# Solid State Relay (SSR)
# User Manual

Before using the product, please read this manual.

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# SOLID STATE RELAY (SSR)

## 1. Guidelines for Safety

● Guidelines for safety is to use product safe and properly and prevent accidents or dangers. Never forget to keep it.

● Guidelines can be classified into two, warning and caution, and their meanings are as follows.

| ⚠ **Warning** When there is the possibility that serious injury or death can occur when violating directions. |
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| ⚠ **Caution** When there is the possibility that slight injury or the damage of products can occur when violating directions. |
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| ● The meaning of ⚠ lexigram indicated on the products and instructions is to handle with care as any danger can occur under specific conditions. |
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| ⚠ Warning |
| --- |

1. When using in instruments that have great influence on lives or properties(for examples: nuclear energy control, medical equipment, vehicles, railroad, aviation, combustion apparatus, entertainment systems or safety device), use after being sure to attach duplex safety device.
- There may be fire, loss of lives, or property damages.
2. Use after being sure to attach to panel, and ground FG or terminal.
-There may be the possibility of electric shock.
3. Don't connect, inspect and repair under the power-up.
-There may be the possibility of electric shock.
4. Don't remodel products except by the company's engineers.
-There may be the possibility of fire or electric shock.
5. Be sure to check input power source options, and connect after checking terminal number when connecting power sources.
-There may be the possibility of fire.
6. Don't touch the terminal of load side immediately after power source is cut off.
-There may be the possibility of electric shock.

| ⚠ Caution |
| --- |

1. Don't use outdoors (for outdoor, separate order) -It can be a cause of product's life becoming short, and there may be the possibility of electric shock.
2. When connecting power source and load wiring, pay attention to the thickness of cables according to load current.
-There may be the danger of fire if the thickness of cables is small for the current.
3. Tighten the screw of port by the regulated torque.
The regulated torque - M3.5 : 0.6~1.2N(6~12kgf.cm), M4 : 1.3~1.5 N(10~14Kgf.
cm), M5 : 2.1~3.0N(21~30kgf.cm) M8 : 10.6~12.5N(108~127kgf.cm), M12 :
35.7~42N(364~428kgf.cm), M14 : 57.8~68N(590~693kgf.cm) -If the screw comes loose,

there may be the possibility of fire because of bad contact.
4. Be sure to use within the range of rating and performance.
-Product's life is shortened, and it may be a cause of troubles.
5. Don't use water or organic solvent when cleaning.
-There may be the possibility of electric shock, fire and product deformation.
6. Don't install or operate in places with inflammable gas, explosive gas, direct ray of light, radiation heat, vibration and shock.
-There may be the possibility of troubles and fire.
7. Make sure that harmful conductors such as dust or fragments of cables may not be flowed into the inside of product.
-There may be the possibility of trouble or fire.
8. Don't use this product where closed and not ventilated place - It may cause a fire and the damage to product.
9. Never touch during operation as there is superheat on the radiator board.
10. Dispose as industrial waste when discarding products.

## 2. Items to be verified and approved when ordering products

Dear customers who purchase Woon Young products!
Thank you for purchasing Woon Young products.
If there is no particular information on estimates, contracts or specifications when you order products from this catalog, the following conditions of use and warranty shall apply. Please place orders after you read and approve the following items.
1. Content of Warranty
① Warranty period The warranty period of this product shall be 1 year from the date of purchase or from the day the product is delivered to a designated place.
② Scope of warranty If failure occurs due to reasons attributable to this company during the above-said warranty period, this company will provide substitute products or repair the product free of charge at the place of purchase. However, if the cause of failure is one of the following, it shall be excluded from being eligible for warranty benefits.
a) Products were handled or used under the conditions and environmnt not entered in this catalog or in specification.
b) Failure occurred due to reasons other than those caused by this product.
c) Failure occurred due to modification or repairs performed by persons other than this company.
d) Failure occurred because the product was used based on the method other than the original usage of this product.
e) Failure was not expected by the scientific and technical levels prevailing at the time of shipment.
f) Failure occurred due to causes beyond the control of this company, e.g. natural disasters and accidents.
Warranty as specified herein means the warranty covering only the product of this company, and any damage caused by the failure of this product shall be excluded from being eligible for warranty coverage.
2. Limitations on responsibility
① This company shall not be held liable whatsoever for any special damage, indirect damage or passive damage caused by this product of this company.
② This company shall not be held liable whatsoever for any programming performed by persons other than this company on the programmable products or for the results of such programming.

# SOLID STATE RELAY (SSR)

3. Conditions of compatibility

① Please check the standards, laws and regulations applicable when this product is used in combination with other products.

In addition, be sure to check the compatibility of this product covering the systems, machines and devices used by you.

If you fail to take actions as above, this company shall not be held liable for the compatibility of the product.

② If the product is used for the following purposes, discuss details with the sales manager of this company based on the provided specifications. At the same time, allow sufficient rating and performance, or take appropriate safety measures through the safety circuits that can minimize risks even if failure occurs.

a) Using the product outside or under environment exposed to potential chemical pollution or electric interference, or using the products under the conditions or environment not specified in this catalog.

b) Nuclear controllers, incinerators, railways, aviation, vehicles, medical equipment, semiconductor manufacturing equipment, game machines, safety devices and equipment regulated by administrative agencies or individual maker.

c) Systems, machines and devices that can cause personal or property damage.

d) Equipment requiring high degree of reliability, e.g. gas, water and electricity supply systems, and 24-hour continuous operation systems.

e) Automobile (Including two-wheeled vehicles) mounted equipment f) Other purposes equivalent to the above-said paragraph a) through e) requiring high degree of safety.

③ If the product is used for purposes that might induce serious personal or property damage, be sure that you inform risks covering the entire system in advance or verify whether the product is designed to ensure required safety or whether the product is properly connected and installed to suit the intended overall purposes

④ The purposes of the products shown in this catalog are only for reference purposes. Apply such purposes only after you check the functions and the safety of the equipment and devices.

⑤ To prevent unexpected damage to you or to third parties resulting from improper use of this product, be sure to use the product after you thoroughly read and understand items related to prohibitions and caution during use.

4. Changing specifications

The products and specifications entered in this catalog are subject to change as needed for improvement or for other reasons. Discuss with the sales manager of this company and verify actual specifications of the products.

5. Range of service

The product prices do not contain any service expenses, e.g. dispatch of technicians. If you need any services, discuss with the sales manager of this company.

6. Scope of application

Items described above are on the premise that the products are traded and used in the Republic of Korea. Discuss with the sales manager of this company regarding overseas transactions and uses.

# SOLID STATE RELAY (SSR)

## 3. Installing SSR and Cautions

•SSR installing spacing (Panel installing conditions)
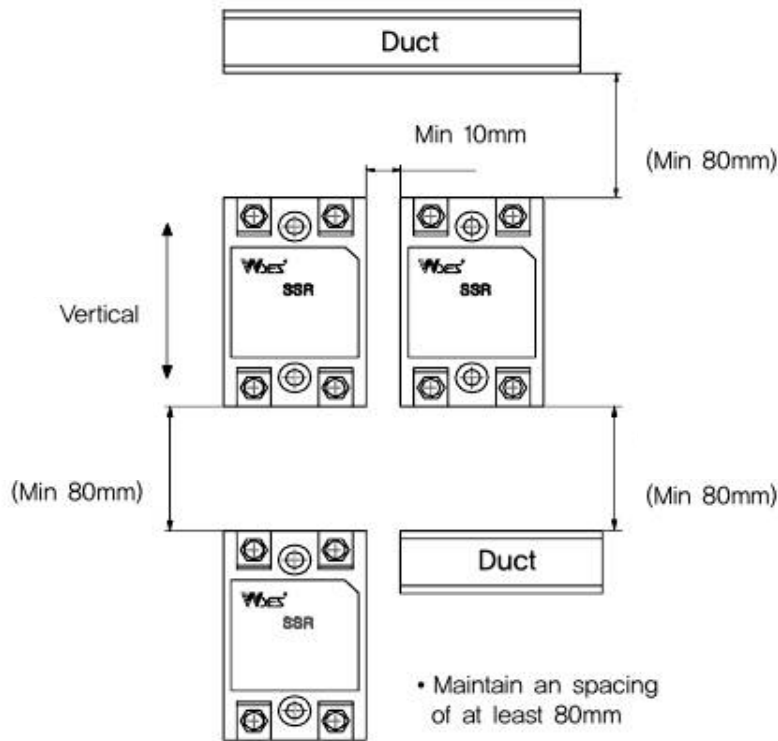


•Relation between SSR and duct (Duct height)



| Bad | Good 1 | Good 2 |
|---|---|---|

Heat radiation becomes unsatisfactory if the top and bottom are covered with duct.

Install ducts low.

If the duct cannot installed low, install a support (metal) to avoid ducts from covering SSR.

# SOLID STATE RELAY (SSR)

•How to air out the control panel



※ If filters are installed on the air inlet or exhaust port, clean them periodically to prevent deterioration of efficiency resulting from clogged filters.
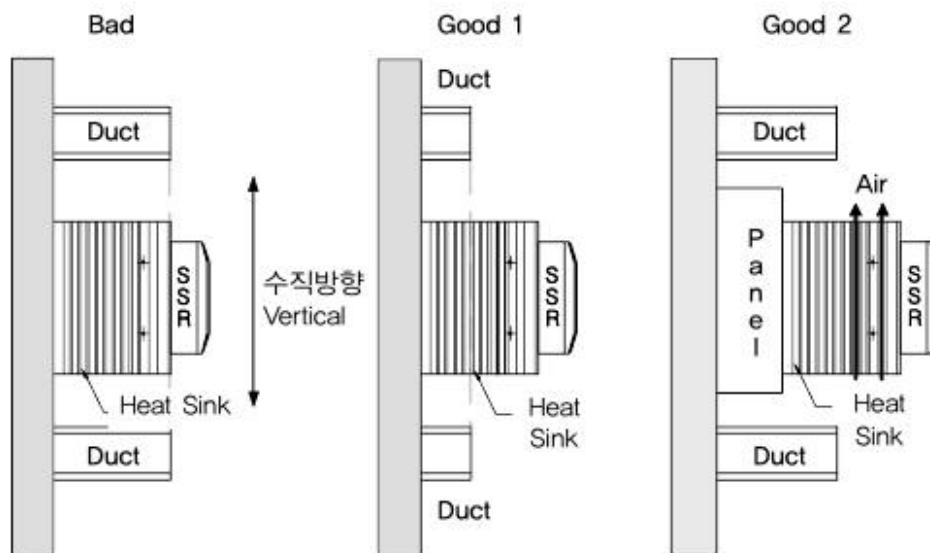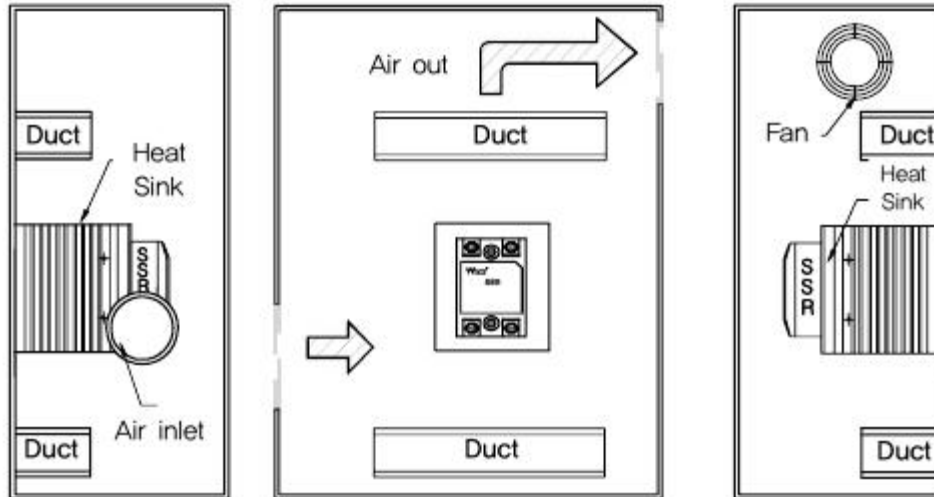
※ Do not place any articles in and outside the area to prevent interference with the air inlet or exhaust port.

※ For more effects, install heat exchanger (Air-conditioner) in front of SSR.

● Lower the ambient temperature of SSR The rated current is the value calculated at SSR's ambient temperature of 40°C.

● Since SSR opens or closes load with the semiconductor device, it is heated when power is connected and the temperature inside the panel also rises. This heat is ventilated by adding fans to the control panel. Reliability is improved if SSR's ambient temperature is reduced.

(If temperature is reduced by 10°C, the expected life is doubled.)

● Standard for installing fans

## 3 Phase

| SSR Rating(A) | 10A | 20A | 30A | 40A |
|---|---|---|---|---|
| SSR Fan/EA | 0.70 EA | 1.17 EA | 1.63 EA | 2.09 EA |

## 1 Phase

| SSR Rating(A) | 10A | 20A | 30A | 40A |
|---|---|---|---|---|
| SSR Fan/EA | 0.47 EA | 0.78 EA | 1.09 EA | 1.40 EA |

Example :

Since the formula is 1.63 x 10 = 16.3 when there are 10 units of 30A (3-phase) SSR, 17 units of fan are needed.

※ Fan size : 92mm x 92mm, Airflow : 0.7m 3 /min, Panel's ambient temperature : Calculated at 30°C

※ If there are other types of heated equipment inside the same panel, separate ventilation is required.

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● Heat sink and thermal grease
• When SSR is installed on the heat sink, apply heatdissipating silicon grease (Toshiba silicon YG6111 or Shin Etsu silicon G746) to the installing surface.
• To prevent abnormal heating, tighten bolts to prescribed torque when installing SSR on the heat sink. Tightening torque : 2.0N.m
● About the conditions of use
• Do not allow flow of current in excess of the rate level as it causes abnormal heating.
• Take caution about the rise in ambient temperature resulting from self-heating. If the product is installed inside the panel, install fans as shown in the figure on the left side to allow sufficient ventilation with the outside air.
● About tightening bolts
• Tighten SSR bolts up to prescribed torque to prevent Errors.
• Do not use the product with the bolts on the output terminal loose. It may lead to fires caused by abnormal heating of the terminals and internal heating.

| Terminal | BOLT | Recommended Torque |
|----------|------|--------------------|
| Input | M3.5 | 0.59 ~ 1.18N.m |
| Output | M4 | 0.98 ~ 1.47N.m |
| | M5 | 1.47 ~ 2.45N.m |
| | M6 | 4.41 ~ 4.90N.m |
| | M8 | 8.82 ~ 9.80N.m |

## ⚠ Safety caution

The semiconductor device is heated when current flows, and this heat is indicated as Heat $[W]=1.6[V]\times$Load current$[A]$ (3-phase x 3). SSR users therefore must install a means that effectively cools this heat produced while power is connected and maintain a temperature at which the semiconductor device can safely be operated. Observe the following to ensure safety:
1. Do not apply voltage or current exceeding the rate levels to the terminals of SSR.
2. Apply electrically, mechanically and physically satisfactory design considering safety to prevent human accidents, fires or social damage resulting from SSR failure.
3. To prepare against contingencies, pay particular attention to safety design, e.g. anti-burning design and anti-error design.
4. Do not allow instantaneous short circuit current to flow to SSR as it may induce the device to be short-circuited or damaged, or product may be ruptured.
5. Be sure to install quick-acting fuses of rated current between SSR and power supply.
6. Do not interfere with the air convection in the vicinity of SSR and the heat sink as it may lead to abnormal heating.
7. Never place heating elements, e.g. thermal relays in the vicinity of SSR as it may reduce life at a fast speed and/or induce fires.

# SOLID STATE RELAY (SSR)

## 4. Over view of SSR

4-1 Characteristic

(1) Complete solid state relay

Contact point is operated by electronics rather than mechanical motions by electronic power from relay of coil and ARC, chattering and bounce occurred in general relay do not exist.  On top of that, it obtains high reliability and long duration and does not create the noise from motion because of resin molding on its exterior.  It has been recently able to be manufactured by assembly so that major parts are able to be exchanged when necessary.

(2) Photo isolation

Noise on the load is not transmitted to the input part out of insulation between input and output by use of photo coupler at the circuit for electric insulation of input and output in relaying.

(3) Motions with small signal

Since input signal is operated by small current and small voltage because of photo coupler in comparison with general relay, it can be directly operation by small signal such as TTL-IC and other Linear IC etc.

(4) Zero cross, random cross, switching

Since motion trigger of major electronics occurs around zero voltage of alternating current, it starts at about zero voltage though input signal occurs during cycle. It does not place a fatal impact on IC, MICOM and other electronic device because existing switching noise, excessive current and thrust current are extremely restricted. Circuit of random cross type operates at high speed immediately up on receipt of signal.

(5) Constant current circuit input

Constant current regardless of voltage is contained at the input.

(6) Small sized product and easy to handle

Huge electric force opens and shuts with small sized scale.  With regard to the figure, there are types to which print plate is affixed and that of plateand socket type.

(7) High performance under the environment

It is a humidity free since it is tightly sealed by use of incombustible resin as well as explosion free at the place of dangerous goods so that it performs highly under the surroundings.

(8) Metal Bonding Method

SSR Products are applied the highest quality metal bonding process about combining a main device and a heat sink. It remases heat of a device so reliability of our products to other companies is hegher than the 30%.

4 - 2. Category

| INPUT | OUTPUT | OUTPUT KIND | TRIGGER CIRCUIT | SOURCE (POWER LINE) | CONTACT(A) | SHAPE |
|---|---|---|---|---|---|---|
| · DC Input<br>· AC Input | · AC Contact | · 1Ø<br>· 3Ø | · Zero Cross Trigger<br>· Random Trigger | · 90–240VAC<br>· 90–480VAC | · 1A–3A<br>· 10A–150A | · PCB Insert Type<br>· Heat Sink Type |
| · DC Input | · DC Contact | · DC Line | · On/Off Trigger | · 200–1200VDC | · 1A–3A<br>· 5A–400A | · PCB Insert Type<br>· Heat Sink Type |
| · DC Input | · AC/DC<br>Free Contact | · AC/DC<br>Free Line | · On/Off Trigger | · 5~240VAC/DC | · 0.6A<br>· 1.2A | · PCB Insert Type<br>· Socket Type |
| · DC Input<br>· AC Input | · AC Contact<br>2 Circuit<br>· DC Contact<br>2 Circuit | · AC Line<br>· DC Line | · Zero Cross Trigger<br>· Random Trigger<br>· On/Off Trigger | · 50~240VAC<br>· 5~240VDC | · 1A | · PCB Insert Type<br>· Socket Type |

# SOLID STATE RELAY (SSR)

4 - 3. Structural Feature

| STRUCTURE FEATURE | | CHARACTER |
|---|---|---|
| Isolate Part | Photo Transistor Type | · Larger range of trigger signal. <br> · Low current of input signal. |
| | Photo Transistor Type (SCR, TRIAC) | · Small range of trigger signal. <br> · Confidence profitable. |
| | Photo Voltaic Diode | · Mos FET Drive |
| Trigger Circuit | Zero Cross Type | · Low noise of on switching noise. <br> · Inrush current restraint to on time. |
| | Random Type | · High speed switching possible. <br> · Can use phase control. |
| CR Snubber | Inner Case Type | · Leakage current many happened. |
| | Out Case Type | · Can useful choice of load. <br> · Option constant "Condenser and resisior" determine. |
| Source | AC Type | · Application is various <br> · AC type and respond time quickly. |
| | DC TYPE | · Can use DC source. <br> · Respond time is very quickly. |
| Structure | Useful by PCB | DIP TYPE | · Height is low. |
| | | Single in line Type | · Can use PCB profitable PCB Art−working. |
| | Heat Sink Type | | · Load current is heavy. <br> · Can use heat sink. |

4 - 4. Function of circuit and basic motions

(1) The structure of circuit
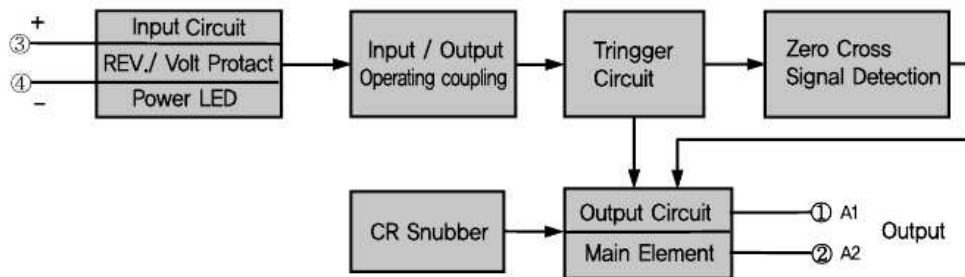


(Fig1) SSR Basic Block Diagram

(2) The function of the circuit
• Operating coupling : it indicates restriction of input current and input motions.
• Photo circuit : it delivers insulation and current through photo coupler between input and output.
• Trigger circuit : on-off trigger major electronics after receipt of input signal.
• Circuit of signal detection : detect zero cross and random on-off signal at the AC supply.
• Output circuit : electronics of Main Element receives trigger signal and on-off the electric source.
• CR Snubber : it absorbs an excessive electric source so that trigger circuit and Main Element operate normally.
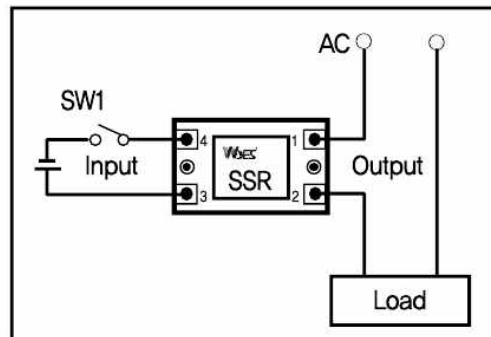


(Fig2) Typical Application of SSR

# SOLID STATE RELAY (SSR)

(3) Basic motions
• Connect load and alternating power source at output terminal 1 and 2 by closing circuit as manifested in Picture 2.
• When there is no direct current in input terminal 3 and 4, main element is off and current does not operate.
• When input signal is apply, main element is on at about zero and current operates at the load as LED turn on and optical coupling circuit operates by zero cross trigger circuit.
• When input signal is off, main element off as load current is below sustaining current of main element and motion of basic relay operation.

(4) Waveform of basic motions according to the type of load
• SSR motions is implemented by terminal voltage of main element (voltage between output terminals of SSR).
• This terminal voltage varies according to the type of load, and condition of motions of load. There are three types of load such as resistance load, inductive load and capacitive load etc.
largely speaking and wave type of motions according to load are as following.

4 - 5. Basic waveform according to the status of load
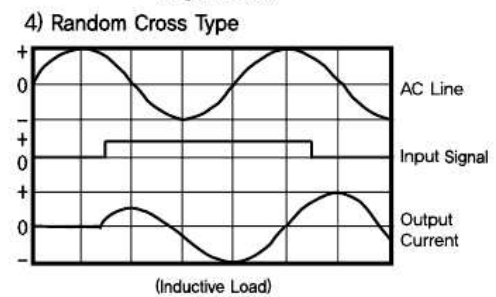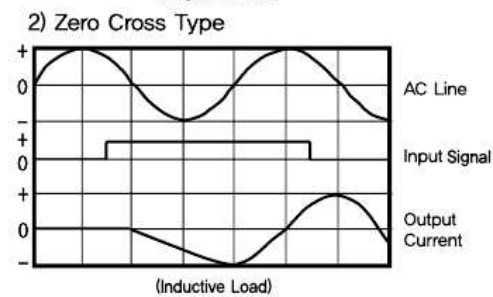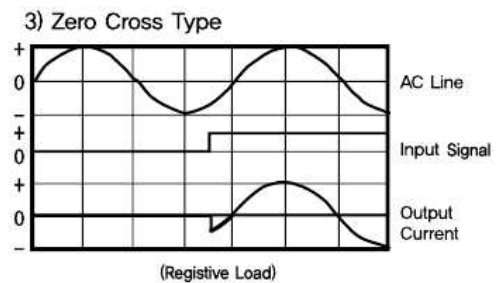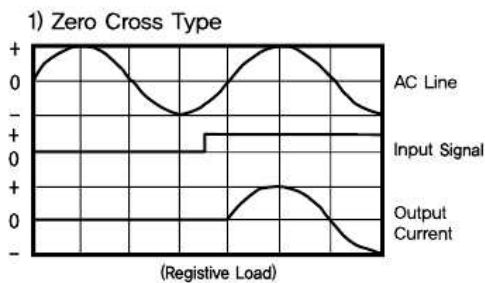
# SOLID STATE RELAY (SSR)

4 - 6. Application
SSR is being applied to the extensive and various areas such as general relay because of high performance under the environment.
(1) Applications and uses of SSR

| APPLICATION FIELD | APPLICATION PRODUCTION | MAIN APPLICATION (LOAD) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | SOLE-NOID | MOTOR | HEATER | INCANDESCENT LAMP | NOCTILU-CENCE | INTER-FACE | POWER |
| Traffic Controller | · Traffic Signal, | | | | ○ | | | |
| | · Railroad Signal | | | | ○ | | | |
| | · Electric Light | | | | ○ | | | |
| | · Station Equipment | ○ | ○ | | ○ | ○ | | ○ |
| Controller | · Sequence Cecontroller | | | | ○ | | ○ | |
| | · Press Controller | | | | | | | ○ |
| | · NC Controller | ○ | ○ | | | | | ○ |
| | · Voltage Regulator | | | | | | | |
| | · Electric Furnace | | ○ | ○ | | | | |
| | · Temperature Machine | | ○ | ○ | | | | |
| Machine Tools | · NC Machine | ○ | ○ | | | | | ○ |
| | · Program ON/OFF CONT. | ○ | ○ | ○ | | | | ○ |
| | · General Machine Tools | ○ | ○ | | | | | |
| Office Works | · Copying | ○ | ○ | ○ | | | | ○ |
| | · Facsimile | | ○ | ○ | | | | |
| | · Computer | ○ | ○ | | | | ○ | |
| | · Electronic Register | ○ | ○ | | | | | ○ |
| Household Electric Product | · Air Conditioner | | ○ | | | | | |
| | · Refrigerator | | ○ | ○ | | | | |
| | · Electric Motive TOOLS | | ○ | | | | | |
| | · Electric Sewing Machine | | ○ | | | | | |
| ETC. | · Resin Shape Tools | ○ | ○ | ○ | | | | |
| | · Water Level Dection Tools | ○ | ○ | | | | | |
| | · Emergencesource | ○ | ○ | | | ○ | | |
| | · Elevator | ○ | ○ | | | | | |
| | · AUTO, Door | ○ | ○ | | | | | |
| | · Phenomenon Machine | ○ | ○ | ○ | | ○ | | |
| | · Medical Appliances | ○ | ○ | | | | ○ | |

# SOLID STATE RELAY (SSR)

4 - 7. Comparison between SSR(Solid State Relay) and MC(Magnetic Contractor)
Following is the table to compare SSR and MC according to the characteristics of each item in terms of strengths and weaknesses. Characteristics and economical side of installment can be obtained only by selecting them in accordance with the characteristics of circuit to be designed. SSR manifests excellent input motions , high performance under the surroundings and high speed of motions while generates the heat and restrictive features of electricity.
(1) Comparison between SSR and MC

| CATEGORY | ITEM | SSR | MC |
|---|---|---|---|
| Input rating | Operating power | Below Few mW | Few 100mW~W |
| | Range of oprating voltage | Free voltage is available. | Rated voltage±about10% |
| | Noise, surge generation | Not at all | Occurs in coil off |
| Output rating | Contact | 1a is common but multi contact point is available. | Multi contact is available. |
| | Range of power voltage | It depends on voltage feature of main element at peak. | Wide range. |
| | Load current | It depends on rating of main element but many times in case of excessive current. | Wide range but damage of point of contact is huge in case of excessive current. |
| | Transient status | Breakage and error might occur in case of high voltage and power. | No problem but it must be selective in case of high voltage |
| | Reliability of contact | No error of contact | Error of contact occurs. |
| | Bounce, Chattering | None | Yes |
| | Leakage current | Below100mA | Not at all |
| | Noise, surge generation | Not at all | Occurs in case of inductive load |
| | Occurrence of ARC | N/A | Occurs depending load |
| | Occurrence of heat at contact | Occurs 1.5W per 1A genrate heat dissipation | Occurs in case of false contact point |
| | Function of zero cross | Available | Not available |
| | Insulation, voltage resistance | About 2,500V withstanding voltage | High withstanding voltage is available. |
| | Speed of opration | Within 10mS | More than 100mS |
| | Life time | Long(regardless of motions of contact point) | A few 100,000 times |
| Features of environment | Resistance of vibration, shock, corrosion | No problem | Possible because of error |
| | Chemical, gas danger | No problem | Danger of explosion By contacting ARC. |
| | Temperature | Need to consider generation of heat against temperature. | Heat proof of materials and change of motions needs to be checked. |
| | Humidity | No problem(resin seal) | Lowering insulation |
| | Sound of motions | None | Noise of motions of magnet |

# SOLID STATE RELAY (SSR)

## 5. SSR 방열설계와 방열기 선정법 SSR thermal design and heat sink selection

5 - 1. Features of heat sink
Many variables are depending internal condition of heat sink and that of thermaldesign. Design therefore has to be implemented based on the reference of features of heat sink and also it should be cautiously designed since powerelectronics of SSR is radiation. If unless heat sink is used, normal motions will occur initially but main element damage some time later because temp. rise point of internal SSR.
(1) Radiation volume of heat sink is in a proportion to the surface area of heat sink.
(2) Radiation volume of heat sink is in a proportion to the difference between surface temperature of heat sink and the temperature of the surrounding air.
(3) Color black has high radiation effect on the surface of rheat sink.
(4) Function like data of catalog can not be expected unless heat sink is mounting in a vertical direction.
(5) When contact between semiconductor and heat sink are false, effect of radiation is dramatically dropped.
(6) Unless natural convection occur in the place of heat sink, effect of the heat sink is decreased.
(7) Forced Air cooling by fan will be able to increase the performance of heat sink as more than twice as much.
(8) When surrounding temperature is more than 40C, forced Air cooling is required by use of fan according to the oprating c urrent so that safe usage of SSR can be guaranteed.
5 - 2. Thrmal radiation and item to calculate the Thrmal design
(1) Junction temperature : Tj • Junction indicates the P-N junction of semiconductor and core of Main element. When electric current flows as semiconductor, heat (Pw) occurs and sustains the regular temperature under the heating. It is the function of heat sink.
• Junction temperature is based on the temperature which is recommended by SSR maker. Normaly in case of SCR and TRIAC, temperature is normally 110-125, but around 10 decrease is decided for reliability.
(2) Thermal resistance from junction to case : Rjc • The figure is decided based on the research of data of SSR maker in terms of thrmal resistance from junction to case and unit is which indicates the temperature gap in per 1W dissipation power.
(3) Heat resistance between SSR case and heat sink • Thrmal resistance between case and heat sink varies by the method to mounting heat sink plate. It depends on direct attach, using or, using thrmal grease, process of surface of heat sink etc.
Mounting of heat sink and SSR must be precis.
※ Following is the junction common thrmal resistance of SSR according ot the method of mounting.
→ Thrmal resistance in case of direct attachment =0.1-0.5 C/W → Thrmal resistance when silicon is used =0.05-0.5 C/W.
(4) Decision of temperature of surrounding air (Ta) Item (1)-(3) mentioned above has been almost set by SSR but temperature of surrounding air must be checked by user.
Having considered structure of device, status of usage, maximum temperature to be used must be decided. After completion of production, maximum temperature must be considered based on the actual status of operation. For reference, when temperature of SSR assembly is 40℃, internal temperature of object of which inflow of air ventilation is assumed around 50℃. But, machinery which is susceptible to the direct sun ray, temperature might reach up to 80℃. Heating object in this case should be cnsidered.
(5) Decision of heating of SSR (Pw) When average electric current of SSR load to be used is multiplied by dropping voltage occurred at the point of contact, consumptive electric power is automatically calculated and it is possible to use chart of consumptive electric power.
• Consumptive electric power (Pw)= average electric current x voltage of SSR which drops (W)...........(1)

# SOLID STATE RELAY (SSR)

● Calculation of average current (resistance load)



$$Iav = \sqrt{\frac{ION^2 \times Ton}{Toff + Ton}} = \sqrt{\frac{30A^2 \times 10}{5 + 10}} = 24.5A \cdots \cdots (2)$$
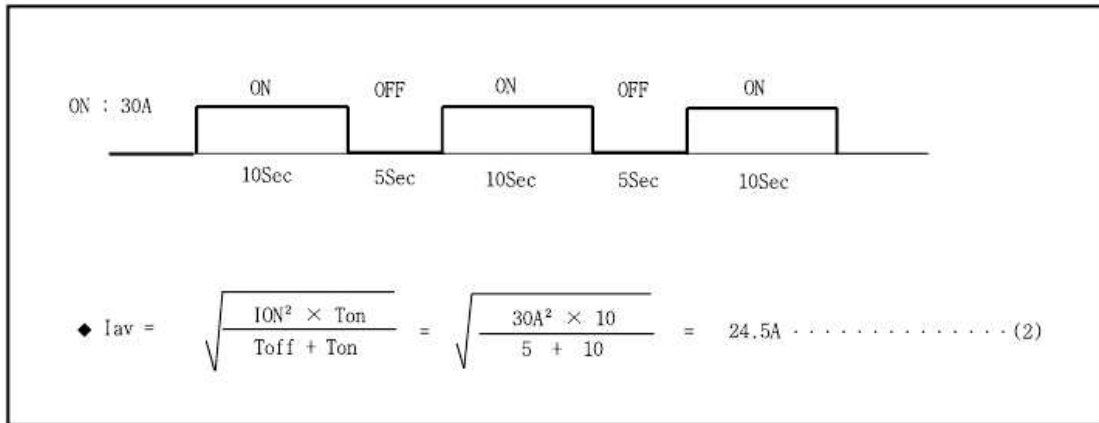
● Calculation of average current (inductive load)

◆ START = 30A
◆ RUN = 5A



$$Iav = \sqrt{\frac{Ista^2 \times Tsta + Iru^2 \times Tru}{Tsta + Tru + Tst}} = \sqrt{\frac{30A^2 \times 5 + 5A^2 \times 20}{5 + 20 + 15}} = 11A \cdots \cdots (3)$$
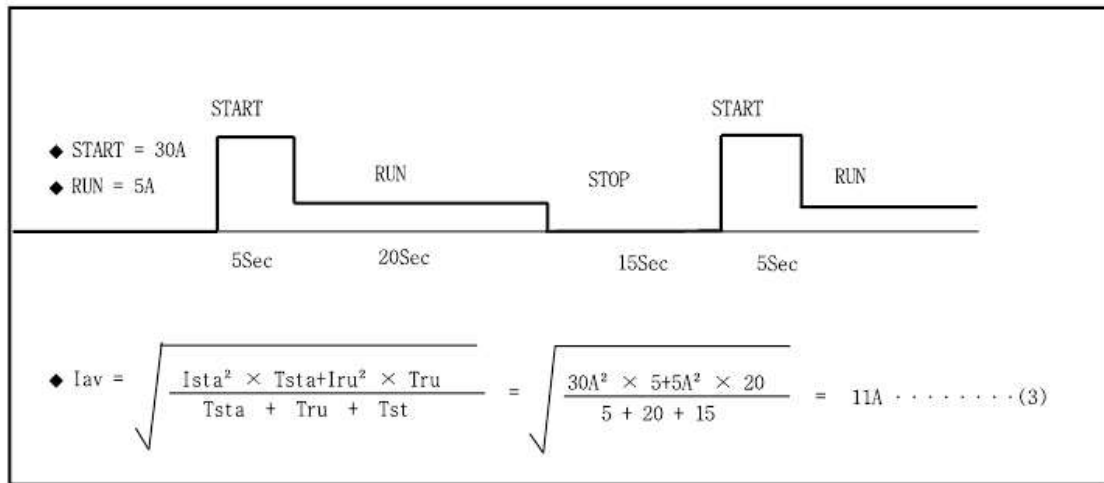
5 - 3. Thermal design of SSR circuit
(1) Design circuit : single-phase heater control circuit
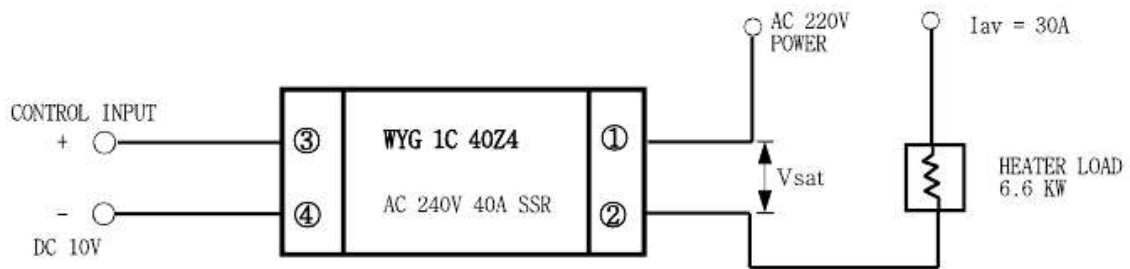
# SOLID STATE RELAY (SSR)

(2) Equivalent circuit of thermal resistance
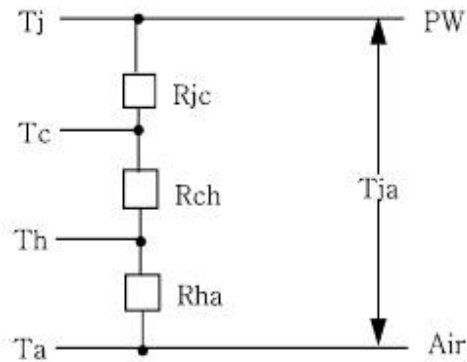


·Tj : SSR junction temperature
·Tc : SSR case temperature.
·Th : heat sink temperature.
·Ta : ambient temperature.
·Pw : SSR to average power loss
·Rjc : Thermal resistance between SSR junction and heat sink
·Rch : Thermal resistance of case and heat sink
·Rha : Temperature gap between SSR case and heat sink
·Tja : Temperature gap Triac and Air

(3) Calculation of thermal resistance of heat sink
① SSR to be used : WYG 1C 40Z4 ② Average dissipation power of SSR :
Pw=38W (Iav x Vast =30A x 1.3V=39W)
③ Tj of SSR : 125℃
④ Thermal resistance of SSR Rjc : 1.1C/W
⑤ Temperature gap between SSR junction and case : Tjc .................................................................................(1)
·Tjc = Rjc(℃/W) × Pw = 1.1 × 38 = 41.8℃
⑥ Temperature gap between SSR case and heat sink : Tch..(2)
·Rch = 0.1℃/W with silicon grease
·Tch = (℃/w)× Pw = 0.1 × 38 = 3.8℃
⑦ Temperature gap of junction of SSR and air : Tja (around of heat sink).......................................................(3)
·Tj=125℃ → Set temperature to 115℃ considering reliability.
· Ta=40℃ → Decide maximum value of the ambient temperature of the heat sink.
· Tja=Tj-Ta=115℃-40℃=75℃
⑧ Difference of temperature (Tha) between heat sink temperature (Th) and the ambient air temperature
(Ta)................................(4)
·Tha=Tja-Tjc-Tch(°...)=75℃-41.8℃-3.8℃=29.4℃
⑨ Heat sink thermal resistance : Rha..............................(5)

$$Rha = \frac{Tha}{P(W)} \ (℃/w) = \frac{29.4}{38} = 0.77(℃/w) → \text{Hea sink data.}$$

· The 3-phase SSR is calculated as P(W)×3 from the formula (5) shown above.
⑩ From the catalogue, select and use a model with the required thermal resistance of lessthan 0.77℃/W, or use the standard model selected by the SSR manufacturer.

5 - 4. References of standard heat sink (aluminum) to select
(1) Method of Cooling
    → convection cooling or forced air cooling?
(2) Thermal resistance of heat sink
    → choose the lower than designed thermal resistance based on the data of catalog.
(3) Method of mounting
    → vertical mounting is available at radiating through in a consideration of ventilation ?
(4) Coloring
    → it has been colored by acidification, aluminate or paint?
(5) Use silicon grease for heat sink Silicon grease is a compound of grease type containing metal oxidization of which thermal conduction is high and obtains excellent electric features such as transmission of electricity and insulation as well as radiation. It is applied for SSR and junction of heat sink of electric unit in general. Minimizing the thermal resistance resulted from imbalance between heat sink and contact of SSR, it increases the radiation so that it must be used for unit of electric power.

# SOLID STATE RELAY (SSR)

5 - 5. Data of Wyes SSR thermal design
(1) thermal data of single phase SSR

| APPLICATION SSR | CURRENT(A) | PD(W) | Tj(℃) | Rjc(℃/W) |
|---|---|---|---|---|
| WYG 1C 10Z4, 10Z40, 10R4 | 10 | 11 | 110 | 2.60 |
| WYH 1C 10Z4, 10Z40, 10R4 | 10 | 15 | 110 | 2.0 |
| WYG 1C 20Z4, 20Z40, 20R4 | 20 | 20 | 125 | 1.20 |
| WYH 1C 20Z4, 20Z40, 20R4 | 20 | 28 | 125 | 1.20 |
| WYG 1C 30Z4, 30Z40, 30R4 | 30 | 32 | 125 | 1.0 |
| WYH 1C 30Z4, 30Z40, 30R4 | 30 | 32 | 125 | 1.0 |
| WYG 1C 40Z4, 40Z40, 40R4 | 40 | 55 | 125 | 1.0 |
| WYH 1C 40Z4, 40Z40, 40R4 | 40 | 55 | 125 | 1.0 |
| WYG 1C 50Z4, 50Z40, 50R4 WYH 1C 50Z4, 50Z40, 50R4 | 50 | 54 | 125 | 1.10 |
| WYG 1C 60Z4, 60Z40, 60R4 WYH 1C 60Z4, 60Z40, 60R4 | 60 | 70 | 125 | – |
| WYH 1C 80Z4, 80Z40, 80R4 | 80 | 100 | 125 | – |
| WYH 1C 100Z4, 100Z40, 100R4 | 100 | 110 | 125 | – |
| WYH 1C 150Z4, 150Z40, 150R4 | 150 | 155 | 125 | – |
| WYMG 1C 60Z4, 60Z40, 60R4 WYMH 1C 60Z4, 60Z40, 60R4 | 60 | 70 | 125 | 0.55 |
| WYMG 1C 80Z4, 80Z40, 80R4 WYMH 1C 80Z4, 80Z40, 80R4 | 80 | 80 | 125 | 0.50 |
| WYMG 1C 100Z4, 100Z40, 100R4 WYMH 1C 100Z4, 100Z40, 100R4 | 100 | 110 | 125 | 0.33 |
| WYMG 1C 150Z4, 150Z40, 150R4 WYMH 1C 150Z4, 150Z40, 150R4 | 150 | 155 | 125 | 0.25 |

2) thermal data of three phases SSR

| APPLICATION SSR | CURRENT(A) | PD(W) | Tj(℃) | Rjc(℃/W) |
|---|---|---|---|---|
| WY3G 3C 10Z4, 10Z40, 10R4, 10R40 | 10 | 33 | 100 | 0.9 |
| WY3H 3C 10Z4, 10Z40, 10R4, 10R40 | 10 | 45 | 110 | 0.73 |
| WY3G 3C 20Z4, 20Z40, 20R4, 20R40 | 20 | 60 | 125 | 0.46 |
| WY3H 3C 20Z4, 20Z40, 20R4, 20R40 | 20 | 60 | 125 | 0.46 |
| WY3G 3C 30Z4, 30Z40, 30R4, 30R40 WY3H 3C 30Z4, 30Z40, 30R4, 30R40 | 30 | 94 | 125 | 0.43 |
| WY3G 3C 40Z4, 40Z40, 40R4, 40R40 WY3H 3C 40Z4, 40Z40, 40R4, 40R40 | 40 | 165 | 125 | 0.43 |
| WY3x 3C 60Z4, 60Z40, 60R4, 60R40 | 60 | 210 | 125 | – |
| WY3x 3C 80Z4, 80Z40, 80R4, 80R40 | 80 | 240 | 125 | – |
| WY3x 3C 100Z4, 100Z40, 100R4, 100R40 | 100 | 330 | 125 | – |
| WY3x 3C 150Z4, 150Z40, 150R4, 150R40 | 150 | 445 | 125 | – |

※ Rjc ( "–" self heat sink type SSR)

# SOLID STATE RELAY (SSR)

## 6. Safe load design of SSR

Since the selection criteria of SSR varies according to the specification, model which is appropriate to specification of load must be used for economic efficiency. SSR is an expensive combined(solid state) product by use of electric circuit and semiconductor unit. If it is designed commonly like general MC, SSR might be broken by unexpected false which causes economic loss as well as decreases the reliability of product. Therefore, it should be precisely designed from the beginning in a consideration of stability to use reliably on a long term basis. It can be evaluated that initial investment brought economic gain and enhanced quality than design of mechanical method. When certain specification is decided based on the various data on load, SSR which is two times larger than specification of load had better be designed for stability as far as it is allowed from the perspective of investment.

6 - 1. (Load & SSR type charactistic)

| CHARACTER | KIND OF LOAD | LOAD CAP. | SSR | SSR MODEL( Wyes SERIES) |
|---|---|---|---|---|
| Small 'R, L' LOAD | Solenoid Valve, Lamp, Relay | AC 220V/3A 1PHASE | · Zero Cross Type | WYP − 3A, WYPS − 3A, WYPM − 3A, WYPV − 3A |
| Small 'L' LOAD | 1P, 3P Motor Transformer, Inductance Motor | AC 220−440V/40A | · Random Type | WYG 10A−40A, WYH 10A−40A, WY3G 10A−40A, WY3H 10A−40A |
| Large 'L' LOAD | 1P, 3P Motor Transformer, Inductance Motor | AC 220−440V/150A | · Random Type | WYMG 60A−150A, WYMH 60A−150A, WYH 60A−150A, WY3x 60A−150A |
| Small 'R' LOAD | 1P ,3P Heater LAMP, RELAY, | AC 220−440V/40A | · Zero Cross Type | WYG 10A−40A, WYH 10A−40A, WY3G 10A−40A, WY3x 10A−40A |
| Large 'R' LOAD | 1P ,3P Heater | AC 220−440V/150A | · Zero Cross Type | WYMG 60A−150A, WYMH 60A−150A, WYH 60A−150A, W Y3x 60A−150A |

• With regard to on/off type of resistant load, SSR of zero cross type must be used.
• Precaution is required in terms of design because it is impossible to use SSR for load of pure capacitor.
• Both zero cross type or random type of inductive load are used, but random type is recommended to be used as inductance is larger.
• Measure of surge current and voltage must be designed in terms of inductive load.
• When inductive load such as M/C and inverter etc. are connected in the internal panel, measure of surge must be considered.

6 - 2. Table of SSR application for inductive load
(1) Starting current and operation current of single phase AC motor (HP) vs SSR

| MOTOR | 110V MOTOR | | | 220V MOTOR | | | 440V MOTOR | | | Operating condition |
|---|---|---|---|---|---|---|---|---|---|---|
| H.P | LOAD(A) | START(A) | APPL. SSR(A) | LOAD(A) | START(A) | APPL. SSR(A) | LOAD(A) | START(A) | APPL. SSR(A) | |
| 1/16 | 1,9 | 11,4 | 10 | | | | | | | |
| 1/10 | 2,6 | 15,6 | 20 | | | | | | | |
| 1/8 | 3,4 | 20,4 | 20 | | | | | | | |
| 1/6 | 4,2 | 25,2 | 30 | 2,1 | 12,6 | 10 | | | | |
| 1/4 | 5,5 | 33,0 | 30 | 2,8 | 16,8 | 20 | | | | · use with standard heat sink |
| 1/3 | 6,8 | 40,8 | 40 | 3,4 | 20,4 | 20 | 1,8 | 10,8 | 10 | |
| 1/2 | 8,4 | 50,4 | 50/60 | 4,2 | 25,2 | 30 | 2,4 | 15,0 | 20 | |
| 3/4 | 12,4 | 74,4 | 70/80 | 6,2 | 37,2 | 20 | 3,2 | 19,2 | 20 | |
| 1 | 14,7 | 88,2 | 80 | 7,2 | 43,2 | 40 | 3,9 | 23,4 | 30 | · start time within 2sec |
| 1,5 | 20,0 | 120,0 | 100 | 10,0 | 60,0 | 60 | 5,0 | 30,0 | 20 | |
| 2 | 25,2 | 151,2 | 150 | 12,6 | 75,6 | 80 | 6,2 | 37,2 | 40 | |
| 3 | | | | 17,9 | 107,4 | 100 | 8,0 | 48,0 | 50/60 | |
| 5 | | | | 29,4 | 176,4 | 150 | 13,0 | 78,0 | 70/80 | |
| 7,5 | | | | | | | 21,0 | 126,0 | 150 | |
| 10 | | | | | | | 26,0 | 156,0 | 150 | |

# SOLID STATE RELAY (SSR)

(2) Starting current and operation current of three phases AC motor (HP) vs SSR

| MOTOR | 220V MOTOR | | | 440V MOTOR | | | Operating condition |
|---|---|---|---|---|---|---|---|
| H.P | LOAD(A) | START (A) | APPLICATION SSR(A) | LOAD(A) | START (A) | APPLICATION SSR(A) | |
| 1/2 | 2.0 | 12.0 | 10 | 0.9 | 5.4 | 10 | |
| 3/4 | 2.9 | 17.4 | 20 | 1.5 | 9.0 | 10 | |
| 1 | 3.7 | 22.2 | 20 | 1.9 | 11.4 | 10 | • use with standard heat sink |
| 1.5 | 5.4 | 32.4 | 20 | 2.6 | 15.6 | 10 | |
| 2 | 6.9 | 41.4 | 30 | 3.4 | 20.4 | 20 | |
| 3 | 10.0 | 60.0 | 40 | 4.6 | 27.6 | 20 | |
| 5 | 15.8 | 94.8 | 60 | 7.5 | 45.0 | 20 | |
| 7.5 | 23.1 | 138.6 | 80 | 11.0 | 66.0 | 40 | • start time within 2sec |
| 10 | 29.4 | 176.4 | 150 | 14.0 | 84.0 | 60 | |
| 15 | | | | 20.0 | 120.0 | 80 | |
| 20 | | | | 26.0 | 156.0 | 100 | |

6 - 3. Application table of SSR for resistant load

(1) specification of single and three phases SSR vs heater power

| SSR Current (A) 1PHASE,3PHASE AC220V~440V | | HEATER LOAD CAP. | | | | | | Operating condition |
|---|---|---|---|---|---|---|---|---|
| | | 1PHASE HEATER(KW) | | | 3PHASE HEATER (KW) | | | |
| curr. rating(A) | avg.current(A) | 220 V | 380 V | 440 V | 220 V | 380 V | 440 V | |
| 10 | 8 | 1.8 | 3.0 | 3.5 | 3.0 | 5.3 | 6.1 | |
| 20 | 16 | 3.5 | 6.1 | 7.0 | 6.1 | 10.5 | 12.2 | • use with standard heat sink |
| 30 | 24 | 5.3 | 9.1 | 10.6 | 9.1 | 15.8 | 18.3 | |
| 40 | 32 | 7.0 | 12.2 | 14.1 | 12.2 | 21.1 | 24.4 | |
| 50 | 40 | 8.8 | 15.2 | 17.6 | 15.2 | 26.3 | 30.5 | |
| 60 | 48 | 10.6 | 18.2 | 21.1 | 18.3 | 31.6 | 36.6 | • ambient temperature lessthan 40°C |
| 70 | 56 | 12.3 | 21.3 | 24.6 | 21.3 | 36.9 | 42.7 | |
| 80 | 64 | 14.1 | 24.3 | 28.2 | 24.4 | 42.1 | 48.8 | |
| 100 | 80 | 17.6 | 30.4 | 35.2 | 30.5 | 52.7 | 61.0 | |
| 150 | 120 | 26.4 | 45.6 | 52.8 | 45.7 | 79.0 | 91.4 | |

# SOLID STATE RELAY (SSR)

## 7. Circuit design to protect contact of SSR

• Whether device of SSR and Thyristor operates satisfactorily or not depends on how much the system can resist at abnormal excessive electric current and how much protect expensive SSR or semiconductor from breakage in case of absolute thermal design. The optimal status is when appropriate SSR is used at rated load and protective device of overload is available in case of error other than it can be resistant under the electric current of error or there is no problem to power element regardless of economic loss. The general method i.e., interceptor of excessive current which is used for existing MC/ affixed at the electric device circuit and other spring fuse are interceptor by AC effective electric current, they can not protect SSR or semiconductor at dramatic error electric current. In order to protect point of contact under the excessive current absolutely such as load short of SSR, semiconductor-protection fuse has been developed for a long time ago. Method to apply the fuse will be briefly described as below.

7-1. I $^2$ T of semiconductor element

It is a unit to indicate unrepeatable maximum electric current volume against short duration time, 10mS. I is an electric current of practical value and unit is (A). T is a durable time and indicated by (S), second as an unit. With regard to the specification of I 2 T, it is normally maximum current square time when point ofcontact of semiconductor is broken within the AC half cycle and the specification of semiconductor element is regulated by all means.

7 - 2. Specification table of Wyes SSR series I $^2$ T

(1) I$^2$T specification and surge current vs SSR of single and three phases AC 220V

| SSR current rating (A) | CONTACT CAPACITY | | TEST CONDITION |
|---|---|---|---|
| WYG 1C series WYMG 1C series WY3G 3C series | Surge Current (A) | I ² T Standard | |
| 10 | 125 | 72 | |
| 20 | 260 | 250 | • Tj initial = 25℃ |
| 30 | 300 | 450 | |
| 40 | 315 | 450 | • Non repetitive |
| 50 | 525 | 1,250 | |
| 60 | 1,300 | 7,200 | • T = 10mS |
| 70 | 950 | 3,745 | • 1phase current of |
| 80 | 1,750 | 12,800 | 3phase current |
| 100 | 1,950 | 16,200 | |
| 150 | 2,550 | 26,500 | |

(2) I $^2$ T specification and surge current vs SSR of single and three phases AC440V

| SSR Standard Current("A") | CONTACT CAPACITY | | TEST CONDITION |
|---|---|---|---|
| WYH 1C SEries WYMH 1C SEries WY3H 3C SEries | Surge Current(A) | I ² T Standard | |
| 10 | 170 | 72 | |
| 20 | 250 | 265 | • Tj initial = 25℃ |
| 30 | 350 | 610 | |
| 40 | 370 | 610 | • Non repetitive |
| 50 | 525 | 800 | |
| 60 | 1,300 | 7,200 | • T = 10mS |
| 80 | 1,750 | 12,800 | • 1phase current of |
| 100 | 1,950 | 16,200 | 3phase current |
| 150 | 2,550 | 26,500 | |

# SOLID STATE RELAY (SSR)

7-3. Overview of semiconductor protective fuse

Semiconductor protection fuse is a special structure and composed of linking point with external, container to protect heat, fuse and element etc. Concerning external structure, there are cylinder, rectangle and type to affix warning linkage etc. Particularly, internal fuse element is produced with special structure which is intercepted by rapid melting earlier than linkage of SSR when error current more than regulated electric occurs for absolute protection. For this fuse, usage voltage, the first melting/cutting time, ARC time at the interceptor, the fist melting/cutting electric current and limited electric current for complete interception are provided for data. Status of motions are manifested in the following picture by graph. In case of actual design, effective electric current, voltage to use and current for complete interception are important.
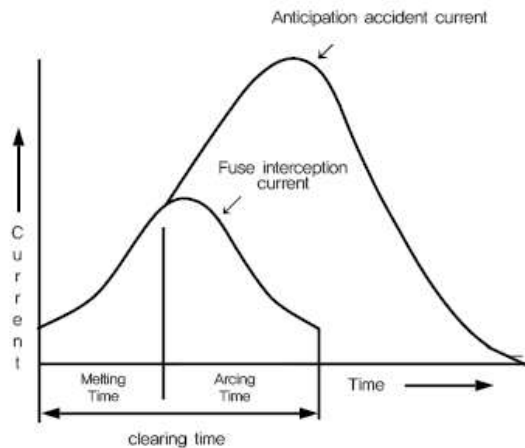


- Fuse interception current :
  Maximum current flowing through fuse
- Anticipation accident current :
  Maximum expected current value in case of short circuit of electric circuit
- Melting time : Fuse by overcurrent Time when it melts
- Arcing time :
  ARC time generated when the fuse element is melted
- Clearing time : Total time the fuse is completely closed.

7 - 4 Design of semiconductor fuse

(1) Effective voltage of load circuit (2) Maximum operating load current (3) Maximum anticipation accident current (4) Current rating of SSR and I 2 T to be used (5) Selection of fuse specification

AC 220V circuit of single phase AC 12A.

AC 200A.(it is varied by output of power source of circuit and impedance) AC 20A - 265 A 2 S (SSR : WYG 1C 20Z4 - 20A).

AC 250V-15A / 60 A 2 S (GOULD A25-101 AMP - TRAP).

※ Current comparison : LOAD current 〈 FUSE current 〈 SSR current = 12A 〈 15A 〈 20A

※ I ² T comparison : FUSE I ² T 〈 SSR I ² T = 60 A ² S < 265 A ² S

7 - 5. Precaution in case of design of other protective circuit.

(1) Rated voltage of fuse and load voltage of circuit must be designed at same value. When fuse voltage is higher than circuit voltage, I 2 T of fuse is reduced at proportional rate of circuit voltage than specification and can be intercepted by load current (2 times of voltage ..... Electric current x 0.5) (2) When effective current of load varies seriously, fuse and SSR must be designed flexibly. If not, fuse may be destroyed gradually and cut after certain lapse..

(3) When fuse is connected, electric current varies depending on one fuse is connected in the same closed circuit or two fuses are connected at series. Therefore, data of manufacturing company must be referred. Otherwise, brief value of specification can be obtained by multiplying 0.6 to the specification.

(4) Because there is an inconsistency between Total load current and phase current in case of three phases (Total load current x√ = phase current). Precaution must be made in order not to select fuse specification by Tota load current.

(5) Starting current must be calculated by practical maximum current in order not to intercept fuse by current to start in case of inductive load such as motor etc.

(6) Because overload current excessive other than dramatic error of load is not intercepted at the fuse and causes damage at SSR or load, electronic or thermal acting interceptor of over current must be used.

# SOLID STATE RELAY (SSR)

## 8. Design for prevention of transient voltage of SSR

8. Design for prevention of transient voltage of SSR

When SSR is used at inductive load such as motor etc. transient voltage occurs in case of open/close of power source. If the transient voltage is over peak off-state voltage at the main elecment of SSR (Vdm : repetitive peak off-state voltage), main elecment is likely destroyed. Therefore, unit to absorb transient voltage must be affixed at the point of contact or load for safe motions. resistor, Zener diode have been used as an absorb unit but now metal oxide varistor namely MOV are commonly used and this is evaluated as an unit to protect SSR completely from transient voltage

8 - 1. Available peak voltage of Wyes SSR

| SSR SERIES | NON REPETITIVE PEAK – OFF VOLTAGE (V) | MAXIMUM VOLTAGE (V) | OTHERS |
|---|---|---|---|
| WYP    2 ～ 3A | 600 | AC240 | |
| WYG    10A–40A | 600 | AC240 | |
| WYMG   60A–150A | 600 | AC240 | |
| WY3G   10A–40A | 600 | AC240 | Each Phase |
| WYH    10A | 800 | AC240 | |
| WYH    20–40A | 1,200 | AC480 | |
| WYH    60A–150A | 1,200 ～ 1,600 | AC480 | |
| WYMH   60A–150A | 1,200 ～ 1,600 | AC480 | |
| WY3H   10A | 800 | AC480 | Each Phase |
| WY3H   20A–40A | 1,200 | AC480 | Each Phase |
| WY3H   60A–100A | 1,200 ～ 1,600 | AC480 | Each Phase |

8 - 2. Overview of circuit design to prevent transient voltage

With regard to items to be considered in selecting the specification of Varistor, data of size of transient voltage, impedance of load and voltage of contact point of SSR at peak etc. must be decided prior to the selection of specification of Varistor. Because it is difficult to get these data at the stage of circuit design, load status is either referred or data is available by actual measure. Equivalent circuit is obtained as below after wards.

● Data to measure transient voltage (example)
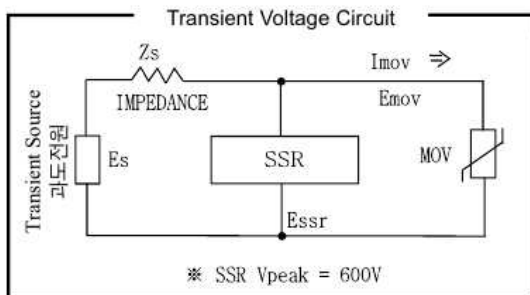


• Transient voltage 3 KV/30(us)

• Circuit impedance 50Ω

8 - 3. Specification design of Varistor (MOV)

(1) Data is available from the equivalent circuit to be designed
• Measured figure of over voltage (Es) : 3kV/30us
• Circuit impedance (Zs) : 50Ω
• SSR peak voltage (Essr) : 600V (from data of SSR 8-1)
• Power voltage of circuit : AC 220V
• Frequency of transient voltage : 100,000 times/10Sec interval.
2) Selection effective voltage and limiting voltage of Varistor.
(Example is calculated based on the data of TNR series product here in after) • Source voltage × 10% < Varistor voltage =AC 220V × 10% = more than 242V(AC rms) .
• 245V is equivalent to TNR x x G391K of effective voltage 250V (x x is a size of Varistor).
• Varistor maximum voltage of 391K : 429V appropriate since SSR peak voltage is less than 600V.

# SOLID STATE RELAY (SSR)

(3) Varistor current calculated at equivalent circuit.

- $Es(max) = (Imov, Zs) + Emov$.............(1)

- $Imov = \dfrac{Es - Essr}{Zs}$ .............(2) Varistor current

- $Imov = \dfrac{3000-600}{50} = 48\ A$

(4) Operation time of Varistor is compared at curve graph of pulse life time rating.
Since duration of varistor varies according to the frequency of transient voltage other than the first electric standard, coordinates of peak current of varistor and width of pulse at duration curve graph must be checked if they are over curve graph of pulse motions.
• Current (48A) / size of pulse (less than 30uS) → comparison
  ← frequency graph of transient voltage of 100,000 times.
When it is improper resulted from outcome of comparison, select standard by finding up and down of Varistor graph.
(5) Select size of diameter of Varistor.
In other words, though electric feature is identical at the effective voltage, diameter size of Varistor varies depending on size of transient voltage and lapse time of pulse. This size is classified by model number of each producers.
(TNR15G x x x x = diameter is 15mm.)
※ Varistor which is appropriate circuit as an example is decided by TNR15G391K type
(6) Method to connect Varistor It must be affixed with short wiring at the source of transient voltage nearest possible by connecting at parallel circuit to the contact point of SSR.
(7) Caution Always select a varistor which more than fully satisfies the design specifications so that it can absorb surge when there is an unexpected strong surge voltage. Since MOV may automatically be short-circuited leading to power supply error, must attach fuses to the front of the varistor circuits to prevent such phenomena and to ensure safety.

# SOLID STATE RELAY (SSR)

## 9. Applied circuit of SSR

Circuit which is commonly used at the electric circuit has been selected and circuit of SSR was redesigned to structure as follows. In order to use the circuit, please refer to the surrounding conditions and various data in detail and apply them to the device to be produced.

9 - 1 Circuit of Contact point of A and B by use of single phased SSR

• It is a circuit to make A and B contact point according to the input signal at the two single phases by use of 2 SSR(AC input type, DC input type) so that load alternate operated .

• Resistant load and inductive load are available up to AC90V-220V, current 10A-150A.

• With regard to motions, L1 load is on when SW1 is on and L2 is on when it is off.



CONTACTOR A,B SWITCHING SSR
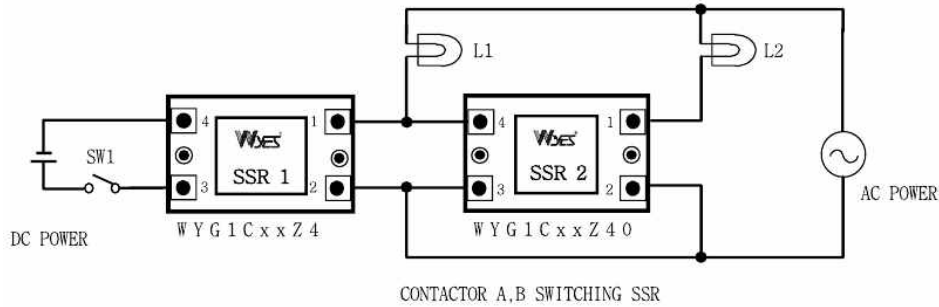
FIG 1

※ SSR 1 = DC Type (WYG1CxxZ4),  SSR 2 = AC type (WYG1CxxZ40)

9 - 2 Latching by use of a single phase SSR (Latching circuit )

• SSR latching circuit at the single phase circuit by use of SSR with AC input type is as below.

• With regard to the range of electric power, it is able to operate at AC 90-220V and 10A -150A of electric current

• When start switch is on, SSR immediately is on and latching.

On the other hand, SSR is off when stop switch is off. Accurate operation is, however, not expected at the less than 1A of load current.



LATCHING SSR CIRCUIT
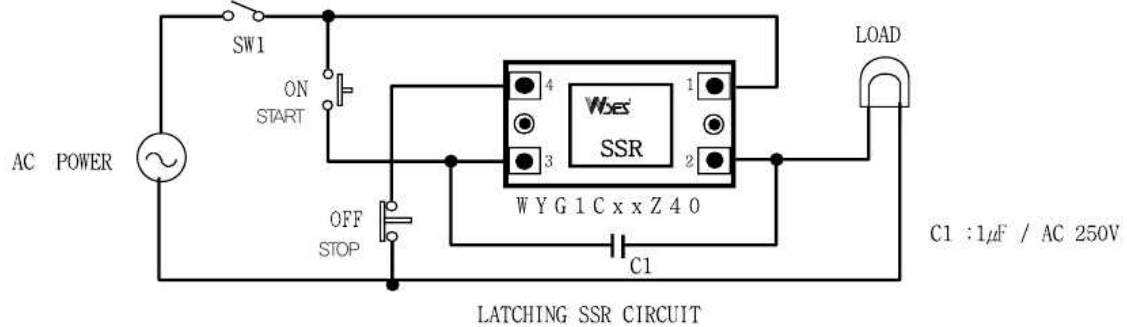
FIG 2
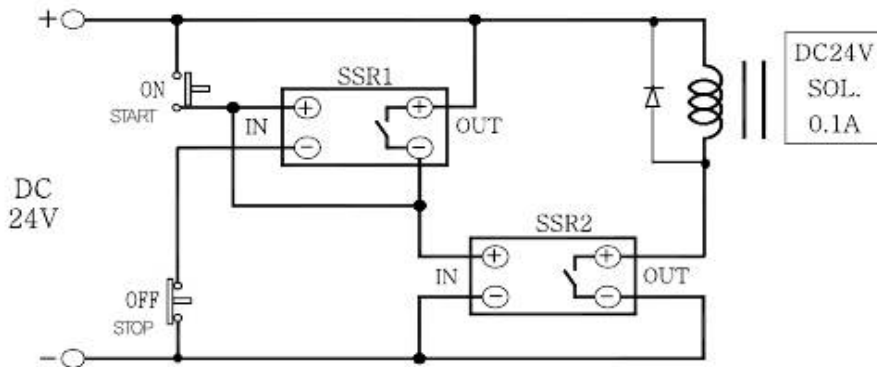
※ SSR = AC input type (WYG1CxxZ40).

# SOLID STATE RELAY (SSR)

9 - 3. Latching circuit by use of a DC SSR (latching circuit)
1) use of 1 SSR by 2 circuit SSR
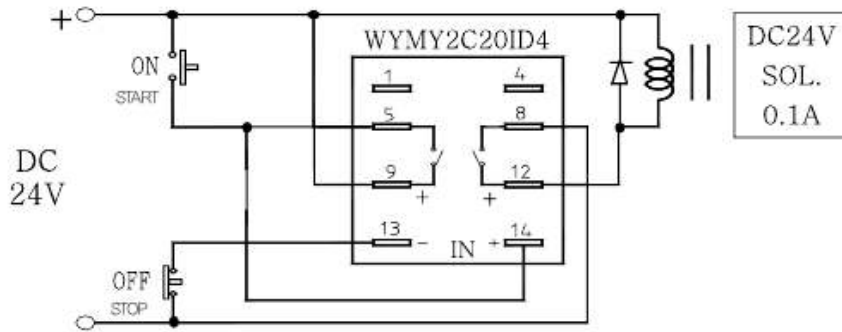


2) 1 Circuit by use of 2 SSR



9 - 4. Circuit to prevent relay arc by use of SSR

• General relay or M/C (Magnetic Contractor) may face ARC at the contact point in case of off which damages contact point and cause noise. It must be prevented. SSR is required to be more than 6 times larger than that of operation current because of inrush current of motor to start, but it is acceptable to use equivalent capacity of operation current if this circuit is used. Also heat sink to be used for SSR is not required.

• When SW is on, M/C operates first and then SSR after a while. If SW is off, M/C is off first before SSR is off so that M/C and SSR operates in a supplementary manner and ARC of M/C can be prevented.

• You can select SSR about AC 90~480V, 10~150A.
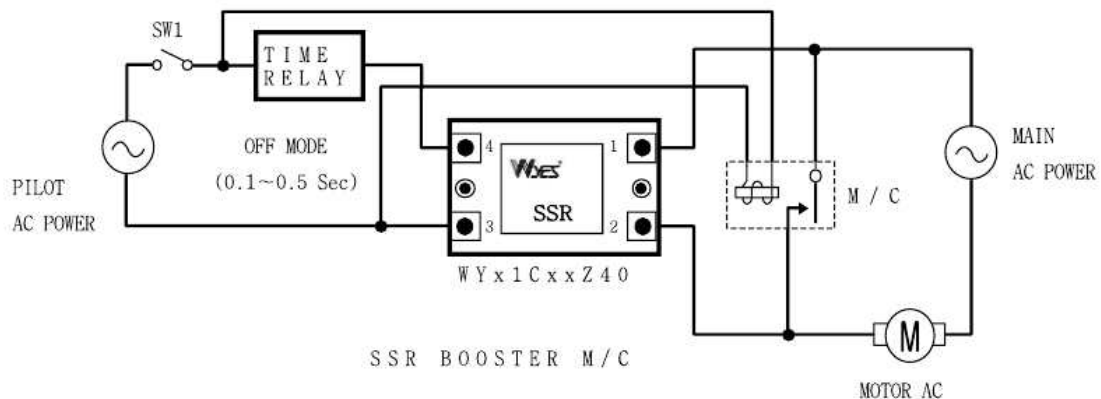


FIG 3

※ SSR = AC input type (WYx1CxxZ40).

# SOLID STATE RELAY (SSR)

9 - 5. Safety circuit of inductive load of high capacity by use of single phase SSR
• Inductive load(Transformer, Solenoid) of high capacity are lage of instant electric charge and discharge motion of SSR is unstable. So, safe motion will be available if it is connected to the following circuit.
• SSR must be a random type and safety resistance of R2 must be equivalent to that of DC resistance of load coil.(caution : Temp. rise of resistor) • You can select SSR about AC 90~480V, 10~150A



SWITCHING HIGHLY INDUCTIVE LOADS
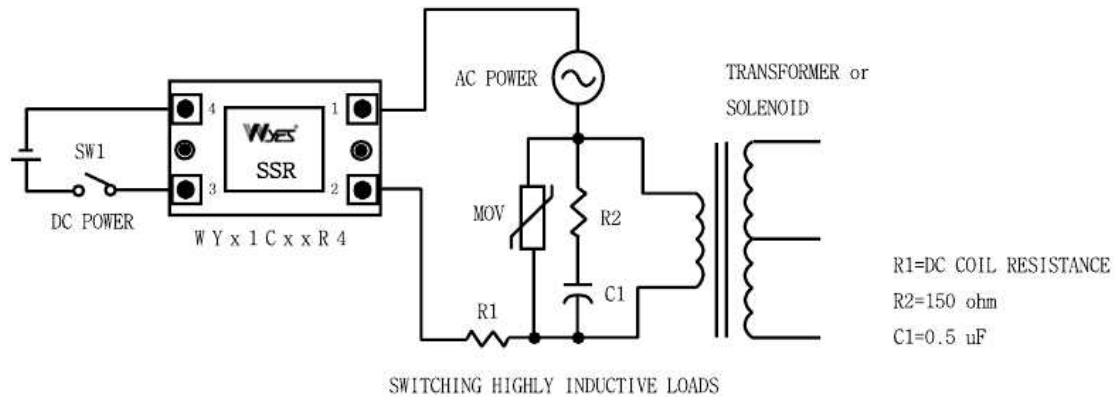
※ SSR = DC input type (WYx1CxxR4)

9 - 6. Phase angle control circuit by use of single phase SSR
(1) Phase angle control is produced by use of SCR or other components in order to control AC load voltage of electric device. It is easy to control phase angle by use of SSR and control unit, it can be applied and utilized for simple motor device and electric heater control.
(2) Type of control unit :  WYU - P180AC : INPUT DC 4 - 20 mA or 1~5V
(3) SSR is random type SSR : AC90-240V, range of apply current is 10A-150A.
(4) When voltage and electric current signal are transferred to the No.1 and 3 terminal of control unit, phase angle of output power varies to 0-180 degree and output voltage is varied.
※ Caution: If it is desired to form a single-phase control circuit using 3-phase power supply, the load phase of R or S, T must be synchronized with the unit power supply as the circuits shown in the following figures 5 and 6
Power control equipment using SSR 9 - 7. Overview
(5) As described earlier, the thyristor unit normally holds the input signal control circuit and power element in one unit for the configuration of error detection and current control circuit. Thus, the unit can be conveniently used, and is commonly used for heater and AC control.
However, thedisadvantage of the thyristor unit is the high price depending on the function available. Woonyoung Co., Ltd. specialized in the production of SSR, produces the power control unit for SSR to have the economic price using the control unit and SSR for simpleAC power controller.

9 - 8 . Control unit function explanation
(1) Phase control unit for 4-20mA and 1-5V input :  WYU - P180AC
 • While this unit is able to conduct the control which is the same as in the WYU-P180A described above, it is used to control temperature, FAN speed, valve and feedback with the heater mainly by means of 4 - 20mA and 1 - 5V input.
 • SSR used: Single WYG1C□□□R4, WYH1C□□□R4 (□indicates current)
 •  Application circuit diagram : Page 249
(2) Cycle control unit for 4-20mA and 1-5V input : WYU-P180TC
 • This unit is able to control accurate temperature using the heater as a cycle control unit for both single phase and three phase for heater only. It can control only single phase in the phase control but it is used for both single phase and three phase without unnecessary reflection noise. The unit is excellent in its linearity.
 • SSR used : All SSR including zero type single phase and three phase are available

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# SOLID STATE RELAY (SSR)

• Application circuit diagram : Page 249


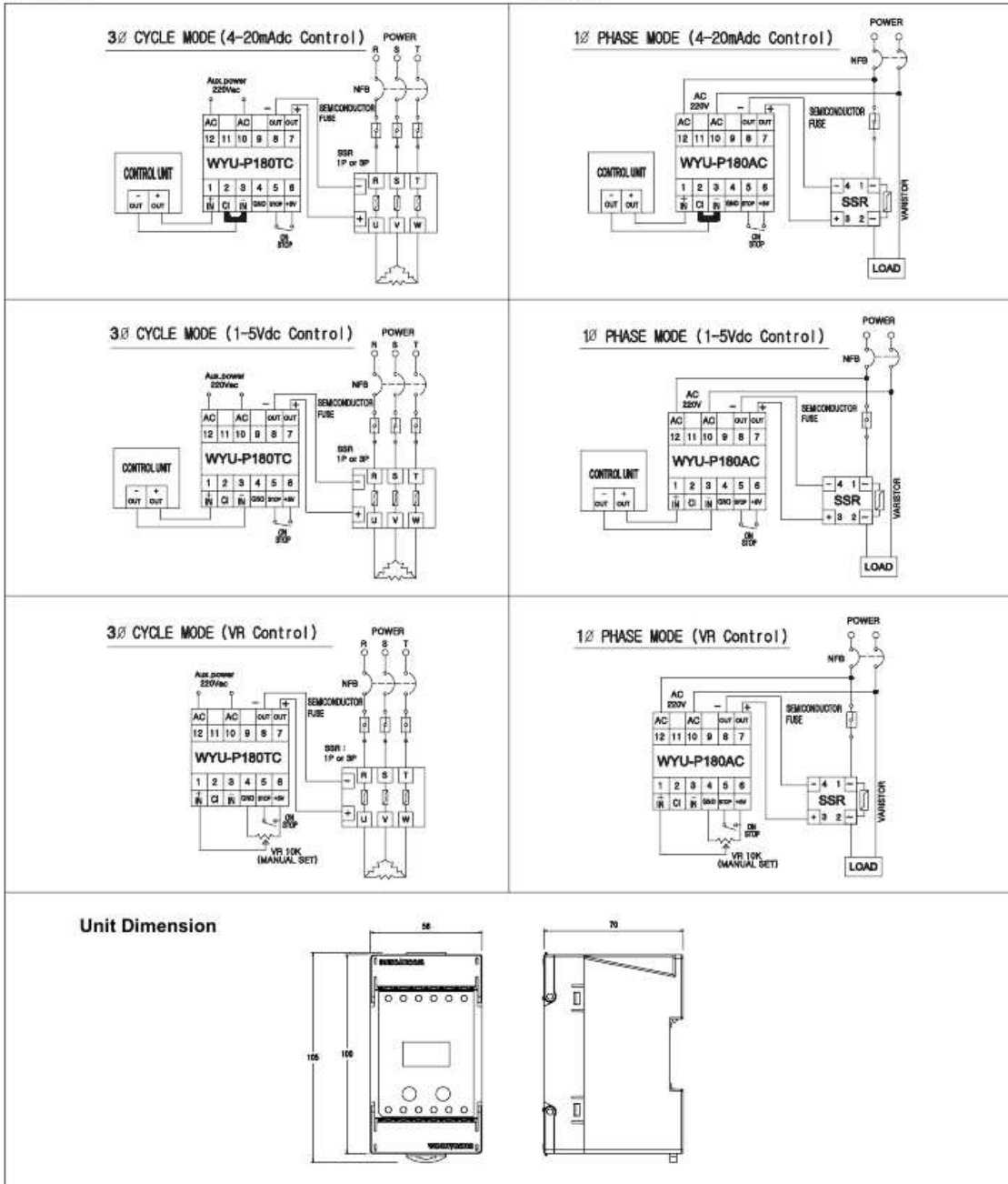
## 9 - 9. Functions and Specifications of the Control Unit

| Unit | Power Voltage | Input Signal | Control | Load Property | SSR Type | Output Signal |
|---|---|---|---|---|---|---|
| WYU–P180AC | AC220V±10% | · 4 ～ 20mA<br>· 1 ～ 5V<br>· VR(10K) | Phase angle control | · Inductive load<br>· Resistance load | Random type<br>Single phase type | DC12V pulse |
| WYU–P180TC | AC220V±10% | | Zero Cycle control | · Resistance load | Zero closs type<br>Single Three phase | DC12V pulse |

26

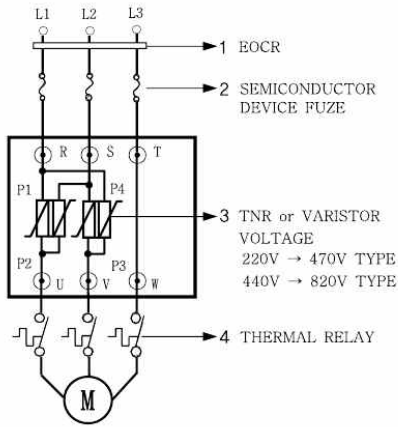# SOLID STATE RELAY (SSR)

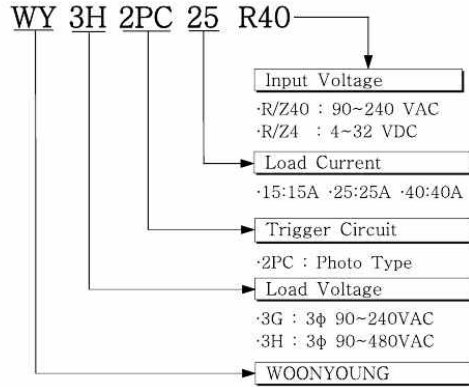9 - 10. Applied circuit of SSR

180TC(3Ø)                                                    180AC(1Ø)



**Unit Dimension**
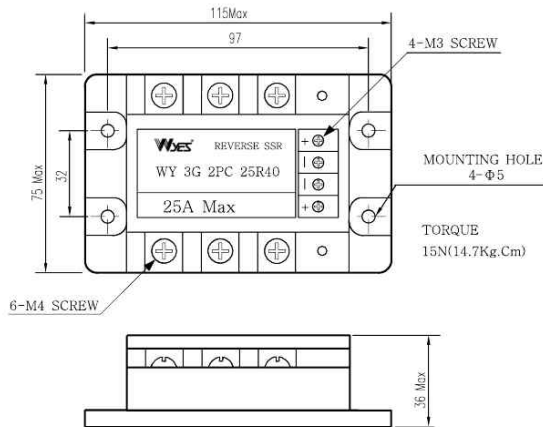
# SOLID STATE RELAY (SSR)

9 - 11. Forward and reverse circuit of three phased motor
(1) AC Input (WY3G (H) 2PC ☐ ☐ R/Z40)



(2) DC INPUT (WY3G (H) 2PC ☐ ☐ R/Z4)
- MINI PLC UNIT WYU-PL16A (Program No. P11 Motor Forward and Reverse Control)



① Improved irrational exiating of forward and reverse SSR. add dead time control circuit inside of SSR for SSR protection when it's without interval time between forward and reverse operating.
(from PLC unit output directly applied to SSR input available by PLC unit user)
② Existing forward and reverse SSR was only controled by DC control input signal. but user can do comprehensive selection of SSR because it was developed by AC control input signal type SSR.
③ if 4 last number of model number WY3G(H)2PCxxR/Z4. must have DC control input signal applied in SSR input
· SSR dead time : 1Hz(0.016s) - internal type
· SSR capacity : 5~10 times of motor rating(can depend on load)
· MCCB : 3 times of motor rating
· FUSE(semiconductor type) : 100% of SSR rating current
· Thermal relay (SRH type) : 100%(600% 2s) of motor rating current

# SOLID STATE RELAY (SSR)



● Forward and Reveres SSR Protection

L1 L2 L3

1 EOCR

2 SEMICONDUCTOR DEVICE FUZE

3 TNR or VARISTOR VOLTAGE
220V → 470V TYPE
440V → 820V TYPE

4 THERMAL RELAY

● Forward and Reveres SSR Model Part

WY 3H 2PC 25 R40

Input Voltage
·R/Z40 : 90~240 VAC
·R/Z4  : 4~32 VDC

Load Current
·15:15A ·25:25A ·40:40A

Trigger Circuit
·2PC : Photo Type

Load Voltage
·3G : 3φ 90~240VAC
·3H : 3φ 90~480VAC

WOONYOUNG

● Dimension

[UNIT : mm]



115Max
97
4-M3 SCREW

REVERSE SSR
WY 3G 2PC 25R40
25A Max

MOUNTING HOLE
4-Φ5

TORQUE
15N(14.7Kg.Cm)

75 Max
32

6-M4 SCREW

36 Max

9 - 12. Control motor and valve by DC SSR

• Protective diode which absorbs reverse eletromotive force must be connected at inductive lode
• You can select SSR about AC 90~480V, 10~150A
• It can be used for DC motor and DC control device



SW
CONTROL

DC SSR

W Y x 1 C x x D 4
W Y  M Y  S e r i e s
W Y  P S  S e r i e s
W Y  V   S e r i e s
W Y  2 C  S e r i e s

M
DIODE

DC POWER
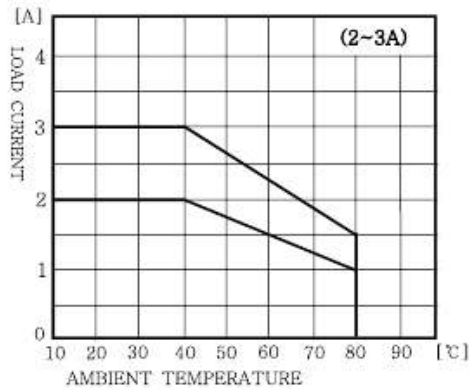
• MOTOR
• VALVE
• CLUTCH / BRAKE

29
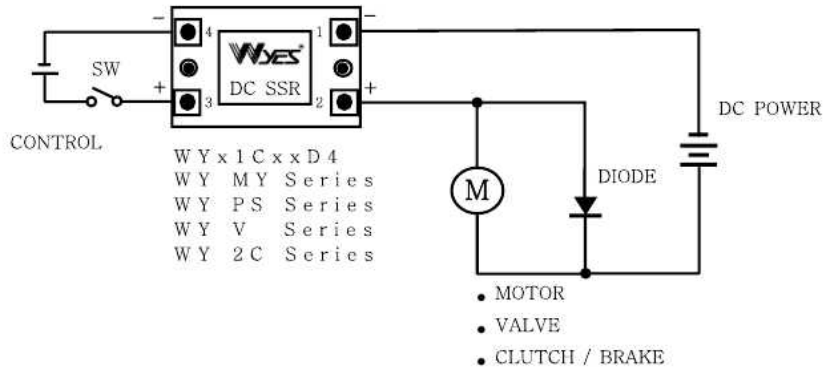
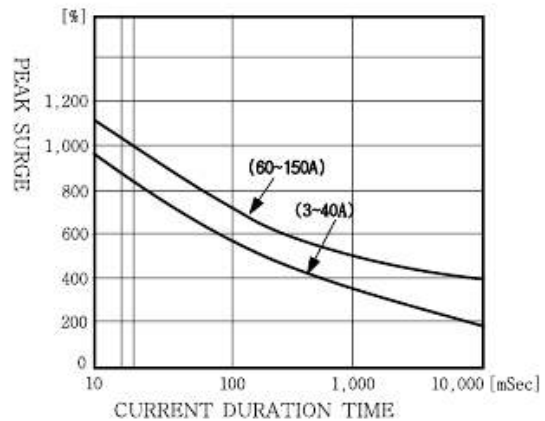# SOLID STATE RELAY (SSR)

## 10. SSR Characteristic Curves

● Input voltage vs current
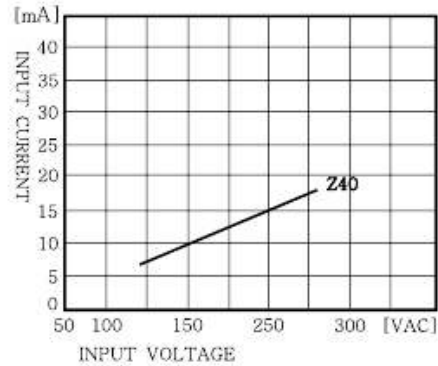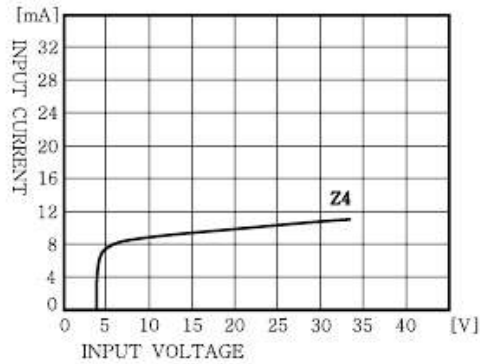
● Maximum Allowable Current vs Ambient Temperature
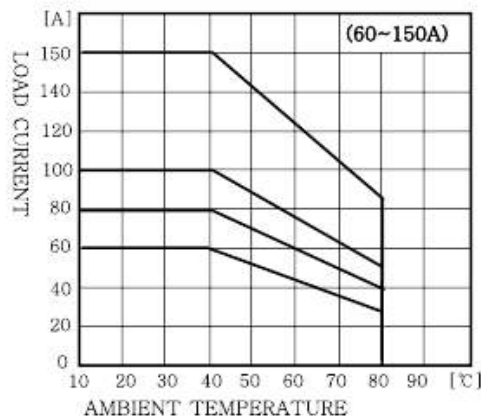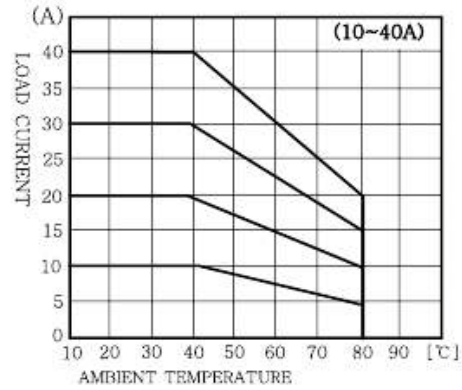
● Surge Current Duration

# SOLID STATE RELAY (SSR)

## 11. Certificate for applicable UL and cUL std.

All our SSR products are certified by UL and cUL, and the products fall under the category of pollution degree 2.

11-1. Listed model and ratings

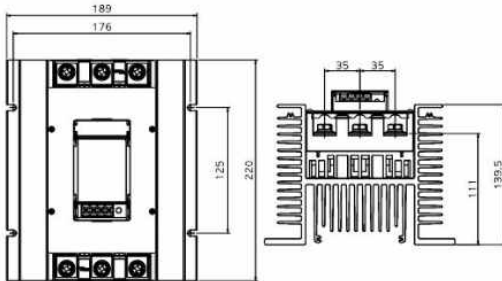| MODEL | RATED VOLTAGE | RATED CURRENT | HEAT SINK TYPE | Surround Air Temperature Curve |
|---|---|---|---|---|
| WYG1C10Z4 | 240V | 10A | HS−A1010 | A |
| WYG1C20Z4 | | 20A | HS−A2020 | A |
| WYG1C30Z4 | | 30A | HS−A3040 | B |
| WYG1C40Z4 | | 40A | HS−A3040 | B |
| WYH1C10Z4 | 480V | 10A | HS−A1010 | A |
| WYH1C20Z4 | | 20A | HS−A2020 | A |
| WYH1C30Z4 | | 30A | HS−A3040 | B |
| WYH1C40Z4 | | 40A | HS−A3040 | B |
| WY3G3C10Z4 | 240V | 10A | H3M−80 | A |
| WY3G3C20Z4 | | 20A | H3M−80 | A |
| WY3G3C30Z4 | | 30A | H3M−110 W/FAN* | B |
| WY3G3C40Z4 | | 40A | H3M−140 W/FAN* | B |
| WY3H3C10Z4 | 480V | 10A | H3M−80 | A |
| WY3H3C20Z4 | | 20A | H3M−80 | A |
| WY3H3C30Z4 | | 30A | H3M−110 W/FAN* | B |
| WY3H3C40Z4 | | 40A | H3M−140 W/FAN* | B |

※ FAN : NMB−MATC3615KL−04W−B50)or equivalent, 92 X 92 X 38L 76.2CFM
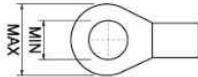
# SOLID STATE RELAY (SSR)



This integral type SSR with fan and heat sink is a product of large capacity of AC90~240V, 60~150A. This SSR has designed self heat sink without attaching to ensure convenient use

● Dimension



189
176
35 35
125
220
111
139.5

60A는 FAN 미부착, 80A 이상은 FAN 부착
Install Fan of over 80A
FAN : AC220V, *option : DC12 or 24V

● Terminal



MAX MIN

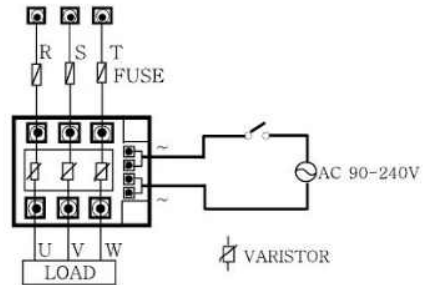Input Ter : Max 6.2, Min 3
Output Ter : Max 20, Min 8

| ITEM | MODEL | WYFM3G3C60/80/100/150Z40 WYFM3G3C60/80/100/150R40 |
|---|---|---|
| **O U T P U T** | Rated voltage | 220VAC |
| | Voltage range | 90~240VAC |
| | Non repetitive peak voltage | 600V |
| | Rated load current | 60/80/100/150A |
| | Frequency | 50/60Hz |
| | Peak surge current | 1300/1750/1950/2550A |
| | leakage current | 10mA |
| | Contact voltage drop | 1.95/1.8/1.8/1.8V |
| | Minimum operating current | 1A |
| **I N P U T** | Maximum input voltage | 240VAC |
| | Input voltage range | 90~240VAC |
| | Input current | 16mA ±3mA(240VAC) |
| | Minimum operating voltage | 85VAC |
| | Turn off voltage | 20VAC |
| **G E N E R A L** | Dielectric withstand | 2000VAC / rms / 1Min |
| | Insulation resistance | DC 500V / 100MΩ |
| | Response time | Z40 : 30ms |
| | Circuit control | Z40 : Zero cross type R40 : Random cross type |
| | Operating temperature | -10 ~ +60℃ |
| | Storage temperature | -20 ~ +80℃ |
| | Weight | 5.6kg |

● Block Diagram



R  S  T

INPUT

3PH ZVC 3PH RVC

R C  R C  R C

U  V  W

* 3PH ZVC : 3PH ZERO CROSS VOLTAGE CIRCUIT
* 3PH RVC : 3PH RANDOM CROSS VOLTAGE CIRCUIT

● Application Circuit



R  S  T  FUSE

~
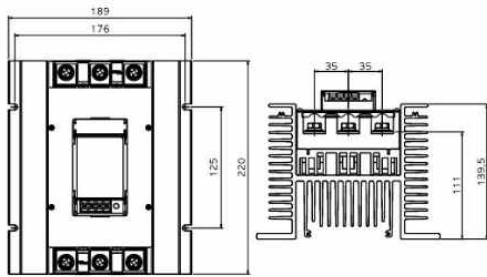~
AC 90~240V

U  V  W
LOAD

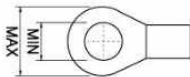VARISTOR
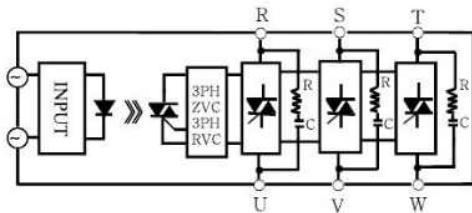
# SOLID STATE RELAY (SSR)

This integral type SSR with fan and heat sink is a product of large capacity of AC90~480V, 60~150A. This SSR has designed self heat sink without attaching to ensure convenient use

## Dimension

189
176
35 35
125
220
111
139.5

60A는 FAN 미부착, 80A 이상은 FAN 부착
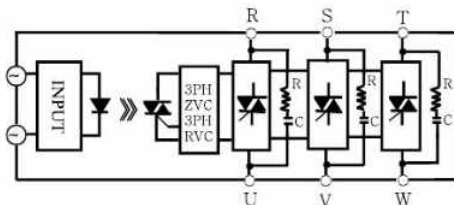Install Fan of over 80A
FAN : AC220V, *option : DC12 or 24V

## Terminal

MAX
MIN

Input Ter : Max 6.2, Min 3
Output Ter : Max 20, Min 8

| ITEM | | MODEL | WYFM3H3C60/80/100/150Z40<br>WYFM3H3C60/80/100/150R40 |
|---|---|---|---|
| O U T P U T | Rated voltage | | 440VAC |
| | Voltage range | | 90~480VAC |
| | Non repetitive peak voltage | | 1600V |
| | Rated load current | | 60/80/100/150A |
| | Frequency | | 50/60Hz |
| | Peak surge current | | 1300/1750/1950/2550A |
| | leakage current | | 10mA |
| | Contact voltage drop | | 1.95/1.8/1.8/1.8V |
| | Minimum operating current | | 1A |
| I N P U T | Maximum input voltage | | 240VAC |
| | Input voltage range | | 90~240VAC |
| | Input current | | 16mA ±3mA(240VAC) |
| | Minimum operating voltage | | 85VAC |
| | Turn off voltage | | 20VAC |
| G E N E R A L | Dielectric withstand | | 2000VAC / rms / 1Min |
| | Insulation resistance | | DC 500V / 100MΩ |
| | Response time | | R40, Z40 : 30ms |
| | Circuit control | | Z40 : Zero cross type<br>R40 : Random cross type |
| | Operating temperature | | -10 ~ +60℃ |
| | Storage temperature | | -20 ~ +80℃ |
| | Weight | | 5.6kg |

## Block Diagram

* 3PH ZVC : 3PH ZERO CROSS VOLTAGE CIRCUIT
* 3PH RVC : 3PH RANDOM CROSS VOLTAGE CIRCUIT

## Application Circuit

R S T FUSE
AC 90~240V
U V W
LOAD
VARISTOR
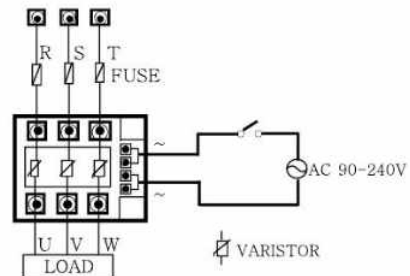
# SOLID STATE RELAY (SSR)



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Chungcheongnam-do, Korea

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