Relay General Application Guidelines

PREFACE

Thanks for choosing our relay and your time to read this guideline .If you have any suggestion please feel free to contact sales @ foward-relays.com. We will read your suggestion carefully and it will be appreciated.

The product reliability is means its working reliability. In a word it is as the probability that a relay can perform a required function under given conditions for a given duration or number of cycles. It is formed by the product's intrinsic reliability and application reliability. The former is determined by the product design and manufacturing process, while the latter is related with the customer's proper selection and the manufacturer's before-service and after-service. Based on the years of experience. we present this application guideline. Although we are not updated with the ever changing application circuits, we would like to discuss and exchange ideas with the customers so as to enhance the relay reliability and also improve our service.

1. SIMPLE PRINCIPLE AND APPLICATION

Relay is an automatic electrical switch, when given a certain input signal, such as electricity, magnetism, light, heat or pressure etc. (Note: It means all ro nothing ,or the relay performance will be compromised) and maintain a long enough time, it can automatically switch the controlled circuit to produce a jump change. When the input is reduced to a certain extent and maintain a long enough time, it then restored to its original state, the control circuit is also stepped back to the original status. Regardless of the relay function principle and structure of any form, it is always consists of input circuit, comparative structure and output circuit. Therefore, the relay is a four-terminal component, and its input and output must be isolated.

As for the electromagnetic relays, it is the electromagnetic suction and the elastic material mechanical reaction force that makes the jump change in the output circuit (contacts circuit) (regardless of permanent magnet of latching relay). After the relay has passed the verification of design and production, its electromagnetic suction and mechanical reaction force is generally able to meet the relationship shown in Fig.1. The arch is for electromagnetic suction, the curve is for mechanical reaction force. Here:

Uc rated voltage　　Ub rated pick-up voltage
Ue rated hold voltage, specified　　Up actual pick-up voltage

Regarding the magnetic circuit, when the coil is powered, the magnetic components in the magnetic circuit will be magnetized. When coil is applied with Ub, it is a rational magnetic circuit design to have its partly magnetization curve of the magnetic system as A point in Fig. 2, the soft magnetic parts close to full capacity when armature is pulled in ; When coil is applied with Uc, the curve is as that point B in Fig. 2, the soft magnetic parts have been basically saturated when armature is pulled in.

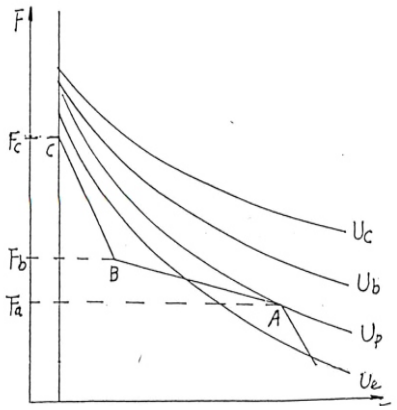


Fig.1 Suction force and reaction force curve

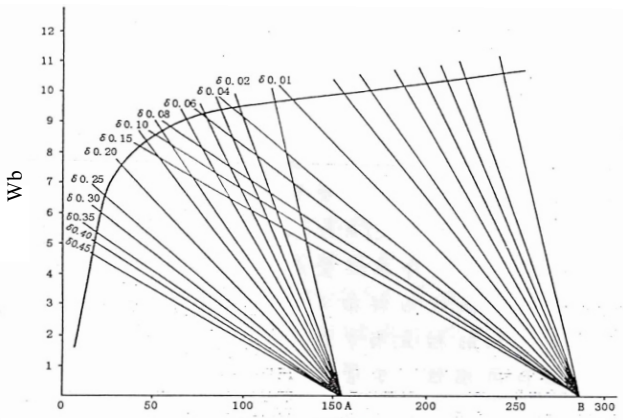


Fig.2 Partly magnetization curve of the magnetic system (d is armature gap)

There are a lot of relay applications, they are summed up as follows:
1） Separation between the input and output circuit;
2） Signal transfer (from make break or whereas);
3） Strengthening output circuit (Between transfer several loads or different power loads);
4） Repeating signal;
5） Transfer different voltage or current;
6） Remain output signal;
7） Locking circuit;
8） Providing remote control.

2. DEFINITION OF RELAY TERMINOLOGY

Electrical relay
Device designed to produce sudden and predetermined changes in one or more output circuits when Certain conditions are fulfilled in the electric input circuits controlling the device.
All-or-nothing relay
Electrical relay, which is intended to be energized by a quantity, the value of which is either within its operative range or effectively zero .
Note: “All-or-nothing relays ” include both “elementary relays ” and “time relays” .
Electromechanical relay
Electrical relay in which the intended response results mainly from the movement of mechanical Elements.
Electromagnetic relay
Electromechanical relay in with the designed response is produced by means of electromagnetic forces.
Monostable relay
Electrical relay which having responded to an energizing quantity and having changed its condition ,returns to its previous condition when that quantity is removed.
Bistable relay
Electrical relay which, having responded to an energizing quantity and having changed its condition , remains in that condition after the quantity has been removed; a further appropriate energization is required to make it change its condition.
Polarized relay
Elementary relay, the change of condition of which depends upon the polarity of its DC energizing quantity.
Rated value
Value of a quantity used for specification purposes, established for a specific set of operating conditions.
Coil Rated voltage
The coil voltage which make the relay work, meeting all the electrical, mechanical and environmental requirements.
Operate voltage（also named pick-up voltage）
Value of the input voltage at which a relay operates .
Non-operate voltage（also named non-pick-up voltage）
Value of the input voltage at which a relay does not operate.
Release voltage
Value of the input voltage at which a monostable relay releases .
Non-release voltage（sometimes it is called holding voltage）
Value of the input voltage at which a monostable relay does not release .
Operate range of the input voltage
Rage of values of the input voltage for which a relay is able to perform its specified function.
Rated pickup value (voltage)
As the current or voltage on an unoperated relay is increased , the value (voltage) at or below which all contacts must function.
Rated hold value (voltage)
As the current or voltage on an operated relay is decreased , the value which must be reached before Any contact change occurs.
Reset voltage
Value of the input voltage at which a bistable relay resets.
Non reset voltage
Value of the input voltage at which a bistable relay does not reset.

Operate time

Time interval between the application of the specified input voltage to a relay in the release condition and the change of state of the last output circuit, bounce time not included.

Release time

Time interval between the removal of the specified input voltage from a monostable relay in the operate condition and the change of state of the last output circuit ,bounce time not included.

Reset time

Time interval between the application of the specified input voltage to a bistable relay in the operate condition and the change of state of the last output circuit, bounce time not included.

Bounce time

For a contact which is closing /opening its circuit, time interval between the instant when the contact circuit first closes /opens and the instant when the circuit is finally closed/opened.

Stabilization time

Time interval between the instant when a specified input voltage is applied to an electromechanical relay and the instant when the last output circuit is closed /open and fulfils the specified requirements, bounce time included.

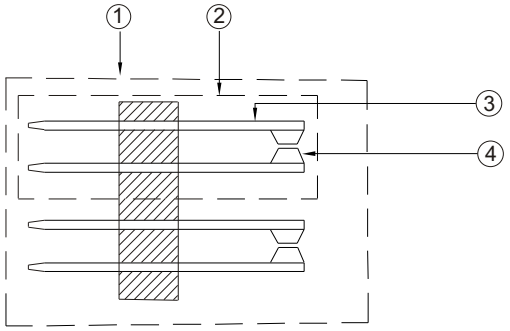
Contact time difference

For a relay having several contacts of the same type, the difference between the maximum value of the operate(release) time of slowest and the minimum value of the operate(release) time of the Fastest. As for the 1 form C contact, it is the break time for both contact circuit.

Contact circuit

Output circuit containing contact members.

Note : A change-over contact involves two connected contact circuits.



(1) contact set
(2)contact circuit
(3)contact member
(4)contact point

Fig. 3 Contact circuit

Contact set

Combination of contacts within a relay, separated by their insulation (see Fig. 3).

Contact

Arrangement of contact members, with their insulation, which close or open their contact circuit by their relative movement (see Fig. 3).

Contact resistance

Resistance or voltage-drop measured from the contact terminals when they are closed.

Contact gap

Gap between the contact points when the contact circuit is open.

Creepage distance

Shortest distance along the surface of the insulating material between the two conductive parts.

Clearance

Shortest distance in air between tow conductive parts, or between a conductive part and the accessible surface of a relay.

Shelf Life

The shelf duration interval when the relay cannot put into operation but can store before the relay's unstable change appears and when the relay cannot operate its function according to the concerned specs.

Service life

Continuous operation cycles or time, until the determined failure percentage occurred.

Remarks: According to IEC61810-2：2017, the defined percentage is 10% and the confidence level is 90% . GB/T definition (that is IEC terminology)

Contact load type

CC0 A load characterized by a maximum switching voltage of 30mV and maximum switching current of 10mA.

CC1 A low load without contact arcing.

Note: Arcing with a duration of up to 1ms is disregarded.

CC2 A high load where contact arcing can occur.

Load types

Resistive GB/T specified $L \leqslant R \times 10^{-6}$ or $L \leqslant 10^{-4}$ H (R-Ω, L-H);

Inductance L/R=0.005s±15%, load range: <250V, <1A, used for communication, data processing;

L/R=0.040s※ ±15%, load range: 0.02-600V, <100A;

AC $\cos\Phi$=0.4±0.1

Note※ :allow to use other than 0.040s, yet consent is required between the manufacturer and the user.

Categories of protection

GB/T (IEC) specified:

RT 0: Unenclosed relay Relay not provided with a protective case.

RT Ⅰ: Dust protected relay Relay provided with a case which protects its mechanism from dust.

RTⅡ: Flux proof relay Relay capable of being automatically soldered without allowing the migration of solder fluxes beyond the intended areas.

RTⅢ: Wash tight relay Relay capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents.

Note: In service, this type of relay is sometimes vented to the atmosphere after the soldering or washing process in this case the requirements with respect to clearances and creepage distances can change.

RTⅣ: Sealed relay Relay provided with a case which has no venting to the outside atmosphere, and having a time constant better than 2×10^{4}s in accordance with IEC 60068-2-17.

RTⅤ: Hermetically sealed relay Sealed relay having an enhanced level of sealing, assuring a time constant better than 2×10^{6}s in accordance with IEC 60068-2-17.

Note:

$$\frac{P_0 \ V_0}{L}$$

$_0$ Standard atmospheric pressure (Pa)

V_0 Relay inside effective space (cm^3)

L Leakage rate (Pa cm^3/s)

Basic module

Module is a unit of size used as an increment in module co-ordination(ISO standard 1791)

Basic module(M) is a step in a grid system as shown Fig. 4.

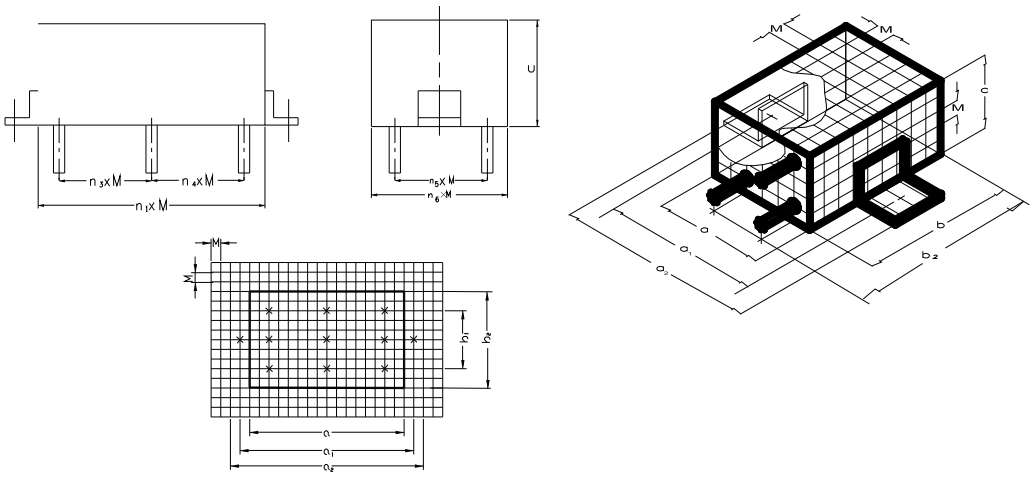


Fig.4 Basic module

3. GENERAL REQUIREMENTS

3.1. Safety

3.1.1. Life and property safety, and pollution free

Relay should maximize the use of environmental protection materials, recyclable materials and regenerated materials. Materials should be able to self-extinguishing, Not self-ignition, non-combustion, non-release harmful levels of gases (such as to enable cover explosion, toxic or to contaminate contact); at a longer period of time (3 ~ 7 years), no transformation, non-deformation; plastics used must be thermosetting, no cotton or wood filler; reinforced plastics should not release solid particles in the thermal shock; leak test should not use silicone oil; external part shall have zinc plated; forbidden or less use of the following 18 kinds of materials, use only when other materials can not meet the performance requirements, these materials are:

Chromium and its compounds, cadmium and its compounds, lead and its compounds, mercury and its compounds, nickel and its compounds, benzene, toluene, xylene, dichloroethane, chloroform, trichlorethylene, tetrachlorophthalic ethylene, tetrafluoroethylene CFC, MEK, Freon, cyanide and its compounds, methyl isobutyl ketone, magnesium and its compounds.

Others, such as electromagnetic interference, radio frequency interference, noise and electromagnetic compatibility and other restrictions should also be limited.

Some European users claim not to use poly PBDE (PBDE), poly biphenyls (PBB) and perfluorooctane acid (PFOS) (as a flame retardant).

3.1.2. Normal performance under predictable environment

That is environmental adaptability, such as insulation (including lightning strikes, electrical clearance, creepage distance, etc.), dangerous fire test, heat and flame resistance, PTI, flame, electromagnetic interference and mechanical stress (vibration shocks, centrifugation, etc.) and some climate parameters (climate cycle, thermal shock, humidity, salt spray, thermal resistance, dust, solvent resistance and fluid contamination, etc.). Furthermore, products and their packages should be able to withstand rough road transportation, such as vibrations and swing tests, as well as storage test. Material highest temperature specified and its proof should be in line with IEC 60695-2-10 and IEC 61810-1:2015 Article 16. Material should be subject to IEC 60695-2-12 (flammability index) and IEC 60695-2-13 (ignition temperature) test.

3.2. Quality consistency

Product selection can get away failed product at early stage and improve the reliability of the entire batch of products, but the selection can not improve the reliability of single product. It should not rely on selection to get best individual product from a lot. Therefore, 100% test items (such as hand-over inspection), if the failure number is cumulatively more than 10%, the entire batch should be rejected.

3.3. Useful life and failure rate, Service life and its reliability

There are two ways to express product function reliability

3.3.1 In determining the percentage of failure (also known as the cumulative failure rate) under the cycle number or time , that is, the useful life expectancy. On behalf of IEC 61810-2:2017 and MIL-PRF-32140:2004. The former or time specifies failure percentage as 10%, confidence level as 90%. The later specifies a maximum cumulative failure rate as 1%, confidence level as 95%. Both get from Weibull distribution.

3.3.2. The largest failure rate within useful life expectancy, it represents in GB/T 14598.1-2002 and IEC 60255-23. Weibull distribution is used to calculate the instantaneous failure rate for IEC.

Note:

a) The failure rate and useful life provided by manufacturers are got from testing lab, not the user’s actual failure rate.

b)As the test data is obtained from a test laboratory, there is an issue of confidence level (1-α), that is the probability estimates are right. In other words, users have certain risk, the risk is (α).

3.4. Quality assurance
3.4.1. Quality assurance systems： Quality assurance systems are ISO9001, ISO14001, IATF 16949. The instruments and equipments used for controlling, monitoring and testing are not only in line with above quality assurance systems(such as ISO9001、GJB/T9001B), but also the requirement from 4-4-2. The inspectors and manufacturers must pay attention to it.
3.4.2. Testing instruments and equipment
Modern industrial production approach great importance to SPC (statistical process control), it requires data to do statistics, requires inspection to get the data. In relay manufacturing process, (regardless of semi-automatic automatic manufacturing) have several quality control points, inspecting a certain number of parts and components every day from time to time for quality control and supervision. There are dozens of items in ISO9001 mentioned about inspection and testing. There are two key factors in inspection and testing: First is testing instruments and equipment; second is testing standards. This is also one of the key parts in Quality Assurance, One of five elements in IATF16949 is MSA (Measurement Systems Analysis).
3.4.2.1.The instrument must be went through the standardization examination
Principle and requirement
1)Standardization examination：
Terminology and definition: It has the direct relation with the measuring method, test environment and the failure criteria. The most updated standard must be applied for the terminology and definition.
Measuring method, it including test principle, test environment, data collection way, collection failure criteria and the stress applied during the test & pretreatment before the test. If no other specified, the destructive treatment or non-destructive treatment should not be applied before the test, as it can cause the invalid test result, such as the baking, etc.
Accuracy, see 3.4.2.3
It must be pointed out that the instrument error cannot be treated as the measuring data error.
Data processing, it must be scientific and accurate, conforms to the the related regulation. If it is necessary, the formula and the computing method should be approved by the accrediting body.
Failure criteria(or qualification evaluation), it must confirm to the standard requirement. If the test result must be converted into the value under the base condition after the the measuring for some parameters, then the formula must conform to the data processing requirement. If necessary, the failure confirmation process should be approved by the accrediting body.
Arbitration: In case of any dispute, it should be proceeded based on the relevant arbitration condition and test method. If it is the function check and there is any dispute, then it shall refer to the step function method.
2)Repeatability and reproducibility, no matter it is the special instrument or the test circuit, it must conform to the principle of repeatability and reproducibility, so as to ensure the comparability and credibility for the test result.
3.4.2.2. The instrument must be approved
Appraisal certificate
The instrument and machine must be approved, its copies should be packed together with the instrument and machine to the end user. The appraisal certificate must mark what the standard that the instrument and machine meet, including the standard number and issue number. The standard audit report must be available during the appraisal(including instrument and machine), if the instrument is not appraised , it should be used with caution.
3.4.2.3 Instrument and machine error
The error for the instrument and machine should be less than the 1/3 of the allowable error of the measured parameter. The error for the calibration test machine should be less than 1/4 of the allowable error of the measured parameter.
Remarks: The error of the instrument and machine should not be regarded as the measured parameter error.
3.4.2.4 Certificate of permission to use
The instrument must be calibrated regularly, verify the measurement accuracy and it error, the most important is to check if it conforms to the current standard. If the standard proposed in expertise report of the instrument and machine has been invalid, then it is necessary to re-audit whether it conforms to the current standard, including the terminology, measurement method&, principle, stress&tolerance, data collection&resolution ratio, failure criteria and data processing, etc. It is suggested that the standard number and issue number should be stated in the certificate of permission to use.
3.4.2.5 Instrument and machine life time
The life time for the instrument and machine should not be determined the by time duration, and it

shall also not based on if it conforms to the product technical condition. The life time for the instrument and machine shall be based on if it conforms to the current standard, if not, it cannot be in use even though it is in intact or it is the just released from the factory.

3.4.2.6 Remarks

(1) Unless otherwise specified, the tested product should not be impacted by the destructive or non-destructive handling .

(2) The former test item should not affect the the test for the next item.

(3) The test should not bring the contamination or damage for the product.

(4) The test should be with the repeatability and reproducibility.

(5) It is better with the statistic analysis for the batch test result.

(6) The acceptance for any piece parts and material doesn't mean the acceptance for the finished product. Test machine should not generate the jamming signal or reduce, remove the signal generated by the relay.

3.4.3 Alternative circuit

Taking the relay for example, the test machine and test circuit as this standard specified should be prioritized, any alternative test machine and test circuit must be approved by the related authority. Article 6 from IEC61810-1:2006 has the regulation: under the special case, the adoption of the deviation value should be approved to be reasonable. These values should comply with the manufacturer requirement, any alternative method shall be approved by the related authority, also it must be noted in inspection report. Above requirement also be suitable for the document which is deviated from the standard(such as the mounting way for the temperature rise test). It shows any condition that is deviated from the standard or any alternative test circuit or test machine must be approved by the relevant authority, which can prove it is the reasonable, and also it should be stated in the report.

Table1 Relay parameters and their using conditions

Item	Using conditions	Requirements	Remarks
Energizing condition	DC or AC Rated Value	DC or AC relay Rated voltage Uc Pick-up voltage Ub=75%Uc（DC） =85%Uc（AC） Release voltage Uf=10%~5%(DC) =15%Uc(AC)	AC relay shall specify 50Hz or 60Hz Tolerance:MIL±10%，IEC±5%. When voltage from Ub→Uc→Ue or from Uf→0→Ua （non-operate voltage），contact is not allowed to change status(break or Re-close), except for normal contact bounce Measurement should be done at three axles.
	Output Power Power Supply res Rs (or Zs) Max environmental temp Tmax Provide DC supply by using component or filter, Continuous working(energizing) for several days	Coil consumption（W） Coil Resistance R_0(or Z_0) should >20 times Rs or Zs Max allowed working temp Tmax Heat Resistance=△T/W Temprise△T=material temp－Tmax When component anti-voltage at ≤10Uc，should have coil Latching relay	 Tolerance ±10% Basetemp IEC: 23℃ Any transient suppression will affect relay pull-in and drop-out time as well as life.
Load switching	Switching mode and load numbers, phase transfer. Rated load nature & level. allowed contact circuit consumption	Contact mode and load numbers Best to select（K）type contact Rated load nature, max value and min value Pay attention to inrush current of special load Contact circuit resistance(or voltage drop) and its stability. That is under Ub、Uc、Ue and Uf、zero、Ua contact circuit resistance and difference of max and min.	Contact types referring table 3 Tolerance±10%; inrush current of special load referring to table 4 Difference of max and min contact circuit resistance should be ≤10% of beginning value. Step function testing，test per each cycle，total 3 times.
	allowed contact circuit resistance abnormal change time.	If＜10μs, it should be specified in the contract	IEC specify any abnormal changes less than 10μs is to be ignored
	Rated life Failure rate	Rated life（whether with reliability） Failure rate under different rated loads	Best value under Tmax Failure ratio of middle level current under high temperature specify separately. Manufacturer should provide magnet route structure type IEC is not compulsory.

Table1 Refer to table 1(continued) Relay parameters and their using conditions

Item	Using conditions	Requirements	Remarks
Time parameters	Max switching ratio	Max switching ratio = $\frac{0.1}{t_0 + t_r}$ （time/s）	High level（or CC2）should reduce
	Allowed max switching time	t_0 operate time，t_r release time time for contact to stable closing（or break）(t_c)	
	Transfer time	Transfer time（t_s）	$t_s \geqslant 50\ \mu s$(IEC)
Environmental condition	Environmental temp	Allowed operating temp range	
	PC board use	Not to select RT0，should select RTⅡ~RTⅤ	Terminal pin space distance and mounting holes space distance is full times of 0.508mm.
		solder ability	
		Solder heat-resistant	Pb free solder material is 30℃ higher than that of Pb solder material
	1000m above high air space or high vacuum	Low air pressure	
		Best to select latching relay	
	Used on transport equipment (tools),	It is better to add bumps and (or) swing tests besides vibration, shock and centrifuge tests.	Discuss with manufacturer for specific requirement
	damp or corrosive gases containing	Relative humidity, salt spray, solvent resistance and fluid test	
		Should select RTⅣ or RTⅤ	Manufacturer should provide effective internal space for the product .
	explosive gas, place sensitive to electromagnetism	Electromagnetic Compatibility	Remarks: Products and the distance between product and lead wire.
		Electromagnetic interference	
	Several products side-by-side or near large current line	Electromagnetic interference	
	Insulation property	Insulation resistance 、 Dielectric strength （including lightning strike） clearance、creeping distance、PTI	
		Mounting method	
	Mounting method socket	Contact resistance between relay terminal pin and socket	May be measured with contact circuit in the socket
	Safety certificates	UL、VDE、TüV、CQC etc	
	For special items, try to find the relevant standards, if there is no standards to be based on, should try to put forward specific quantitative requirements and test methods .(Quantitative requirement is better）		

Notes：1.Unless otherwise specified, all electrical and mechanical and environmental parameters tolerance is ±10%.
2.Storage condition recommended: clear air pollution is less than(3C level 2 of IEC 60721-3-3).

4.2 Allowance tolerance of influence quantity
Mace sure the tolerance for influence quantity is not more than the allowance value.
Please refer to table 2 for the allowance tolerance of influence quantity(IEC).

Table 2 Allowance tolerance of influence quantity(IEC)

Influence quantity		Reference quantity	Allowable deviation
Temperature		Low temp. 23℃ High temp.	±5K
RH		50%	±25%
Pressure		96 kPa	±10 kPa
Atmosphere		Clear air	Pollution less than 3C2 of IEC60721-3-3
External magnetic induction		0	±0.5mT
Frequency		16 2/3、50、60、400（HZ）	±2%
AC waveform		Sine wave	Distortion factor 5% Wave form distortion<10% Waveform factor：0.95~1.25
DC component within AC current		0	peak2%
DC ripple		0	6%
Resistive		L=0	L≤RX10^{-6}；L≤10^{-4}H
		cos Φ =1	$^{0}_{-0.01}$
Voltage/Current（Coil/Rating）		Decided by the manufacturer	±5%
Load resistive			±5%
Load inductance		DC（H）	±15%
		ACcos Φ	±0.1
Load capacitor （Indading distribution）			＜50pF
Power source	Output resistive（Zs）	Load impedance Z	Zs＜0.02Z(0.05Z)
	Output resistor（Rs）	Load impedance R	Rs＜0.02R(0.05R)
	Adjustment rate	Coil ≤5% Other≤9%	

5. Ordering

Order contract is the first step. The beginning is the most difficult part . It is the good men for signing the contact , the pile and record is critical.

NingBo Forward Relay Corp. Relay orderng information:

JZC-32F C Z 10 DC12V 0.2

- Coil power consumption,(W)
- Coil rated voltage, DC or AC,(V)
- Rated contact current , (A)
- Enclosure: Z-flux proof relay S-Wash tight relay
- Contact arrangement：A-make B-break C-transfer(break before make)
- Type

Table3 Contact arrangements:

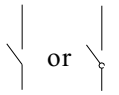
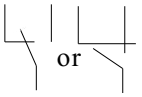
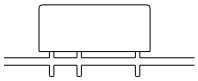
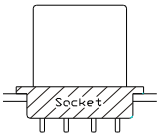
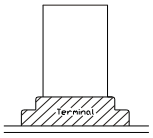
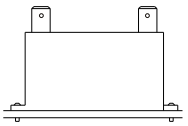
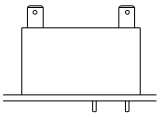
Name		SPSTNO	SPSTNC	SPDT(B-M)	SPDTNO	SPDT(M-B)	SPSTNODM	SPSTNCDB
Marks								
Alphabet letter	China	H	D	Z	E	B	SH	SD
	USA	A	B	C	K	D	U	V

Table4 Types of loads and level of inrush current

Types of loads	Level of inrush current	Inrush time(s)	Remarks
Resistive	Steady current		$L \leqslant 10^{-4}$H or $COS\Phi = 1^{0}_{-0.01}$
Solenoid	10~20 times as large as the steady current	0.07~0.1	Shall be regarded as inductive load ,but $\tau = L/R < 10^{-4}$s can be regarded as resistive load
Motor	5~10 times as large as the steady current	0.2~0.5	Can replace the test with 5~6 times current resistive load
Incandescent lamp	10~15 times as large as the steady current	0.34	
Mercury lamp	About 3 times as large as the steady current	180~300	
Fluorescent lamp	5~10 times as large as the steady current	⩽10	
Sodium vapor lamp	1~3 times as large as the steady current		
Condenser	20~40 times as large as the steady current	0.01~0.04	Long transfer wire、filter、power source shall be regarded as capacitive load
Transformer	5~15 times as large as the steady current		
Contactor	3~10 times as large as the steady current	0.02~0.04	

Table 5 Mounting Method:

Type	PC board mount	Socket mount	Terminal socket mount	TM type	TMP type
Mounting configuration					
Typical relay type	P、M4、M4S、M1B、JZC-22F、JZC-22F$_2$、M1BS、M4S、JRC-23F NG8N、NG8ND、NG8QN、NT72、NT73、NT73-2、NT73series、NT77、NT78、N4100、4117、N68F JZC-32F、33F、NV23K、NV231.....	N4078、JQX-14F$_1$、NT90T、NT90TP、NT75.....	NVF4 series NVFM、NVFS、JQX-13F、JZX-18FF、NVF7.....	NT90TP、JQX-13F、JZX-18FF.....	NT90T、NT98T、JQX-102F.....

6.THE USE OF RELAYS

6.1. Coil

Note:

a) The use of any coil voltage less than the rated coil voltage will compromise the operation of the relay .

b) pick-up, hold and release voltage for test purposes only, are not to be used as design criteria.

c)NARM states in "Engineer’ s Relay Handbook" 15.3.7: " relay should not work under pick-up voltage.

d) when energizing is too high, the higher part after pulling-in will be converted mostly to heat and flux leakage, more harm than good.

Energizing time: relay at continuous work should be energized continuously; magnetic latching relays energizing time is three times the operate or release time, whichever is greater; for the dual-coil magnetic latching relay, two coils should not be energized at the same time.

Suppression circuit: it is not recommended for the users to add their own suppression circuit, any transient suppression circuit will extend the action or (and) the release time, affecting life expectancy. If needed, consult with the manufacturers and state in the contract, it is best to have the factory to Provided, where necessary, to carry out life test.

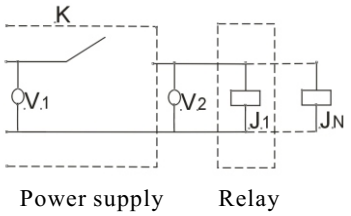


Fig.5 Transistor driven circuit

When energizing with transistors, it is important to pay attention to the relationship of leakage current and conduction voltage drop and working current, circuit as shown in Fig. 5, it is OK to inspire one relay, but not functional to inspire two relays, when inspiring 3 relays, the relays will not be able to function. When several product coils in parallel, pay attention to coil counter electromotive .

force, because drop-out and pull-in of several products are not always at the same time. Fig. 6 to Fig.9 Is comparison of several commonly used circuits in parallel.

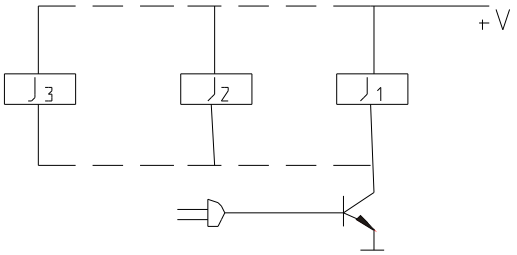
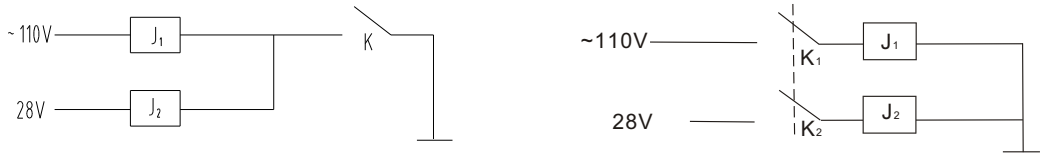
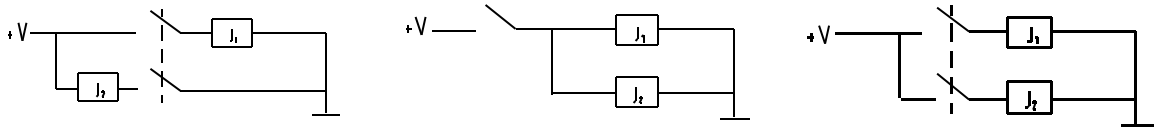


Fig.6 One type of relay parallel connections



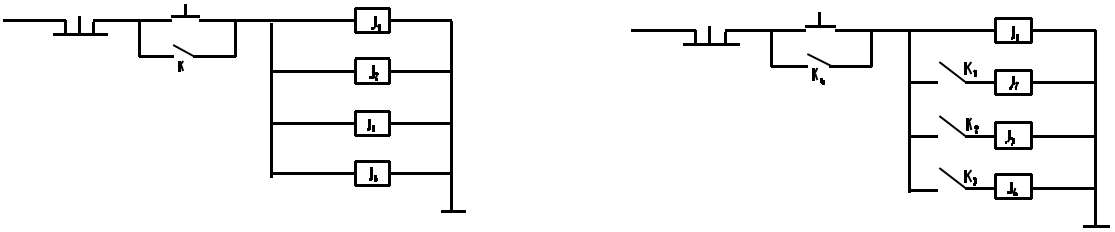
（a）Unreasonable parallel connection (b) Reasonable parallel connection

Fig.7 One type of relay parallel connections



(A）Unreasonable parallel connection (b）Unreasonable parallel connection (c) Reasonable parallel connection

Fig.8 The second type of relay parallel connection



（a）Unreasonable parallel connection (b) Reasonable parallel connection

Fig.9 The third type of relay parallel connection

6.2. Contact

6.2.1 General requirement

Contact shall be used based on rated load nature of the contact size, its upper limit shall not exceed the upper rating limit, and the lower limit shall not exceed the lower requirements. It is easy to have problems if contact not used within specs scope.

It is one of the methods to improve the reliability by use at lower rating, but be careful when decreased to intermediate current, especially at high temperatures. The relay contacts which can switch 10A reliably, may not be able to perform reliably at low current level; A product which can work reliably at rated load and low-level current, not necessarily reliable under intermediate current. Should not improve contact rated load by using two contacts in parallel, nor enhance the rated voltage by application of contacts in series, because contacts do not always move simultaneously. When using redundancy technology to improve system reliability, pay attention to contact failure modes and failure mechanism. Two relay contacts connecting in parallel may make contact first off then on visa verse. When paralleling one relay contacts, it is important to the standards in accordance with, transfer time definition in

Relay cover is marked with only the rated resistive load value, the ratings of other nature and the smallest rated load should check the product detailed specifications or obtain the related materials from manufacturer.

The relay which can switch single-phase AC power supply does not necessarily to be suitable to switch 2 non-synchronous single-phase AC load. Any product being used with more than 10mA/6V (resistive) or being tested is no longer recommended for low-level.

6.2.2. Contact Connect

Contact circuit and its symbol, see section 6. 3.2.

Connection of load circuits impact a lot on the contacts performance reliability. Fig. 10 (b) is more reasonable than Fig.10 (a) , because the former arcing time is half shorter than the latter. Fig.11 are two unreasonable connection, especially in motor load, inductive load or capacitive load.

For phase conversion, polarity conversion load, three location contacts (E type) should be selected, such as Fig. 13 and Fig. 12 (b), yet, Fig.12 (a) is not recommended, unless authorized by manufacturer, at this time, product should have specific time for conversion, its life test should be in accordance with IEC 61810-1:2008 and IEC 61810-7:2006 requirements.

Value of a quantity used for specification purposes, established for a specific set of operating Conditions.

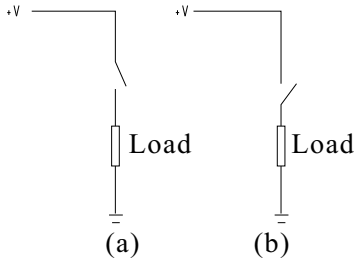


Fig. 10 relay load connection method

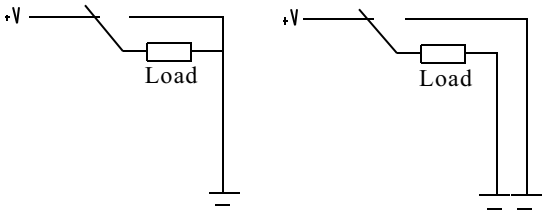
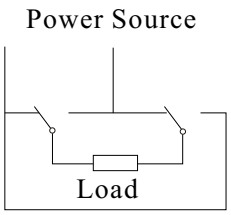
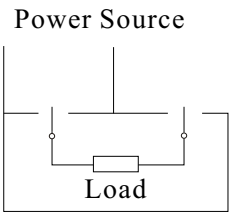


Fig. 11 Unreasonable load circuit



(a) Unreasonable



(b) reasonable

Fig.12 Polarity transfer load

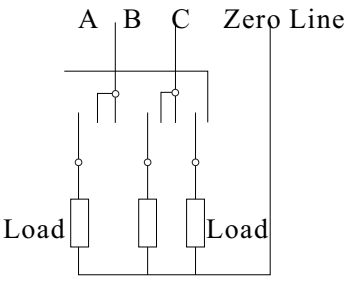


Fig.13Phase position transfer load

6.3. When the contact load ⩾CC1 class, there will be arcing, along with sparks and metal flying, therefore, Rt0 products are forbidden on PC board. RT0 and RTⅠ products are forbidden under explosive atmosphere or heavier wind sand condition, preferably RtⅣ or RTⅤ Products are recommended. Although relay has certain anti-interference ability, but relay should not be installed near big magnetic field, unless being magnetic shielded, because of limited anti-interference ability. The interval between several relays installed side by side should be 1mm at least.

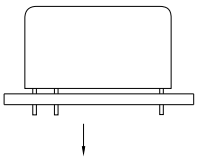
When install relays, do not hit on relays or bend the leads. For bolt or screw terminal installation, the torque should not be greater than the values listed in Table 6. If the terminal leads are too long, it is better to contact with manufacturers to get shorter leads products. The users should not cut leads short themselves.

Table6 Bolt Twisting Force Value(N.m)

Boltspecs		M2.5	M3.0	M3.5	M4.0	M5.0	M6.0	M8.0
For wire connection	head-in	0.40	0.50	0.80	1.20	2.00	2.50	
	head-out	0.20	0.25	0.40	0.70	0.80		
For terminals		0.40	0.50	1.00	2.28	4.00	8.00	11.00
For mounting			1.00	2.00	4.20			

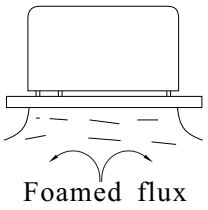
6.4. Please refer to below for the relay soldering and cleaning

1.Mounting



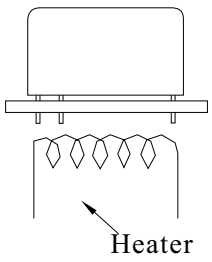
Avoid bending the terminals and hitting the relay. A bent terminal will not assure relay characteristics, especially a sealed relay. If the terminal is too long, please ask the manufacturer to make a short one, not to cut by yourself.

2.Flux coating



Do not overflow onto the top of PC board. Use rosin-based flux, not to use acid-based flux. Automatic flux coating is just suitable for sealed type relay, hand flux coating shall be used for dust-cover type relay.

3.Preheating



Preheating acts to improve solderability, but the preheating temp. shall not be over the highest temp. designed with the product.

4.Soldering

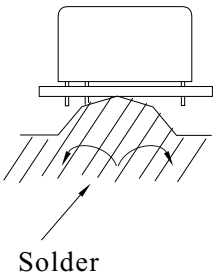
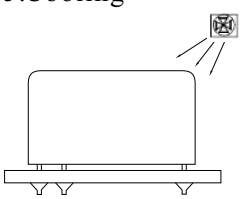


Table7

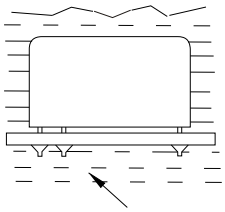
Automatic soldering	Hand soldering
Wave soldering	Electric iron
No solder overflow PC board	Iron power 30~60W
Solder temp:260℃	Iron tip temp:280-300℃
Solder time≤5s	Solder time≤3s

5.Cooling



An immediate cooling after soldering, avoid using frozen gas blow. Clean relay when its temp. is back to the room temp.
Avoid of terminal cut.if teminal cat is carried out,breaking of wire at a coil may be caused by vibration of a catter.

6.Cleaning



Immersion cleaning is just suitable for sealed type relay. Avoid ultrasonic cleaning. Avoid the cleaning solvent penetrate the relay when brushing clean the relay. Use alcohol cleaning solvent. After cleaning, open the vent hole if there is one in the case, but avoid the solid particle dropping into the relay.

6.5. The contact between metals:

The contact between different metals will produce couples-potential difference, in the atmosphere of moist or corrosion, it will speed the corrosion by the effect of primary battery . especially for the grounding connecting line, the higher electric potential will be caused by improper use.The relative standard of relay have stipulated that the coupling potential difference should not be over 0.25V. The table 8 has listed common metals electromotive force (basic standard by silver) and compatible

Table 8 Compatible couples[1)]

Group No.	Metallurgical category	EMF V	Anodic index 0.01V	Compatible couples
1	Gold, solid and plated; gold-platinum alloys; wrought platinum (most cathodic)	0.15	0	
2	Rhodium plated on silver-plated copper	0.05	10	
3	Silver, solid or plated ;high silver alloys	0	15	
4	Nickel, solid or plated ;monel metal high nickel-cooper alloys	-0.15	30	
5	Copper, solid or plated ; low brasses or bronzes silver solder; German silver; high copper-nickel alloys; nickel-chromium alloys; austenitic corrosion-resistant steels	-0.20	35	
6	Commercial yellow brasses and bronzes	-0.25	40	
7	High brasses and bronzes, naval brass; Muntz metal	-0.30	45	
8	18 percent chromium type corrosion-resistant steels	-0.35	50	
9	Chromium, plated; tin, plated; 12 percent chromium type corrosion-resistant steels	-0.45	60	
10	Tin-plate; tinplate; tin-load colder	-0.50	65	
11	Lead, solid or plated; high lead alloys	-0.55	70	
12	Aluminum, wrought alloys of the duralumin type	-0.60	75	
13	Iron ,wrought alloys other than duralumin type; aluminum, case alloys of the silicon type	-0.70	85	
14	Aluminum, wrought alloys other than duralumin type; aluminum, case alloys of the silicon type	-0.75	90	
15	Aluminum, cast alloys other than silicon type; cadmium, plated and chromated	-0.80	95	
16	Hot-dip-zinc plate; galvanized steel	-1.05	120	
17	Zinc, wrought; zinc-base die-casting alloys; zinc,plated	-1.10	125	
18	Magnesium and magnesium-base alloys, cast or wrought(most anodic)	-1.60	175	

Note: 1)Compatible couples-potential difference of 0.25 V maximum between groups;

6.6. The selection of mental wire cross-sectional area

There will be the thermal effect once the current passes through the mental conductor. The bigger current density, the more serious the heating problem, thus the mental conductor or the insulating layer for lead wire will be burned out, so the current density of Copper and Aluminium which allowed to be passed will be limited in a certain degree. The table 9 lists some allowable current density for Copper and Aluminium, that is the relationship between cross-sectional area and current magnitude. The user shall choose the size of connecting wire based on switching current (or carrying current). Here the conductive area after being soldered shall also be considered.

Table 9

Wires		Material	Bareness single wire (A)	Non-bareness wire or handle conductor (A)	Material	Bareness single wire (A)	Non-bareness wire or handle conductor (A)
Diameters (mm)	Area (mm^2)						
0.50	0.20	Cu		2	Al		
0.60	0.28			5			
0.80	0.50		11	7.5			
1.00	0.79		16	10			
1.25	1.23		22	13			
1.60	2.01		32	17			
2.00	3.14		41	23			
2.80	6.16		55	33			
3.15	7.80		73	46		60	36
4.00	12.57		101	60		83	50
5.60	24.63		135	80		108	66
6.50	33.18		181	100		152	82
7.20	40.72		211	125		174	105
8.00	50.27		245	150		202	123
9.00	63.62		283	175		235	145
11.00	95.02		382	200		266	162

Reference Document

〔1〕GB/T 2900.63；GB/T21711.1-2018；GB/T2423.23-2013；

〔2〕NARM：《Engineers'Relay Handbook》1990；

〔3〕IEC 60255-23：IEC 61709：2017； IEC 61810-1：2015； IEC 61810-2：2017； IEC 61810-7：2006；

〔4〕Zhao Jian-xiong：“JRC-490M Design of Ultra-compact Sealed DC Electromagnetic Relay”，Electrical components, 1998 NO.2；

〔5〕Electronics Standardization Institute：“The Base of Reliability”1980；.

〔6〕Zheng Tian-pei：“Inspection of Electromagnetic Relay”Ningbo Forward Relay Corporation Ltd. 2006；

〔7〕Zhang Jiao-suo：“The Research of Relay Arc Phenomenon and Its Parameters Test”，master's their of Xian Jiaotong University 1987.