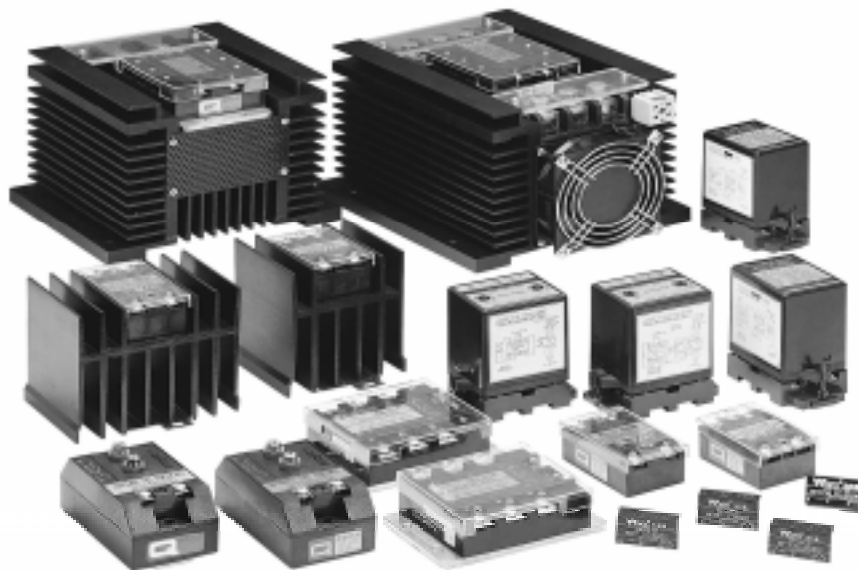


# SSR

(Solid State Relay)

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- SSR SPECIFICATION.....2-26



ORDER MADE OF OVER 150A .

# SSR

(Solid State Relay)

## EXPLANATION

### ORDER

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## **1. Overview of SSR**

### **1 - 1. Features**

#### **(1) Complete solid state relay**

Contact point is operated by microelectronics 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 micro current and micro voltage because of photo coupler in comparison with general relay, it can be directly started by micro signal such as TTL-IC and other Linear IC etc.

#### **(4) Zero voltage, random voltage, switching**

Since motion trigger of major microelectronics 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 voltage type operates at high velocity immediately up on receipt of signal.

#### **(5) Protective circuit**

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 radiating plate.

#### **(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..

### 1 - 2. Category

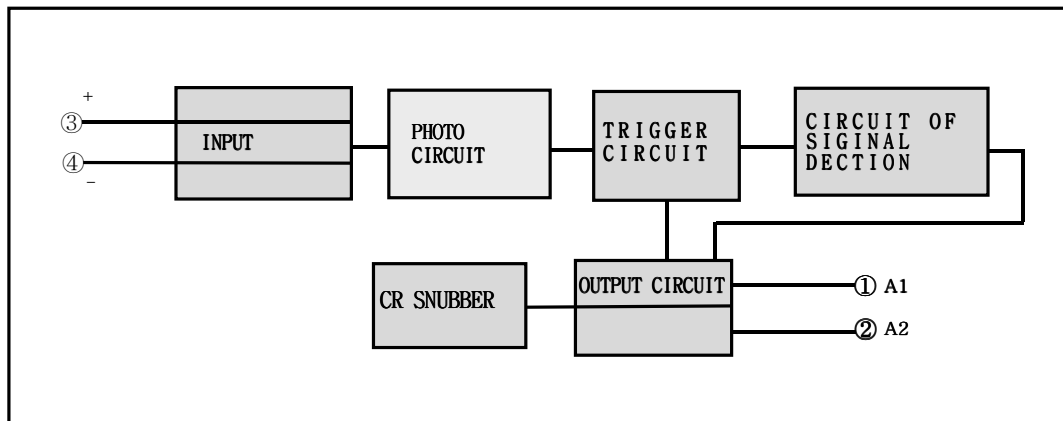
INPUT	OUTPUT	OUTPUT KINF	TRIGGER CIRCUIT	SOURCE	CONTACT "A"	SHAPE
· DC INPUT	· AC CONTACT	· 1 PHACE	· ZERO CROSS TRIGGER	· 90 - 240 VAC	· 1A - 3A	· CAN USE TO PCB
· AC INPUT		· 3 PHASE	· RANDOM TRIGGER	· 90 - 480 VAC	· 10A-150A	· CAN USE HEATSINK
· DC INPUT	· DC CONTACT	· DC	· ON/OFF TRIGGER	· 200 - 1,200 VDC	· 1A - 3A · 5A - 400A	· PCB · USE HEATSINK

### 1 - 3. Structural feature

STRUCTURE FEATURE		CHARACTER	
ISOLATE 부 품	PHOTO TRANSISTOR TYPE	<ul style="list-style-type: none"> <li>● LARGE RANGE OF TRIGGER SIGNAL.</li> <li>● LOW CURRENT OF INPUT SIGNAL.</li> </ul>	
	PHOTO THYRISTOR TYPE(SCR. TRIAC)	<ul style="list-style-type: none"> <li>● SMALL RANGE OF TRIGGER SIGNAL.</li> <li>● CONFIDENCE PROFITABLE.</li> </ul>	
TRIGGER CIRCUIT	ZERO CROSS TYPE	<ul style="list-style-type: none"> <li>● LOW NOISE OF ON SWITCHING NOISE</li> <li>● INRUSH CURRENT RESTRAINT TO ON TIME .</li> </ul>	
	RANDOM TYPE	<ul style="list-style-type: none"> <li>● HIGH SPEED SWITCHING POSSIBLE.</li> <li>● CAN USE PHASE CONTROL.</li> </ul>	
CR SNUBBER	INNER CASE TYPE	<ul style="list-style-type: none"> <li>● LEAKAGE CURRENT MANY HAPPENED.</li> </ul>	
	OUT CASE TYPE	<ul style="list-style-type: none"> <li>● CAN USEFUL CHOICE OF LOAD.</li> <li>● OPTION CONSTANT "CONDENSER AND RESISIOR" DETERMINE LOAD CONDITION</li> </ul>	
SOURCE	AC TYPE	<ul style="list-style-type: none"> <li>● APPLICATION IS VARIOUS.</li> <li>● AC TYPE AND RESPOND TIME QUICKLY.</li> </ul>	
	DC TYPE	<ul style="list-style-type: none"> <li>● CAN USE DC SOURCE.</li> <li>● RESPOND TIME IS VERY QUICKLY .</li> </ul>	
STRUCTURE	USEFUL BY PCB	DIP TYPE	<ul style="list-style-type: none"> <li>● HEIGHT IS LOW.</li> </ul>
		SINGLE IN LINE TYPE	<ul style="list-style-type: none"> <li>● CAN USE PCB, .PROFITABLE PCB ART-WORKING</li> </ul>
	HEAT-SINK TYPE		<ul style="list-style-type: none"> <li>● LOAD CURRENT IS HEAVY.</li> <li>● CAN USE HEAT-SINK.</li> </ul>

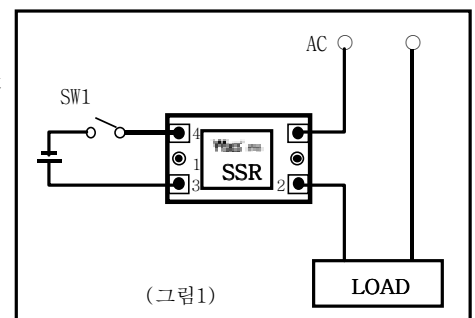
## 1-4 Function of circuit and basic motions

### (1) The structure of circuit



### (2) The function of the circuit

- **Input circuit** : 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 microelectronics after receipt of input signal.
- **Circuit of signal detection** : detect zero cross and random on-off signal at the AC supply.
- **Output circuit** : microelectronics of major contact point receives trigger signal and on-off the electric source.
- **CR Snubber** : it absorbs an excessive electric source so that trigger circuit and major microelectronics operate normally.



### (3) Basic motions

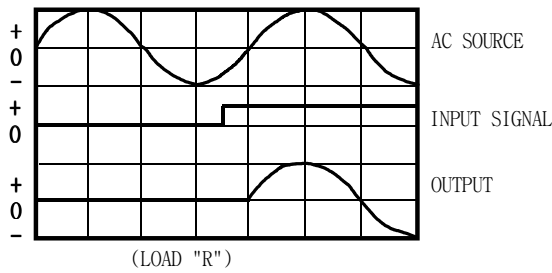
- Connect load and alternating power source at output terminal 1 and 2 by closing circuit as manifested in Picture 1.
- When there is no direct current in input terminal 3 and 4, major microelectronics is off and current does not operate.
- When input signal is accepted, major microelectronics is on at about zero and current operates at the load as LED radiates and photo linking circuit operates by zero cross trigger circuit.
- When input signal is off, major microelectronics is off as load current is below sustaining current of major electronics and motion of basic relay starts.

### (4) Wave type of basic motions according to the type of load

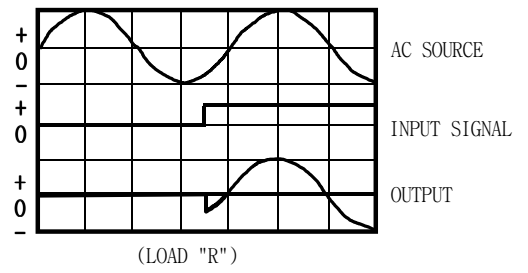
- SSR motions is implemented by terminal voltage of major microelectronics (voltage between output terminals of SSR).
- This terminal voltage varies according to the type of load, and condition of motions of load. There are three types of load such as resistance load, inductive load and load of volume etc. largely speaking and wave type of motions according to load are as following.

### 1 - 5. Basic wave type according to the status of load

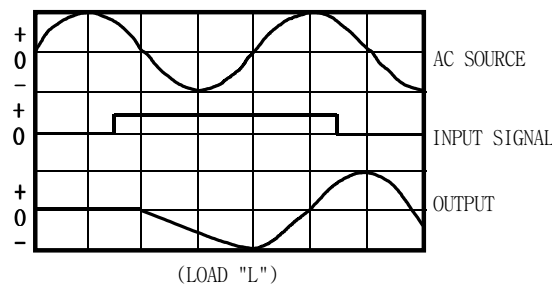
(1) Motion wave of zero cross



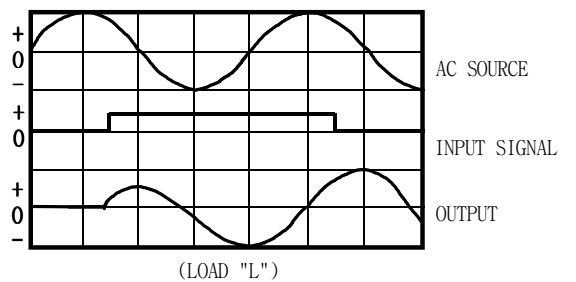
(3) Motion wave of random cross



(2) Motion wave of zero cross



(4) Motion wave of random cross



### 1 - 6. Application

SSR is being applied to the extensive and various areas such as general relay because of high performance under the environment.

#### (1) Products and applications applied by SSR

APPLICATION FIELD	APPLICATION PRODUCTION	COURSE APPLICATION (LOAD)						
		SOLENOID	MOTOR	HEATER	GLOW LAMP	NOCTILU-CENCE	INTERFA-CE	POWER
TRAFFIC CONTROLLER	<ul style="list-style-type: none"> <li>• TRAFFIC SIGNAL</li> <li>• RAILROAD SIGNAL</li> <li>• ELECTRIC LIGHT</li> <li>• STATION EQUIPMENT</li> </ul>	○	○		○ ○ ○ ○	○		○
CONTROLLER	<ul style="list-style-type: none"> <li>• SEQUENCE CONTROLLER</li> <li>• PRESS CONTROLLER</li> <li>• NC</li> <li>• VOLTAGE REGULATOR</li> <li>• ELECTRIC FURNACE</li> <li>• CONSTANT TEMPERATURE MACHINE</li> </ul>	○	○		○		○ ○	
MACHINE TOOLS	<ul style="list-style-type: none"> <li>• NC</li> <li>• PROGRAM ON OFF CONTROL</li> <li>• GENERAL MACHINE TOOLS</li> </ul>	○ ○ ○	○ ○ ○	○			○ ○	
OFFICE WORKS	<ul style="list-style-type: none"> <li>• COPYING PRESS</li> <li>• FACSIMILE</li> <li>• COMPUTER</li> <li>• REGISTER</li> </ul>	○ ○ ○ ○	○ ○ ○ ○	○ ○			○ ○	
HOUSEHOLD ELECTRIC PRODUCT	<ul style="list-style-type: none"> <li>• AIR CONDITIONER</li> <li>• REFRIGERATOR</li> <li>• ELECTRIC MOTIVE TOOLS</li> <li>• ELECTRIC SEWING MACHINE</li> </ul>		○ ○ ○ ○					
ETC.	<ul style="list-style-type: none"> <li>• SESIN SHAPE TOOLS</li> <li>• WATER LEVEL DETECTION TOOLS</li> <li>• EMERGENCY SOURCE</li> <li>• ELEVATOR</li> <li>• AUTO DOOR</li> <li>• PHENOMENON MACHINE</li> <li>• MEDICAL APPLIANCES</li> </ul>	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○	○	○	○		

## 1 - 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 velocity of motions while generates the heat and restrictive features of electricity.

Category	Item	SSR	M C
Characteristics of input	Motions power	Below figure mW	Figure 100mW-W
	Range of motions voltage	Free voltage is available.	Rated voltage+-about10%
	Noise, surge	Not at all	Occurs in coil off
Feature of output	Electrode of point of linking	1a is common but multi contact point is available.	Multi electrode is available.
	Range of power voltage	It depends on voltage feature of microelectronics of major open/shut semiconductor at peak.	Wide range.
	Load current	It depends on rating of microelectronics of major open/shut semiconductor but many times in case of excessive current.	Wide range but damage of point of contact is huge in case of excessive current.
	Excessive 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	Available
	Leakage current	Below10mA	Not at all
	Noise, surge	Not at all	Occurs in case of inductive load
	Occurrence of ARC	N/A	Occurs depending load
	Occurrence of heat at linkage	Occurs 1.5W per 1A	Occurs in case of false contact point
	Function of zero cross	Available	Not available
	Insulation, voltage resistance	About 2.500V	High resistance voltage is available.
	Velocity of motions	Within 10mS	More than 100mS
	Duration	Long(regardless of motions of contact point)	A few 10,000 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

## 2. SSR design of radiator and the criteria of selection

### 2 - 1. Features of radiator

Many variables are depending internal condition of radiator and that of design. Design therefore has to be implemented based on the reference of features of radiator and also it should be cautiously designed since microelectronics of SSR is radiation. Unless radiation is used, normal motions will occur initially but point of internal SSR.

- (1) Radiation volume of radiator is in a proportion to the surface area of radiation plate.
- (2) Radiation volume of radiator is in a proportion to the difference between surface temperature of radiation plate and the temperature of the surrounding air.
- (3) Color black has high radiation effect on the surface of radiator.
- (4) Function like data of catalog can not be expected unless radiation plate is handles in a vertical direction.
- (5) When contact between semiconductor and radiation plate are false, effect of heatproof is dramatically dropped.
- (6) Unless natural convection occur in the place of radiator, function of the radiator is decreased.
- (7) Artificial freezing by radiation plate will be able to increase the performance of radiator as more than twice as much.
- (8) When surrounding temperature is more than 40C, artificial freezing is required by use of fan according to the electric current so that safe usage of SSR can be guaranteed.

### 2 - 2. Heating and item to calculate the heat

#### (1) Junction temperature : $T_j$

- Junction indicates the P-N junction of semiconductor and core of microelectronics. When electric current flows as semiconductor moves, heat ( $P_w$ ) occurs and sustains the regular temperature under the heating. It is the function of radiator.
- Junction temperature is based on the temperature which is recommended by SSR maker . In case of SCR and TRIAC, temperature is normally 110-125C, but around 10C decrease is decided for reliability.

#### (2) Heat resistance between junction and case : $R_{jc}$

- The figure is decided based on the research of data of SSR maker in terms of heat resistance between junction and case and unit is C/W which indicates the temperature gap in 1C per 1W consumptive power.

#### (3) Heat resistance between SSR case and radiator

- Heat resistance between case and radiator varies by the method to use radiator plate. It depends on direct radiation, using insulation, using radiation grease, process of surface of radiator etc. Affixation of radiator and SSR must be precis



※ Following is the junction common heat resistance of SSR according to the method of affixation.

- Heat resistance in case of direct attachment =0.1-0.5 C/W
- Heat resistance when silicon is used =0.05-0.5 C/W.

**(4) Decision of temperature of surrounding air (Ta)**

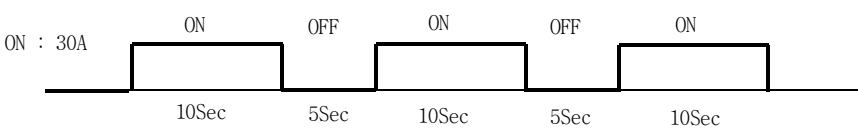
Item (1) - (3) mentioned above has been almost set by SSR but temperature of surrounding air must be checked by user. Having considered structure of device, status of usage, maximum temperature to be used must be decided. After completion of production, maximum temperature must be considered based on the actual status of operation. For reference, when temperature of SSR assembly is 40C, internal temperature of object of which inflow of air ventilation is assumed around 50C. But, machinery which is susceptible to the direct ray, temperature might reach up to 80C. Heating object in this case should be considered.

**(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)

● **Calculation of average electric current (resistance load)**



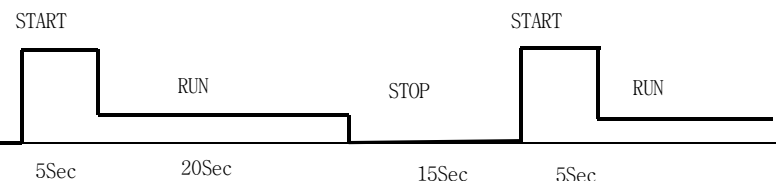
ON : 30A

ON      OFF      ON      OFF      ON

10Sec    5Sec    10Sec    5Sec    10Sec

◆ VA =  $\sqrt{\frac{PON^2 \times Ton}{Toff + Ton}} = \sqrt{\frac{30A^2 \times 10}{5 + 10}} = 24.5A$  ..... (2)

● **Calculation of average electric current (inductive load)**



◆ START = 30A

◆ RUN = 5A

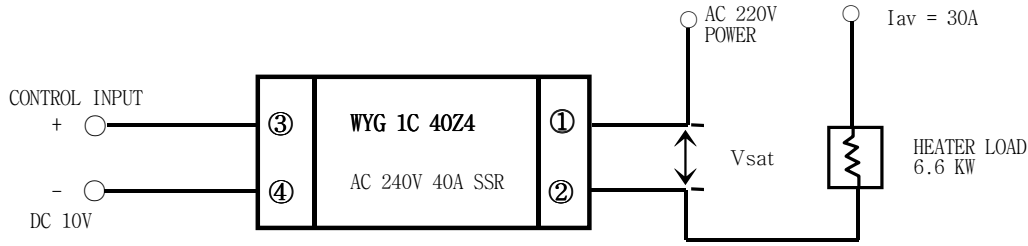
START      RUN      STOP      START      RUN

5Sec      20Sec      15Sec      5Sec

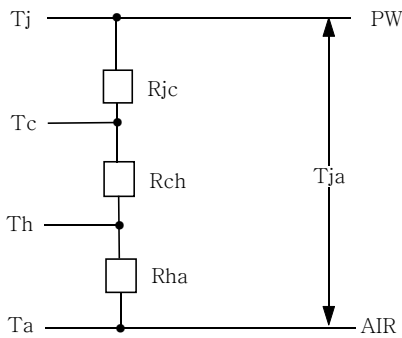
◆ VA =  $\sqrt{\frac{Ista^2 \times Tsta + Iru^2 \times Tru}{Tsta + Tru + Tst}} = \sqrt{\frac{30A^2 \times 5 + 5A^2 \times 20}{5 + 20 + 15}} = 11A$  ..... (3)

## 2 - 3. Design of radiator of SSR circuit

### (1) Design circuit line : single-phase control circuit



### (2) Equivalent circuit of heat resistance



- Tj : SSR JUNCTION TEMPERATURE
- Tc : SSR CSE TEMPERATURE.
- Th : HEAT-SINK TEMPERATURE.
- Ta : AMBIENT TEMPERATURE.
- Pw : SSR TO AVERAGE POWER LOSS
- Rjc : JUNCTION TEMPERATURE SSR AND HEATSINK .
- Rch : JUNCTION TEMPERATURE CASE AND HEATSINK .
- Rha : TEMPERATURE GAP BETWEEN SSRCASE AND HEATSINK.
- Tja : TEMPERATURE GAP TRIAC AND AIR.

### (3) Calculation of heat resistance of radiator (data is obtained by catalog)

- ① SSR to be used : WYG 1C 40Z4
- ② Average consumptive electric power of SSR :  $P_w = 38W (I_{av} \times V_{sat} = 30A \times 1.3V = 39W)$
- ③ Tj of SSR : 125C
- ④ Heat resistance of SSR Rjc : 1.1C/W
- ⑤ Temperature gap between SSR junction and case.....(1)
  - $T_{jc} = R_{jc}(C/W) \times P_w = 1.1 \times 38 = 41.8C$
- ⑥ Temperature gap between SSR case and radiator.....(2)
  - $R_{ch} = 0.1C/W$
  - $T_{ch} = (C/w) \times P_w = 0.1 \times 38 = 3.8C$
- ⑦ SSR 접합부와 공기 (방열판 주위) 온도차 Tja.....(3)
  - $T_j = 125C \rightarrow$  신뢰성을 고려하여 115C 로 한다.
  - $T_a = 40C \rightarrow$  방열판 주위온도의 최대로 결정.
  - $T_{ja} = T_j - T_a = 115C - 40C = 75C$
- ⑧ 방열기의 온도 (Th)와 주위 공기 온도 (Ta)의 온도차 Tha.....(4)
  - $T_{ha} = T_{ja} - T_{jc} - T_{ch}(C) = 75C - 41.8C - 3.8C = 29.4C$
- ⑨ 방열기의 열저항 Rha .....(5)

$$R_{ha} = \frac{T_{ha}}{P(W)} (C/w) = \frac{29.4}{38} = 0.77C/w \longrightarrow \text{방열판 규격 DATA.}$$

· 3상 SSR은 위 공식 (5)에서 P(W) × 3 으로 계산 한다.

- ⑩ 방열기의 CATALOG DATA에서 소요열저항 0.77C/W 이하의 MODEL 을 선정하여 사용하거나 SSR 제조업체에서 선정하는 표준형을 사용합니다.

## 2 - 4. References of standard radiator (aluminum) to select

- (1) Method of freezing → natural freezing or artificial freezing?
- (2) Heat resistance of radiator → choose the lower than designed heat 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 and paint?
- (5) Use silicon grease for radiator

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 radiator plate of electric unit in general. Minimizing the heat resistance resulted from imbalance between radiator plate and contact of SSR, it increases the radiation so that it must be used for unit of electric power.

## 2 - 5. Data of Wyes SSR heat design

### (1) Data of single phase SSR heat

APPLICATION SSR	(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	-
WYG 1C 70Z4, 70Z40, 70R4 WYH 1C 70Z4, 70Z40, 70R4	70	80	125	0.70
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) Data of three phases SSR heat**

TYPE SSR	CURRENT(A)	PD(W)	Tj(℃)	Rjc(℃/W)
WY3G 3C 10Z4, 10Z40, 10R4, 10R40	10	33	10	0.9
WY3H 3C 10Z4, 10Z40, 10R4, 10R40	10	45	110	0.73
WY3G 3C 20Z4, 20Z40, 20R4, 20R40	20	60	125	0.46
WY3G 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	-

※ " - " Is plate of radiator in Rjc

### 3.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.

#### 3 - 1. Feature of load and category of SSR by function .

CHARACTER	KIND OF LOAD	LOAD CAP.	SSR	SSR MODEL( Wyes SERIES)
<b>SMALL "R, L" LOAD</b>	SOLENOID VALVE. LAMP. RELAY.	AC 220V/3A 1PHASE	· ZERO CROSS TYPE	WYP - 3A. WYPS - 3A. WYPM - 3A. WYPV - 3A.
<b>SMALL "L" LOAD</b>	1P, 3P MOTOR TRANSFORMER. INDUCTANCE MOTOR	AC 220-440V/40A	· RANDOM TYPE	WYG 10A-40A. WYH 10A-40A. WY3G 10A-40A. WY3H 10A-40A
<b>LARGE "L" LOAD</b>	1P, 3P MOTOR TRANSFORMER. INDUCTANCE MOTOR	AC 220-440V/150A	· RANDOM TYPE	WYMG 60A-150A. WYMH 60A-150A. WYH 60A-150A. WY3x 60A-150A.
<b>SMALL "R" LOAD</b>	1P ,3P HEATER	AC 220-440V/40A	· ZERO CROSS TYPE	WYG 10A-40A. WYH 10A-40A. WY3G 10A-40A. WY3x 10A-40A.
<b>LARGE "R" LOAD</b>	1P ,3P HEATER	AC 220-440V/150A	· ZERO CROSS TYPE	WYMG 60A-150A. WYMH 60A-150A. WYH 60A-150A. WY3x 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 genuine capacitor..
- Both zero cross type or random type of inductive load are used, but random type is recommended to be used as capacitor is larger.
- Measure of surge current and voltage must be designed in terms of inductive load.
- It is unavailable to use zero cross type at motor of inductor such as break and clutch etc..
- When inductive load such as M/C and inverter etc. are connected in the internal panel, measure of surge must be considered.

### 3 - 2. Table of application of inductive load

(1) Start electric current and operation current at single phase AC motor (HP) and SSR to be applied.

MOTOR	110V MOTOR			220V MOTOR			440V MOTOR			DRIVE CON.
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							● USE HEATSINK  ● START -TIME 2SECOND
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				
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	
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	

(2) Start electric current and operation current at three phases AC motor (HP) and SSR to be applied.

MOTOR	220V MOTOR			440V MOTOR			DRIVE 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	● CAN SUED HEAT-SINK  ● START TIME 2SECOND
3/4	2.9	17.4	20	1.5	9.0	10	
1	3.7	22.2	20	1.9	11.4	10	
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	
10	29.4	176.4	150	14.0	84.0	60	
15				20.0	120.0	80	
20				26.0	156.0	100	

### 3 - 3. Application table of SSR of resistant load

(1) Electric specification of single and three phases SSR and specification of electricity of heater

SSR " A "		HEATER LOAD CAP.						DRIVE CONDITION
		1PHASE HEATER(KW)			3PHASE HEATER (KW)			
(A)	AVERAGE(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	CAN USED HEAT-SINK  AMBIENT TEMPERAT URE 40℃
20	16	3.5	6.1	7.0	6.1	10.5	12.2	
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	
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	

## 4. Circuit design to protect linking point 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 heat 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 microelectronics 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.

### 4 - 1. I<sup>2</sup> T of semiconductor unit

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<sup>2</sup> T, it is normally maximum current square time when point of contact of semiconductor is broken within the AC anti-cycle and the specification of semiconductor unit is regulated by all means.

4 - 2. Specification table of Wyes SSR series I<sup>2</sup> T

(1) I<sup>2</sup> T specification and surge current of SSR at single and three phases AC 220V

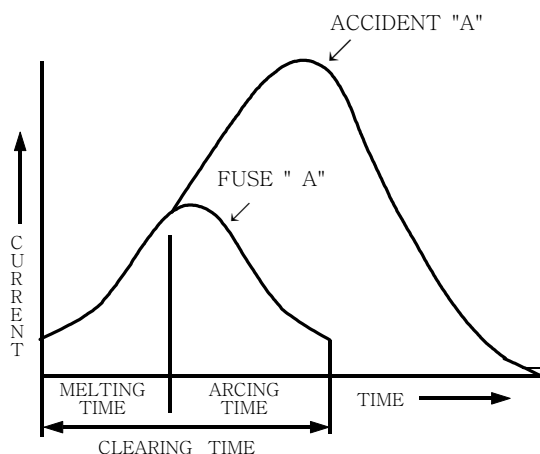
WYG 1C SERIES WYMG 1C SERIES WY3G 3C SERIES	CONTACT CAPACITY		TEST CONDITION
	SURGE CURRENT	I <sup>2</sup> T	
10A	125A	72 A <sup>2</sup> S	<ul style="list-style-type: none"> <li>● Tj initial = 25℃</li> <li>● Non repetitive</li> <li>● T = 10mS</li> </ul>
20	260	250	
30	300	450	
40	315	450	
50	525	1,250	
60	1,300	7,200	
70	950	3,745	
80	1,750	12,800	
100	1,950	16,200	
150	2,550	26,500	

(2) I<sup>2</sup> T specification and surge current of SSR at single and three phases AC 440V

SSR "A" WYH 1C SERIES WYMH 1C SERIES WY3H 3C SERIES	LOAD CAP.		TEST CONDITION
	SURGE 전류	I <sup>2</sup> T 규격	
10A	170A	72 A <sup>2</sup> S	<ul style="list-style-type: none"> <li>● Tj initial = 25℃</li> <li>● Non repetitive</li> <li>● T = 10mS</li> </ul>
20	250	265	
30	350	610	
40	370	610	
50	525	800	
60	1,300	7,200	
80	1,750	12,800	
100	1,950	16,200	
150	2,550	26,500	

### 4 - 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.



### 4 - 4. Specified design of semiconductor fuse

Specification of following conditions must be considered for circuit design to protect SSR at the excessive electric current. (following figure is an example.)

- (1) Effective voltage of load circuit .....AC 220V circuit of single phase
- (2) Maximum serial load current.....AC 12A.
- (3) Maximum electric current to be expected in case of error..AC 200A.(it is varied by output of power source of circuit and impedance)
- (4) Specification of current of SSR and I 2 T to be used.....AC 20A - 265 A<sup>2</sup> S (SSR : WYG 1C 20Z4 - 20A).
- (5) Selection of fuse specification.....AC 250V-15A / 60 A<sup>2</sup> S (GOULD A25× -101 AMP - TRAP).

- ※ "A" - LOAD "A" < FUZE "A" < SSR "A" = 12A < 15A < 20A
- ※ I<sup>2</sup> T - FUZE I<sup>2</sup> T < SSR I<sup>2</sup> T = 60A<sup>2</sup> S < 265 A<sup>2</sup> S

### 4 - 5. Precaution in case of design of other protective circuit.

- (1) Rated voltage of fuse and load voltage of circuit must be designed at identical specification. 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 pre load current and phase current in case of three phases (pre load current  $\times \sqrt{3}$  = phase current). Precaution must be made in order not to select fuse specification by pre 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 heating interceptor of over current must be used.

## 5. Design for prevention of excessive voltage of SSR

When SSR is used at inductive load such as motor etc. excessive voltage occurs in case of open/close of power source. If the excessive voltage is over peak off-state voltage at the unit of linkage of SSR ( $V_{dm}$  : repetitive peak off-state voltage), microelectronics is likely destroyed. Therefore, unit to absorb excessive voltage must be affixed at the point of contact or load for safe motions. Resistance Generdiode 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 voltage

### 5 - 1. Peak voltage (off status) of Wyes SSR

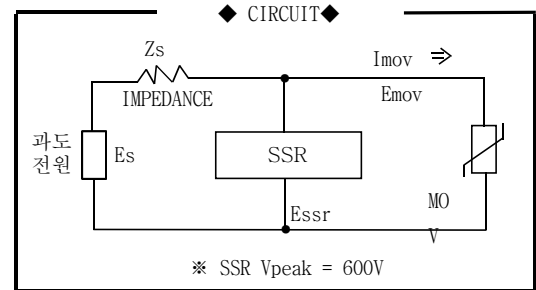
SSR SERIES	PEAK 비반복 OFF 전압	최대 전원전압	비 고
WYP 2 ~ 3A	600	AC 240V	
WYG 10A-40A	600	240	
WYMG 60A-150A	600	240	
WY3G 10A-40A	600	240	
WYH 10A	800	240	
WYH 20-40A	1,200	480	
WYH 60A-150A	1,200 ~ 1,600	480	
WYMH 60A-150A	1,200 ~ 1,600	480	
WY3H 10A	800	480	
WY3H 20A-40A	1,200	480	
WY3H 60A-100A	1,200 ~ 1,600	480	

## 5 - 2. Overview of circuit design to prevent excessive voltage

With regard to items to be considered in selecting the specification of Varistor, data of size of excessive 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 excessive voltage (example)

- ◇ Excessive voltage ..... 3 KV/30uS
- ◇ Circuit impedance.....50 Omega.



## 5 - 3. Specification design of Varistor(MOV)

### (1) Data is available from the equivalent circuit to be designed

- Measured figure of over voltage (Es) : 3,000V/30us
- Circuit impedance : 50 Omega .
- SSR peak voltage (Essr) : 600V (data of SSR 5-1)
- Power voltage of circuit : AC 220V
- Frequency of excessive voltage : 100,000 times/10Sec distance.

### (2) Specification of effective voltage of Varistor and voltage of Varistor are selected.

(Example?is calculated based on the data of TNR series product hereinafter)

- Voltage power x 10% <Varistor voltage =AC 220V x 10%=more than 242V(Acrms)
- 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).

### (3) Electric current of Varistor at equivalent circuit is calculated.

$$\begin{aligned} & \cdot Es(max) = (Imov \cdot Zs) + Emov \dots \dots \dots (1) \\ & \cdot Imov = \frac{Es - Essr}{Zs} \dots \dots \dots (2) \text{ 바리스타 전류} \\ & \cdot Imov = \frac{3000-600}{50} = 48 \text{ A} \end{aligned}$$

### (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 excessive 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.

- Coordinates of current (48A) / size of pulse (less than 30uS) → comparison ← frequency graph of excessive 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 excessive 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 suggested as an example is decided by TNR15G391K type

**(6) Method to connect Varistor**

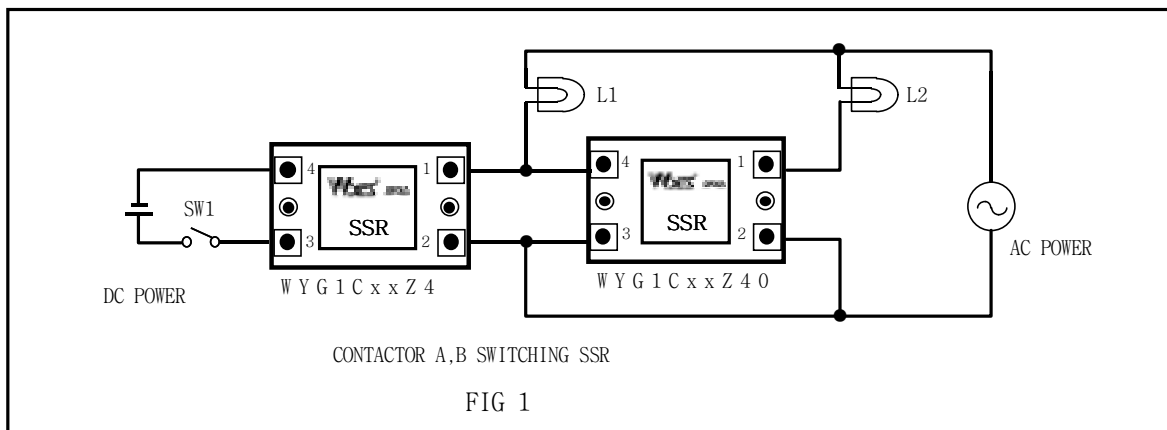
It must be affixed with short wiring at the source of over voltage nearest possible by connecting at parallel circuit to the contact point of SSR, voltage of power source and load etc.

## 6. 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.

### 6 - 1. Circuit of linkage of A and B by use of single phased SSR

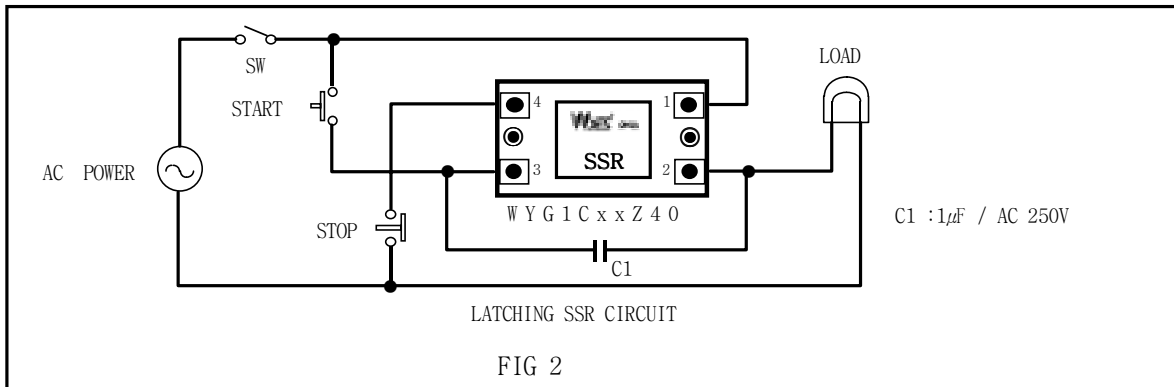
- It is a circuit to make A and B linkage according to the input signal at the two single phases by use of 2 SSR(AC input type, DC input type) so that load operated every other time.
- Resistant load and inductive load are available up to AC90V-220V, current 10A-150A.
- With regard to motions, L1 load is on when SW1 is on and Ls is on when it is off.



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

### 6 - 2. Latching by use of a single phase SSR (magnetic circuit )

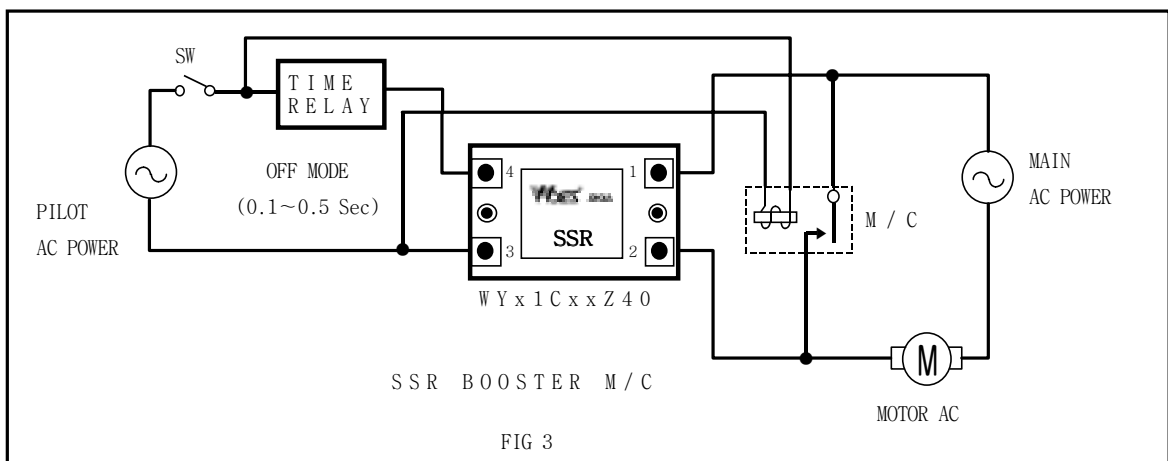
- SSR magnetic circuit at the single phase circuit by use of SSR with AC input type is as below.
- With regard to the range of electric power, it is able to operate at ac 90-220v and 10A -150A of electric current
- When start switch is on, SSR immediately is on and sustains the magnetic. On the other hand, SSR is off when stop switch is off. Accurate operation is, however, not expected at the less than 1A of load current.



※ SSR = AC INPUT (WYG1CxxZ40).

### 6 - 3. Circuit to prevent relay arc by use of SSR

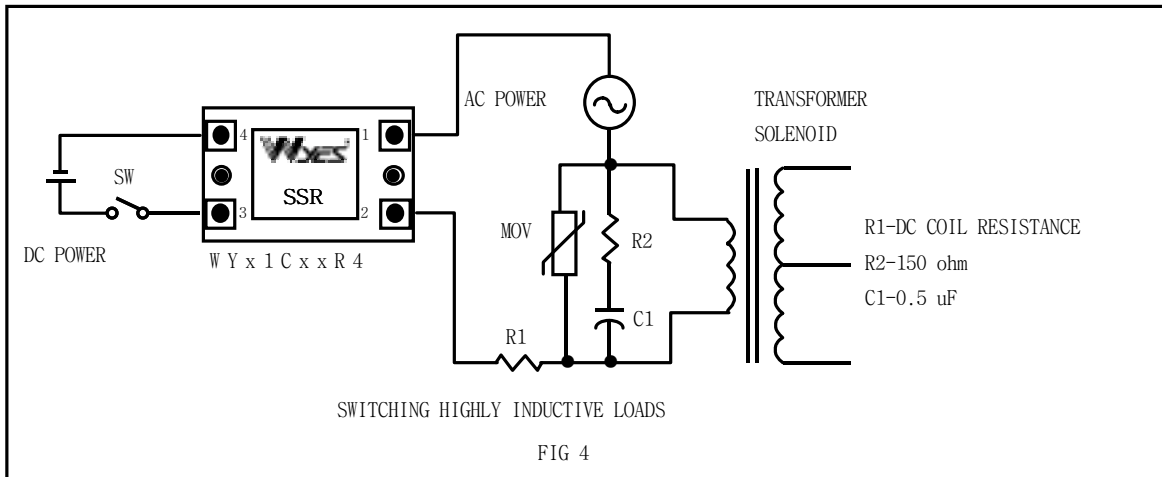
- General relay or M/C (Magnetic Contractor) may face ARC at the linkage in case of on/off which damages linkage and cause noise. It must be prevented. SSR is required to be more than 6 times larger than that of operation current because of electric current of motor to start, but it is acceptable to use equivalent capacity of operation current if this circuit is used. Also radiator plate to be used for SSR is not required.
- When SW is on, SSR operates first and then M/C 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.
- Scope of electric power is AC90-480V and electric current 10A-150A.



※ SSR =AC input type(WY x 1CxxZ40)

### 6 - 4. Safety circuit of inductive load of high capacity by use single phase SSR

- Since transformer, solenoid of high capacity have high monetary electric charge and recharge, 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 : resistant heat)
- Scope of electric power is AC90-480V and electric current 10A-150A.

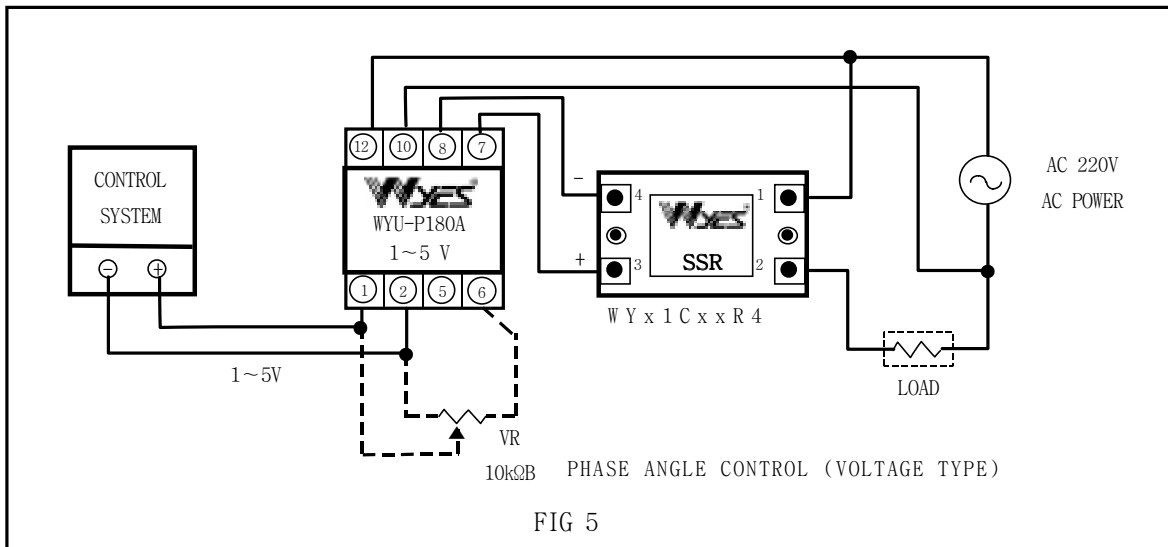


※ SSR = DC input type (WY x 1CxxZ4)

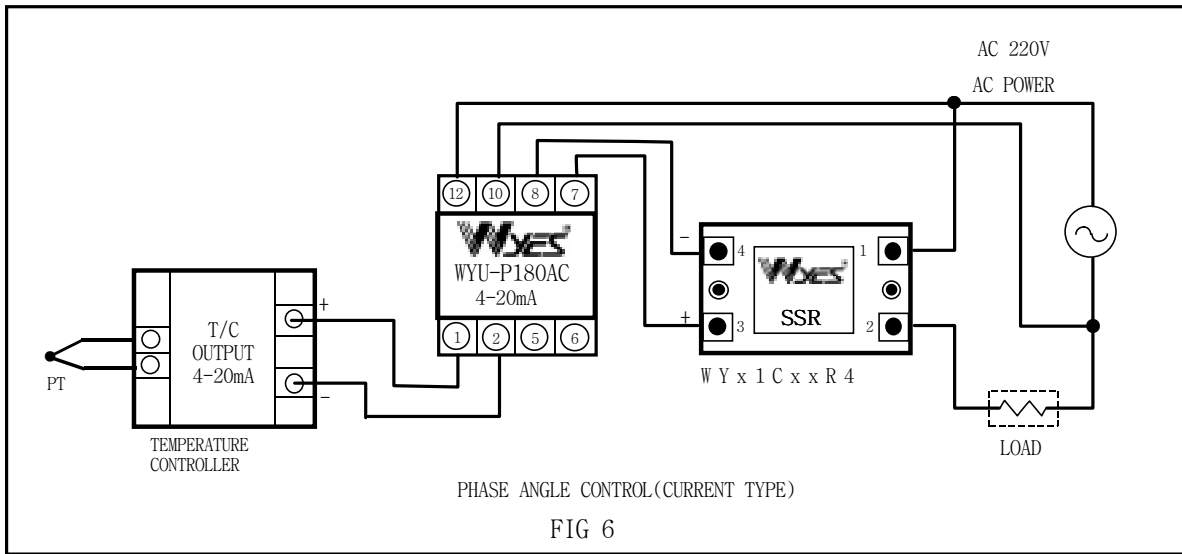
### 6 - 5. Phase angle control circuit by use of single phase of SSR

- 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 rotary device and electric thermal control.
- Type of control unit :
  - WYU - P180A : INPUT DC 1 - 5VDC .....exclusive control of AC load
  - WYU - P180AC : INPUT DC 4 - 20 mA.....exclusive for temperature.
- SSR is random type SSR : AC90-480V, scope of electric current is 10A-150A.
- When voltage and electric current signal are transferred to the No.1 and 2 unit of control unit, phase angle of output electric power varies to 0-180 degree and voltage is varied.

#### (1) Application circuit for electric current control

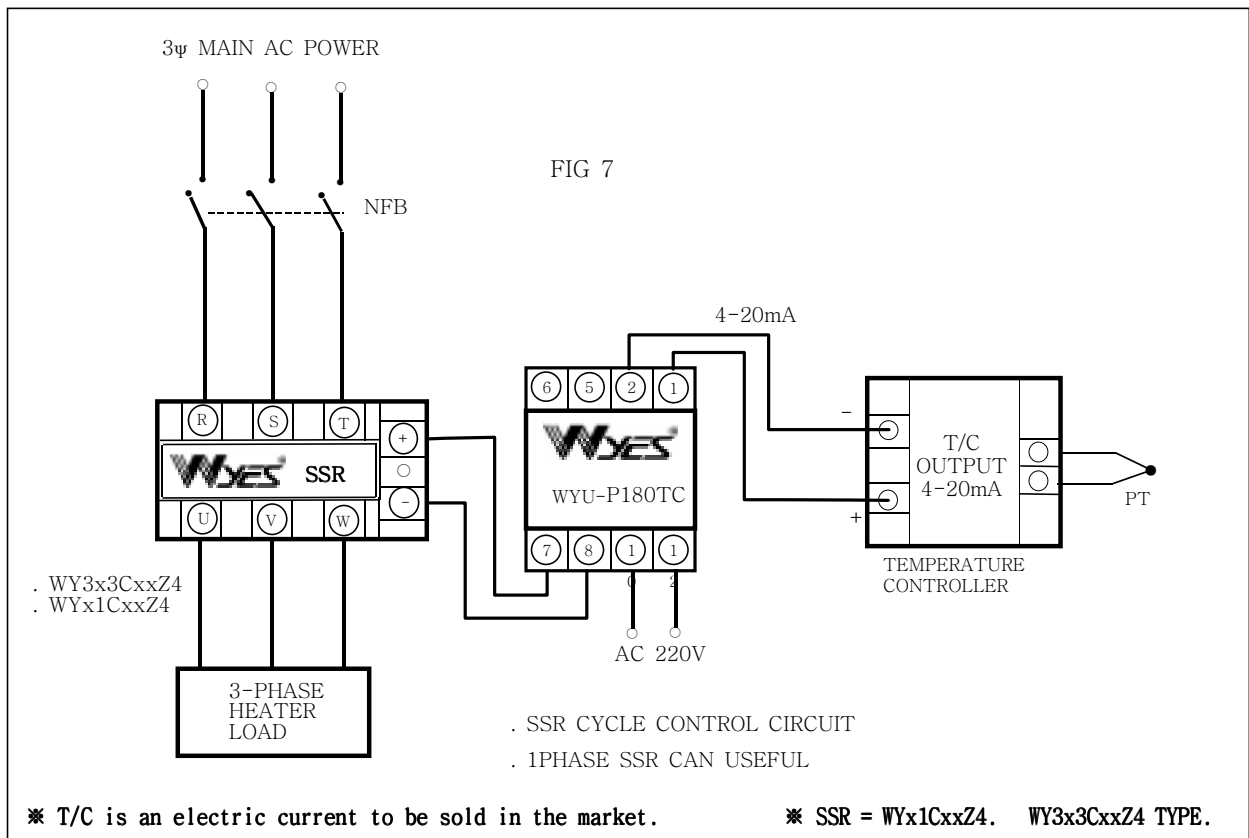


(2) Application circuit for electric current control



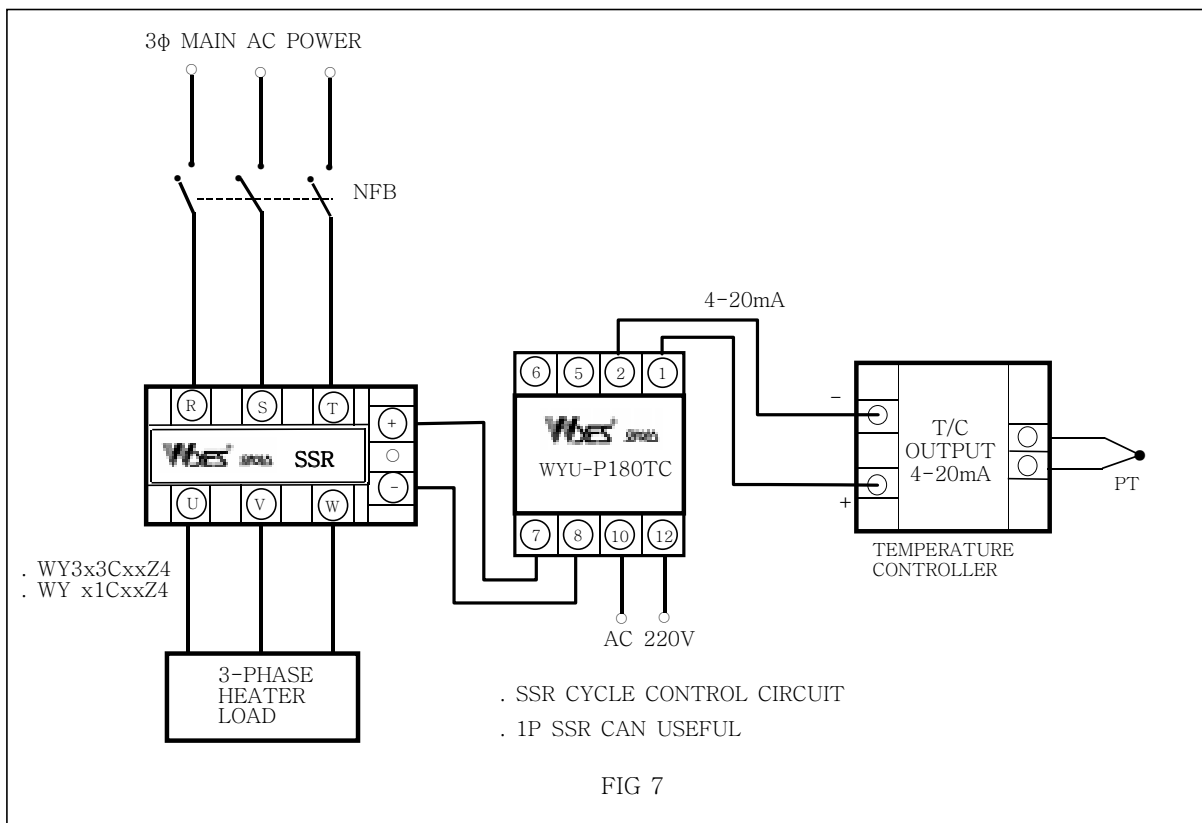
6 - 6. Single phase, three phases cycle control circuit

- Electric power of load is controlled by various circuit and zero cross-cycle control is commonly controlled in terms of control of heater. The method is to control the gap between on and off during certain cycle in accordance with proportion of electric power by repeating output power in a regular (about 160mS) cycle and vary average electric power of load.
- With regard to digital thermometer for proportional control in general , output control power is 4-20mA. Thermometer is proportionally controlled if control unit and SSR are connected as below in order to SSR by this signal.
- Scope of electric power is AC 90-480V, 10A-150A of electric current.



**6 - 7. Forward and reverse circuit of three phased motor.**  
**(WYU-R50BCunit/WY3x2RxxR8-SSR)**

- Though pro and reverse of three phase motor are processed by classification, pro and reverse of 2 SSR, it is easy to control pro and reverse of three phase motor by use of one exclusive SSR and control unit as manifested below. When the direction of motion changed from pro to reverse or from reverse to pro, interlock timer during regular time is operated for safe motion of motor and SSR.
- Interlock time of pro and reserve is controlled during 0.3~3 seconds. Concerning input signal of pro and reverse motion, earlier direction comes first though input signal of pro and reverse motion is repeated.
- If S1 is on in the picture 8, motor rotates at the pro direction. When S2 is on after S1 is off, it rotates in the opposite direction. In order to stop, all S1 and S2 are off.
- Fuse and varistor must be connected as Picture 9 in terms of pro and reversing circuit in order to protect SSR from error electric current and excessive voltage.
  - . F1-F2= fuse to protect semiconductor
  - . P1-P4=varistor (MOV)

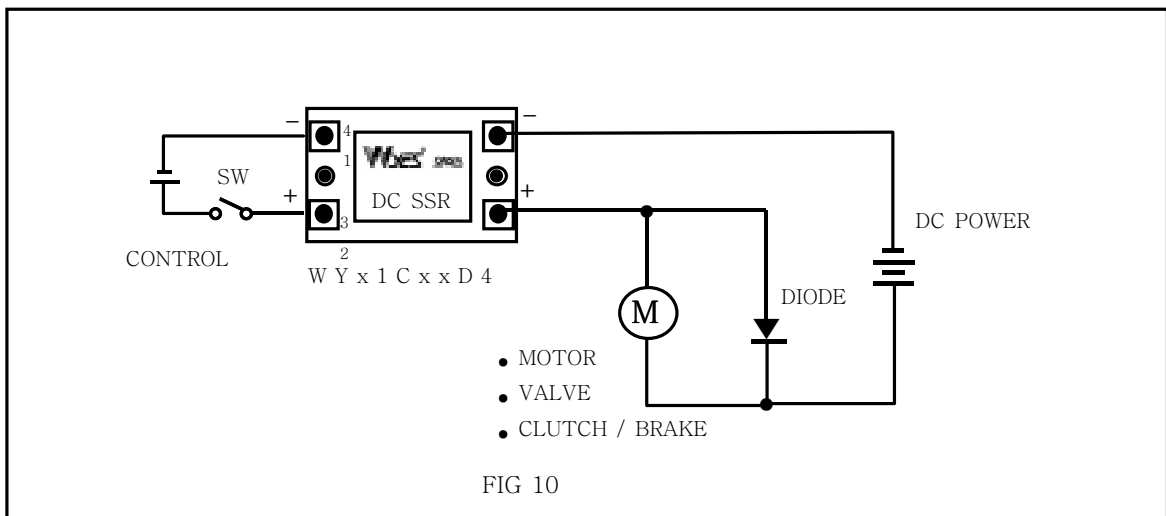


**6 - 8. Unit to control pro and reverse WYU-R50BC specification**

- Voltage of electric power : AC220V+/-10%
- Interlock at pro and reverse direction : 0.3~3 sec.
- Temperature to be used : 0 - 50°
- SSR to be used : WY3G 2RxxR8, WY3H 2RxxR8 exclusive
- Internal DC electric power : DC 12V+/-10%

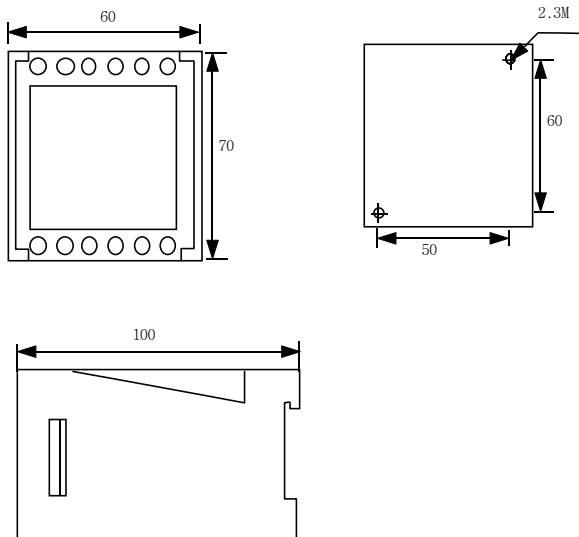
### 6 - 9. Control motor and valve by DC SSR

- Protective diode which absorbs reverse power must be linked at inductance
- Scope of electric power is DC 10-1,200V and 1A-40A of electric current
- It can be used for DC motor and DC control.



### 6 - 10. Shape of SSR control unit and dimension

● DIMENSION



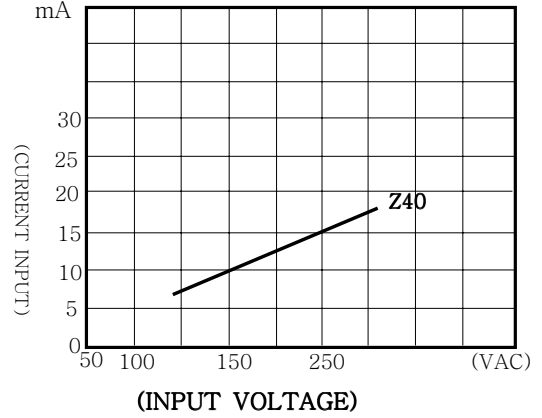
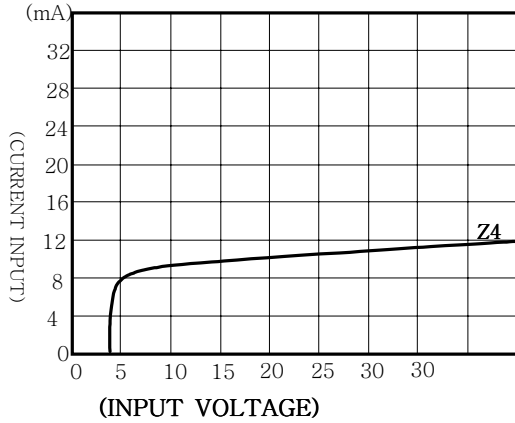
● SHAPE OF UNIT



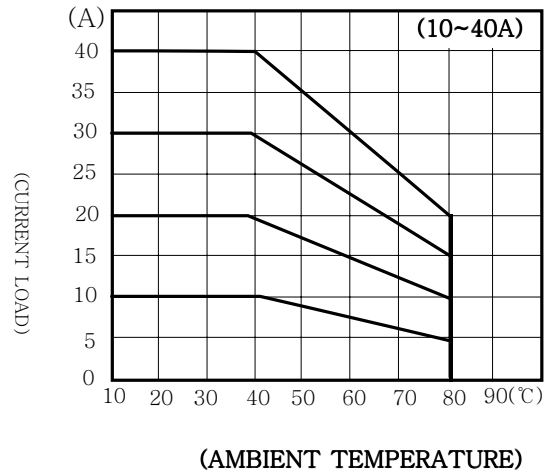
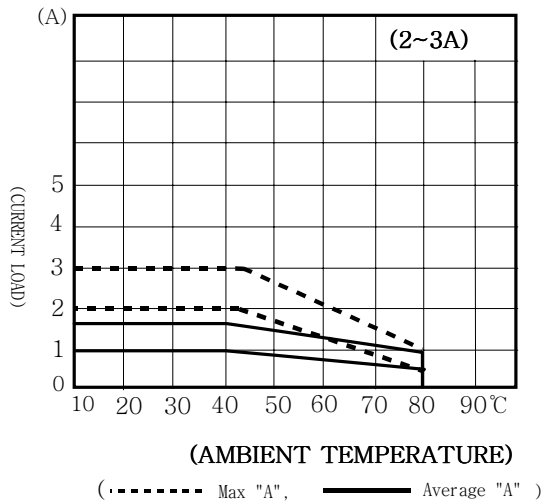


## 7. SSR Characteristic Curves

### ▶ Input Current CS Voltage



### ▶ Maximum Allowable Current CS Ambient Temperature



### ▶ Surge Current Duration

