Relay is a kind of automatic switching component with isolation function, which is widely used in remote control, remote measuring, telecom, automatic control, integration of machinery and electrification, electric and electronic equipments. It is one of the most important controlling components.

Generally, relays have the inductive organ (input part) that can reflect the input value (such as current, voltage, power, impedance, frequency, temperature, pressure, speed, light etc.); have the executive organ (output part) that has the capability of switching the controlled circuit on or off ; between the input and output parts, there is the medium organ (actuator) that can make input value coupling-isolation and drive the output part.
As a kind of controlling component, generally, relay mainly has the following functions:
1) To enlarge the range of control. E.g., when the controlling signal of a multi-contacts relay reaches a certain value, according to the different forms of the contacts, it can synchronously change over, close or open several circuits.
2) Enlargement. E.g., sensitive relays and medium relays can control a high-power circuit with minute controlling power.
3) To integrate signals. E.g., when several controlling signals are put into a multi-winding relay in the stated form, the relay can realize the expectant controlling function by analyzing the different signals.
4) Automatization, remote control and monitoring. E.g., in automatic equipments, the relays and other electronic components can constitute program-controlled circuit, realizing the automatic operation.

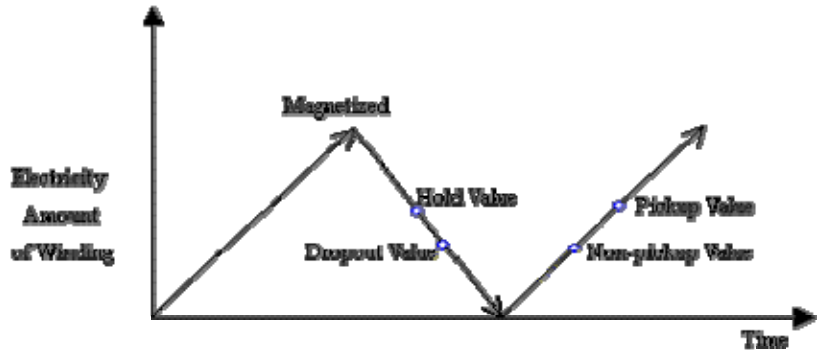
TECHNICAL REQUESTS OF MAIN PARAMETERS OF RELAY

1. Requests of mechanical and physical parameters:
To Guarantee the mounting dimension, weight, the intensity and soldering of the terminals etc.,mechanical parameters mainly include contact force, contact gap, contact follow, return spring force, armature travel, stop plate height etc.
2. Requests of time parameters:
When controlling the circuits, pickup and dropout time is usually required. Other time parameters include armature changeover, contact chatter, pulse distortion etc.
3. Request of ambient adaptability:
According to the application fields, in order to guarantee the relay operates reliably, ambient adaptability items mainly include temperature (max. and min temperature, temperature cycle, temperature shock, low temperature storage etc.), humidity resistance (high humidity at normal temperature, high humidity at high temperature), low air pressure resistance, vibration stability and vibration strength, shock stability and shock strength, constant acceleration.
In special environment, it also includes salt-mist resistance, mildew resistance, radiation resistance, transportation, storage etc.
4. Requests of life and failure ratio:
When relay works under the specified ambient, specified contact load, and in specified operating times, the failure times should not exceed the specified times. The failure refers to the contact freezing that makes the contact voltage drop exceed the specified level when the contacts pick up when the relay is working.
All the relays that have the requests of established reliability index have specified class of failure ratio.
5. Requests of safety specification:
To avoid electric-shock and fire, the product must accord to the safety stipulation of relevant country, e.g. CQC of China, UL of America, CSA of Canada, VDE and TUV of Germany etc.
Not all the relays should reach all the requests. The technical requests differ from the different application conditions.

TEST OF MAIN PARAMETERS

1. Pickup and dropout value

The test of non-pickup value, pickup value, hold value and dropout value should be carried out according to the test process drawing (Fig 1) followed. The process is uniform to both manufacturers and users. The biggest merit of the process is that the tested parameters can be repeated. It doesnot indicate that the relay would be magnetized first and work second when the relay is used.



Generally, the pickup voltage of AC relay doesnot exceed 85% of the rated voltage, and the pickup voltage of DC relay doesnot exceed 75% (some are 80%) of the rated voltage. The hold voltage of DC relay is 30%-40% of the rated voltage, but the hold voltage of AC relay is a little higher than that of the DC relay. The dropout voltage of DC relay isnot less than 10% of the rated voltage, and under limited low temperature, it is not less than 5% of the rated voltage. The dropout voltage of AC relay generally is about 30% of the rated voltage, and under limited low temperature, it is not less than 10% of the rated voltage.

2. Coil resistance

Coil resistance can be measured by the voltage-current means and electrobridge means. When using voltage-current means, the inner resistance of the voltmeter and ammeter should be lessened as little as possible and the measuring process should be as short as possible to avoid the rise of the coil temperature. The coil resistance is sensitive to the ambient temperature, so within 1-2 hours before the testing, the relay should be placed in the testing ambient and (had better) do not energize the coil. The tested value R_a should be converted to the value under basis temperature (normally 20), the conversion formula is:

$R_a=R_0[1+a(T_a-20)]$

In the formula Ta is the ambient temperature.

a is the temperature coefficient of resistance the temperature coefficient of cupreous lead wire is 0.004

3. Contact resistance

When measuring the contact resistance of NC contacts, the relay is on un-energized state; when measuring the contact resistance of NO contacts, the relay is on energized state. The contact resistance can be measured by voltmeter-ammeter means. When measuring, the contact load (resistive) should accord with the regulations showed in table 1. The tested part is within 4mm to the end of the terminals. The load should be applied on the contact after it stably closes and cut off before it breaks.

The international specified load value when measuring the contact resistance (or voltage drop).

(Table 1)

Application type		**Testing load resistive**	
CA0	30mV 10mA	10mA	30mV
CA1	30mV~6V 0.01~0.1A	10mA	100mV
CA2	5~250V 0.1~1.0A	100mA	24V
CA3	5~600V 0.1~100A	1A	24V

Note: When there are several application types, the criterion is the requests of the lowest application type.

4. Insulation function

Generally, the insulation resistance is tested by mega-ohmmeter; the tested relay should be paced on high quality insulating board; the testing voltage should accord with the technical requirements of the relay; the minimum value after the voltage is applied for 2s is the measured value.

A dielectric strength test should last 1~5s under the high-tension voltage (110% of the rated voltage). If any dispute exists, the test should last 1minute under the rated voltage.

5. Time parameters

The measuring circuit drawing of the time parameters is showed in figure 2 followed. Other apparatus and instruments are allowed to use as substitutes, but the contact load should be resistive. To measure the operate time, release time and bounce time, the contact load should be 10mA 6v (resistive load); to measure the stable time, the load should be 50A 50mV (resistive). The distinguish ability of the instruments is 1S.

To measure the operate time, the relay should be energized by the lower limit of the rated voltage; to measuring the release time, the energized voltage should be cut off from the upper limit of the rated voltage. The typical wave figure is showed in figure 2:

6. Outline dimension

The criterion of outline dimension test is the outline drawing of the relay. To measure the dimension of terminals position, the correct measuring position is in 3mm apart from the holder. When measuring, the outside force applied should not bring any damage to the relay.

If there are no special regulations, the measure mentioned in 6.1 to 6.5 are all carried out in normal climate conditions: The temperature is 15-35 ; the relative humidity is 45%-75%; the air pressure is 86.7~106.7Kpa.

GUIDELINES OF RELAY CHOOSING

1. Choosing relay according to the applicative ambient

The conditions of applicative ambient mainly refer to temperature (highest and lowest), humidity (generally refers to the highest relative humidity at 40), low air pressure (it can be ignored if the relay is used under the height of 1000m), vibration and shock. Besides, the package type, mounting method, outline dimension and insulating function are also required. Because the material and the construction are different, relays bear different ambient mechanics conditions. The relay may be damaged if it is used under the conditions that exceed the specified ambient mechanics conditions specified by the product standard. It is feasible to choose the right relay according to the ambient mechanics conditions or higher-level requirements.

AC relay is not very suited for the ambient that is sensitive to the electromagnetic or RF interference. When choosing DC relay, you should choose the relay with transient suppression circuit. In the mounting ambient in which the relay is energized by solid-state components or circuits, or the ambient is sensitive to peak signals, you also should choose the relays with transient suppression circuit.

2. Choosing the relay type according to input signals

There is no question to choose electromagnetic relay, temperature relay, time relay or photoelectrical relay according to the different input signals of electricity, temperature, time or light. Here, we specially indicate the choosing of voltage relay and current relay. You should choose current relay if the equipment could provide the coil constant current and choose voltage relay if the machine could provide the coil constant voltage.

3. Choosing the input parameter

The input parameter that is tightly connected to the user is the coil operating voltage (or current). The pickup voltage (or current) is the parameter to control the sensitivity, to judge and examine the relay for the relay manufacturer. To the users, the pickup voltage (or current) is just a lower limit of the operating parameter. The control safety coefficient is operating voltage (current) / pickup voltage (current). It is unreliable and unsafe to use

the relay under the pickup values. The ambient temperature rise, vibration and shock would lead the relay to operate unreliably. When designing the equipment, it is not right to use the unload voltage as the criterion of the relay operating voltage. The right method is to calculate the actual voltage regarding the coil as the load, especially when the inner resistance of the power source is high. When using transistor as the controller to switch on or off the coil, the transistor must be on the on-off state. For the relay that the operating voltage is less than 6VDC, it is required to deduct the saturation voltage drop of the transistor. Of course, it does notean that the operating value can be increased unlimitedly. If the operating value exceeds the rated value too much, the shock abrasion of armature and contact bounce times would be increased; the electrical life would be shortened. Generally, the operating value is 1.5 times of the pickup value; the error of the operating value is in the range of 10%.

4. Choosing the contact type and capacity according to the load

It is verified by practice that about 70% of the faults are because of the contact, which indicates that correctly choosing and using the relay contact is very important.

The contact form and amount of sets should be determined by the actual conditions of the controlled circuit. The common contact arrangements are showed in table 6. Because of less amount of bounce times when the circuit is switched on and larger amount of compensation after ablation, the load capacity and reliability of the make-contacts and make-contact in changeover contacts is higher than that of the break-contacts and break-contact in changeover contacts. So the circuit can adjust the contact position to choose make contacts as long as possible.

It is very important to determine the parameters according to the load capacity and characteristics (resistive, inductive, capacitive, lamp load and motor load). It is wrong to consider that small contact-switching load is certainly more reliable than large contact-switching load. Generally, it is best that when the switching load is under the rated voltage, the current exceeds 100mA and less than 75% of the rated current. If the current is less than 100mA, the contact carbon collection will increase and thus the reliability will decrease. So 100mA is regarded as the experiment current, which is the examined content to the world relay manufacturers to estimate the relay manufacturing technics level and conditions according to the professional criterion. Because most relays donot have the low level switching capability, when ordering the relay with switching load less than 50mV 50 A, the user must give special note or ask the manufacturer to assist to choose the right type of relay if necessary.

The rated load life of relay is the operating times of relay under rated voltage, rated current and resistive load. When the voltage exceeds the rated voltage, the relay can be chosen according to the contact load curve. When the characteristics of the load changes, the contact switching capability will change, and the user can change the load current according to table 2.

(Table 2)

Resistive current	**Inductive current**	**Motor machine current**	**Lamp current**	**Least current**
100%	30%	20%	15%	100mA

Only resistive rated load is noted on the cover of relay. Please look up other kind of rated load in the detailed technical information, and the surge current is showed in table 3.

If the relay is used in occasions of polar changeover load or phase changeover load, the three-position contact of K type (in table 6) is the best choice. Donot choose the two-position contact of Z type unless the relay is clearly prescribed to be used in three-phase AC load occasion. Or, with the increase of the operating times, the burning arc will increase, so the power source circuit may be shortened by Z type contacts.

When switching un-synchronous single-phase AC load, the phase dispersion will exist, so the contact rated current should be 4 times of the load current, and the rated voltage is 2 times of the load voltage. The contacts that is suited for AC load is not always suited for the load switching between several source phases. When necessary, relevant experiment of electric life should be done.

(Table 3)

Types of loads	Surge current	**Surge time**	**Remarks**
Resistance	Steady current		L 10^{-4}H or cos =$1^{0}_{-0.01}$
Solenoid	10~20 times of steady current	0.07~0.1	Treated as inductive load, if=L/R<10^{-4}S, it can be treated as resistive load.
Motor	5~10 times of steady current	0.2~0.5	Can replace the motor load with 5~6 times current of resistive load.
Incandescent lamp	10~15 times of steady current	0.34	
Mercury lamp	About 3 times of steady current	180~300	
Neon lamp	5~10 times of steady current	10	
Sodium lamp	1~3 times of steady current		
Capacitive load	20~40 times of steady current	0.01~0.04	Long transfer wirefilter power source etc. can be regarded as capacitive load.
Transformer	3~15 times of steady current		
Electromagnetic contactor	3~10 times of steady current	0.02~0.04	

APPLICATION OF RELAY

The product reliability generally refers to the operating reliability. It is defined as: the ability of accomplishing the specified function under prescribed conditions and in prescribed time. It consists of intrinsic reliability and application reliability. The intrinsic reliability is determined by product designing and manufacturing technique, and the application reliability is concerned with the correct application of users and the services provided by the manufacturer before and after selling. When using relay, the user should pay attention to the following items.

1. Coil applied voltage

It is best to choose the coil applicative voltage according to the rated voltage in design, or choose the voltage according to the temperature rising curve. Using any coil voltage that is less than the rated voltage will affect the operation of the relay. The coil operating voltage refers to the voltage that is applied between the coil terminals. The voltage value between the two terminals must be guaranteed, especially when using enlargement circuit to energize the coil. Whereas, it will also affect the relay characteristics if the applied voltage exceeds the highest rated voltage. Exorbitant voltage will bring exorbitant coil temperature rising, especially in high temperature ambient. Exorbitant temperature rising will damage the insulating material and affect the working safety of relay. For magnetic latching relay, energizing (or return) pulse width should not less than 3 times of the operating (or return) time, otherwise, the relay would be left on the middle-position state. When using solid-state components to energize the coil, the components dielectric strength must be above 80V, and the leakage of current must be as little as possible to ensure the relay to release.

Energizing power source: Under 110% of the rated current, the adjusting ratio of the power source is less than 10% (or the output impedance is less than 5% of the coil impedance), the wave voltage of the DC power source is less than 5%. The AC wave is sine wave; the waviness coefficient is between 0.95~1.25; wave distortion is within 10%; the frequency change is within 1Hz or 1% of the specified frequency (choosing the bigger value). The output power should not less than coil power consumption.

2. Transient suppression

At the moment when the coil power is stopped, peak-inverse voltage that is more than 30 times of the coil rated voltage is produced on the coil, which is harmful to the electronic circuit. Generally, the peak-inverse voltage is suppressed by transient suppression cutting-peak diode or resistance to limit the peak-inverse voltage within 50V. But the diode in parallel connection will delay 3~5 times of the release time. If the request of the release time is high, a suitable resistance in series can be putted with and at one end of the diode.

3. The power supply to relays in parallel connection and series connection

When several relays in parallel connection are supplied, the relay that the peak-inverse voltage is higher will release power to the relays that the peak-inverse voltage is lower. The release time of the relay will delay. So the relays in parallel connection should be controlled separately to eliminate mutual influence.

The relays with different coil resistance and power can notbe used in series, otherwise, the relay that the coil current is higher in the series circuit can notoperate reliably. Only the relays of the same specification can be used in series, but the peak-inverse voltage will be increased and the peak-inverse voltage should be suppressed. Resistance in series can be used to bear the part voltage that exceeds the rated voltage of the coil according to the ratio of the divided voltage.

4. Contact load

The load applied to the contacts should be accordant to the rated load and characteristics of the contacts. A load that is not applied according to the rated value range will cause problem. The relay that is only suitable for DC load cannot be used in AC occasions. The relay that can switch 10A load cannot always reliably operate in low level load (less than 10**m**A 6A) or in dry circuit occasions. The relay that can switch single-phase AC power source isnot always suitable to switch two single-phase AC loads that arenot synchronous; the relay that is only specified to switch the load of AC 50Hz or 60Hz cannot be used to switch AC load of 400Hz.

5. Parallel and series connection of contacts

The contacts used in parallel connection cannot increase the load current, because the operating times of several sets of contacts are absolutely different; that is to say, there is still only a set of contacts switching the increased load. This would damage or weld the contacts and make the contacts cannot close or open. The parallel connection of the contacts can decrease the misplay of break. But the parallel connection of the contacts would increase the misplay of freezing. Because the misplay of break is the main pattern of invalidation of contacts, the parallel connection can increase the reliability and can be used on the pivotal part of equipments. But the applied voltage should not exceed the highest operating voltage of the coil and should not less than 90% of the rated voltage, otherwise, the coil life and the applicative reliability would be damaged. The series connection of the contacts can increase the load voltage. The amount of the contact sets is equal to the times that the load voltage can be increased. The series connection of contacts can decrease the misplay of freezing, but it would increase the misplay of break. Anyway, when using redundant technology to increase the operating reliability of contacts, the characteristics and size and the failure mode of load must be considered.

6. Switching speed

The switching speed should not exceed the reciprocal of 10 times of the sum of operating and release time (times/s), otherwise, the contacts cannot switch on steadily. Magnetic latching should be used under the pulse width specified in the technique criterion, or the coil may be damaged.

MOUNTING OF RELAY

1. Protection of the terminals

If the relay is soldered on PCB, the distance among the holes must be correct, and the diameter of the hole should not be too little. When it is necessary to pull or turn the terminals, the terminals must be fixed at the position 3mm from the relay holder. The terminals that the diameter is more than 0.8mm cannot be pulled or turned. There should be a distance exceeding 0.3mm between the holder and the PCB, which can protect the terminals from outer damage and be convenient for the cleaning solvent to flow out and volatilize of after

soldering. To the soldering hole and soldering hook types of terminals, when soldering the joining lead and the lower lead, twisting or drawing to the lead must be prevented, otherwise, the terminals may become flexible. As for screw and bolt mounting terminals, the moment of torsion should less than the values listed in table 4 when mounting.

Specification of bolt		M2.5	M3.0	M3.5	M4.0	M5.0	M6.0
Used for connection	With heads	0.40	0.50	0.80	1.20	2.00	2.5
	Without heads	0.20	0.25	0.40	0.70	0.8	
Used as terminal		0.40	0.50	1.14	2.28	4.00	8.00
Used as mounting parts			1.00	2.00	4.20		

Note: If the relay falls to the ground when mounting, the inner parts may be damaged because of the strong shock. The relay cannot be used until it is examined again.

2. Soldering and cleaning

The terminals should be soldered with the litmusless resin-type flux, not acidic flux. After soldering, the relay must be cleaned and dried. The wattage of the soldering iron is appropriate between 30~60W; the highest tip temperature is appropriate between 280~330; the soldering time is 3s max. In automatic soldering , the temperature of molten solder is 260; the soldering time is 5s max. When soldering and cleaning, the un-sealed relay must be protected to avoid polluting the inner construction by the flux and cleaning solvent; the hermetic and washable plastic-sealed relays can be immersed to the cleaning solvent when cleaning.

3. Preventing enlargement of vibration

For the relay with requirements of vibration resistance, choosing the suitable mounting method can prevent or lessen the enlargement of vibration. The best means is to mount the relay at the position that the direct of the vibration is vertical to the movement direct of the armature. Avoid choosing the relays mounted with top crew bolt or bracket.

4. Adjacent mounting method of several relays

When several relays are mounted on a PCB or a card rack, abnormally high temperature may result from the combined heat. The relay without magnet-screen cover may operate abnormally because of the magnetic influence. The question can be settled by the means of mounting the relays with sufficient space between them or mounting other components (that can not produce strong heat and magnetic field; can bear certain influence of heat and magnet) between them.

RELAY PROTECTION

1. Coil protection

If possible, the coil and core should be kept at the same potential level whenever the coil is on or off, to avoid the electrochemical corrosion.

2. Contact protection

There are many protective circuits to protect the contact. For inductive load, diode in parallel connection with the load is generally used to eliminate sparkle; RC absorption network or voltage-sensitive resistance in parallel connection with the contact is used to protect the contact. To capacitive load or lamp load, little power resistance or RL suppressing network in series is generally used in the loop circuit to suppress the shock from surge current.