



**THE DATASHEET OF  
STK760-211-E**





**SANYO Semiconductors**

# DATA SHEET

An ON Semiconductor Company

## STK760-211-E — 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.

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# STK760-211-E

## Specifications

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

| Parameter                           |                                   | Symbol    | Conditions                                    | Ratings          | unit             |                  |
|-------------------------------------|-----------------------------------|-----------|---|------------------|------------------|------------------|
| IGBT<br>(TR1+TR2)                   | Collector-emitter voltage         | VCE       |   | 600              | V                |                  |
|                                     | Repetitive peak collector current | ICP       | *1  | 185              | A                |                  |
|                                     | Collector current                 | IC        |   | 72               | A                |                  |
|                                     | Power dissipation                 | PC1       |   | 125              | W                |                  |
| FRD1<br>(D1)                        | Diode reverse voltage             | VRM       |   | 600              | V                |                  |
|                                     | Repetitive peak forward current   | IF1P      | *1  | 106              | A                |                  |
|                                     | Diode forward current             | IF1       |   | 36               | A                |                  |
|                                     | Power dissipation                 | PD1       |   | 73               | W                |                  |
| FRD2<br>(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 4                             | VIS       |   | -10 to 0.3       | V                |                  |
|                                     | Pin 5                             | VCOMP     |   | -0.3 to 6.5      |                  |                  |
|                                     | Pin 8                             | VFB       |   |                  |                  |                  |
|                                     | Pin 9                             | VOVP      |   |                  |                  |                  |
|                                     | Pin 2                             | VONF      |   | -0.3 to $V_{CC}$ |                  |                  |
|                                     | Pin 6                             | Vctl      |   |                  |                  |                  |
| Maximum input AC voltage            |                                   | VAC       | Single-phase Full-rectified                   | 264              | V                |                  |
| Maximum output voltage              |                                   | $V_O$     | Under the Application condition<br>(VAC=200V) | 450              | V                |                  |
| Maximum output power                |                                   | $W_o$     |   | 4                | kW               |                  |
| Input AC current (normal condition) |                                   | $I_{IN}$  |   | 20               | 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               | 1.0              | 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 1.0N•m. Flatness of the heat-sink should be lower than 0.15mm.

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

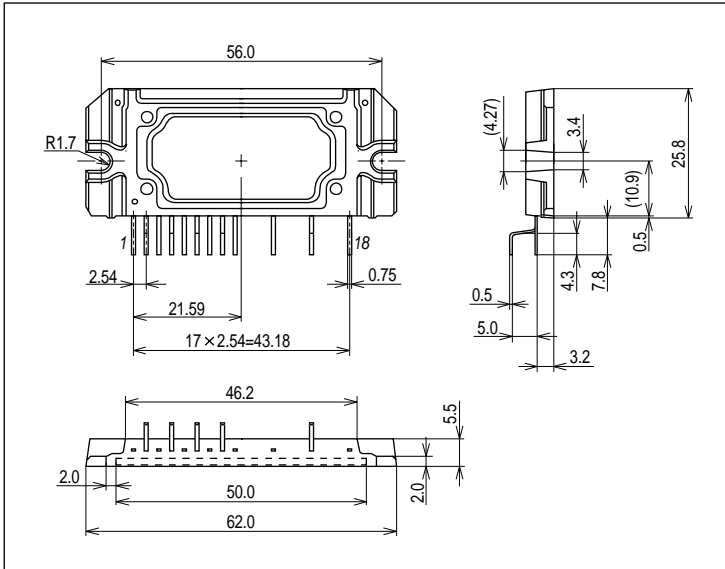
# STK760-211-E

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

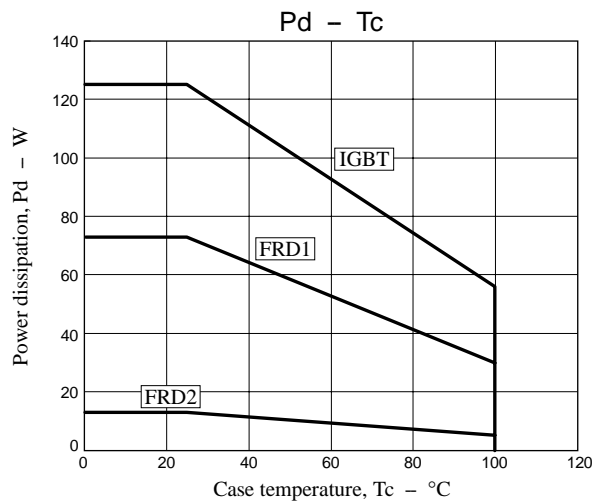
| Parameter  | Symbol          | Conditions                                    | Test circuit | Ratings |       |       | unit               |
|--|-----------------|---|--------------|---------|-------|-------|--------------------|
|  |                 |   |              | min     | typ   | max   |                    |
| 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)  | $V_{CE(sat)}$   | $I_C = 30\text{A}$                            | Fig.2        |         | 1.4   | 2.0   | V                  |
| Diode reverse current (FRD1)   | $I_R$           | $V_R = 600\text{V}$                           | Fig.1        |         |       | 200   | $\mu\text{A}$      |
| Diode forward voltage (FRD1)   | $V_{F1}$        | $I_F = 30\text{A}$                            | Fig.3        |         | 2.0   | 2.6   | 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)                                |              |         | 1.0   |       | $^\circ\text{C/W}$ |
|  | $\theta_{j-c2}$ | FRD1 (D1)                                     |              |         | 1.7   |       | $^\circ\text{C/W}$ |
|  | $\theta_{j-c3}$ | FRD2 (D2)                                     |              |         | 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  | Vref            |   | Fig.5        | 4.88    | 5.0   | 5.12  | V                  |
| Peak current protection threshold voltage  | VIS(PK)         |   |              | -0.58   | -0.5  | -0.42 | V                  |
| Over voltage protection threshold voltage  | VOVP(ON)        |   | Fig.6        | 5.095   | 5.3   | 5.51  | V                  |
| ON/OFF threshold voltage   | VTHON           | $V_{CC} = 15\text{V}$                         | Fig.7        | 3.0     |       |       | V                  |
|  | VTHOFF          |   |              |         |       | 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                  |
| 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

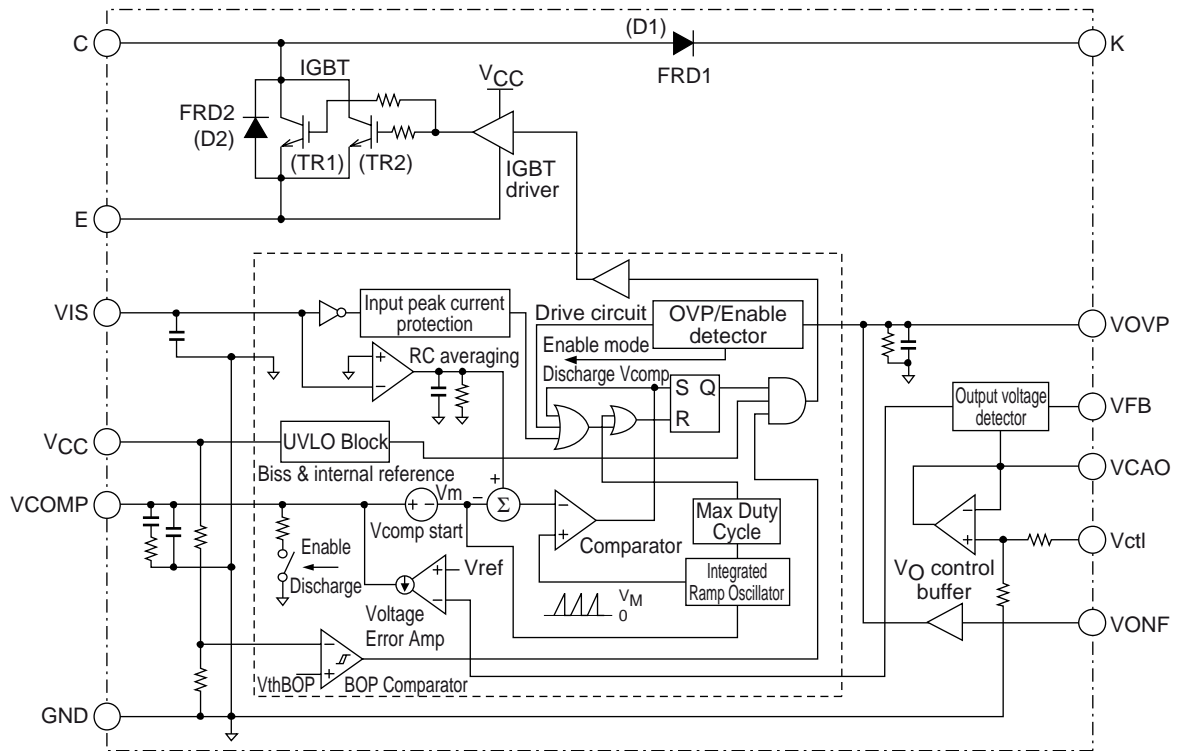
unit:mm (typ)



IGBT (TR1+TR2), FRD1 (D1) & FRD2 (D2) vs. Temperature Derating ( $T_a = 25^\circ\text{C}$ )



Block Diagram



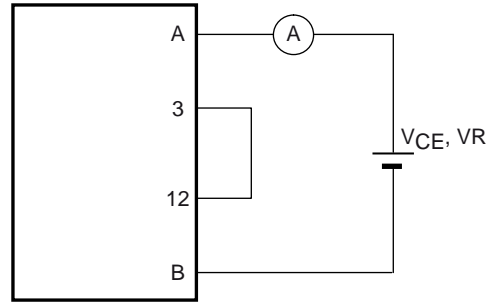
Explanation of Terminal

| Terminal No. | Symbol | Explanation   |
|--------------|--------|---|
| 1            | VCC    | Control IC power supply input                             |
| 2            | VONF   | ON/OFF control terminal                                   |
| 3            | GND    | Signal GND  |
| 4            | VIS    | Current detection terminal                                |
| 5            | VCOMP  | Phase compensation terminal (Voltage error amplifier out) |
| 6            | Vctl   | Output voltage control signal input                       |
| 7            | VCAO   | Output voltage control amplifier output                   |
| 8            | VFB    | Output voltage feed back terminal                         |
| 9            | VOVP   | Over voltage protection terminal                          |
| 10, 11       | -      | An empty terminal   |
| 12           | E      | IGBT (TR1+TR2) Emitter                                    |
| 13, 14       | -      | An empty terminal   |
| 15           | C      | IGBT (TR1+TR2) Collector                                  |
| 16, 17       | -      | An empty terminal   |
| 18           | K      | FRD1 (D1) Cathode   |

Test Circuit -1

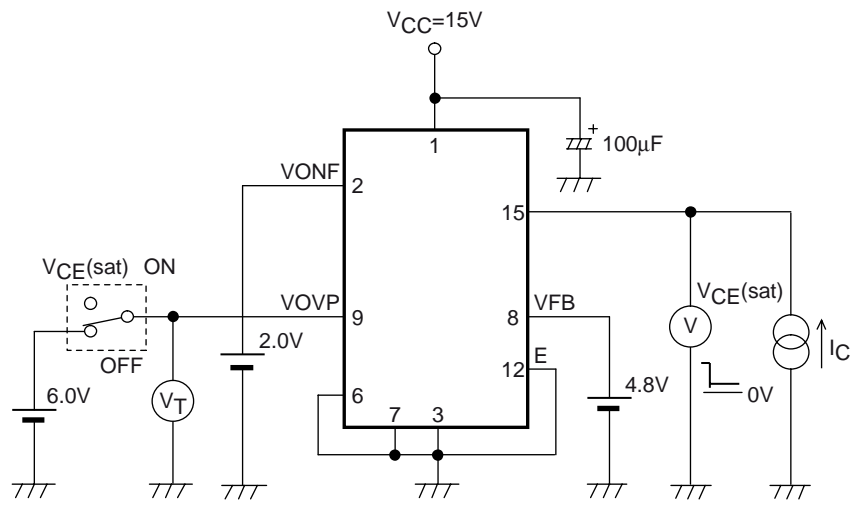
(1)  $I_{CES}$ ,  $I_R$

|   | IGBT | FRD1 |
|---|------|------|
| A | 15   | 18   |
| B | 12   | 15   |



(Fig.1)

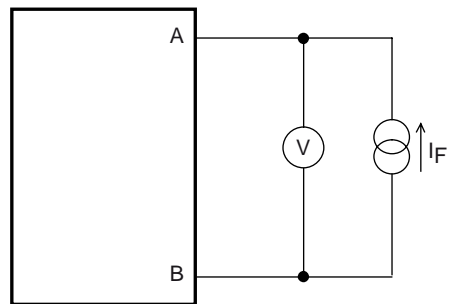
(2)  $V_{CE(sat)}$  (Test by Pulse)



(Fig.2)

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

|   | FRD1 | FRD2 |
|---|------|------|
| A | 15   | 12   |
| B | 18   | 15   |

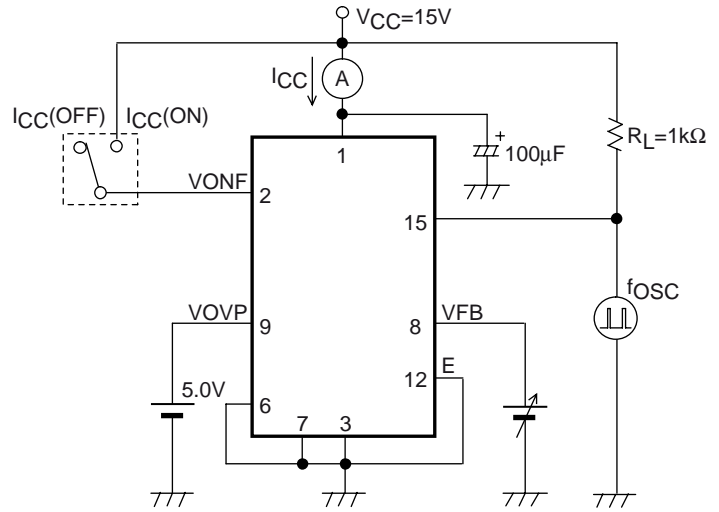


(Fig.3)

Test Circuit -2

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

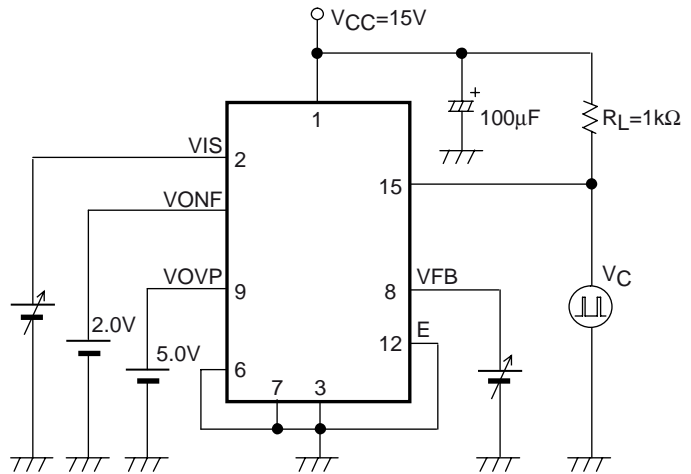
|                   |             |
|-------------------|-------------|
| $I_{CC}, f_{OSC}$ | VOLP        |
| VFB = 1.1V        | VONF = 5.0V |



(Fig.4)

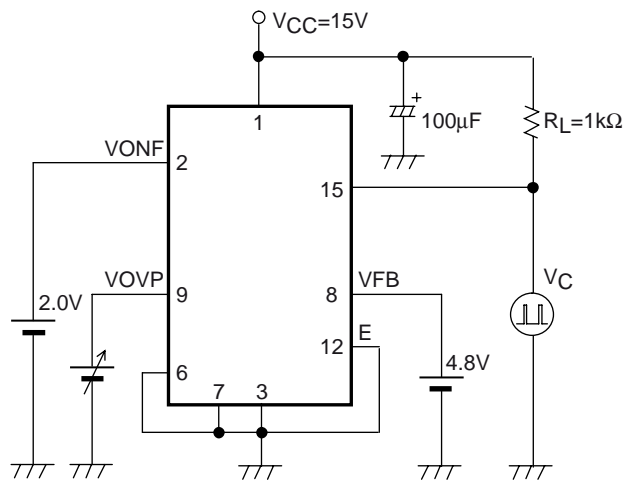
(5)  $V_{ref}$ , VIS(PK)

|             |            |
|-------------|------------|
| $V_{ref}$   | VIS(PK)    |
| VIS = -0.6V | VFB = 4.8V |



(Fig.5)

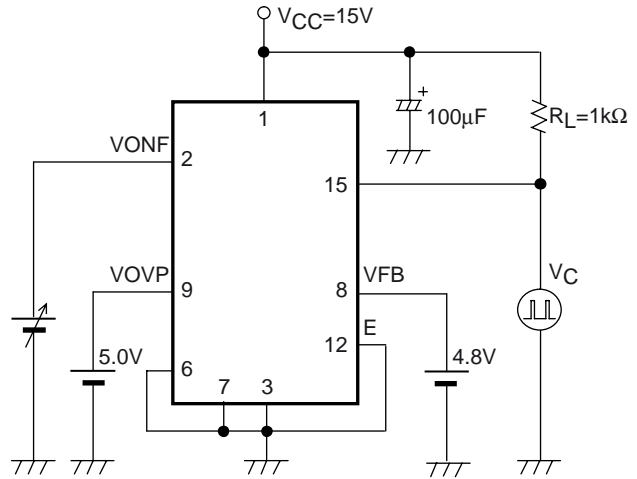
(6) VOVP(ON)



(Fig.6)

Test Circuit -3

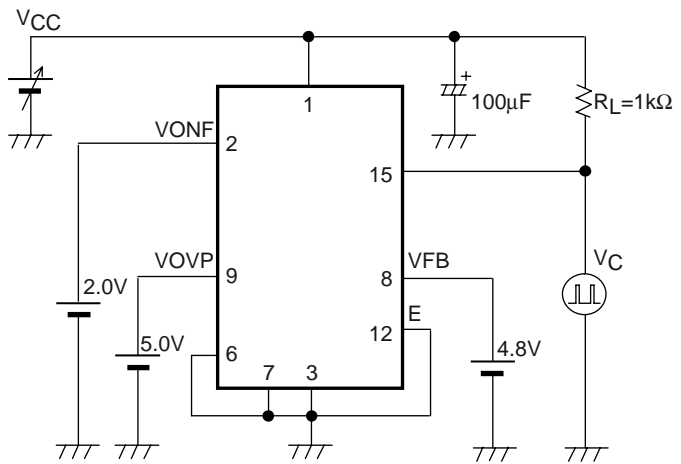
(7) V<sub>THON</sub>, V<sub>THOFF</sub>



(Fig.7)

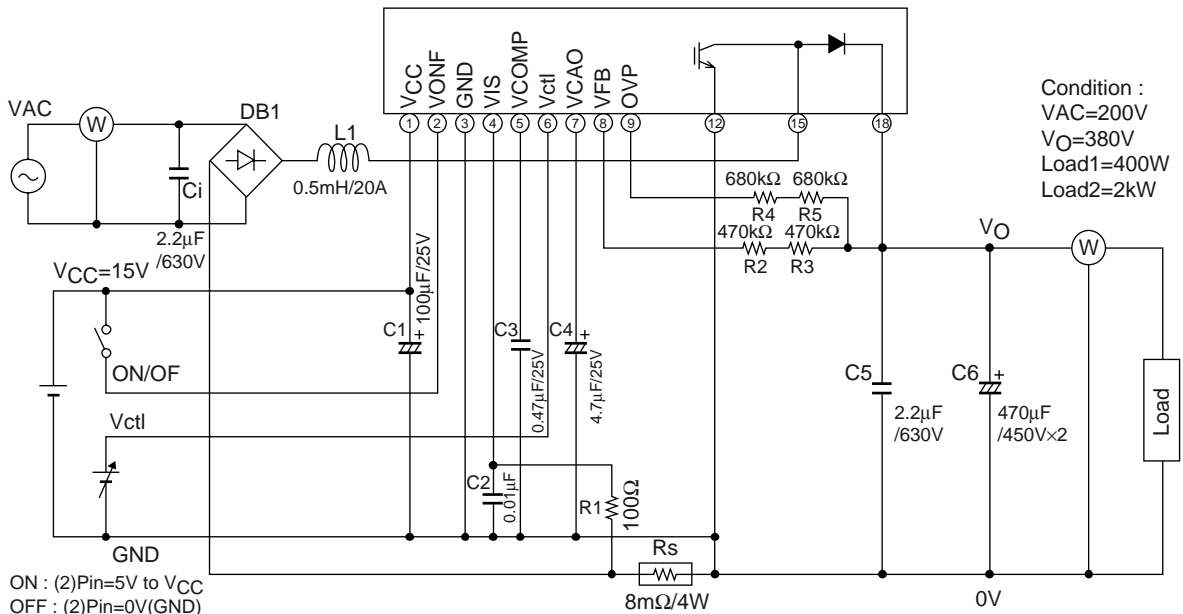
(8) V<sub>CC(ON)</sub>, V<sub>CC(OFF)</sub>

|                     |                      |
|---------------------|----------------------|
| V <sub>CC(ON)</sub> | V <sub>CC(OFF)</sub> |
| V <sub>c-ON</sub>   | V <sub>c-OFF</sub>   |



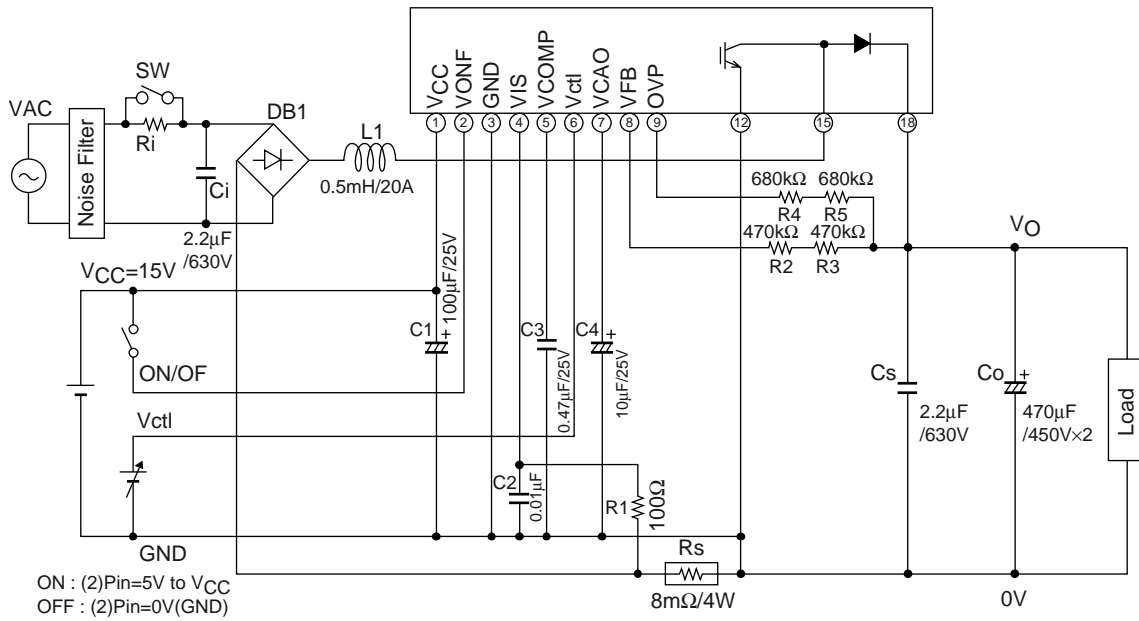
(Fig.8)

(9) Power Factor (COSφ)



(Fig.9)

Application Circuit

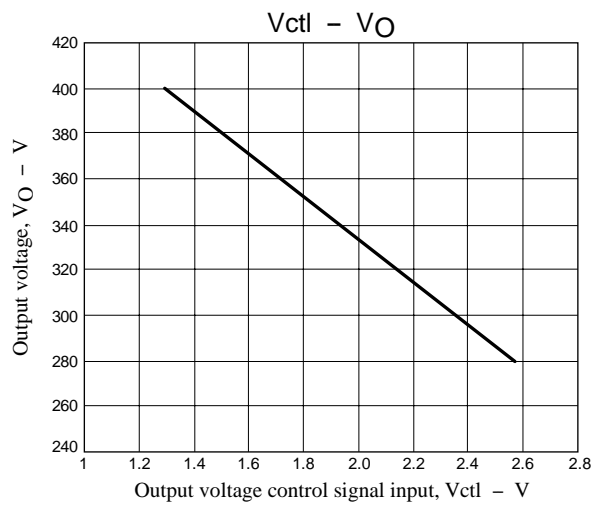


Recommended Condition

| Parameter                      | Symbol          | Conditions           | Ratings  | unit |
|--------------------------------|-----------------|----------------------|--|------|
| AC Voltage                     | VAC             | 50/60Hz              | 170 to 264   | Vrms |
| Output voltage                 | V <sub>O</sub>  |                      | $VAC \times \sqrt{2} + (10 \text{ to } 15) \leq 450$ | V    |
| Over-voltage detection voltage | VOV             |                      | $V_{OUT} + (10 \text{ to } 20)$                      | V    |
| Control IC supply voltage      | V <sub>CC</sub> | V <sub>CC</sub> -GND | 14.5 to 17.0   | V    |
| Inductor                       | L1              |                      | 0.5  | mH   |
| Input film capacitor           | Ci              |                      | $2.2 \leq Ci$  | µF   |
| Output film capacitor          | Cs              |                      | $2.2 \leq Cs$  | µF   |
| Output electrolytic capacitor  | Co              |                      | $940 \leq Co$  | µF   |

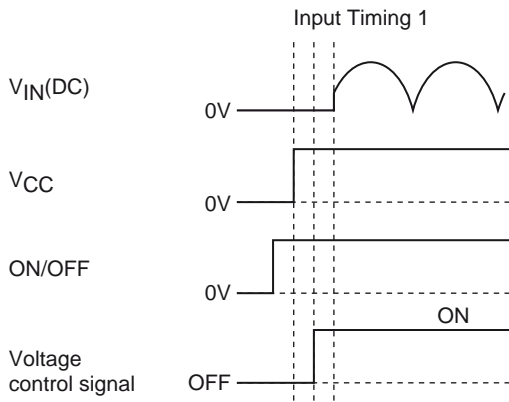
Output Voltage Control

Output voltage control signal V<sub>ctl</sub> sets referring to the V<sub>ctl</sub>-V<sub>O</sub> characteristic of the figure below.

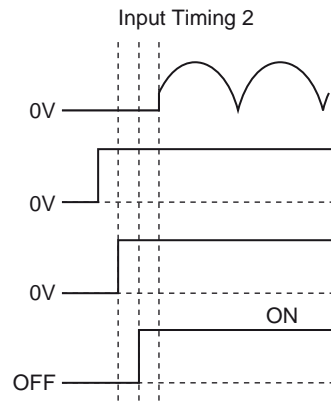


**Timing Chart**

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>

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