Operating Conditions

1. General Operational Environment

Warning

Apart from standard operatinal conditions if you use under circumstantial conditions it may cause a breakdown. You must consider general operational, as well as alternate solutions under special circumstances.

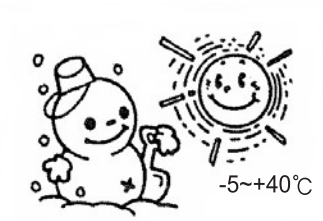
The magnetic switch has many operational options to be used in a wide range of circumstances, but it is based on and manufactured for the following standard operational conditions. Alternate solutions are required depending on the condition.

1.1 General Operational Environment

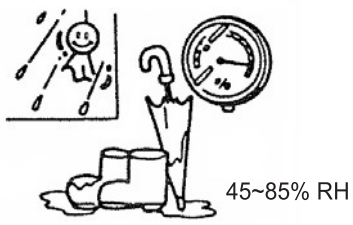
■ Standard operational conditions

- Ambient temperature: -5℃~40℃
- Temperature inside the panel : standard 20℃, -10℃~40℃(maximum 35℃ average daily environmental temperature, maximum 25℃ yearly average environmental) Maximum temperature inside panel is AC3 grade 55℃. If AC4 grade rating standard is applied, maximum temperature is 65℃, and internal temperature/humidity should not cause condensation or freezing. (AC3 grade, AC4 grade rating refer to the standards described in the magnetic switch catalog) Because activating characteristics of magnetic contactor and TOR is changed by the surrounding temperature, be cautious.
- Relative humidity: 45~85%RH
- Altitude : less than 2,000m
- Vibration resistance: 10~55Hz 19.6m/s^2 (less than 2g)
- Shock resistance : 49m/s^2 (less than 5g)
- Environmental conditions : no dust, no smoke, no corrosive gas, no flammable gas, no moisture, not sealed (it may reach contact fault if used for a long time in a sealed environment)

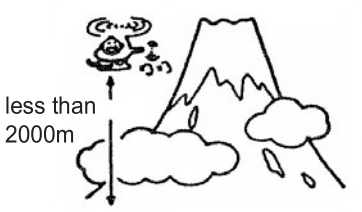
Ambient temperature



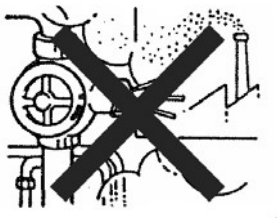
Relative humidity



Altitude



Environmental conditions



■ Applicable tempera-ture range

Product type \ Temperature	Operational temperature (℃)	Storage temperature (℃)
Enclosed product	-10 ~ 40	-30 ~ 65
Single product	-10 ~55	-30 ~ 65

Note 1) Storage temperature is surrounding temperature while shipping or storing, needs to be in the range of ambient temperature suitable with the initial condition of use.
Note 2) No condensation, freezing conditions resulting from rapid temperature change.
Note 3) Short period (less than 1000hours) storage permitted up to 80℃

■ Additional handling information

- When the device operational is suspended for a long period of time, a heater must be used (0.5kW at 0.2 per Square decimeter of outer housing) heater should be automatically activated when the device is off. This heating will prevent condensation and water dropping, by maintaining the temperature inside the outer housing a little higher than the surrounding external temperature. Under normal operation heat is generated from the device itself and this heat is enough to provide this temperature difference.
- Operational for "standard use circumstances" pilot facility (product) can be exended to outdoor use depending on the assumption that, the assembly type consists of a zinc alloy, light alloy, or plastic material. In this case, it is essential to confirm whether the protection level of liquid or solid penetration is suitable for the application.

2. Special Operational Environment

2.1 Influence and Countermeasures Under Special Environment

Different operational conditions and their representative examples are appearing in the following table. To improve the resistence within an environment, because there is a limit, supplying outer parts (panel, case cover, etc.) should be structured with outdoor type, vibration resistance type, corrosion resistance type to prevent the fault.

Special environment	Applicable place	Magnetic switch influence	General countermeasures
Rapid temperature change (Climate)	❖ Rapid temperature changing location (temperature difference between morning and evening) ❖ It is used as an exported product or passes through a tropical, high humidity place where temperature, atmospheric temperature relatively is high	• Rust activation fault by condensation (freezing)	• Decrease relative humidity by setting up a heater • Move it to the place where there is less temperature change • Re-inforce anti-corrosion treatment of the metal product to prevent rust by small quantities of moisture.
Low temperature	❖ Refridgerator ❖ Low temperature storage ❖ Operational for passing through or being used in a cold environment	• Freezing • Activation fault, rust by moisture (condensation)	• Increase the temperature by setting up a heater • Dry
High temperature	❖ Iron works ❖ Plastic mold plants	• Mis-activation • Heat-resistance of connecting cable • Overheating of insulated material	• Reduction of load current • Operational of heat resistent cable • Do not use in a place where inside the panel will be over 65℃
High humidity	❖ Facility, Panel are for high humidity environmental operational • Farming greenhouse • Kitchen facility • Chemical plant • High temperature, high ❖ Humidity sealed environment • Car wash control unit • Explosion unit for mining ❖ Temperature, high humidity environment	• Decrease insulating resistence • Corrosion, Rust • NH3 gas (in the plastic moulding process) and rust	• Use with a waterproof panel (anti-corrosion treatment) • Frequent inspection • Ammonia free material is used for phenolic rosins, plastic moulded product
Corrosive gas, Salinity	❖ Operational in environments with small quantities of hydrogen sulfide(H2S) • Oil refinery • Chemical plant • Coastal area • Water supply pump room (chlorine sterilizer) • Geothermal power plant	• Decrease insulating resistance • Corrosion, rust	• Use anti-corrosion treated product inside anti-corrosion type panel • Basically improve the structure of the panel
Dust and moisture	❖ Gas environment of dust or corrosiveness • Cement plant • Cotton mill	• Current flow fault of contact point • Activation fault of mechanical part • Insulation fire • Decreased insulation resistance	• Vibration resistance, anti-corrosion type case cover is used

2.2 High Temperature

The temperature is usually determined by insulation durability (continuous current flow durability) of control coil and real-time change of plastic molded product when using with high surrounding temperature. The temperature rise of the control coil is stipulated with the standard including surrounding temperature, A type insulation at less than 125℃, E type insulation at less than 140℃, but MS is taking E type insulation for long-term use under 50℃ inside the control panel and refraining from temperature rises less than A type. To estimate continuous flow current durability of the control coil, confirm whether there is a fault of damage and loss to the device by following continuous current flow acceleration tests at the control electromagnetic part.

- Thermostat temperature : 80℃
- Control coil permitted voltage : 110%(60Hz) of rated voltage
- Continuous flow current time: 5000hours
- Number of products for testing : 5 control electromagnets of each frame
- Test result: no damage or loss, no fault to surge layer test

Continuous flow current durability of control coil is usually determined by heating of coil material, according to Arrhenius' law, shown in figure six. From this result, the insulation durability of the control coil can be estimated from average surrounding temperature +coil temperature rise, generally has an estimated life span between 10 and 20 years.

To investigate real-time change of the plastic moulded product, an acceleration test is implemented over 96h by adding 65℃specified degrees of element temperature rise to surrounding temperature 40℃ which totals 105℃ but tested at 125℃ to leave room for safety. If the main cause of elapsed year heating of part is temperature, the durability of the product τ calculated by Arrhenuis' formula which is 「τ=A · exp(-Ea/kT)」 (A, Ea : Characteristic positive number per failure mode, T : absolute temperature, k :Boltzmann' constant). It is used for acceleration testing or estimating the life span of the product. Generally, as Arrhenuis' Law stipulates that if temperature of operational circumstances are decreased by 10℃, durability is improved twofold, this is often used for calculating product durability.

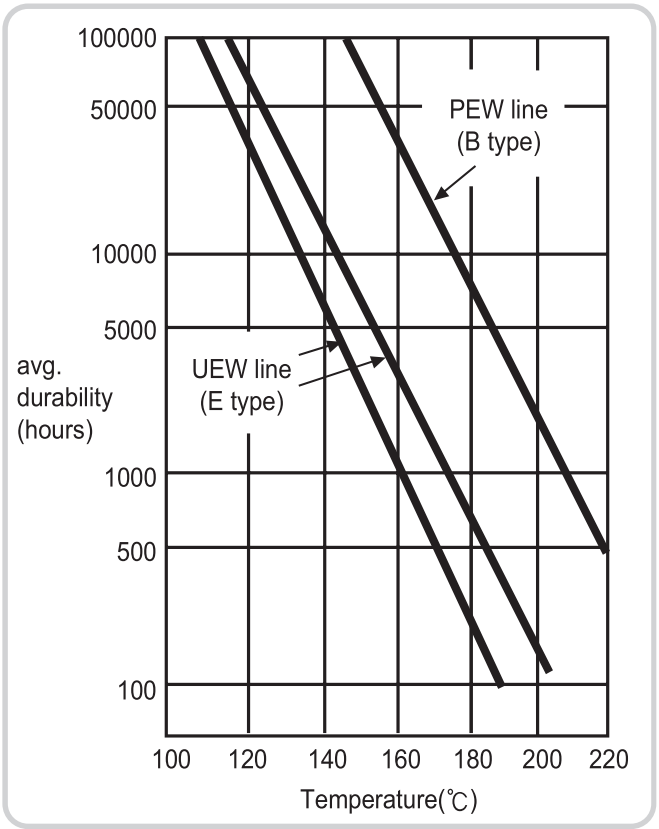


Fig. 6. Graph of coil wire heat-resistance durability

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2. Special Operational Environment

2.2 High Temperature

Magnet switches and magnet contactores are assembled inside the panel and are shipped to cold areas or often used for extreme conditions such as operational inside of freezers. In this case the problem of cold resistence characteristics is used for standard storage, operational temperature is distinctly used as follows.

1. Storage temperature · · · · · Over-55℃
   No problem at each part, results from placing test within one month at -55℃. Therefore, it can resist enough over -55℃ storage. There is usually waterproof, moisture proof packaging with the panel which is being sent to the cold area, but packed from a warmer area needs to have product damage considered due moisture, condensation, and freezing in the cold area. Therefore, we need to be concerned with dehumidification inside the packing, putting in three kilograms of silica gel per meter cubed inside the packaging is recommended.
2. Operational temperature over · · · · · Over-25℃
   Control implementation test was done in under -25℃ conditions.
   - Temperature : -25℃
     There is no problem with the result, so it is possible for use at the low temperature range over -25℃.

Surrounding conditions			Standard product	Specified product from cold area
Temperature	Operating	Without case cover	-5 ~ +50℃	-50 ~ +50℃ *1)
		With case cover	-5 ~ +40℃	-50 ~ +40℃
	Shipping storage		-40 ~ +65℃	-55 ~ +65℃ *2)
Relative humidity			less than 85% RH	less than 95% RH

Note 1) No condensation, freezing conditions by rapid temperature change
Note*1) TOR range up to -5℃
Note*2) TOR range up to -55℃

2.3 Temperature

Magnetic switch, magnetic contactor are not designed for high temperature, humidity conditions in principle. If used under such conditions, basically it is recommended to use by putting in assembled type of moistureproof structure considering the decrease in insulation capacity, electrical performace or durability decrease, and rust of metal products (especially the electromagnetic core). Therefore every kind of test is implemented considering the occurance of abnormal environmental conditions. And also the test is being implemented with humid conditions from Lloyd' standard.

■ The treatment of high temperature, high humidity

This treatment is for setup within hot and humid environments with danger of condensation, water dropping, and rust. We apply the following treatment, plasitic insulation part can prevent damage from white ants, cockroaches and other insects, but it doesn't mean this product has systematically high temperature and high humidity protection when it is set up in equatorial areas or other tropical areas.
(Standards IEC 60947, NF C 26-220, DIN 5348)

- A metal assembly type is treated for anti-corrosion.

Protection treatment selection guide

Location	Environmental condition	Duty cycle	Internal heating of outer housing without use	Climate type	Protection treatment	
					component	Enclosure type
Indoor	no condensation or water dropping	not important	unneccessary	not important	standard use circumstances	standard use circumstances
	condensation or water dropping	frequent switching on and off for over one day	none	temperate region	standard use circumstances	high temperature, high humidity
				temperate region	high temperature, high humidity	high temperature, high humidity
			exists	not important	standard use circumstances	high temperature, high humidity
		continuous	unneccessary	not important	standard use circumstances	high temperature, high humidity
Outdoor (protected)	no water dropping or condensation	not important	unneccessary	temperate region	standard use circumstances	high temperature, high humidity
				equatorial region	standard use circumstances	high temperature, high humidity
Outdoor, exposed or near the sea	frequent condensation and water dropping	frequent switching on and off for over one day	anone	temperate region	standard use circumstances	high temperature, high humidity
				equatorial region	standard use circumstances	high temperature, high humidity
			exists	not important	standard use circumstances	high temperature, high humidity
		continuous	unneccessary	not important	standard use circumstances	high temperature, high humidity

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■ Switching test under high temperature, high humidity conditions

1.Testing methods and types

Magnetic contactor switch is recommended to be used under standard operational conditions, in the rare case it is difficult to maintain this. Therefore we are testing under the following conditions.

1) Test of temperature and humidity
In fig. 7. after testing under temperature and humidity conditions, if there is no problem with pulsation from corrosion, aging insulating material, change of plastic moulded product, and performance change then the result is satisfactory.

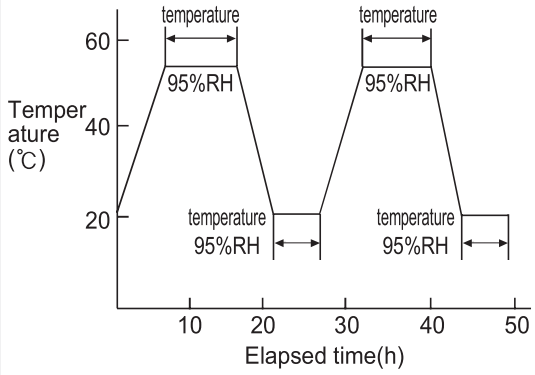


Fig. 7. Testing conditions of temperature and humidity

2) Salt water spraying test
Salt water spraying test is often implemented for evaluating in consideration of the environment of the magnetic contactor. Test specifications are satisfied before and after the salt water spraying test by testing under the following conditions

Water	Salt	Temperature	35℃ PH	35℃ Concentration	Salt water amount of 85cm2 at 1h	Spraying time	Cleaning method of test product
distilled water	refined salt	35℃	7.0	5%	1.3cc	48h	clean with water

2. Special Operational Environment

2.4 Protection Under Special Environment

■ Dust

Magnetic switch contactor cement factory, cotton factory, construction site etc. in case of places where there are high levels of dust, control unit vibration and resistance structure or assembly type structure should be a vibration-resistant structure. When the dust is attached to the contact point, contact resistence is increased, abnormal temperatures at the contact point increase and it causes increased aging of the insulation material or degradation of the electrical on/off durability. Aside from that, the dust attached to the insulation material degrades the insulation characteristics/ability and increases the likelihood of an electrical short. Also, when the dust settles between an electromagnetic armature, because of imperfect electromagnetic apsorbtion, it causes pulsation noises.

■ Gas

1. When magnetic contactor is used for chemical factory, refinery, sewage disposal plant etc where there is much corrosive gas, basically it is recommened to consider the protective structure of the panel. About small quantities of corrosive gas, it is possible to protect by coating the weak points making them strong against corrosive gas but because there no perfect way for a silver series contact point which is used for contact point material, there a limit in protecting a single product. Therefore a small quantity of corrosive gas in this kind of atmosphere please select a magnetic contactor which can be used in this kind of atmosphere.
2. Because the velocity of metal corrosion under an atmosphere containing corrosive gas is delayed as humidity and temperature decrease, it is a good idea to blow in clean air into the panel with increasing internal pressure by using an air conditioner. The figure shows matter/humidity/temperature and tendency of corrosion process velocity.

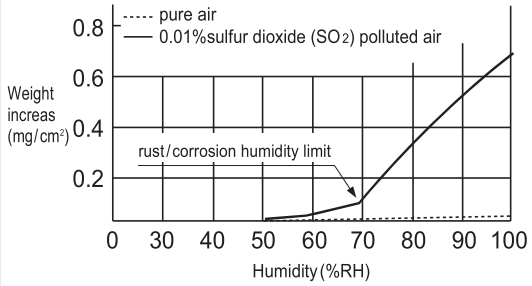


Fig. 8. The amount of corrosion change due to humidity.

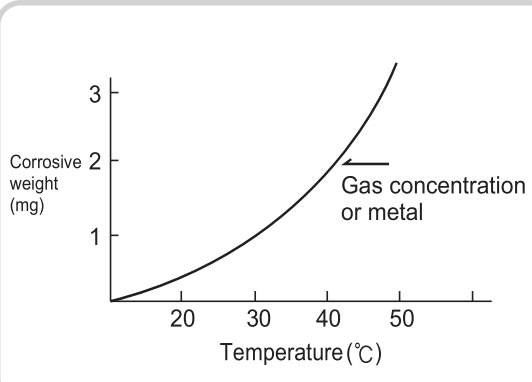


Fig. 9. The amount change in corrosion by temperature

2.5 Corrosive Gas

1) Corrosive gas application circumstances example in the atmosphere

Gas Conditions	Concentration(ppm)		Example of application environment	Influence uapon metal type and conditions
	Normal	Abnormal		
Hydrogen sulphide(H2S)	Less than 0.02	Over 0.07	• Hot springs area • Near a steel plant • Sewage treatment • Paper plant	• Silver(Ag) : tarnishing • Bronze(Cu) : tarnishing, corrosive
Sulfur dioxide(SO2)	Less than 0.04	Over 0.07	• Near a steel plant • Chemical plant	• Nickel(Ni) : tarnishing • Iron(Fe) : turning red and blue, corrosive • Zinc(Zn) : turing white and blue, corrosive • Bronze(Cu) : tarnishing ※Corrosion is strongly reduced when humidity is less than 65%
Cholorine gas(Cl2)	Less than 0.02	Over 0.05	• Water supply • Chemical plant • Pool sterilization room	• Tin(Sn) : tarnishing, corrosion • Chrome(Cr) : tarnishing, corrosion
Nitrogen dioxide(NO2)	Less than 0.04	Over 0.5	• Urban district • Chemical plant	• Iron(Fe) : turning red and blue, corrosion • Zinc(Zn) : turning white and blue, corrosion ※ Corrosion is strongly reduced when humidity is less than 65%
Ammonia(NH3)	Less than 0.01	Over 5	• Chemical plant	• Brass : stress corrosion, cracking

2) Corrosive gas and metal anti-corrosion influence table

Material \ Gas	Hydrogen sulfide (H2S)	Sulfur dioxide (SO2)	Chlorine gas (Cl2)	Nitrogen dioxide (NO2)	Ammonia (NH3)
Silver(Ag)	×	△	△	△	○
Bronze(Cu)	×	△	×	△	○
Nickel(Ni)	△	×	×	△	○
Chrome(Cr)	△	△	△	△	○
Tin(Sn)	○	○	○	○	○
Stainless teel(SUS304)	◎	○	×	◎	◎
Brass(C2680)	×	△	×	△	×
Nickel alloy(CuNi)	△	○	×	×	○

※Legend : ◎Superior, ○Good, △Normal, ×Bad

2. Special Operational Environment

2.6 High Altitude Application

In cases when the air break switch of the magnetic switch is installed at a high altitude, air density, insulation ability and cooling coefficients decrease by the follow standards and need to be properly compensated for.

■ High-altitude application standards

In case of high altitude installation, the rated level of insulation voltage and current flow the magnetic switch is reduced as dictated by ANSI standard, the BS standard or IEC standard and are shown in table 1.

Table 1. Rated compensation coefficient at altitudes of more than 1000m

Type	ANSI C37 30-1971			BS2692 PT1-1971/IEC Pub.282-1-1985			
	Rated insulation voltage	Rated current flow of current	Surrounding temperature	Voltage resistance test voltage	Rated insulation voltage	Rated current flow current	Tempera -ture rise
1000	1.00	1.00	1.00	1.0	1.0	1.0	1.0
1200	0.98	0.995	0.992	↕ proportional	↕ proportional	↕ proportional	↕ proportional
1500	0.95	0.99	0.980	1.05	0.95	0.99	0.98
1800	0.92	0.985	0.968	↕ proportional	↕ proportional	↕ proportional	↕ proportional
2100	0.89	0.98	0.956				
2400	0.86	0.97	0.944				
2700	0.83	0.965	0.932				
3000	0.80	0.96	0.920	1.25	0.80	0.96	0.92
3600	0.75	0.95	0.896				
4200	0.70	0.935	0.872				
4800	0.65	0.925	0.848				
5400	0.61	0.91	0.824				
6000	0.56	0.90	0.800				

Note 1) Magnetic switch's normal operational condition at altitudes of 2000m and when it is more than 2000m rated compensation is done with the standards of this table.
Note 2) Either rated control current or surrounding temperature needs to be reduced (usually they are not both reduced).

■ Surrounding temperature decrease prevention

Because surrounding temperature decreases generally, the specified products of the site are applied by the demand.

2.7 Oil Mist

In case of tooling machine control board, cutting tool oil becomes oil mist, it usually attaches to the contact point of the magnetic contactor and switch inside the panel. Under these circumstances, there is no possibility of danger that the contact point will cause a contact fault, but when the oil is dissolved by the switch arc, it emits much hydrogen gas and accelerates consumption of oil on the contact point. When this happens, it increases consumption of oil on the contact point tens of times faster than without oil. So, in these circumstances, we need to have a protective structure to prevent oil mist penetration inside the panel.

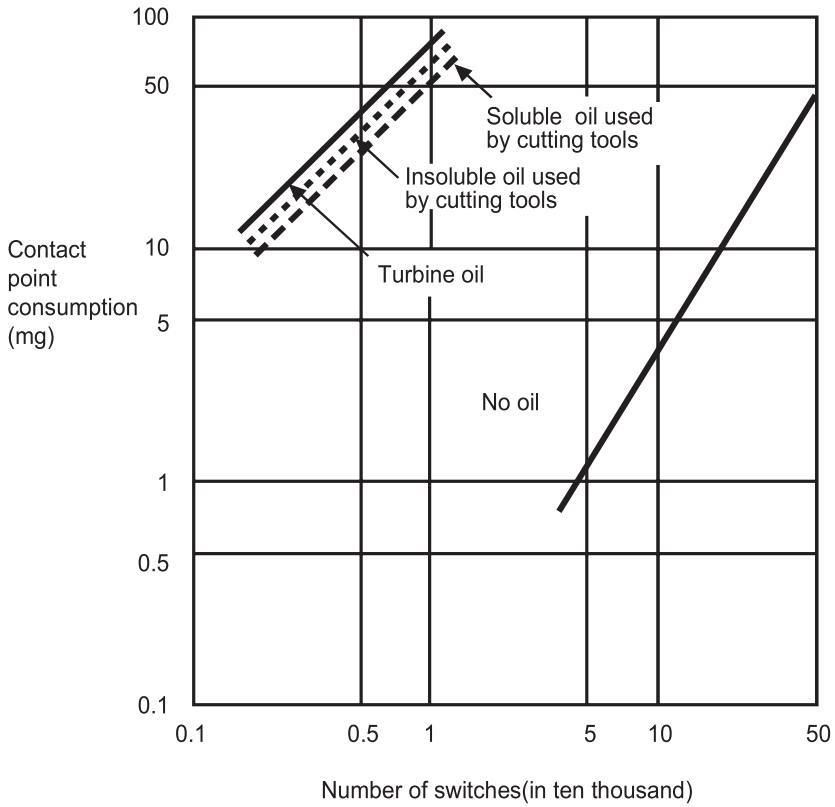


Fig. 10. Comparison with and without oil attached at the contact point

1. Public standard product : MC-9a

(a) product without oil

(b) product with oil

- Spread oil 1.5ml at every contact point before the start of the test or 1000 on/off switches

2. Test conditions

- 3phase 200V 3.7Kw
- AC 3level load
- 1200 numbers/hours

3. Contact point consumption

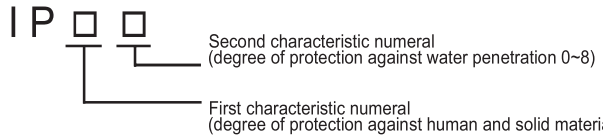
- 3 phase total consumption

2. Special Operational Environment

2.8 Degree of Live Part Protection from Human Access, Solid Material and Water Penetration

The European standard EN 60529 dated October 1991, IEC publication 529 (2nd edtion - November 1989), defines a coding system (IP code) for indicating the degree of protection provided by electrical equipment enclosures against accidental direct contact with live parts and against the ingress of solid foreign objects or water. This standard does not apply to protection against the risk of explosion or condictions such as humidity, corrosive gasses, fungi or vermin.

• **IEC IP Code**



1. IP code

IP(International Protection) is a two-digit code regulating protection against foreign substances and water penetration for electrical equipment enclosures following the IEC standard.

Protection degree	1nd Characteristic numeral			Protection degree	2nd Characteristic numeral		
	Protection of the equipment		Human protection		Harmful effect of water		Waterproofing method
	Example	Requirements			Example	Requirements	
0		Non-protected	Non-Protected	0		Non-protected	Non-Protected
1	Ø50mm	Protected against the penetration of solid objects having a diameter greater than or equal to 50mm	Protected against direct contact with the back of the hand (accidental contacts).	1		Protected against dripping water (condensation)	Vertical dropping
2	Ø12.5mm	Protected against the penetration of solid objects having a diameter greater than or equal to 12.5mm	Protected against the penetration of solid objects having a diameter greater than or equal to 12.5mm	2	15°	Protected against dripping water at an angle of 15deg.	dropping at an angle of 15deg.
				3	60°	Protected against dripping water at an angle of 60deg.	limited spray
3	Ø2.5mm	Protected against the penetration of solid objects having a diameter greater than or equal to2.5mm	Protected against direct contact with a Ø2.5mm tool	4		Protected against splashing water in all directions.	spray from all directions
4	Ø1mm	Protected against the penetration of solid objects having a diameter greater than or equal to1mms	1Protected against direct contact with a Ø1mm wire	5		Protected against jets of water in all directions.	Jets from all directions
5		Dust protected (no harmful deposits)	Protected against direct contact with a Ø1mm wire	6		Protected against powerful jets of water and waves.	Strong jets from all diirections
6		Dust tight	Protected against direct contact with a Ø1mm wire	7	1mm 15cm 15cm min	Protected against the effects of temporary immersion	temporary immerasion
				8	1m	Protected against the effects of prolonged immersion under specified conditions	continuous immersion