terminal, the current in  $R_1$ ,  $R_2$  should be less than several mA.

## (2) CT(OVP) TERMINAL

Timer type latch circuit works as follows.

Constant charge current flows out from CT terminal to the external capacitor when CLM is operative. When the voltage of CT terminal rises up to over 4.0V(typ.), the latch circuit operates to make functions of this IC inoperative. Inoperative status is sustained until supply voltage becomes less than stop voltage. The value for start-up register has to be set so that the current over 1.8mA(typ.) can flow the resistor because the stop status has to be kept by the current in start-up resistor  $R_1$  shown in application circuit.

When timer latch circuit is operative, supply current increases at high voltage as shown in Fig.4 to avoid the damage caused by unnecessarily increased supply voltage.

Inoperative status goes back to operation by forcibly decreasing the voltage of CT terminal to less than 0.7V.

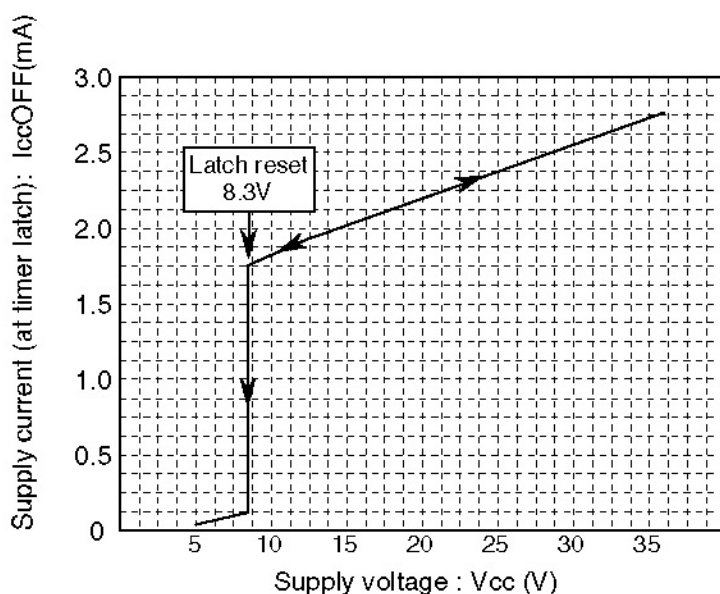


Fig.4 Supply current/voltage characteristics (at timer latch)



Even if the timer function is not needed, latch function operates, that is, IC becomes inoperative when the voltage of CT terminal is forced to be high voltage. Therefore, CT terminal can also be used for OVP(over voltage protection).

When only OVP function is needed(timer latch function is not necessary), connect the resistor between CT terminal and GND. In this case, the above mentioned charge current cannot make the voltage of CT terminal rise up to "H" threshold, thus latch function does not operate. (Refer to Fig.5-1, 5-2)

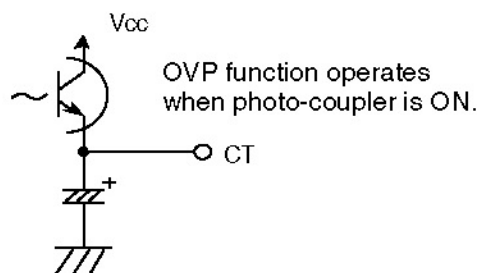


Fig.5-1 Method to use timer type latch and OVP

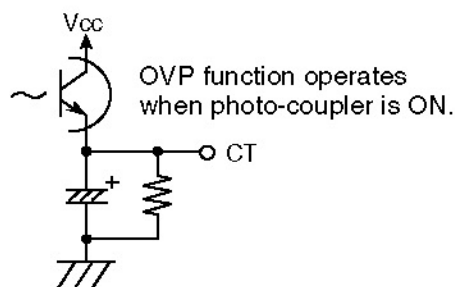


Fig.5-2 Method to use only OVP

### (3) SOFT(DUTY SET-UP) TERMINAL

The voltage of SOFT terminal determines the maximum duty. Maximum duty can be set by connecting the resistor as in Fig.6 because the constant current compensated for temperature flows out of this terminal.

And by connecting the capacitor between the terminal and GND, soft start function operates. That is, we can get the gradual increase of maximum duty at start-up. Maximum duty is represented as:

$$\text{Duty(max.)} \approx (40.5 \cdot V_{\text{SOFT}}) - 58 (\%)$$

,where  $V_{\text{SOFT}} = I_{\text{SOFT}} \cdot R_{\text{SOFT}} (V)$ ,  $I_{\text{SOFT}} \approx 50 \mu A(\text{typ.})$

If the voltage of SOFT terminal is higher than 3.53V(typ.)(upper limit voltage of the oscillation waveform), maximum duty is internally decided to be 90%.

Soft start time ( $T_{\text{SOFT}}$ ) is represented as:

$$T_{\text{SOFT}} \approx C_{\text{SOFT}} \cdot 31 \cdot 10^3 (\text{sec})$$

$T_{\text{SOFT}}$  means the time from start-up until the voltage of SOFT terminal goes up to higher than 1.4V(typ.) (lower limit voltage of the oscillation waveform).

Discharging circuit operative before start-up at  $V_{\text{CC}}$  is internally equipped so that the soft start never fail to operate at the restart of voltage supply.

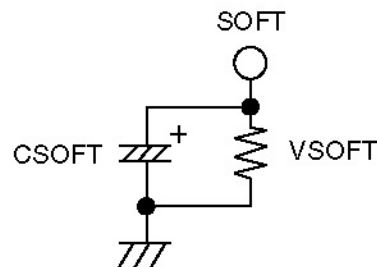


Fig.6  
Method to set up duty  
and SOFT start function.

#### (4) CLM TERMINAL

This terminal is for pulse-by-pulse current limiting.

Current limiting circuit is almost the same as that of M51995.

The voltage detected by the current detecting resistor can be directly input as shown in Fig.7-1, if the detected voltage is about the threshold voltage(200mV(typ.)), but if the voltage is larger than the threshold, the voltage has to be input divided by resistors as shown in Fig.7-2.

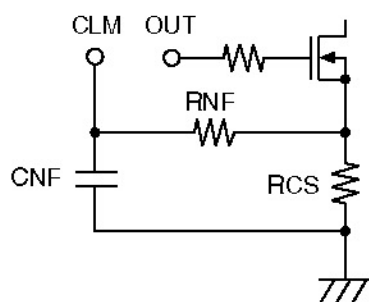


Fig.7-1 peripheral circuit of CLM

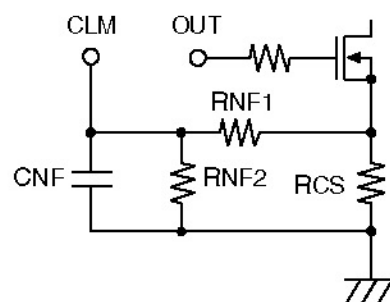


Fig. 7-2 peripheral circuit of CLM when the detected voltage is high.

1000pF to 22000pF is recommended for CNF. Be sure to use 100Ω or less for RNF and RNF1// RNF2 (\*)so that the detection sensitivity is not influenced by the current flown out from CLM terminal.

Non-inductive resistor is recommended for current detecting resistor.

\*  $RNF1 // RNF2 = (RNF1 * RNF2) / (RNF1 + RNF2)$



#### (5) CF TERMINAL

Oscillation frequency is set by capacitor connected to CF terminal.  
The waveform of CF terminal is triangular one with the ratio of 9:1 for charge-discharge period.  
Oscillation frequency is represented as:

$$f_{OSC} = \frac{1}{(19.4 \times 10^3 \times C_{OSC}) + (0.4 \times 10^{-6})} \quad (\text{Hz})$$

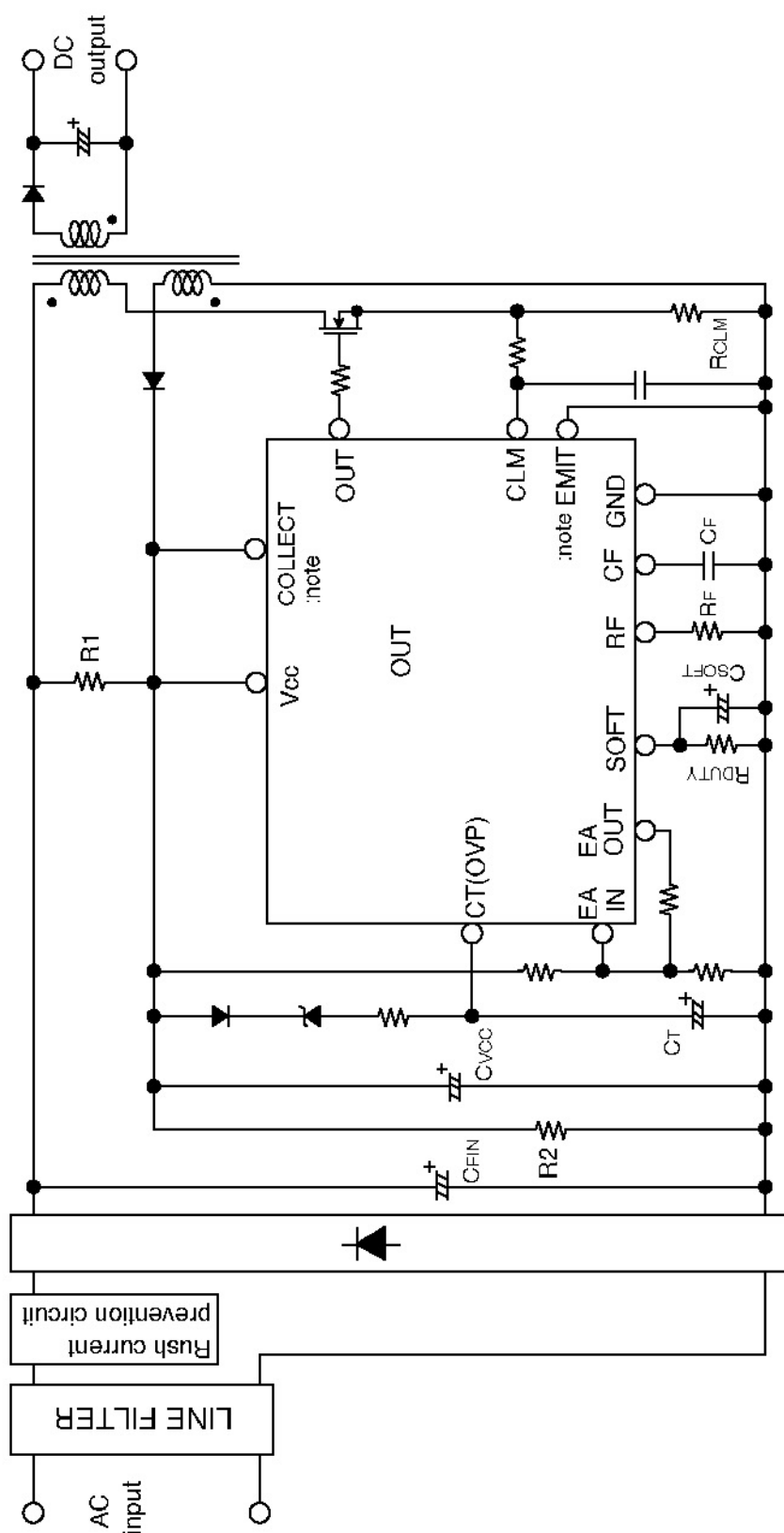
#### (6) Attention for heat generation

Although the absolute maximum rating of ambient temperature is spelled out as 85°C, it is always annoying to specify the location this temperature refers to because the power dissipation generated locally in switching regulator is fairly large and the temperature in the vicinity of the IC varies from place to place.

One of the recommendable ways to solve this problem is to check the temperature on the surface of the IC.

The difference in temperature between IC junction and the surface of IC package is 30°C or less when IC junction temperature is measured by utilizing the temperature characteristics of p-n junction forward voltage, and the surface temperature by "thermo-viewer" on the condition that the IC is mounted on the "phenol-base" PC board in normal atmosphere.

This concludes that maximum case temperature (surface temperature of IC package) rating is 100°C with adequate margin considering the absolute maximum rating of junction temperature is 150°C.



note GND terminal is connected to emitter terminal as M62213FP in IC inside.  
And Vcc terminal is connected to collector terminal as M62213FP in IC inside.