



SANYO Semiconductors

DATA SHEET

STK760-220A-E

Thick-Film Hybrid IC
Single-phase Rectification
PFC Hybrid IC

Overview

The STK760-220A-E is an average current control type hybrid IC that integrates in a single package the power stages for the step-up active converter and the control IC, and overcurrent/overvoltage protection circuits. It is designed to improve the power factor of single-phase AC power supplies.

Applications

- Power rectification for air conditioners and general-purpose inverters as a single-phase rectification active converter.

Features

- IGBT switching power device employed in the active converter output stage.
- On-chip regulator for PFC control supports a wide range of input voltage (up to 50V).
- Full complement of protection circuits, including overcurrent, overvoltage, and undervoltage protection, plus soft start function.
- Logic level PFC controlled ON/OFF control.
- On-chip light-load correction circuit that minimizes output voltage increase when no load is applied.
- SIP package providing a high degree freedom for mounting the IC in the set.

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STK760-220A-E

Specifications

Absolute maximum ratings at $T_c = 25^\circ\text{C}$

| Parameter | | Symbol | Conditions | Ratings | unit |
|---------------------------------|-----------------------------------|--------|--|-------------|-------|
| IGBT (TR2+TR3) | Collector-to-emitter voltage | VCES | | 600 | V |
| | Repetitive peak collector current | ICP | *1 | 180 | A |
| | Collector current | IC | | 70 | A |
| | Allowable power dissipation | Pd | | 166 | W |
| FRD (D2) | Diode reverse voltage | VRM | | 600 | V |
| | Repetitive peak forward current | IF2P | *1 | 160 | A |
| | Forward Current | IF2 | | 41 | A |
| | Allowable power dissipation | Pd | | 73 | W |
| FRD (D3) | Repetitive peak forward current | IFP | *1 | 15 | A |
| | Forward current | IF3 | | 7 | A |
| | Allowable power dissipation | Pd | | 13 | W |
| Supply voltage (Pin 1) | | Vs | | 21 to 50 | V |
| Supply current (Pin 1) | | Isc | | 60 | mA |
| Signal pin input voltage | Pin 5 | VVDET | | -0.3 to 5.0 | V |
| | Pin 12 | VEI | | | |
| | Pin 13 | VOVP | | | |
| | Pin 9 | VIS | | -10 to 5.0 | V |
| | Pin 4 | VONF | | -0.3 to VCC | V |
| Oscillation frequency | | fOSC | | 40 | kHz |
| Maximum AC input voltage | | VAC | Single-phase full-wave rectification waveform voltage | 264 | V |
| Maximum output voltage | | VO | Under the operating conditions of the application circuit | 450 | V |
| Input current (in steady state) | | IIN | Under the operating conditions of the application circuit. | 20 | Arms |
| Load power | | Wo | VAC=200V | 4 | kW |
| Chip junction temperature | | TJ | | 150 | °C |
| Operating case temperature | | Tc | Center of the resin package on the reverse side *2 | -20 to +105 | °C |
| Storage temperature | | Tstg | | -40 to +125 | °C |
| Tightening torque | | | M4 screws *3 | 1.17 | N • m |
| Dielectric strength voltage | | VINS | Sine wave, 50Hz, AC 1 minute *4 | 2000 | VRMS |

*1. Repetitive peak current with the duty ratio of $D=0.1$ and $t_p=1\text{ms}$.

*2. The measurement point must be within 10 millimeters square wide in the center of the resin package on the reverse side.

*3. The tightening torque must be within the range of 0.79 to 1.17N • m.
The flatness of the heat sink to be connected must be 0.15mm or less.

*4. Test conditions: AC 2500V for 1 second.

Electrical Characteristics at $T_c=25^\circ\text{C}$, $V_s=21\text{V}$ with the designated circuit

(Apply $V_{CC}=18.0\text{V}$ directly to pin 2 unless V_s input is specified.)

| Parameter | Symbol | Conditions | min | typ | max | unit | Test circuit |
|---|----------------------|--|-----|------|-----|---------------|--------------|
| Power output block | | | | | | | |
| Collector-to-emitter cutoff current (TR2+TR3) | ICES | $V_{CE}=600\text{V}$ | | | 200 | μA | Fig.1 |
| Collector-to-emitter saturation voltage (TR2+TR3) | $V_{CE}(\text{sat})$ | $V_{CC}=18.0\text{V}$, $I_C=40\text{A}$ | | 1.9 | 2.4 | V | Fig.2 |
| Diode reverse voltage (D2) | IR | $V_R=600\text{V}$ | | | 100 | μA | Fig.1 |
| Diode forward voltage (D2) | VF | $I_F=40\text{A}$ | | 2.1 | 2.6 | V | Fig.3 |
| Diode forward voltage (D3) | VF | $I_F=5\text{A}$ | | 2.5 | 3.5 | V | Fig.3 |
| Junction-to-case thermal resistance | θ_{j-c1} | IGBT (TR2+TR3) | | 0.75 | | °C /W | |
| | θ_{j-c2} | FRD (D2) | | 1.7 | | °C /W | |
| | θ_{j-c3} | FRD (D3) | | 9.0 | | °C /W | |

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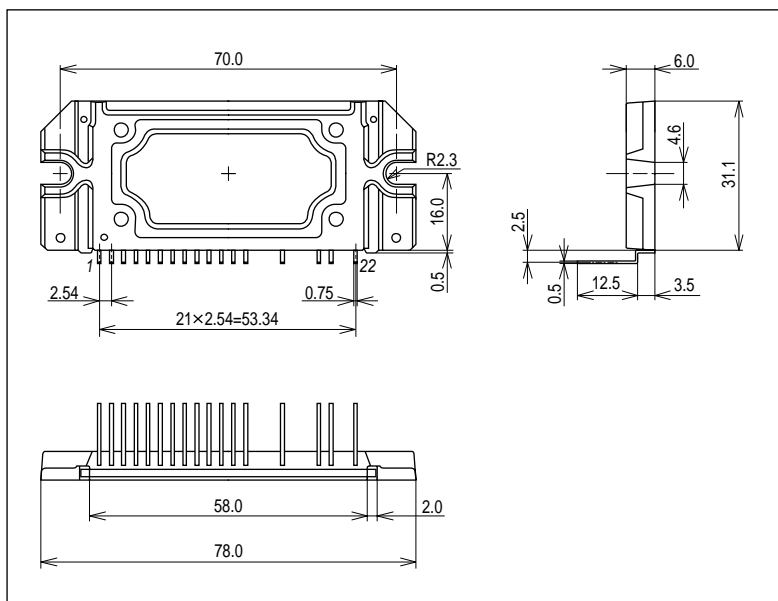
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| Parameter | Symbol | Conditions | min | typ | max | unit | Test circuit |
|--|-----------------------|---|-------|-------|-------|------|--------------|
| V_{CC} regulator block | | | | | | | |
| V _{CC} regulator output voltage | V _{CC} | V _s =21V, I _{CC} OUT=0 to 40mA | 17.9 | 18.7 | 19.6 | V | Fig.4 |
| Control IC block | | | | | | | |
| Control circuit current dissipation | I _{CC} (ON) | V _{CC} =18.0V, ONF=5V | | 7 | 11 | mA | Fig.5 |
| | I _{CC} (OFF) | V _{CC} =18.0V, ONF=0V | | 0.06 | 0.5 | mA | |
| Reference voltage | V _{REF} | V _{CC} =18.0V, ONF=5V | 4.75 | 5.0 | 5.25 | V | Fig.5 |
| Oscillation frequency | f _{OSC} | V _{CC} =18.0V, ONF=5V | 21 | 25 | 28 | kHz | |
| Overcurrent protection input threshold voltage | V _{THOCP} | V _{CC} =18.0V, ONF=5V | -1.20 | -1.10 | -1.00 | V | Fig.6 |
| Voltage error amplifier reference voltage | V _r | V _{CC} =18.0V, ONF=5V | 1.509 | 1.55 | 1.591 | V | |
| OVP threshold voltage | V _{THOVP} | V _{CC} =18.0V, ONF=5V | 1.607 | 1.64 | 1.673 | V | Fig.7 |
| SS charge current | I _{CHG} | V _{CC} =18.0V, ONF=5V | | 11 | | μA | |
| SS input threshold voltage | V _{THSS0} | Duty cycle=0% | | 0.34 | | V | |
| | V _{THSSM} | Duty cycle=D _{MAX} | | 3.4 | | V | |
| ON/OFF threshold voltage | V _{THON} | V _{CC} =18.0V | 3.5 | 3.95 | 4.4 | V | Fig.8 |
| | V _{THOFF} | V _{CC} =18.0V | 2.4 | 2.8 | 3.2 | V | |
| Startup V _{CC} voltage | V _{THUON} | ONF=5V | 15.5 | 16.5 | 17.5 | V | Fig.9 |
| Shutdown V _{CC} voltage | V _{THUOFF} | ONF=5V | 8.2 | 8.9 | 9.6 | V | |
| Power output block | | | | | | | |
| Switching time | t _{ON} | I _C =30A, Inductive load | 0.2 | 0.35 | 0.8 | μs | Fig.10 |
| | t _{OFF} | | | 0.85 | 1.4 | μs | |
| | t _{rr} | | | 0.04 | | μs | |
| Diode recovery current (D2) | I _{rr} | | | 20 | | A | |
| Application circuit operation: Set to V _{AC} =200V, and V _O =380V. | | | | | | | |
| Power factor | cosφ | W _o =400W | 0.9 | 0.95 | | | Fig.11 |
| | | W _o =2kW | 0.98 | 0.99 | 1.0 | | |

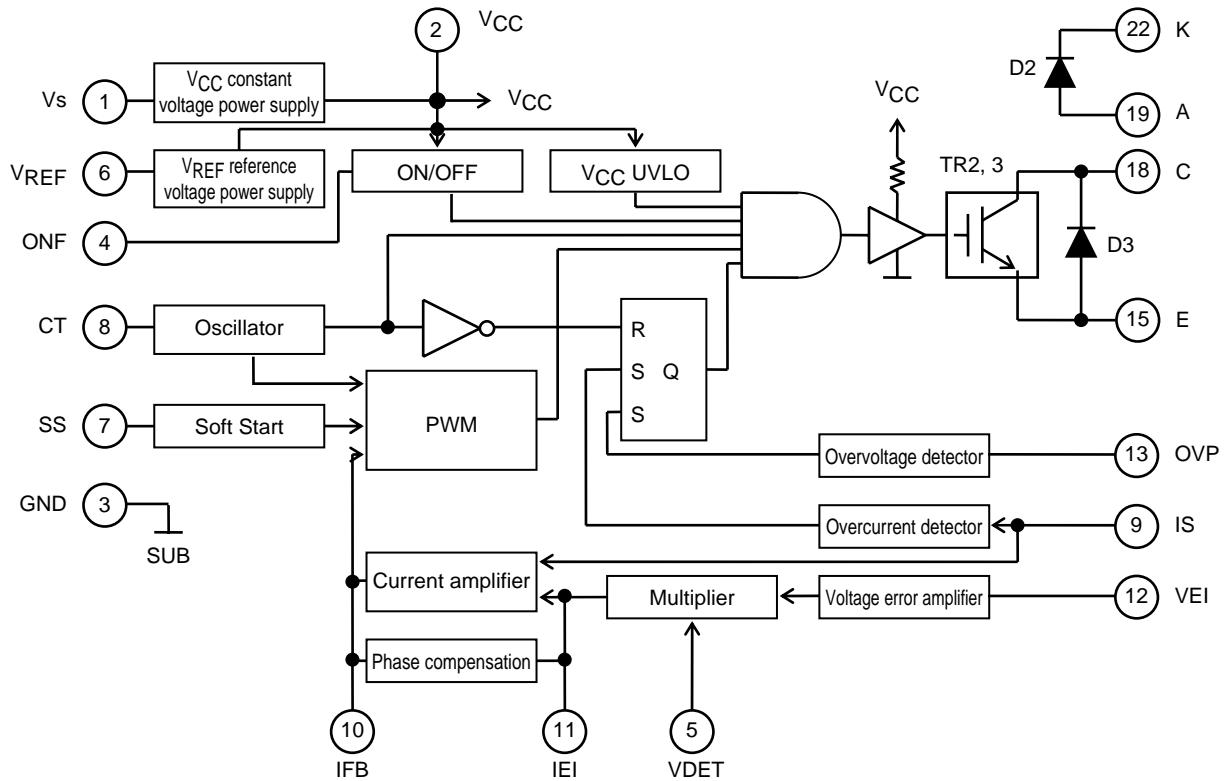
Package Dimensions

unit:mm (typ)



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Block Diagram



Pin Functions

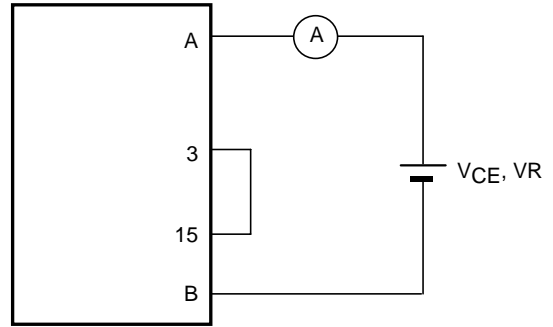
| Pin No. | Pin Name | Description |
|---------|----------|---|
| 1 | Vs | Operating supply voltage (+18V Reg. input) |
| 2 | VCC | +18V VCC power supply output |
| 3 | GND | GND pin |
| 4 | ONF | ON/OFF control pin |
| 5 | VDET | Multiplication input |
| 6 | VREF | +5V reference voltage output |
| 7 | SS | Soft start pin |
| 8 | CT | Operating frequency setting pin |
| 9 | IS | Current detection signal |
| 10 | IFB | Phase compensation (current amplification output) |
| 11 | IEI | Current amplification input |
| 12 | VEI | Output voltage control input |
| 13 | OVP | Overvoltage limiting |
| 14 | - | No connection |
| 15 | E | TR2, 3 (IGBT) emitter |
| 16, 17 | - | No connection |
| 18 | C | TR2, 3 (IGBT) collector |
| 19 | A | D2 (FRD) anode |
| 20, 21 | - | No connection |
| 22 | K | D2 (FRD) cathode |

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Test Circuit

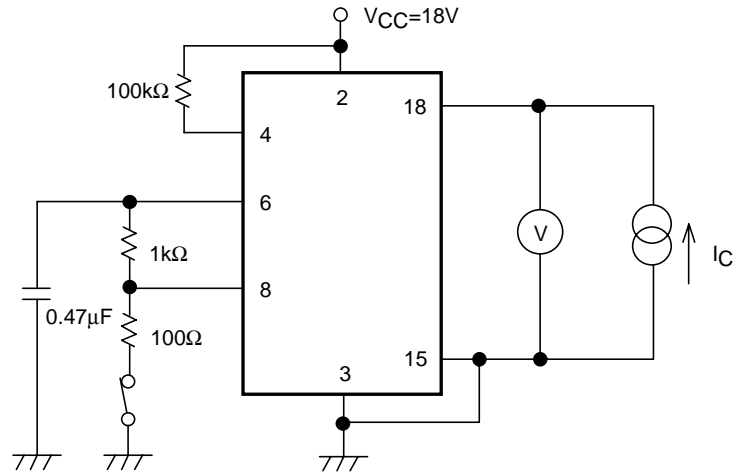
1: IR, ICES

| | | |
|---|-----|----|
| | TR1 | D2 |
| A | 18 | 22 |
| B | 15 | 19 |



<Fig.1>

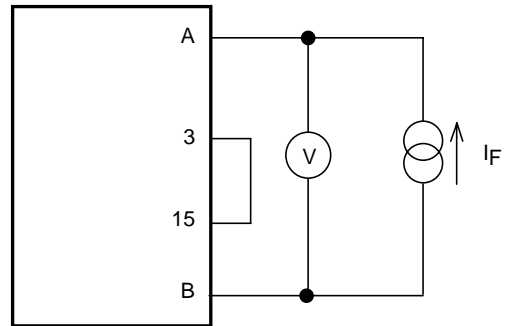
2: V_{CE(sat)} (Test by pulse)



<Fig.2>

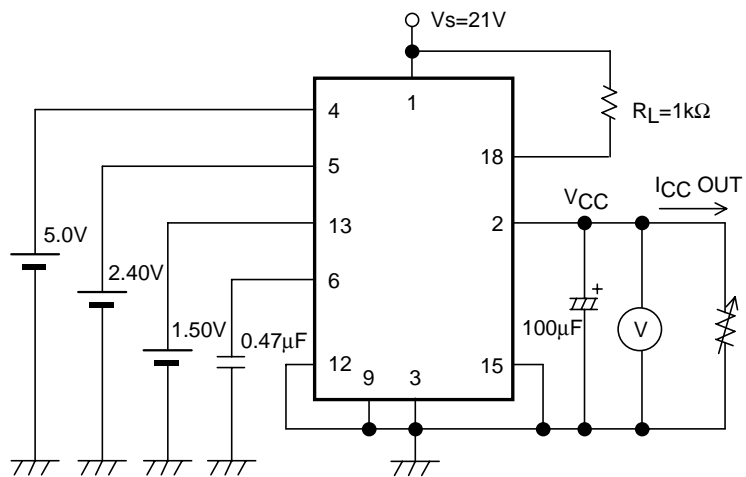
3: V_F (Test by pulse)

| | | |
|---|----|----|
| | D2 | D3 |
| A | 19 | 15 |
| B | 22 | 18 |



<Fig.3>

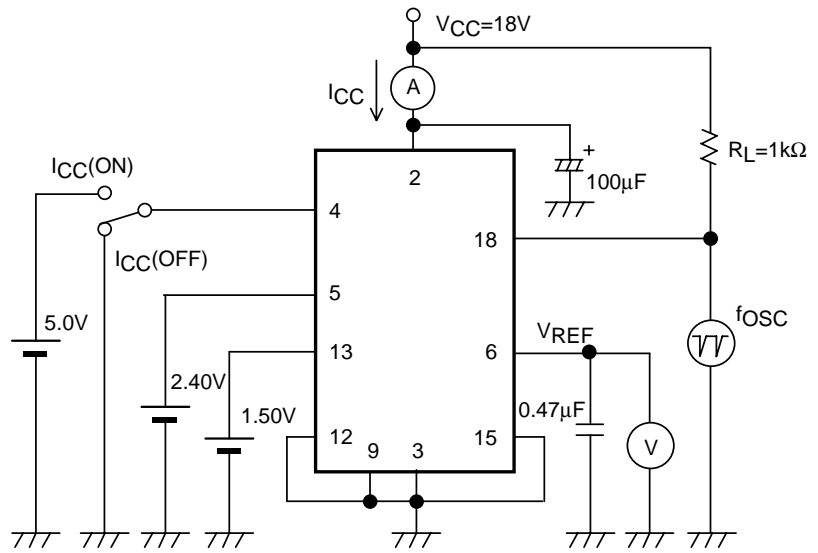
4: V_{CC} (V_{CC}-Reg.OUT)



<Fig.4>

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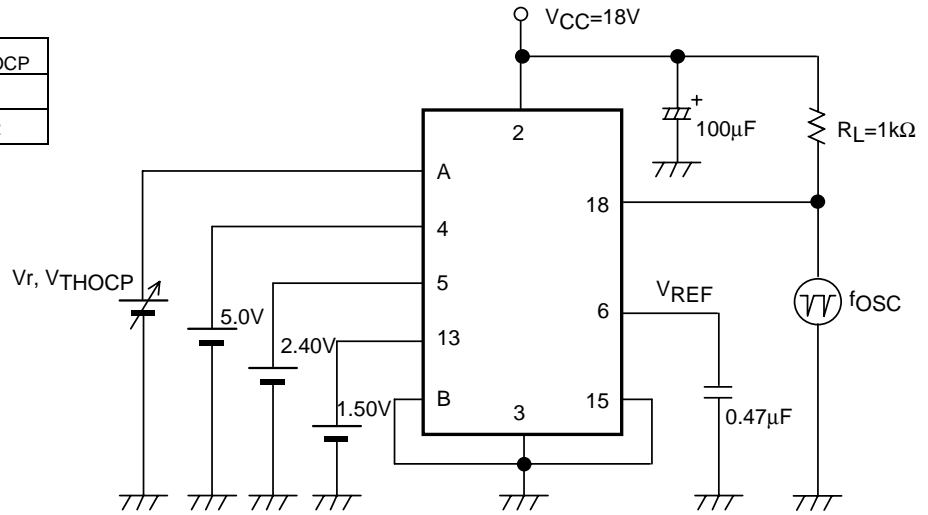
5: $I_{CC(ON)}$ / $I_{CC(OFF)}$, V_{REF} , f_{OSC}



<Fig.5>

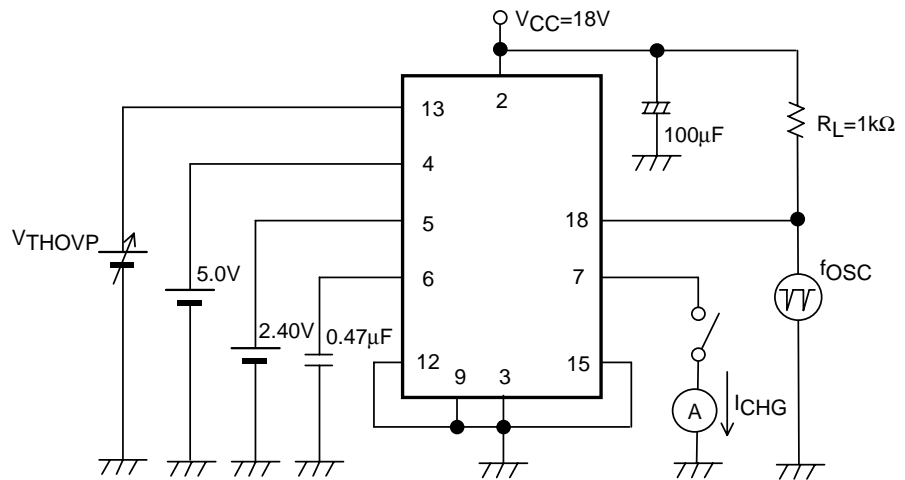
6: V_r , V_{THOCP}

| | V_r | V_{THOCP} |
|---|-------|-------------|
| A | 12 | 9 |
| B | 9 | 12 |



<Fig.6>

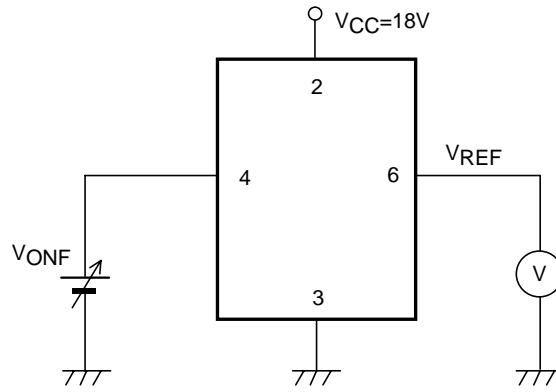
7: V_{THOVP} , I_{CHG}



<Fig.7>

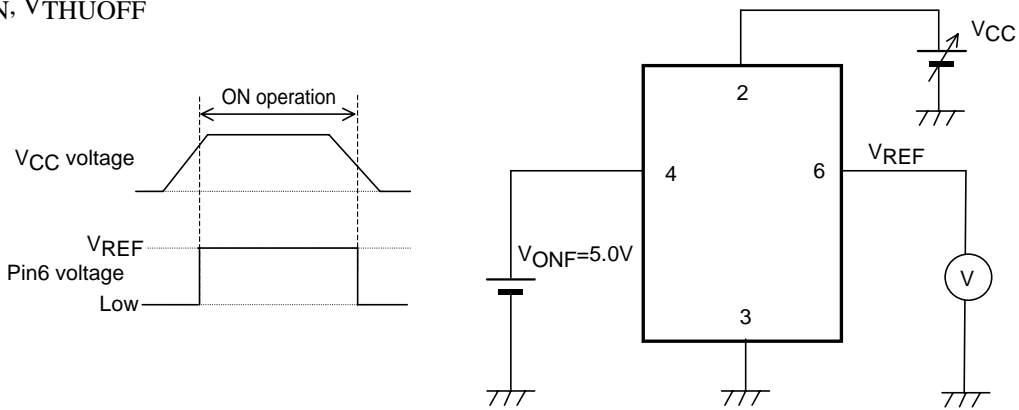
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8: V_{THON} , V_{THOFF}



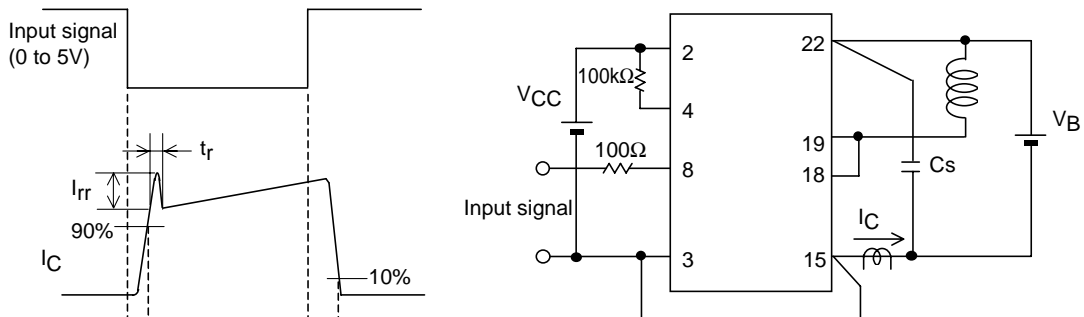
<Fig.8>

9: V_{THUON} , V_{THUOFF}



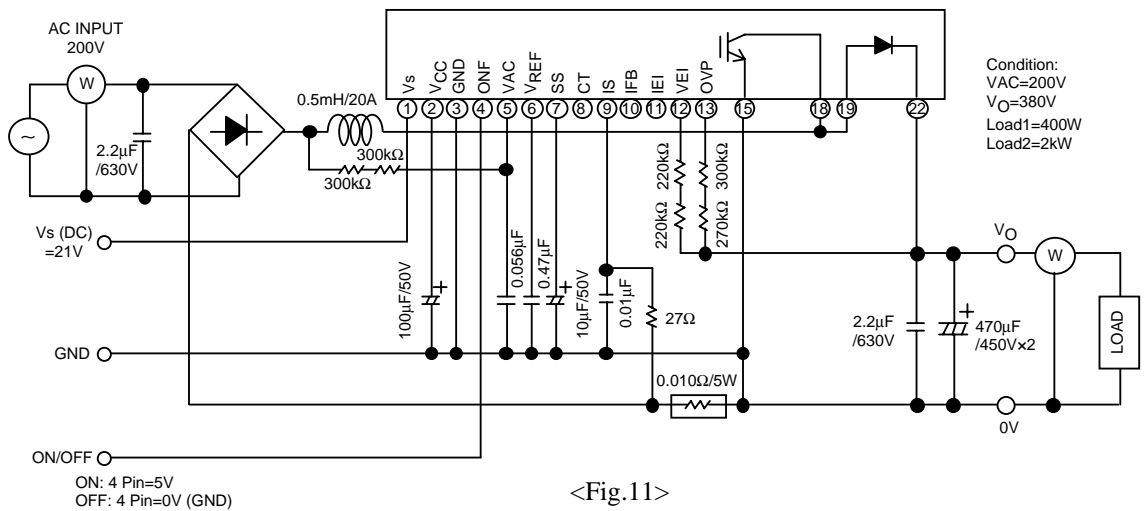
<Fig.9>

10: t_{ON} , t_{OFF} , t_{rr} , I_{rr}



<Fig.10>

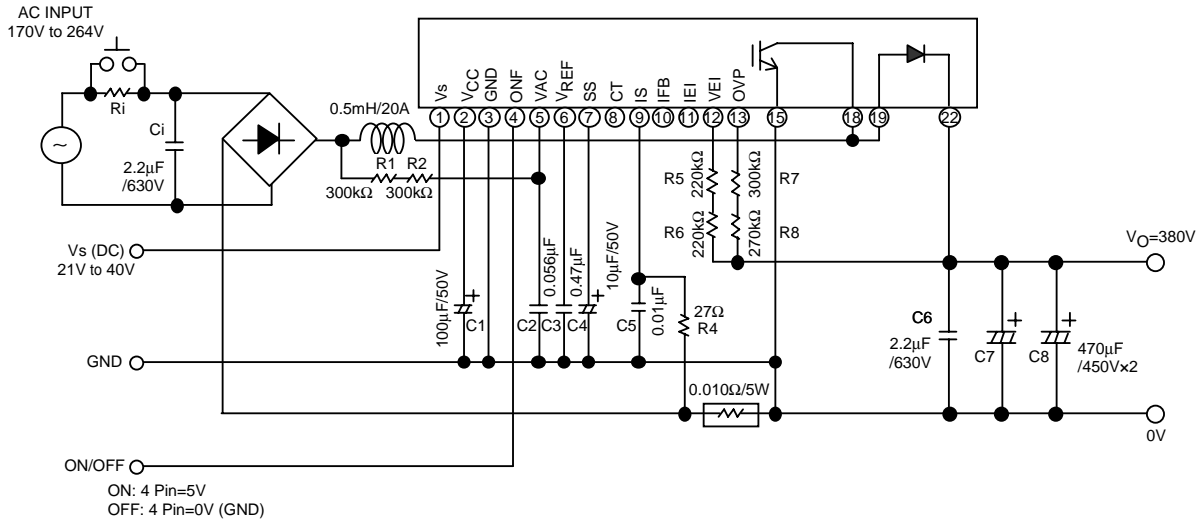
11: Power factor (COS ϕ)



<Fig.11>

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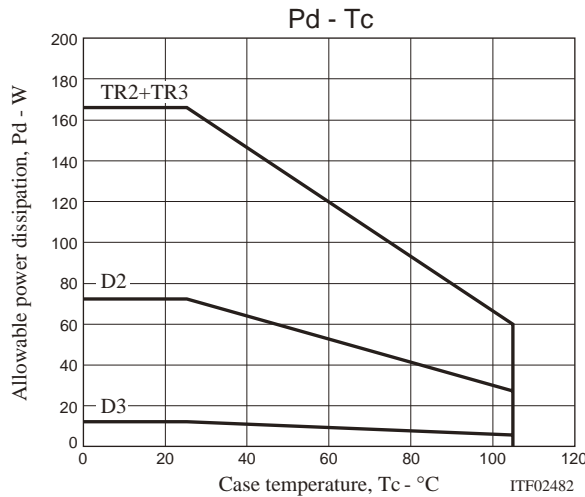
Sample Application Circuit



* When using the IC in a system having an input power voltage of 200V, insert a rush current limiting circuit, which consists of a limiting resistor R_i and a switch, to prevent the internal diodes from being damaged by the charging current from the output capacitor

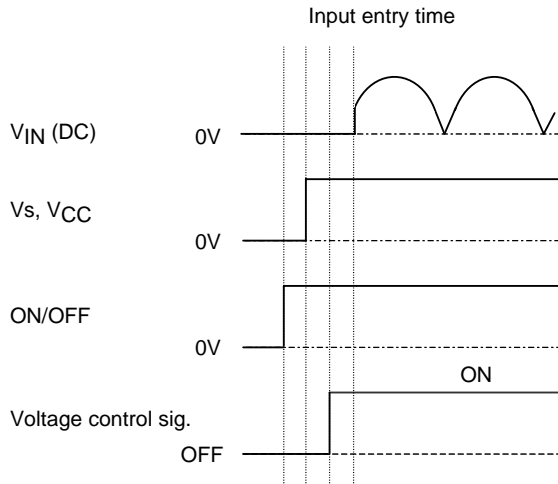
Recommended conditions

| Parameter | Symbol | Conditions | Recommended values | unit |
|--------------------------------------|----------|------------|---|------|
| Commercial AC voltage | VAC | 50/60Hz | 170 to 264 | Vrms |
| Output voltage | V_O | | $V_{AC} \times \sqrt{2} + (10 \text{ to } 15) \leq 450$ | V |
| Output overvoltage detection voltage | V_{OV} | | $V_{OUT} + (10 \text{ to } 20)$ | V |
| Supply voltage (Pin 1) | Vs | | 21 to 40 | V |

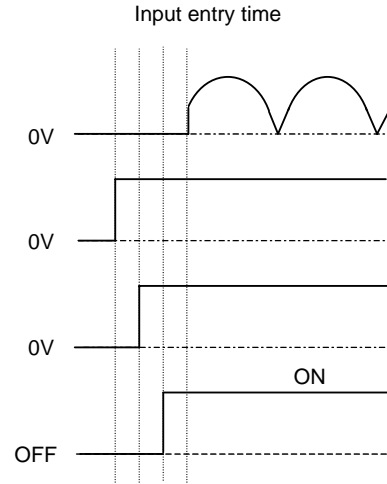


Timing Charts

The IC will never be subjected to fatal damage when a power supply input or signals are applied or are not applied at any timing. If the V_{IN} (DC) input is applied to the IC at the timing shown in Figure 12 or 13, however, since the soft start circuit is inactive in this case, it is likely that the overcurrent protection circuit is activated and audible tone is generated out of the coil. To avoid this area of timing, it is necessary that the ON/OFF or V_{CC} input be applied after V_{IN} (DC).



<Fig.12>



<Fig.13>

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