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# STK760-216-E

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Thick-Film Hybrid IC

## Single-phase rectification Active Converter Hybrid IC

### Overview

This IC is average current control type Active Converter Hybrid IC for power factor improvement of single-phase AC power supply, that containing power devices of step-up active converter, control IC over-current and over-voltage protection circuits.

### Applications

- Single-phase rectification active filter for power rectification for air conditioners and general-purpose inverters.

### Features

- Power switching device for active converter is adopting IGBT.
- Soft start functions and the over current, the over voltage, and the low-voltage are including as protection circuit
- Capable of controlling ON/OFF by logic level input signal.
- Output voltage changeability functions by control signal.

# STK760-216-E

## Specifications

**Absolute Maximum Ratings** at  $T_a = 25^\circ\text{C}$

Parameter		Symbol	Conditions	Ratings	unit
IGBT (TR1+TR2)	Collector-emitter voltage	VCE		600	V
	Repetitive peak collector current	ICP	*1	300	A
	Collector current	IC		148	A
	Power dissipation	PC1		223	W
FRD1 (D1)	Diode reverse voltage	VRM		600	V
	Repetitive peak forward current	IF1P	*1	220	A
	Diode forward current	IF1		73	A
	Power dissipation	PD1		150	W
FRD2 (D2)	Repetitive peak forward current	IF2P	*1	15	A
	Diode forward current	IF2		7	A
	Power dissipation	PD2		13	W
Supply voltage ( $V_{CC-GND}$ )		$V_{CC}$		20	V
Signal pin input voltage	Pin 1	VBOP		-0.3 to 9.0	V
	Pin 7	VIS		-10 to 0.3	
	Pin 8	VCOMP		-0.3 to 6.5	
	Pin 12	VFB			
	Pin 13	VOVP			
	Pin 4	VONF		-0.3 to $V_{CC}$	
	Pin 10	Vctl			
Maximum input AC voltage		VAC	Single-phase Full-rectified	264	V
Maximum output voltage		$V_O$	Under the Application condition ( $V_{AC}=200V$ )	450	V
Maximum output power		$W_o$		8	kW
Input AC current (normal condition)		$I_{IN}$		40	Arms
Junction temperature		$T_J$		150	$^\circ\text{C}$
Operating case temperature		$T_c$	HIC case temperature *2	-20 to +100	$^\circ\text{C}$
Storage temperature		$T_{stg}$		-40 to +125	$^\circ\text{C}$
Tightening torque			A screw part *3	1.17	N•m
Withstand voltage		VINS	50Hz sine wave AC 1minute *4	2000	VRMS

[Note]

\*1: Duty ratio  $D = 0.1$ ,  $t_p = 1\text{ms}$

\*2: Measure point is between 5mm to center of back.

\*3: Torque should be set within 0.79 to 1.17N•m. Flatness of the heat-sink should be lower than 0.2mm.

\*4: The test condition: AC2500V, 1 second.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

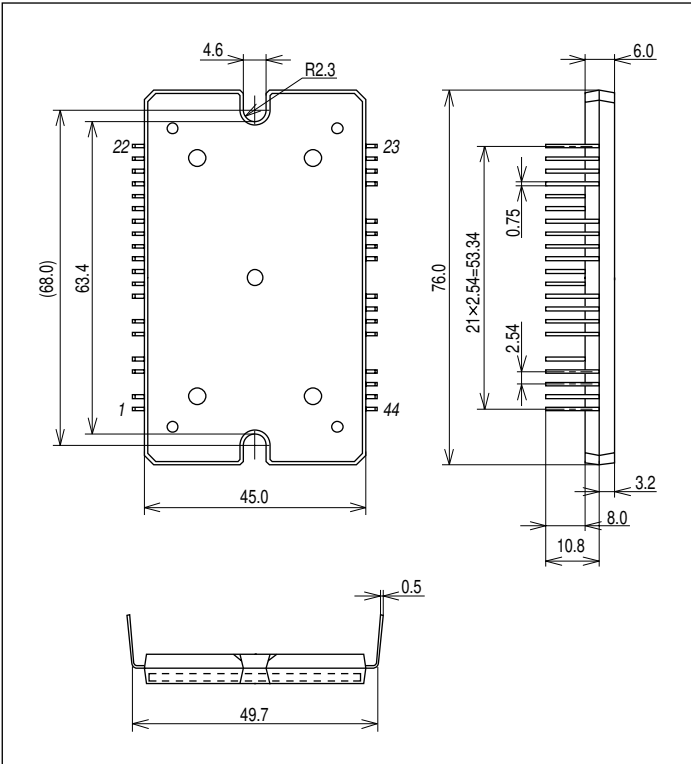
# STK760-216-E

**Electrical Characteristics** at  $T_c = 25^\circ\text{C}$ ,  $V_{CC} = 15.0\text{V}$ : Unless otherwise noted

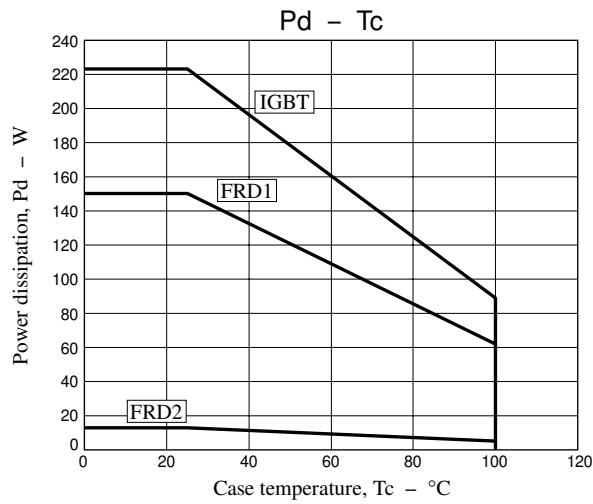
Parameter	Symbol	Conditions	Test circuit	Ratings			unit
				min	typ	max	
Power output part							
Collector-emitter leak current (IGBT)	$I_{CES}$	$V_{CE} = 600\text{V}$	Fig.1			200	$\mu\text{A}$
Collector-emitter saturation voltage (IGBT)	$V_{CE(sat)}$	$I_C = 50\text{A}$	Fig.2		1.2	1.8	V
Diode reverse current (FRD1)	$I_R$	$V_R = 600\text{V}$	Fig.1			200	$\mu\text{A}$
Diode forward voltage (FRD1)	$V_{F1}$	$I_F = 50\text{A}$	Fig.3		1.8	2.4	V
Diode forward voltage (FRD2)	$V_{F2}$	$I_F = 5\text{A}$	Fig.3		2.5	3.5	V
Junction to case thermal resistance	$\theta_{j-c1}$	IGBT (TR1+TR2)			0.56		$^\circ\text{C/W}$
	$\theta_{j-c2}$	FRD1 (D2+D3)			0.83		$^\circ\text{C/W}$
	$\theta_{j-c3}$	FRD2 (D4)			9.0		$^\circ\text{C/W}$
Control IC part							
Control IC input current	$I_{CC(ON)}$	$V_{CC} = 15\text{V}$ , $V_{ONF} = 5\text{V}$	Fig.4		14	20	mA
	$I_{CC(OFF)}$	$V_{CC} = 15\text{V}$ , $V_{ONF} = 0\text{V}$			2.5	5	
Oscillation frequency	$f_{OSC}$	$V_{CC} = 15\text{V}$ , $V_{ONF} = 5\text{V}$	Fig.4	19.5	22.0	24.5	kHz
Open loop protection threshold voltage	VOLP			0.8	0.95	1.1	V
Error-amp reference voltage	$V_{ref}$		Fig.5	4.88	5.0	5.12	V
Peak current protection threshold voltage	$V_{IS(PK)}$			-0.58	-0.5	-0.42	V
Over voltage protection threshold voltage	$V_{OVP(ON)}$		Fig.6	5.095	5.3	5.51	V
Brown-out protection threshold voltage	$V_{BOP(ON)}$			0.66	0.76	0.86	V
Brown-out protection enable voltage	$V_{BOP(EN)}$			1.46	1.56	1.66	V
ON/OFF threshold voltage	$V_{THON}$	$V_{CC} = 15\text{V}$	Fig.7	3.0			V
	$V_{THOFF}$					0.5	V
Start-up $V_{CC}$ voltage	$V_{CC(ON)}$	$V_{ONF} = 5\text{V}$	Fig.8	12.4	13.25	14.1	V
Shut-down $V_{CC}$ voltage	$V_{CC(OFF)}$			9.4	10.0	10.7	V
Substrate temperature monitor resistance	RTH	Resistance between VTH1-VTH2	Fig.3	90	100	110	$\text{k}\Omega$
Application circuit : $V_{AC} = 200\text{V}$ , $V_O = 380\text{V}$ ( $V_{ctl} = 1.507\text{V}$ )							
Output voltage	$V_O$	$W_o = 2\text{kW}$	Fig.9	366	380	394	V
Power Factor	$\cos\phi$	$W_o = 400\text{W}$		0.98	0.99		
		$W_o = 2\text{kW}$		0.99	0.995	1.0	

Package Dimensions

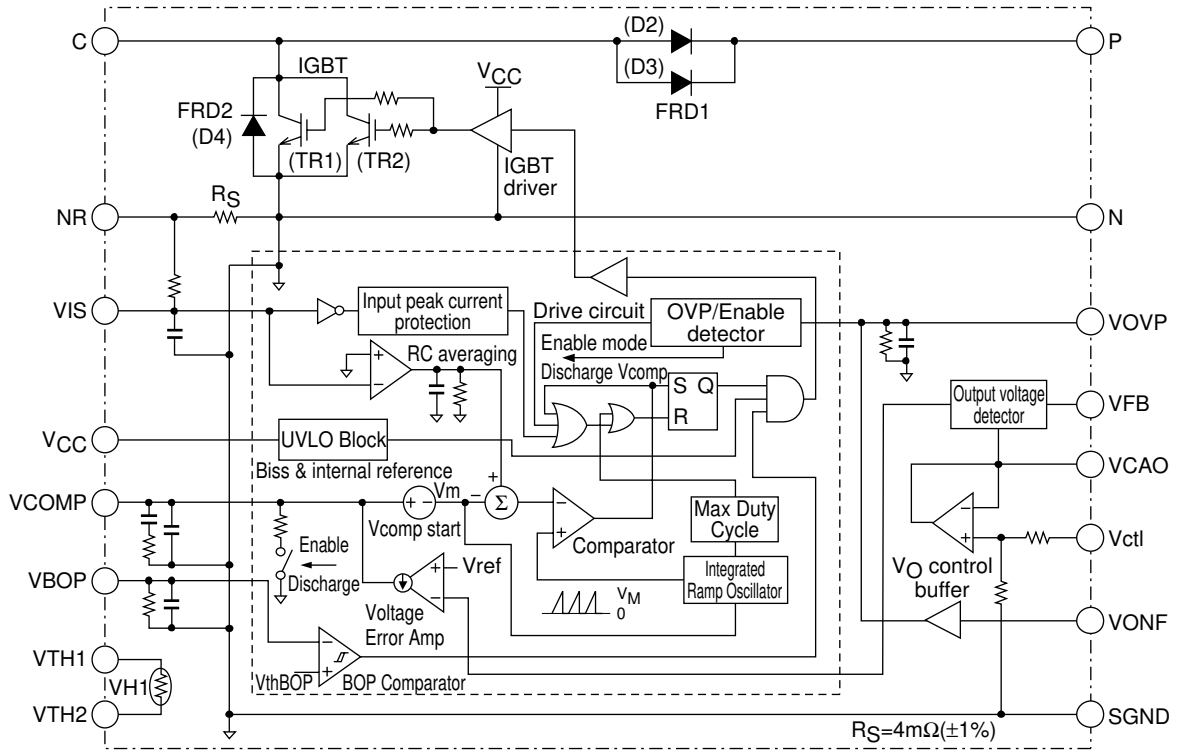
unit:mm (typ)



IGBT (TR1+TR2), FRD1 (D2+D3) & FRD2 (D4) vs. Temperature Derating ( $T_a = 25^\circ\text{C}$ )



Block Diagram



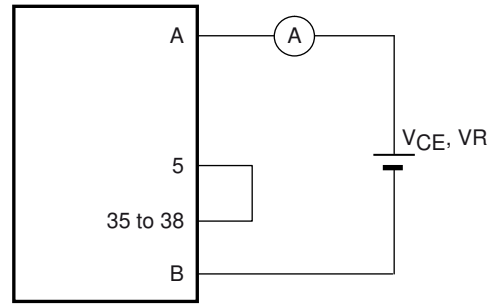
Explanation of Terminal

Terminal No.	Symbol	Explanation
1	VBOP	Brown-out fault detection terminal
2	VCC	Control IC power supply input
3	-	An empty terminal
4	VONF	ON/OFF control terminal
5	GND	Signal GND
6	-	An empty terminal
7	VIS	Current detection terminal
8	VCOMP	Phase compensation terminal (Voltage error amplifier out)
9	-	An empty terminal
10	Vctl	Output voltage control signal input
11	VCAO	Output voltage control amplifier output
12	VFB	Output voltage feed back terminal
13	VOVP	Over voltage protection terminal
14	VTH1	Terminal of thermistor TH1
15	VTH2	Terminal of thermistor TH1
16 to 22	-	A dummy terminal
23 to 26	P	Output (+) terminal of PFC
27, 28	-	An empty terminal
29 to 32	C	IGBT (TR1+TR2) Collector
33,34	-	An empty terminal
35 to 38	N	Output (-) terminal of PFC
39, 40	-	An empty terminal
41 to 44	NR	Input current return terminal

Test Circuit -1

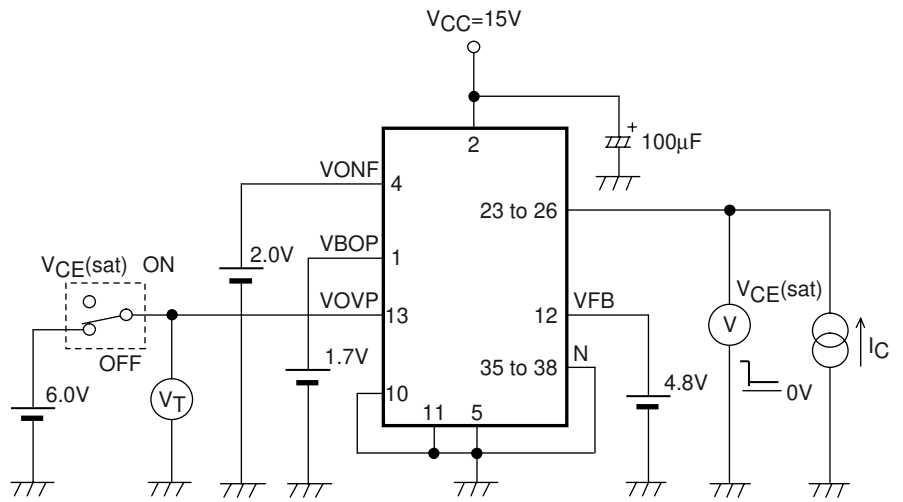
(1)  $I_{CES}$ ,  $I_R$

	IGBT	FRD1
A	29, 30, 31, 32	23, 24, 25, 26
B	35, 36, 37, 38	29, 30, 31, 32



(Fig.1)

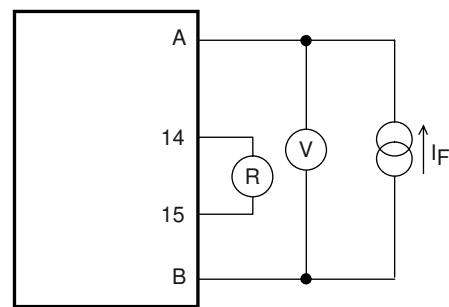
(2)  $V_{CE(sat)}$  (Test by Pulse)



(Fig.2)

(3)  $V_{F1}$ ,  $V_{F2}$  (Test by Pulse),  $R_{TH}$

	FRD1	FRD2
A	29, 30, 31, 32	35, 36, 37, 38
B	23, 24, 25, 26	29, 30, 31, 32

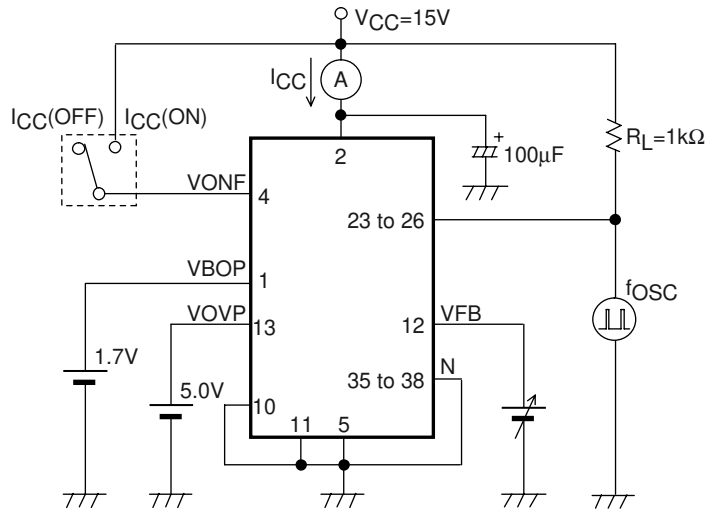


(Fig.3)

Test Circuit -2

(4)  $I_{CC(ON)}/I_{CC(OFF)}$ , VOLP,  $f_{OSC}$

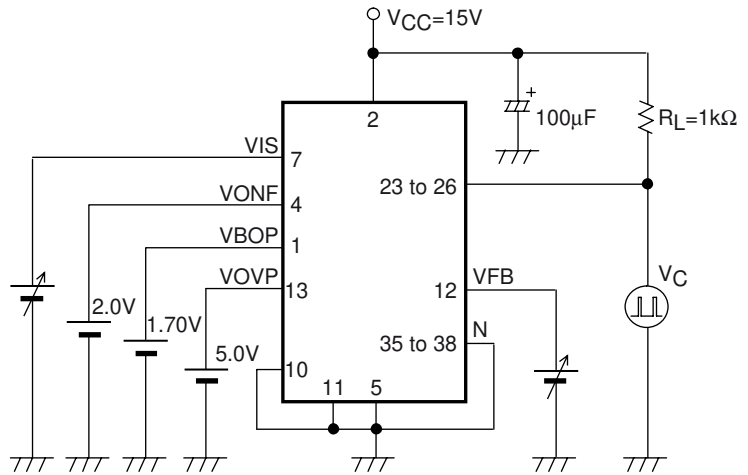
$I_{CC}, f_{OSC}$	VOLP
VFB = 1.1V	VONF = 5.0V



(Fig.4)

(5) Vref, VIS(PK)

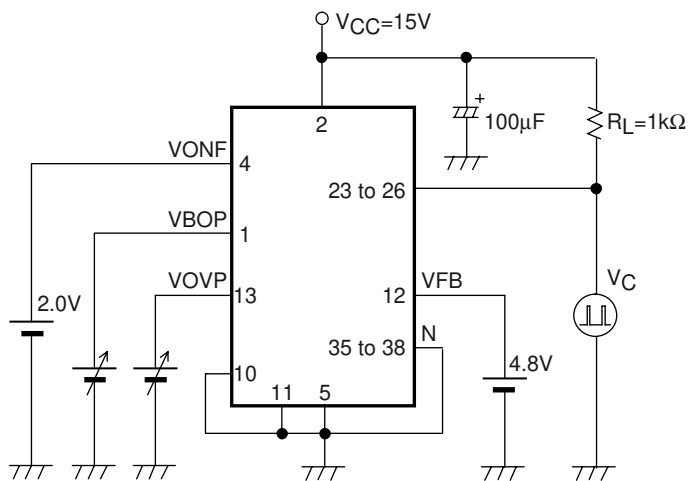
Vref	VIS(PK)
VIS = -0.6V	VFB = 4.8V



(Fig.5)

(6) VOVP(ON), VBOP(ON)

VOVP(ON)	VBOP(ON)
VBOP = 1.70V	VOVP = 5.0V

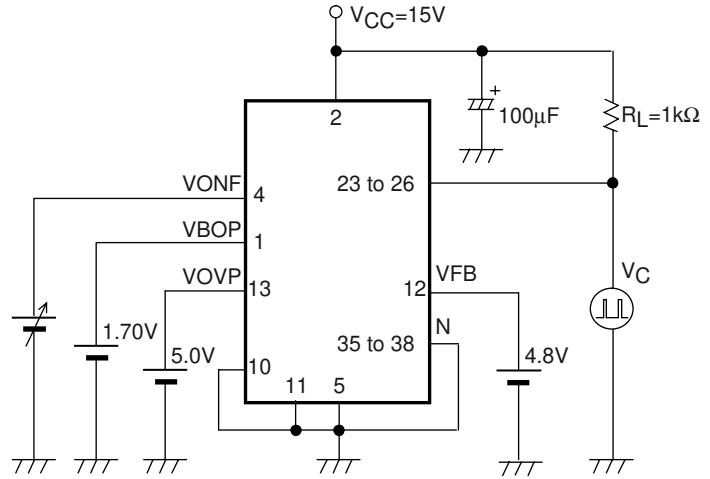


(Fig.6)



Test Circuit -3

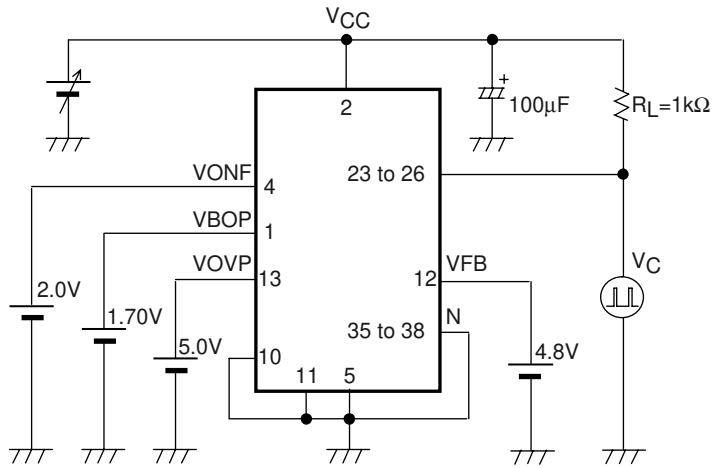
(7) VTHON, VTHOFF



(Fig.7)

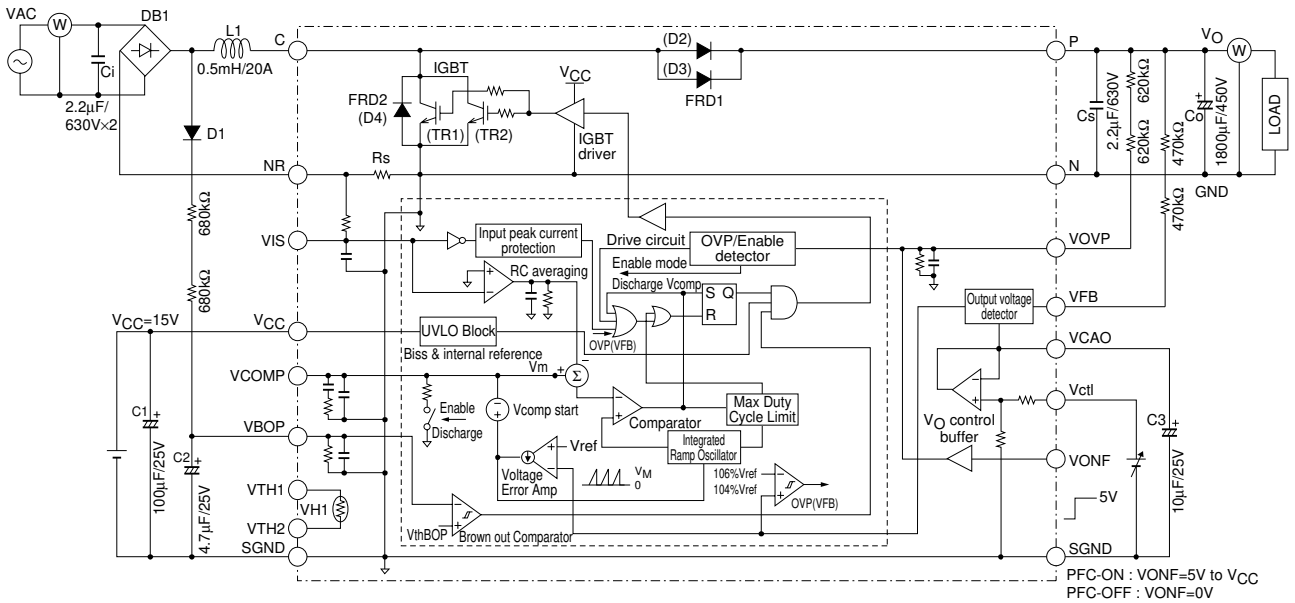
(8) VCC(ON), VCC(OFF)

VCC(ON)	VCC(OFF)
Vc-ON	Vc-OFF



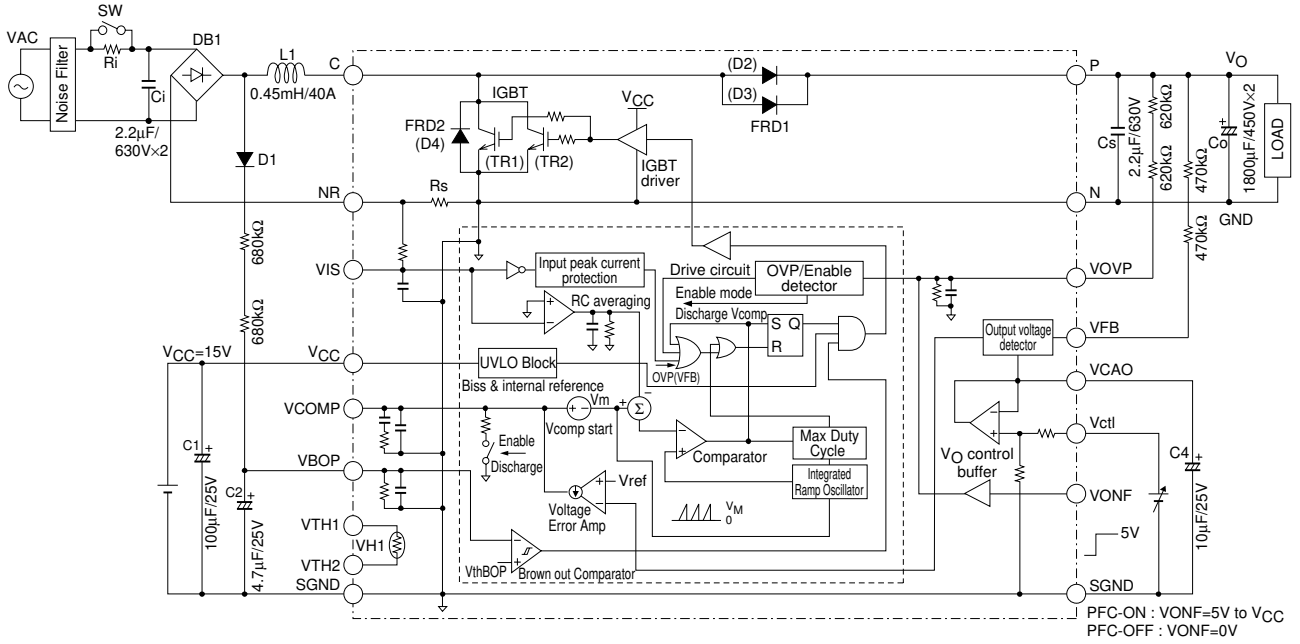
(Fig.8)

(9) Power Factor (COSφ)



(Fig.9)

Application Circuit

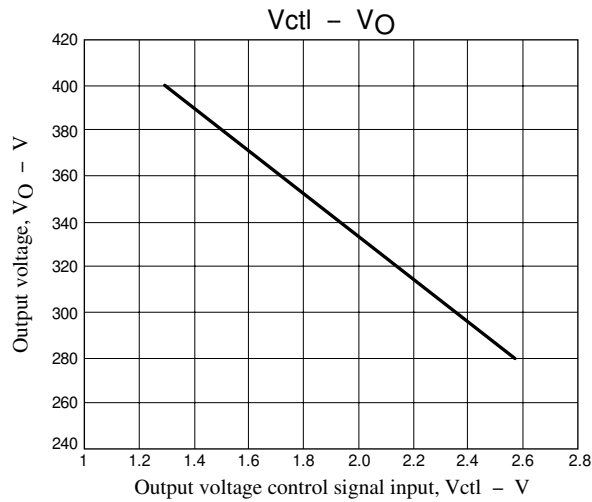


Recommended Condition

Parameter	Symbol	Conditions	Ratings	unit
AC Voltage	VAC	50/60Hz	170 to 264	Vrms
Output voltage	VO		$VAC \times \sqrt{2} + (10 \text{ to } 15) \leq 450$	V
Over-voltage detection voltage	VOV		$VO_{UT} + (10 \text{ to } 20)$	V
Control IC supply voltage	VCC	VCC-GND	14.5 to 17.0	V
Inductor	L1		0.45	mH
Input film capacitor	Ci		$4.4 \leq Ci$	$\mu F$
Output film capacitor	Cs		$4.4 \leq Cs$	$\mu F$
Output electrolytic capacitor	Co		$3600 \leq Co$	$\mu F$

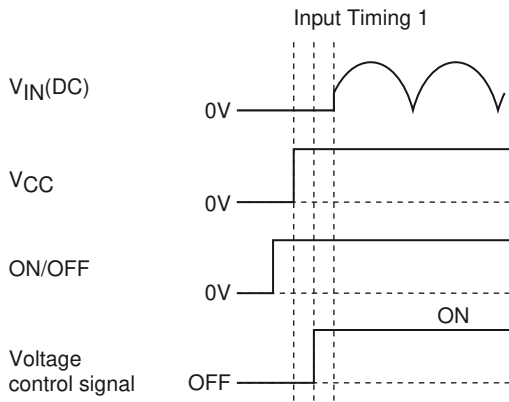
Output Voltage Control

Output voltage control signal Vctl sets referring to the Vctl-VO characteristic of the figure below.

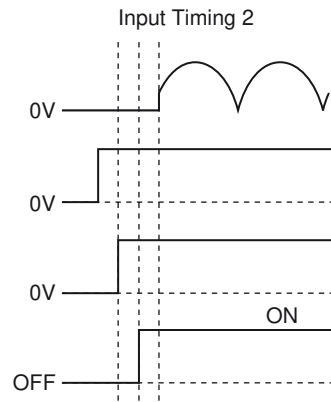


**Timing Chart**

Even if power supply and signal at any timing are input, this IC is not destroyed. However, soft start circuit doesn't operate when  $V_{IN}$  (DC) is input at the timing of Figure 11 and 12. Therefore, overcurrent protection circuit will operate, and audio frequency noise from coil may generate. Please turn on ON/OFF or  $V_{CC}$  after  $V_{IN}$ (DC) to avoid this.

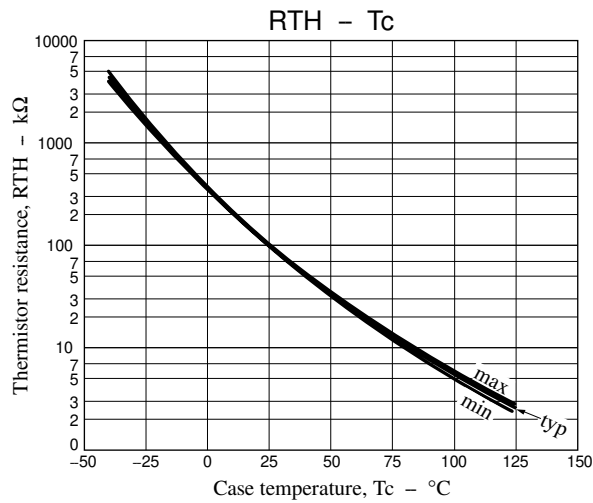


<Fig.11>



<Fig.12>

**The built-in thermistor resistance temperature characteristic**



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