# RELAYS

## Definition, Specifications and Applications

WHITE PAPER

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## What is a Relay?

A relay is an electrically operated switch. It allows a small current to control a larger current, enabling remote control of high current switching. Relays also are commonly called several different names. We define them this way:

### Relay

Relay is the most general term and refers to all devices that use a small electric signal to turn on a larger high current load. This term goes beyond automotive applications, into a wide range of electrical applications.

### Contactor

Contactors are heavy duty DC relays that usually use a solenoid type coil and are designed for higher amperage and higher voltage applications.

### Solenoid

Solenoids are a type of relay, but usually in a can style housing. It is also a simple reference to the solenoid coil of wire within an electromechanical relay that creates the magnetic field required to open and close the circuit.

Relays work on several principles for remote switching, the two most common are electro-mechanical and solid state.

In **electromechanical relays**, an electromagnet is used to close the high current contacts. The current through the coil creates a magnetic field which attracts a ferritic moving core. The moving core creates the contact force to close the high current contacts. The making and breaking of the contacts is a major source of arcing which is one of the major sources of wear in the life of a relay. Higher voltage electromechanical relay generally includes a strategy to reduce arcing including magnetic blowouts and high ionization energy gas fill in the contact area.

**Solid state relays** use one or more solid state devices (typically FETs, IGBTs, or Thyristors) to achieve the rated current so there are no moving parts. These devices are typically placed on a PCBA and then bussed to the high current terminals. One of the major differences is that the solid-state relay has no make or break so there is no arcing. This gives solid state switch a life advantage and an advantage in higher voltage applications by preventing arcing. However, solid state relays are typically significantly higher cost.

## Why Use a Relay?

- A relay allows control of high current switching with a lower current to minimize high current wires runs. This lowers both harness cost and voltage drop in the circuit.
- The lower current required to control the coil of the relay, rather than direct control of the load with a switch, means you can run much smaller wires into the cab or control box. This also reduces wear on costly decorative switches used in these locations.
- Putting the relay on a communications bus, such as CAN or LIN, reduces the wiring even more by allowing control of multiple relays over a common control line.
- The contacts in a relay are larger and more robust than are typically used in a smaller switch. These heavy-duty contacts in the relay will better withstand high inrush loads like inductive and motor loads.
- A relay can allow a load buried deep in a vehicle to be controlled by an operator in a remote location of the vehicle, or even a different geographical location. Aside from operator remote control, the change of state can also happen as an independently timed event or based on an electrically sensed parameter like voltage or amperage. If a relay is on a communications bus or wired directly to a controller, it has the potential to be managed by that controller or long distance via a telematics system.
    - For example, if a piece of construction equipment is sitting on a job site and the remote monitoring office notices that the battery is not disconnected, and the battery is running down, they can send a signal to isolate the battery from the system and preserve starting power in the vehicle.
    - In another example if the vehicle has a DEF system that requires pumping the DEF out of the engine before completely shutting down the electrical system, this can be accomplished with a relay. By using a relay with an integrated timer or connecting it to the engine or vehicle ECU this can be done automatically and reliably which cannot be done with a manual disconnect switch and a human operator.

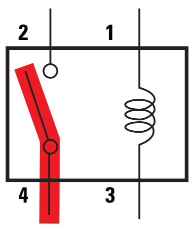
## How Do Relays Work?

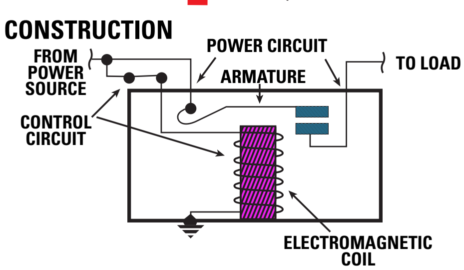
Most relays are electromechanical devices because they use a coil that creates a magnetic field and attracts a ferritic pole piece or core. There are two basic configurations, **armature** and **solenoid** relays.

ARMATURE STYLE RELAY

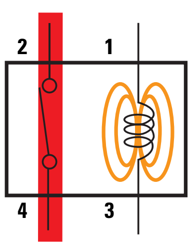
Armature relays use a coil that pulls down on an armature to close the relay. Most automotive cube style plug in relays are armature style relays.

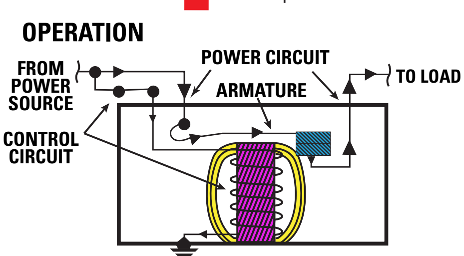
OFF / OPEN



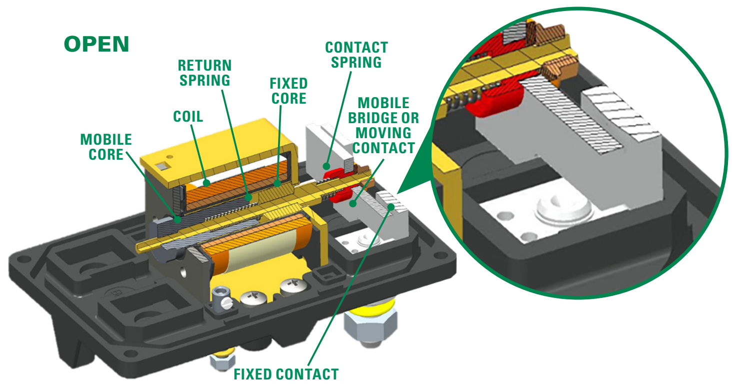

ON / CLOSED



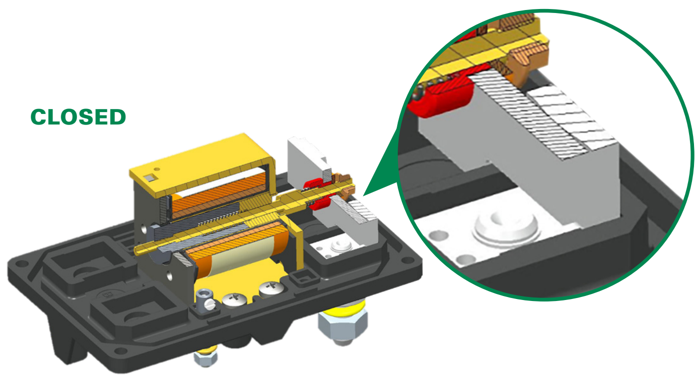




Solenoid (from the Latin solen for pipe) relays have a moving ferritic core that rides on the inside of a tubular coil. When current is run through the tubular coil the pole piece is magnetized and moves to compress the contacts against the external terminals closing the relay. Solenoid coils generate larger magnetic force and therefore greater contact force to lower the resistance and handle the higher currents of demanding applications. They are, however; generally physically larger and more expensive.

OPEN




CLOSED



Solid state relays do not use an electromagnetic closure, they use electronic devices that do not make and break but instead, stop the flow of electrons. This effectively opens the circuit without making and breaking the circuit. Since they do not break the circuit, solid state relays do not suffer from arcing damage unlike electromechanical relays. This capability of eliminating arcing makes it possible for solid state relays to be used in pulse width modulated circuits that allow a system to lower the effective current and voltage running through the circuit on the fly. They do this by turning the relay on and off rapidly, so a downstream device sees less overall electric power. This is useful for dimming LED lighting or controlling proportional valves used in hydraulics. On the other hand, solid state relays are normally highly reliable, but when they do fail, they are subject to failures in closed state so all solid-state relays should be protected with a fast-acting fuse to prevent a high impedance short circuit that can damage wiring.

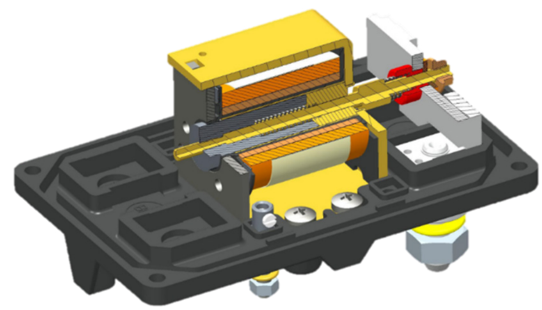
## Types of Relays

Relays are divided into two categories that define how they react to a coil activation.

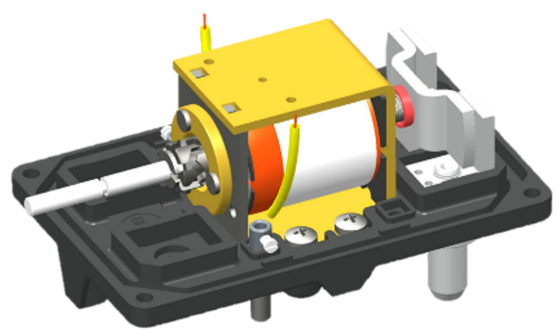
Monostable Relays (also sometimes referred to as normally open, normally closed, or electrically latching) turn ON when the coil is on and turn OFF when the coil is off. They have one position (usually OFF) that they return to when the coil is turned off. This type of relay is usually designed to control a specific load that is turned ON and OFF as needed in the vehicle (applications such as winches, hydraulic power packs, or lighting). Monostable relays usually use a contact design and chemistry optimized for high switching cycles and sacrifice a little higher resistance for contacts that can stand higher cycles. Most automotive cube plug in relays, can or solenoid relays, and plastic body relays fall into this category. Monostable relays can be continuous duty or intermittent duty. Continuous duty (also called uninterrupted use) relays are designed to carry the rated current essentially forever, while in intermittent duty (also called interrupted use) the current rating is supplier specific to a defined duty cycle (length and duration of the ON state and OFF state). Please review the relay data sheet to determine if the intermittent use case meets your application needs.

Bi-stable or Latching Relays are relays that are designed to stay in both the ON and OFF positions with no power applied. The solenoid is powered to change states, but once they change state from OFF to ON (or ON to OFF) they do not consume any power. This type of relay is usually used as a battery disconnect or as main power cutoff to a major subsystem in the vehicle. Bi-stable relays use contact designs and chemistry that is selected for low loss and minimum resistance with limited full current cycle life. Bi-stable relays typically use either separate close and open coils or they reverse the direction of current in a single coil to open and close the relay. With separate coils, each directional motion is driven by a separate coil, usually with a common ground, but separate inputs. The single coil versions change the direction of current flow through the coil to reverse the magnetic field and push the moving contacts to the other state. Bi-stable relays use either a mechanical or magnetic latch. Mechanically latched relays have a toggle mechanism that has peaks and valleys to keep the relay in the open or closed state. Magnetically latched relays have a permanent magnet in the coil assembly that keeps the ferritic core in the closed position without any electric power.

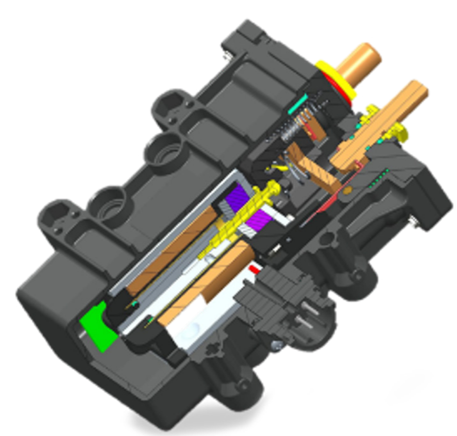
**MONOSTABLE**



**MECHANICALLY LATCHED BI-STABLE**



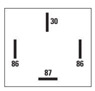
**MAGNETICALLY LATCHED BI-STABLE**

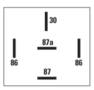


## Relay Configurations

Automotive Cube Plug In Relays, these are mostly defined by a series of ISO standard formats. They use an armature and coil design and while they have bigger contacts than switches, they are not as robust as larger solenoid type relays. They are, however; very cost effective and there are a wide variety of mounting methods and enclosures. These are the relays that are usually used in power distribution boxes in cars and trucks.

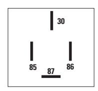
**ISO MINI RELAYS**
(5) 6.3MM Terminals
40-50A (12V) 20-25A (24V)
Form A & Form C

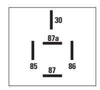

Form A


Form C

RC-400112-DN

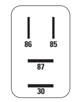
**ISO POWER (MAXI) RELAYS**
(3) 6.3MM Terminals
(2) 9.5MM Terminals
70A-80A (12V) 35-40A (24V)
Form A & Form C


Form A


Form C

RA-700112-DN

**ISO MICRO RELAYS**
(2) 6.3MM Terminals
(3) 4.8MM Terminals
25-35A (12V) 15-20A(24V)
Form A & Form C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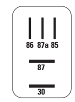
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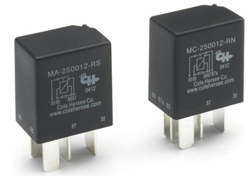
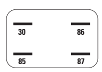
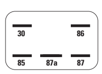

MA-250012-RS MC-250012-RN

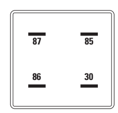
**ISO MICRO 280 RELAYS**
(5) 2.8MM Terminals
30-35A (12V) 15-20A(24V)
Form A & Form C


Form A


Form C


02040090Z

**ISO ULTRA MICRO**
(4) 2.8MM Terminals
20-30A (12V) 10-15A(24V)
Form A


Form A


02040080Z

Can Style Solenoid Relays (sometimes referred to simply as solenoids) are solenoid design and have been produced since the 1950s when they were originally developed as starter relays for the automotive industry. They have very heavy and durable contacts and the high contact force developed by the solenoid allows them to handle high current, high inrush applications such as motor and inductive loads. The "can" has a function in this design supplying the equivalent of "ground" in the magnetic circuit for the coil. Typically, they are not latched, but a latched version is available. These are available with ratings up to 48V nominal.

**STANDARD ISOLATED HIGH CURRENT RELAYS**
5/16" High Current Terminals
#10 Stud Coil Terminals
Isolated Coil
Form A & Form C
85-200A (12&24V)


24059

**STANDARD GROUNDED HIGH CURRENT RELAY**
5/16" High Current Terminals
#10 Stud Coil Terminals
Coil With Housing Ground
Form A & Form C
85-200A (12&24V)


24107

**COATED HIGH CURRENT RELAY**
5/16" High Current Terminals
#10 Stud Coil Terminals
Grounded or Isolated Coil
Form A & Form C
IP66 Protected
85-200A (12&24V)


24063-08

**LATCHED HIGH CURRENT RELAY**
5/16" High Current Terminals
#10 Stud Coil Terminals
Isolated Coil
Form A
110A (12V)


24200

Plastic Bodied Relays are solenoid type and are like can style relays in basic contact and coil design. The major difference is that they use an internal metal part to complete the magnetic circuit. The external parts of the relay are made of either engineered thermoset or thermoplastic material. Because of this external plastic housing they are less susceptible to external corrosion.

**PLASTIC BODIED RELAYS**

Power terminals range from ¼" up to M10
Coil connections range widely with 10-32, M4, and M5 studs, ¼" tabs, and connector options
Current ratings run from 50A all the way up to 500A
These are available with ratings up to 48V nominal
Monostable is most common but there are some latched versions as well
Grounded or isolated coil
Sealing also varies, with many not IP rated, but some go to IP67 and IP6K9K

24512-10

24812

Battery Disconnect Relays are solenoid type, but they are mostly bi-stable because the bi-stable relay reduces the power consumption in this application. Battery disconnect relays are usually higher amperage as they are designed to carry the full draw of the electrical system, starting and charging the battery. They tend to be robust as they are usually expected to last the life of the vehicle and survive vibration and shock while keeping power to the vehicle. Disconnect relays are more common in European applications than in any other geographic region. In other parts of the world, they mostly offer manual disconnect switches.

**BATTERY DISCONNECT RELAYS**

Power terminals range from M8 to M12
Coil connections usually are made with a connector usually sealed. The connector can be integrated into the housing of the relay or on a small harness
Ratings run from about 100A all the way up to 800A
Voltage is 12-48V
Most of these are sealed IP54 or better, and most newer relays are IP67/IP6K9K

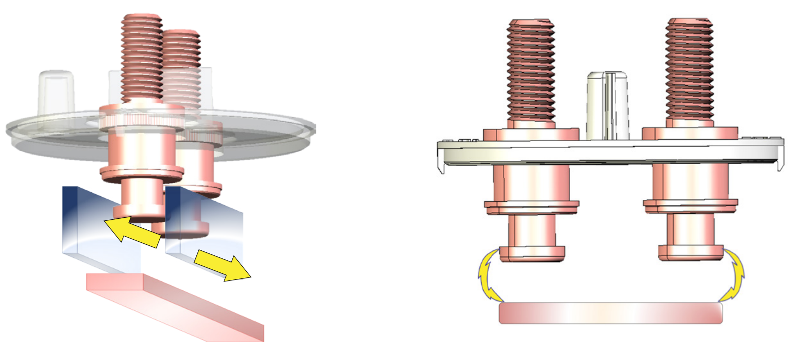

Magnetically Latched Bi-Stable Relay
880086

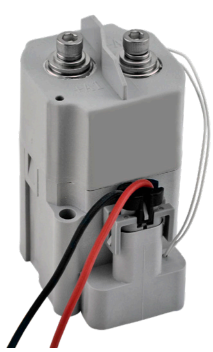
Mechanically Latched Bi-Stable Relay
08070900

Magnetically Latched Bi-Stable Relay
08075063

High Voltage Relays are solenoid type, but they incorporate some unique features to reduce arcing damage to the contacts. Arcing takes place in all opening and closing movements of the metal contacts in a relay. The arc is a very hot ionized plasma that can literally burn holes in the metallic contact surfaces. The driving force of an arc is the voltage differential between the input and load sides of the relay. So, while all relays arc, in low voltage applications (<32V) it has little detrimental effect on the switch. As the voltage of the application goes up, the arc lasts longer, causing more damage. In an AC relay, the sinusoidal voltage values limit the duration of the arc as they pass through a 0 V point every 10 msecs. For DC HV relays, the only thing that quenches the arc is resistance as defined by the ionization energy requirements of the atmosphere and the distance between the contacts. HV DC relays incorporate features to limit the arcing damage. The most common features are a gas filled contact chamber and magnetic blowouts. The gas picked to fill the contact chamber has a high ionization energy requirement, this creates higher resistance to the arc which shortens its duration. The magnetic blowouts, with a double break contact, set up an artificially longer arc path by forcing the arc to follow the magnetic field lines and travel a longer distance. This effect increases the resistance and kills the arc quicker. This is also the reason that HV relays typically do not incorporate internal flyback protection. This can slow contact opening and allow arcing time and damage to go up.

**MAGNETIC BLOWOUT DISSIPATING ARC**





400A 1800V Relay DCNEVT350

50A 900V Relay DCNLEV50

250A 900V Relay DCNEV250

Solid State Relays (SSR) are very different than electromechanical relays as there is no mechanical make or break of the electrical flow to create an arc. SSRs control the flow of electricity by enabling or disabling electron flow through the semi-conductor. When a negative voltage is applied to the control terminal it raises the resistance of the semi-conductor which stops the flow of electricity. This no make or break switching causes no arcing and is particularly good for electronics as it does not create the damaging spikes that can take place with an electro-mechanical relay.

Solid state relay components have some disadvantages too, most are monodirectional devices so they cannot control current in the reverse direction (unless putting them back to back). They also can fail in a semi-closed state and fail to open, and they more susceptible to damage due to in-rush currents. SSRs are also typically are more expensive than similarly rated electromechanical relays. Also, in High Voltage applications solid state relays do not provide true isolation because they do not provide separation and that needs to be accounted for in the system design.

## Critical Design Parameters

These are key parameters that you should consider when picking a relay for your application.

### Current Ratings

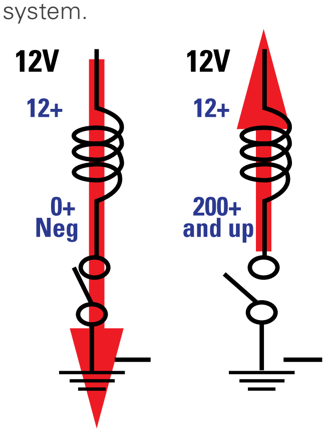
There are several different current ratings that need to be considered when picking a relay.

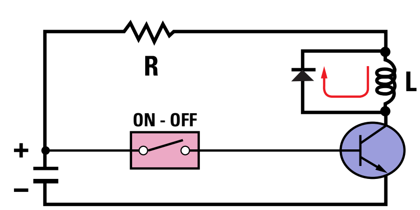
- **Continuous Carry Current** - The current that the relay can carry essentially forever, and the temperature does not rise above a set value.
- **Inrush Current or Starting Current** - A short duration value that is the maximum current the switch can withstand without raising the temperature over that same value (10-60 secs). Examples are a starting event, incandescent light in-rush, and inductive load start up. It is very important to match the in-rush rating of the relay to the application especially in applications with inductive or capacitive loads.
- **Temperature Derating** – If the application is going to be operating at elevated temperature, take note if there is a temperature derating for the relay so you know if the relay can handle the current in the application environment.
- **Current Rating Wire Size** – Typically the current rating for a relay assumes a certain size cable or conductor. Make sure you know what cable size was used for the rating. If you are using a smaller cable the relay may not perform as well and you should test the relay with the cable you will use in the application. Sometimes you can extend the performance of a relay by using a larger cable than was used with the rating. However, this needs a specific test to confirm performance of the relay. Review the voltage drop (there are many available online tools) that will occur in the cable based on wire size and cable run length. For instance, if you want run 300A through a 2 AWG (~35mm2) cable for 10 feet, you would lose approximately 0.5V just in that short cable run. Whereas with the same conditions, 2/0 (~70mm2) loses less than 0.25V.

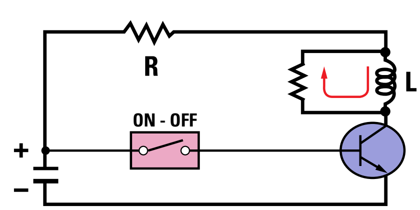
### Voltage Ratings

The voltage of a relay has two separate voltage ratings. There is one for the coil and one for the main contact. In many cases they are the same, but can be very different in other cases. In High Voltage relays they tend to be very different, with relays rated at 1000V operated by coils of 12V-96V.

- **Coil Voltage** - Voltage is very important and tightly defined. Using an incorrect voltage with the coil can cause damage to the coil. If a 12V coil is used in 24V application, it will burn out and the relay will fail. If a 24V coil is used in a 12V application it may not generate enough magnetic force to properly close the contacts.
  - **Standard coils** are simple inductors. They do not use electronic controls, but sometimes incorporate coil suppression or "flyback" protection. This is a resistor, transorb (TVS diode) or diode placed in parallel with the coil to dissipate the energy that is released by the collapsing magnetic field when the coil is turned off. Unchecked, this energy can create a large negative voltage spike that can damage some upstream components. The dissipation slows the release by milliseconds, with is not a problem in lower voltage relays. These features tend to be not used in higher voltage relays as slowing the opening also extends the arcing time and can damage the relay more.  Standard Coils are limited to a single nominal voltage e.g. 9-16V for a nominal 12V system.



- **Electronically controlled coils** come in several different varieties including reversing, time delay, dual coil, or coil economizer. Because of their electronics, electronically controlled coils can operate over a larger range e.g. 9-32V

  **Reversing coils** take the signal from the system and change the direction of current through a single coil to open or close the relay.

  **Time delay coils** use separate open and close coils but manage the amount of time they are activated to shut them off as soon as they are done moving the core.

  **Dual coils relays** have two coils, the first is larger and helps apply the initial force to overcome the return spring and system mechanical resistance. The second coil or hold coil uses less power and is design to generate just enough force to keep the contacts closed. The electronics turn on both coils to start and the turn off the pull-in coil and keep only the hold coil on. This is designed to reduce the drain on the electrical system for a relay that stays on for a long time.

  **A coil economizer** achieves the same aim as the dual coil, it reduces the current used by the coil for keeping the relay closed. The coil economizer does this by pulling the coil in with the full current. Once the relay is closed, it then it begins to rapidly cycle the coil on and off. It counts on the latency of the magnetic field to hold the relay closed, while achieving reduced electric energy used.

- **Main Contact Voltage** - Relays are less sensitive to main contact voltage than coil voltage. The contacts used on a 12V relay are frequently the same ones used on a 36V or even 48V relay. Usually any relay rated for you application voltage or higher will work. When the application goes above 60V it is important to take extra care of the contacts due to higher arcing that occurs at these higher voltages and the shock danger to personnel at this voltage level.

## Electrical Cycles

This is the number of cycles that the relay can do at when switching power. It is important to note in the specifications at what current and voltage this test was done and what was the size of the cable used to rate the switch this way.

## Mechanical Cycles

This is the number of cycles that the relay can withstand with no electrical load. This is an important number particularly for battery disconnect relays and any other applications that frequently switch with no electrical load on the relay.

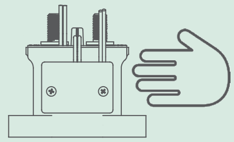
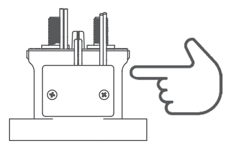
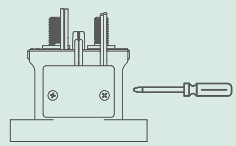
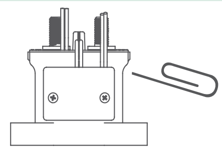
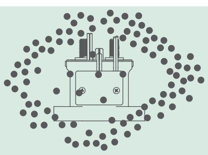
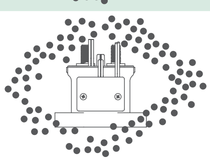
## Contact Chemistries

Contact Chemistires can be optimized for different applications. Battery disconnect or other low cycle, long duration applications are best with a low resistance contact for optimum efficiency. This type of contacts typically has lower electrical cycle ratings. For power control application where there will be more cycles contacts with more exotic silver alloys are common. These are optimized to minimize arcing and allow a high cycle life. It is possible to alter the contact chemistry in a relay that was originally designed for a low cycle application and be able to achieve high cycles. High cycle contact chemistries tend to cost more than low resistance low cycle ones.

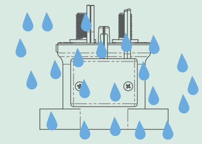
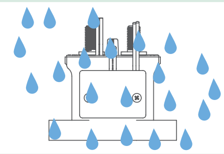
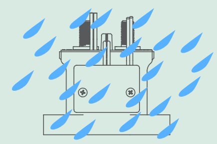
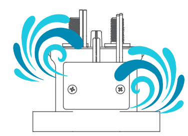
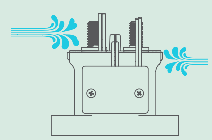
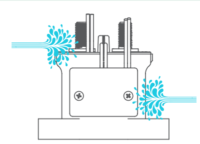
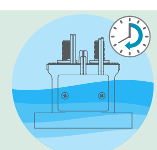
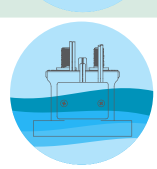
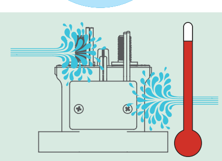
## Sealing

Environmental factors play a huge role in a product's ability to do its job and survive the lifetime of the equipment.  It is important to understand the environmental factors in your application and match the IP rating to where you are going to mount the relay.  Ingress Protection, or IP, indicates the degree of protection of a relay. IP ratings are a measure of how resistant a part is to environmental contaminants such as debris, dust, and water. IP rating selections should be based on where the relay will be mounted and what type of environment the equipment will be used in.  The numbers following IP represent levels of sealing and can range from no sealing (IP00) to protection against dust and continuous immersion in water (IP68). The table on the next page provides a description of the protection at each level.

## 1st Digit - SOLID
Degree of protection against solid objects

| | | |
|---|---|---|
|  | **1** | Protected against a solid object greater than 50mm |
|  | **2** | Protected against a solid object greater than 12.5mm |
|  | **3** | Protected against a solid object greater than 2.5mm |
|  | **4** | Protected against a solid object greater than 1.0mm |
|  | **5** | Dust Protected. Prevents ingress of dust sufficient to cause harm |
|  | **6** | Dust tight. No ingress of dust. |

## 2nd Digit - LIQUID
Degree of protection against water

| | | |
|---|---|---|
|  | **1** | Protected against vertically falling water drops |
|  | **2** | Protected against vertical water drops when enclosure tilted up to 15 degree angle |
|  | **3** | Protected against spraying water from up to a 60 degree angle |
|  | **4** | Protected against splashing water |
|  | **5** | Protected against water jets |
|  | **6** | Protected against powerful water jets |
|  | **7** | Protected against the effects of temporary immersion in water between 15cm and 1m for 30 minutes |
|  | **8** | Protected against the effects of continuous immersion in water under conditions agreed between manufacturer and user |
|  | **9K** | Protected against close-range high pressure, high temperature spray downs |

### Example

# IP67

Dust tight. No ingress of dust. Protected against effects of temporary submersion in water.

One important note, a pressure wash rating such as IP66 or IP69K is independent from an immersion protection rating such as IP67. Because the protection needs are not identical, it is possible for a device to pass IP69K and fail IP67. Look for devices that reference both types of rating for the best protection.

If you are planning on mounting the relay in a battery box or other protected location a relay at IP65 or better is probably enough. If you are mounting on the frame rail or in an exposed position, look for IP67 and IP69K.

### Corrosion Protection

Metal bodied relays are more susceptible to corrosion issues and no more rugged than modern plastic bodied relays. However, the most common point of corrosion is galvanic corrosion on terminals (think big green fuzzballs). This is usually a reaction between the copper and tin commonly used on relay terminals and ring terminals with hardware plated with zinc (usually galvanized steel hardware). It is best to use stainless steel hardware (both nuts and lock washers), as this minimizes the possibility of galvanic corrosion no matter the combination plating on the ring terminals and studs on the relay. Silver plated terminals are less susceptible to galvanic corrosion but are susceptible to oxidation and acid environment corrosion, but are still best with stainless steel hardware.

### Auxiliary Circuits

Many relays offer a secondary switching, usually significantly lower current rating than the main circuit (usually less than 10A). These can be used to confirm change of status or to operate an isolated signal. If confirmation of status is the intent, it is important to understand if the signal of the auxiliary circuit is tied to the closure of the relay or if it is turned on via a different method.

### Mounting Format

There are many different formats for relays and all of them have advantages and disadvantages, it is important than when picking a format make sure that the relay will physically fit in the location you want to put it and the location of the terminals for both power and the coil will allow the routing of the correct size wires. Check to make sure that your bend radius of the wires to access the terminals in the application is acceptable according to proper practice. Look at the actual location of the relay on the vehicle, are there any issues that will interfere with the wires? Make sure that the terminals of the relay are robust enough to support the wire that you will use. Consult an amperage vs. distance chart to select the correct size cable for the application current and cable run distance.

## Applications

### Battery Disconnect Relay

Battery disconnect relays give certain advantages over a traditional manual disconnect switches.

- By placing the relay close to the battery, you can minimize expensive high current cable. A manual disconnect switch needs to run high current cable to an access point for the operator. With a relay you can put a low current switch in the cab, or where to operator can easily reach it to turn off the power.
- A disconnect relay can have an integrated timer. That way the disconnect takes place automatically at a set time after the ignition switch is turned off saving batteries and protecting the vehicle.
- Battery disconnect relays are usually Bi-Stable, so they don't consume coil power while they are switched on. They are also usually optimized for low loses and have limited full power cycles because most of their cycles are usually at very low or 0 power draw. Disconnect relays are usually sized to have a continuous duty rating above the rating of the vehicle alternator. The in-rush current ratings should be sized to withstand cold starting events as well as a short circuit event for the batteries.

### Motor Loads

Due to the inductive nature of motors, motor loads are one of the most aggressive loads for wear on relays. The in-rush that takes place to build the magnetic fields in a DC motor or capacitive load in the inverter, an AC motor creates a significant amount of arcing on the contacts. When selecting a relay for these applications you may want to calculate some leeway in the rating versus the continuous draw of the motor to absorb the initial in-rush. Relays for this application typically are monostable as they are left on only as long as the motor is running, and they are usually a heavy-duty relay due to wear and tear to the contacts.

### Power Distribution Modules

In power distribution it is most common to see a variety of automotive plug in relays but sometimes a main disconnect relay can get designed in to a custom PDM.

### Combiners & Low Voltage Disconnects

Combiners are relays that are specifically adapted for use in dual battery systems. They incorporate special features that allow them connect an auxiliary battery to the main starting battery when the engine is running and charging and isolate it to protect the starting battery when the engine is off. LVDs are similar to combiners in that they sense voltage and connect and disconnect based on voltage. The difference is that the combiner is used bi-directionally (power runs both ways) and the voltages cut off points are usually significantly different. Typically, a combiner is programmed to cut off as soon as the engine turns off (~12.7V for a 12V system) while an LVD will let the battery go much lower in the same system (11V-12V) to allow you to power loads after the engine is off.

For more information, visit
Littelfuse.com/cvp-relays