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The Guide to Solid State and Electromechanical Relays

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The Guide to Solid State and Electromechanical Relays

Relays have been a critical part of electrical machine operation since the beginning of electrical control systems. Since engineers and technicians work with these devices on a daily basis, it's important to understand how they work, how to troubleshoot them, and how to examine the proper parameters when it comes to relay selection.

Relays are most often found within the confines of electrical control cabinets and mounted to printed circuit boards, but their effects can be seen down to the individual field device level of virtually every machine. Packaging and processing equipment, robot controllers, hydraulic and pneumatic systems, and many motor and motion controls make use of some kind of relay.

Our team has compiled this relay ebook in partnership with contributions from our friends at Carlo Gavazzi, a leader in the field of solid state and electromechanical control devices. Carlo Gavazzi generously provided devices for physical bench tests and product images for a wide range of relay applications. The content is exclusively written and edited by our own engineering and editorial team at Control.com, and we hope that you will find the content to be practical as you continue your journey of understanding electrical control systems.

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CONTENT

The industrial relay has been an essential component of virtually all industrial electrical control systems since its invention nearly two centuries ago. Although they have a long history, the implementation of relays continues to be challenging for many engineers, due in part to the multiple purposes for which the devices are used but also because of complementary technologies that are found inside, driving the devices to their end tasks.

Introduction to Industrial Relays

The electromechanical relay(s) is one of the oldest components found in control systems. Although the size and shape of relays have evolved over the decades, the basic device remains the same. Relays consist of a set of input voltage terminals that energize a coil, and this energy, in turn, activates a set of output contacts to control a load device. Since the input voltage passes its status off to a separate contact voltage, this 'handing off' of one circuit to another provides the basis for the name relay, just as it applies to handing off the baton between runners in a relay race.

Although they are found inside virtually all modern control cabinets, there are only a couple of main tasks performed by these switching devices.

Historically, one of the primary purposes of a relay has been to execute sequential logical functions in vast interlocked networks. This task has been slowly replaced by digital programmable logic controllers (PLCs), but these relay control systems can still be commonly found, usually as an emergency backup for a modern controller.

The second function of a relay is to amplify voltage and current to drive load devices that consume enough power to damage sensitive electronics inside a digital controller. This job continues to be a powerful application of relays and is expected to continue being an essential part of the control system architecture well into the future.

Relays for Control Logic Functions

The first function of the relay is to provide an interconnection between discrete (on/off) circuit devices to build logic gates and complex sequences, allowing various combinations of input devices to drive output machinery following very specific logical steps. The first forms of ladder schematics were built from these circuits of sequential relay logic, and later, these ladder schematics were adopted for digital logic controllers.

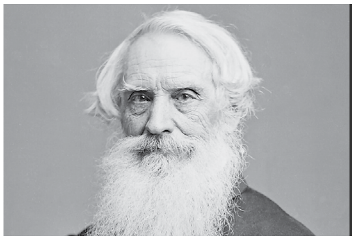
Relays come in both electromechanical and solid state varieties, each with advantages for various applications.

Relays for Power Amplification

The second main purpose for installing relays is to amplify and isolate the smaller voltage control circuits from the large voltages and currents driving larger industrial load devices.

Control circuits, including switches, pushbuttons, and digital controller modules, are kept at a low voltage to ensure operator safety and minimize space in small printed circuit boards.

Larger voltages require more physical space between wires to reduce the risk of sparks from arcing. The coil operates at smaller, safer voltage levels, leaving the contacts to permit the flow of current at much higher voltage levels.



Did you know?

The first official patent for a relay device was in 1840 by Samuel Morse as a way to amplify a signal for long-distance telegraph communication.

Relay Anatomy: The Input and Output

There are two sides to every relay, regardless of its function. The input side is often called the ‘coil’ because, in the original electromechanical world, the input is a literal electromagnetic coil of wire. The output side is called the ‘contact’ because electromechanical arms would move to make or break electrical contact with the output circuit.

In today’s technology world, there are two distinct types of relays, each built for unique purposes: the electromechanical and the solid state relay. Each type provides a few distinct advantages, with every machine design resting on which characteristics are most desirable for the current operation.

Comparing Electromechanical and Solid State Relays

The basic operational nature of the relay is the same, regardless of whether it’s electromechanical or solid state. A control voltage is applied to the ‘coil’ side of the device, and once energized, the output circuit is triggered to turn on or off the load device. In an electromechanical relay(s), this is accomplished via one or more physical moving contacts, but in a solid state relay, the output circuit is energized via a semiconductor switch with no moving parts. This switch is usually a TRIAC or SCR for AC loads, but a FET or IGBT for DC loads.

A typical solid state relay, also known as a 'hockey puck' style

Operating Theory

The electromechanical relay uses a coil of wire to generate a magnetic field. This is the familiar concept of induction, in which a current flowing through a coil of wire generates the magnetic field that attracts or repels ferrous metal. Inside a relay, this magnetic attraction pulls a metal arm against a spring, toggling it between two positions, on or off, as the relay is energized.

The input of a solid state relay energizes an internal infrared LED with an appropriate current-limiting resistor integrated inside. The light from the LED energizes a photo-responsive transistor or diode on the contact side, providing complete electrical isolation from input to output.

Control Coil Voltage Ratings

The electromechanical relay uses a specifically rated AC or DC voltage for the coil input. The coil voltage can vary from 3.3 V in small computer circuits up to 24 V in a DC relay, while it may range from 24 to 120 V, or even higher, in AC control circuits. Each relay coil operates with a single voltage only. To use two control voltages at the same time, you must use two separate models of relay.

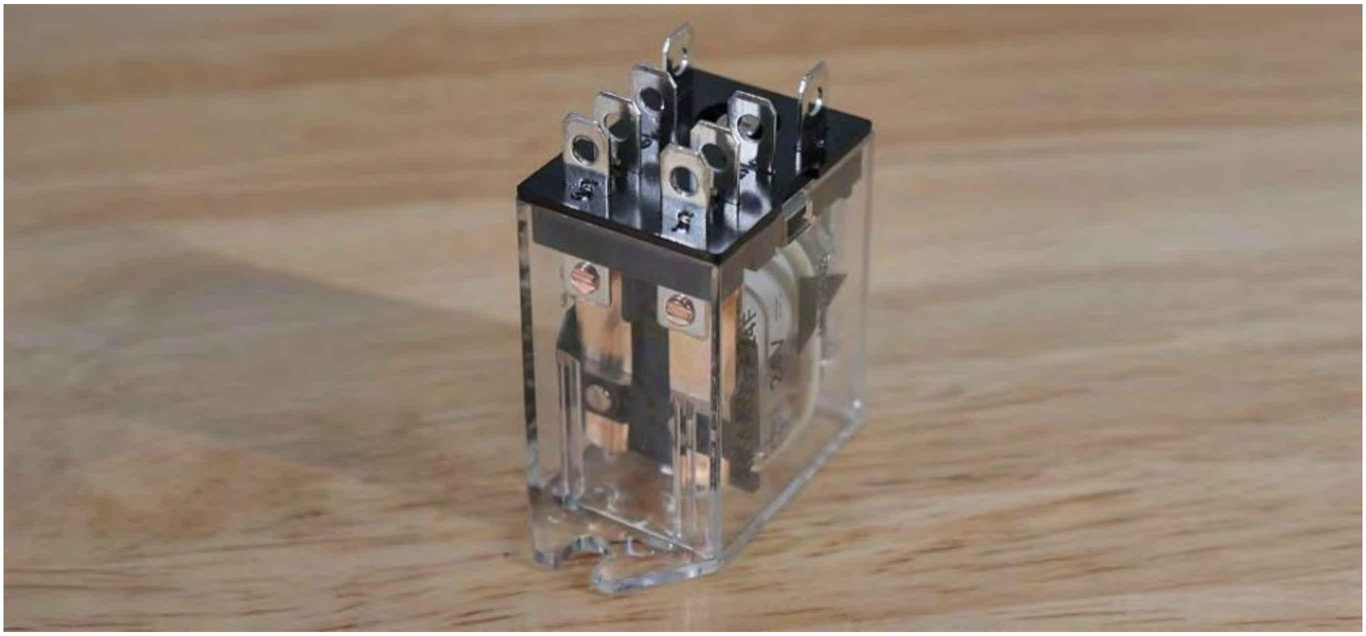
The solid state relay accepts DC inputs, usually with a wide range of voltage. Anywhere from 3 to 32 V is a common range, and a single solid state relay may be installed for any control voltage within this range. Some solid state relays use AC inputs with control voltages ranging from 24 up to 230 V.

Output Contacts (Poles and Throws)

The electromechanical relay always includes one or more sets of physical contacts that open or close with an audible 'click' as the magnetic field is applied from the coil.

The most common arrangement is for each contact set to include a common terminal (COM) and separate terminals for a normally open (NO), as well as a normally closed (NC) output.

This relay form factor that includes the COM, NO, and NC terminals is referred to as 'double-throw'. There may be one, two, three, or four contact sets (called poles), but other variations can be found. These variations lead to naming conventions such as single-pole double-throw (SPDT) or double-pole double-throw (DPDT).



The two copper tabs on this flange-mount electromechanical relay reveal the construction of a double-pole (DP) relay model.

The solid state relay does not have physical contact sets, only a transistor variant, either a silicon-controlled rectifier (SCR) or a TRIAC, which is a switching device designed for AC current. Most solid state relays only include one single contact set, and this contact usually contains one single NO circuit. In contrast to the double-throw of a electromechanical relay, this arrangement consists only of a single pole with a single throw, abbreviated as 'SPST.' Most solid state relays only have one set of contacts, and it is very rare to see anything other than normally open formats. For this reason, solid state relays don't adopt the the pole and throw naming convention of their electromechanical counterparts, with datasheets simply stating the number of output contacts.

Contact Voltage Limits of Electromechanical Relays

electromechanical relays are constructed like switches, so they can handle either AC or DC with ease. Care must be taken to never exceed maximum voltage ratings, or dangerous arcs can occur. For each voltage, only certain current limits may be used to prevent dangerous energy releases upon closing and opening.

Solid state relays do not have the problem with arcs jumping over an open contact like the electromechanical types. Solid state relays can also be damaged when subjected to excessive current. Since SSRs use semiconductors, there is never a complete disconnection of the load, and a small leakage current will always be present even if the switch is turned off. Likewise, there is always some power dissipation when the switch is turned on, and this generates heat. For lowest heat dissipation, try and find the SSR with the lowest rated leakage current and on-state resistance.

Load Circuit Polarity of Solid State Relays

An important fact about the solid state relay construction is that on the output side, it may consist of either a high-power field-effect transistor (FET), an insulated gate bipolar transistor (IGBT), a silicon controlled rectifier (SCR) or a TRIAC. FETs and IGBTs are used to switch DC loads, but any AC relay relies on SCRs or TRIACs for switching. Either device may be switched using photo-sensitive components, but each has a specific purpose.

A bit of knowledge about the semiconductor devices can reveal how these solid state relays actually work. The FET is a switch created to allow a large DC current to pass when the switch is energized by a small DC voltage. These FETs are used in solid state relays that activate DC load circuits. The TRIAC or SCR, while still energized by a small DC or AC control voltage, is designed to pass one or both halves of an AC waveform through the load circuit, so these relays will properly activate and deactivate an AC load.

If using a solid state relay, look at the contact side and pay attention to the voltage, the current, and also the important point of either AC or DC load switching.

An array of solid state relays, each one with input/output capabilities and remote diagnostic monitoring.

Electromechanical and solid state relays are all designed with one goal in mind: the input voltage activates the output contacts. The methods by which they operate are very different; therefore, one may be superior to the other for certain scenarios.

Advantages of Electromechanical Relays

Although solid state relays use much more modern technology and have replaced the older electromechanical models for controlling some load devices, **there are many reasons why the** electromechanical relay **may be the proper choice for an application, including:**

- Multiple contact sets
- Mixed load voltages
- Lower contact resistance
- In-circuit testing ability
- Lower up-front cost

Multiple Contact Sets

Electromechanical relays are commonly found with two or more sets of contacts. This is useful when energizing multiple loads or when the relay must be installed in a seal-in (latching) circuit, where one contact set energizes the load and a second set keeps the relay energized for a longer duration. Most electromechanical relay product families contain variants with up to four contact sets, but some specialty devices can contain even more. In contrast, most solid state relays are limited to activating just one load circuit.

Two variations of 4-pole relays, as shown by the diagrams printed on the plastic cases.

Multiple Load Voltages in One Control

Another side benefit of these multiple contacts is that load devices with different operating voltages can be controlled with the same relay. For example, a single switch may be meant to control both a 24 V indicator light and a 120 V motor; a single DPDT relay can handle this task with ease.

For both logic and load operation, it is often just as critical to determine when an input circuit is switched off, such as a motor power indicator. A light may be illuminated when the relay is de-energized, indicating the motor is shut off. Each set of contacts in a typical electromechanical relay contains both a NO and NC contact. Solid state relays only rely on NO contacts since the job is to activate a load device when energized, never to deactivate the load. When a relay can toggle between both an NC and NO position, we call this a Form C relay.

Occasionally, relay contact sets will be "single throw," which means that they only contain the NO (Form A) or the NC (Form B) contact, but not both. Be aware of this when purchasing relays; always check datasheets for specific part numbers before assuming that all electromechanical relays are created alike.

Lower Electromechanical Contact Resistance

In a electromechanical relay, the contacts have lower resistance when turned on, usually around 0.05 Ω. For example, a load circuit carrying 10 A would only lose about 0.5 V and dissipate about 5 watts across the relay contact. Although any inefficiency is undesirable, that value is inconsequential in this high-power circuit.

The power dissipation in solid state relays is a result of the semiconductor devices, usually around 0.7 to 1 volt. This leads to about 1 watt of power for each amp in the load circuit. Some SSRs can be found with even higher voltage drops, up to 5 volts per amp, leading to higher power dissipations. Consult the documentation to find a graph of power vs. load current, or a listed on-state resistance value.

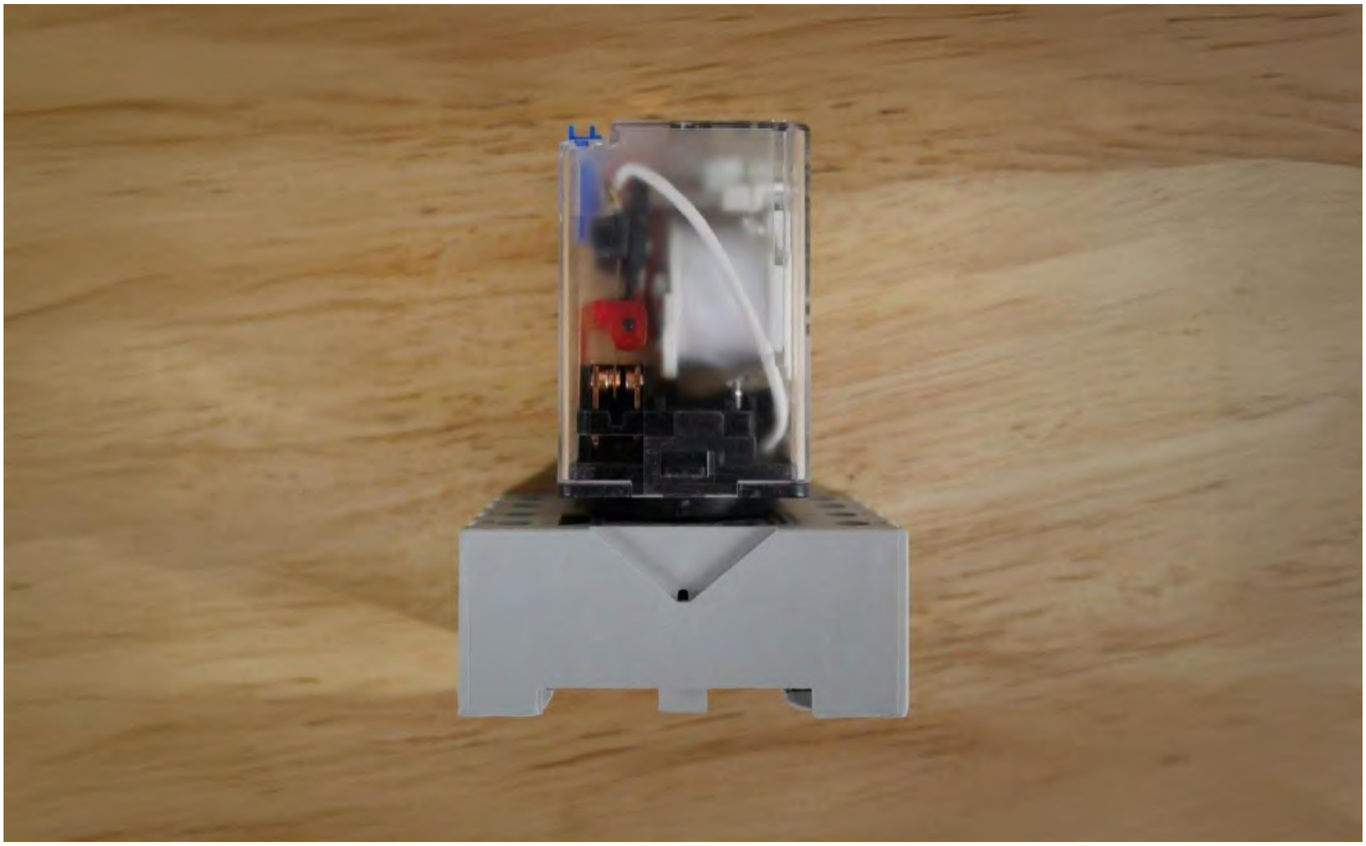
Because of this power dissipation, the backside of a general solid state relay has a metal baseplate, meant to be interfaced with a heatsink to remove the extra energy. Thermal protection for solid state relays is a significant challenge, with many products including charts and user-friendly tools that can be used to select the proper heatsink or devices that include an integrated heatsink for protection.

SSRs can be mounted directly to heatsinks with a thermal grease or thermal pad to maximize heat transfer.

In-Circuit Testing

A fourth major advantage that electromechanical relays hold is the ability to, in some cases, test them easily while still in the circuit. Troubleshooting usually requires isolation or removal of the component and a bench setup to verify operation.

Many relay models have a switch on the top that allows the technician to switch the contacts on and off, even with no power to the coil. This switch can instantly isolate problems to either the input or output side, never requiring a single wire to be removed.



A DPDT relay, which includes a blue test switch at the top, allowing manual toggling between the NO and NC contacts, which can be seen through the transparent side casing.

Even without the integrated test switch, many industrial models mount directly into a DIN rail socket, allowing for easy removal, testing, and replacement without wire removal. Changing wires can lead to other problems, including improper torquing and stripping of screw terminals, so it's always preferred to leave wires firmly connected while troubleshooting or replacing components.

Troubleshooting fact:

While many relays use LEDs to indicate the energized state, some models instead use a colored plastic tab that appears when the relay coil is energized. This tab provides a visual status without consuming extra control power.

Lower Cost

Finally, another benefit of electromechanical relays is a lower relative cost. Although energy savings are desirable, the cost difference between devices can be upwards of $10 or $20, with the solid state relays costing more.

Advantages of Solid state Relays

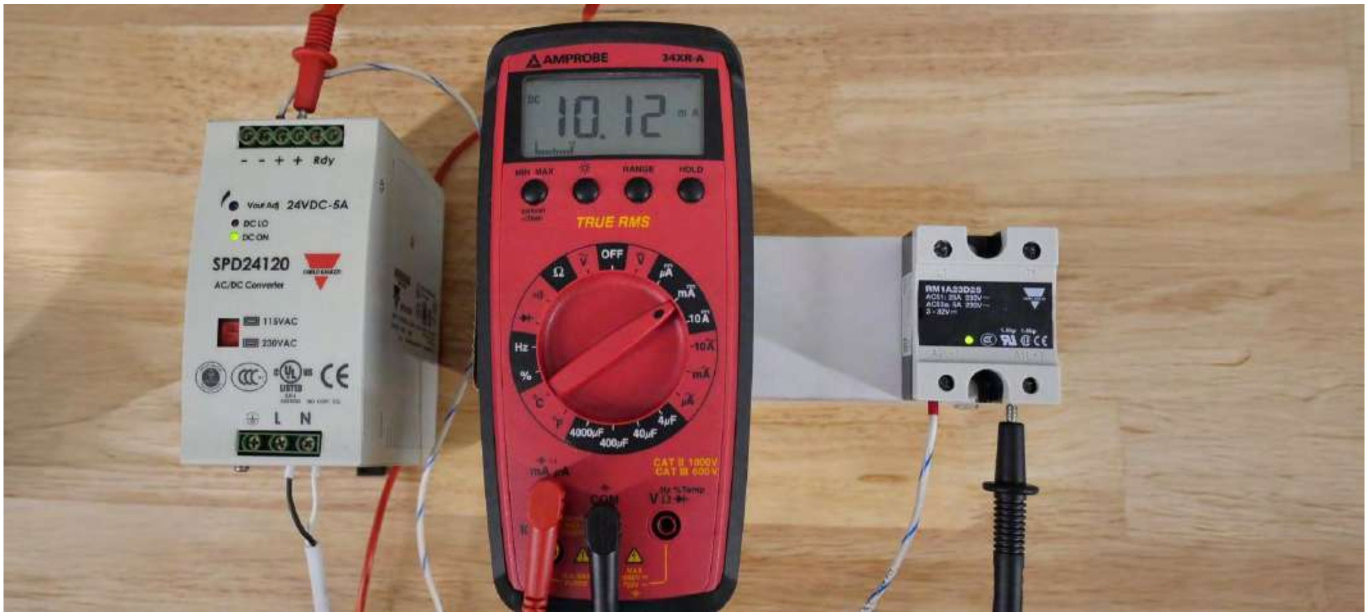
All modern electrical control systems have been greatly enhanced by the invention of solid state (semiconductor) technology like diodes, transistors, and thyristors. For large load devices like heaters and motors, solid state relays that use these technologies can be a huge advantage over traditional electromechanical relays.

The solid state relays are not designed to be a drop-in replacement for electromechanical relays in all cases. There are, however, a few key advantages that might tip the scales in favor of the choice of solid state for control of a load device, including:

- Lower power consumption
- Longer lifespan
- Faster switching speed
- Purely resistive input
- Higher dielectric strength

Lower Power Consumption

The first of these factors that encourage the use of solid state controls is the lower power consumption required to energize them. The activation of a solid state relay is the internal LED with an integrated current limiting resistor, so the entire control circuit only uses a few milliamps.



A bench test with a solid state relay shows a current input of just over 10 mA at 24 volts, which leads to 240 mW of power consumption and an input resistance of 2.4 kΩ.

During a bench test, when a standard industrial 24 V supply and ammeter are connected to a Carlo Gavazzi solid state relay, the input power is measured to be about 240 mW (~10 mA). By comparison, a electromechanical relay with a 24 V coil consumes about 1.3 W of power (~54 mA), more than 5x equivalent solid state relays.

A bench test with an equivalent electromechanical relay shows a current input of roughly 54 mA at 24 volts, which leads to 1.3 W of power consumption and an equivalent coil resistance of 444 Ω.

Longer Lifespan

The next major benefit to using solid state relays is the long lifespan. Since they contain no moving components, there is no electromechanical fatigue failure like there would be in electromechanical devices. This leads to a longer life and lower replacement cost, especially when they are switched at a higher frequency.

A standard solid state relay has a nearly unlimited lifespan when used properly, with millions of hours of use. No bench apparatus can really be devised to verify this rating.

In comparison, a electromechanical relay's lifespan is based on the number of switching cycles it is rated to perform. The datasheet for a particular 24 V relay states an electrical lifespan of 100,000 minimum switches at a rate of 1800 switches per hour (one switch every 2 seconds). At this rate, the lifespan would be less than 60 hours. However, a relay is rarely asked to operate at its maximum switch rate for a sustained time, so the actual lifespan would almost certainly be longer than 60 hours.

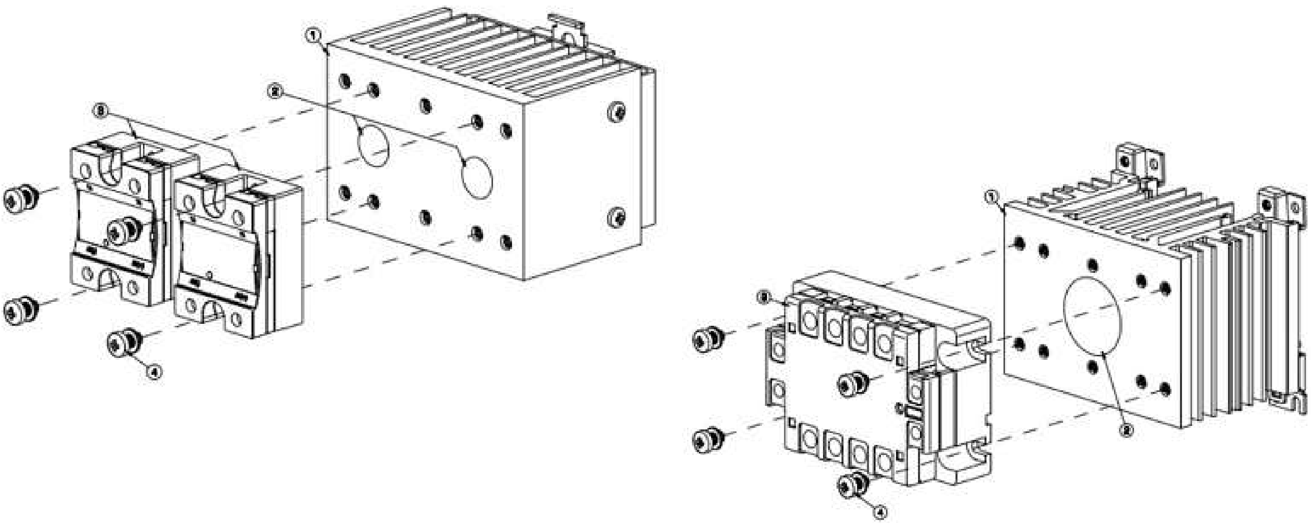
Solid state relay with an in-line PCB mounting style.

Faster Switching Speed

A third major advantage is the extremely fast switching speed. electromechanical relays are limited in speed, or switch frequency, because of the time it takes to switch contacts open and closed. With no moving parts, the solid state relay is faster.

When powering DC loads, this fast switch speed can be used to change duty cycles and send pulse width modulation (PWM) signals to large load devices. When powering DC loads, this fast switch speed can be used to change duty cycles and send pulse width modulation (PWM) signals to large load devices. The rating for the Carlo Gavazzi RM1D solid state relay has an allowable PWM frequency of over 1 kHz (1000 switches per second). It is important to note that a higher duty cycle and higher switching frequency will derate the current. That is, the maximum allowable current must be decreased according to the curve listed on the relay datasheet.

In contrast, a typical electromechanical 24 V relay has an absolute maximum possible switching rate of about 20,000 switches per hour, even less if the electrical load is near the max rating. This is equivalent to only around 5 Hz. At this slow switching rate, it is impossible to maintain precise control over the average voltage sent to the load device.



Large load currents require the use of heat sinks which are attached to relays with mounting screws, available in various configurations

Heightened Value of Dielectric Strength

The fourth benefit of the solid state relay is the heightened value of dielectric strength or resistance to arcing between the input control and output contacts.

One of the reasons for using a relay as opposed to a high-current transistor is that there is absolute isolation between two input and two output terminals. This isolation means the control device will be completely unaffected if a large voltage surge affects the load terminals.

A solid state relay may have a resistance to potential voltages as high as 4,000 or 5,000 volts. However, a electromechanical relay may only have a dielectric strength to resist voltages up to 2,000 or 3,000 volts. Although this may seem like an unreasonably high voltage, inductive devices like motors can generate reverse voltages many times higher than their operating voltages when de-energized.

Resistive Input

Finally, a fifth and final appeal of solid state devices is that the input is purely resistive, as opposed to the inductive loading of the electromechanical relay. Coil-based devices that operate using magnetic fields suffer from a reverse generation of voltage, often called ‘flyback’ or ‘freewheeling,’ when the control voltage is suddenly removed. This large voltage can be fatal to sensitive controls and cause arcing.

Did you know?

While the flyback voltage is often damaging to control circuits, it's not always bad. When a coil is charged by a battery from a distributor and then discharged, that flyback voltage creates a spark across a sparkplug, allowing your car engine to operate!

Fortunately, the solution to inductive flyback is fairly simple, usually as easy as connecting a diode in reverse polarity in parallel with the coil. So, the problem is by no means unsolvable, and it may not always present an argument strong enough to dictate the exclusive use of solid state relays.

Small diode modules are available for most relay sockets. Some relays even contain integrated diodes for protection.

Solid state relays are the preferred option when very precise high-speed switching is desired for just one single load device. They are efficient and have a long operational life, making them ideal devices for those operating circumstances.

Relay Terminal Numbering

Wiring relays can be a difficult challenge, even for experienced electricians. Determining the screw terminal locations of the common, NO, and NC terminals, as well as the coil, is difficult at best. Add in the various sizes, single- vs double-pole configurations, and the best you can hope is that a drop-in replacement is readily available on the supply shelf.

Industrial control relays are primarily produced under the National Electrical Manufacturers Association (NEMA) and International Electrotechnical Commission (IEC) standards, which means you might see relays with one or the other, but often both number conventions side by side.

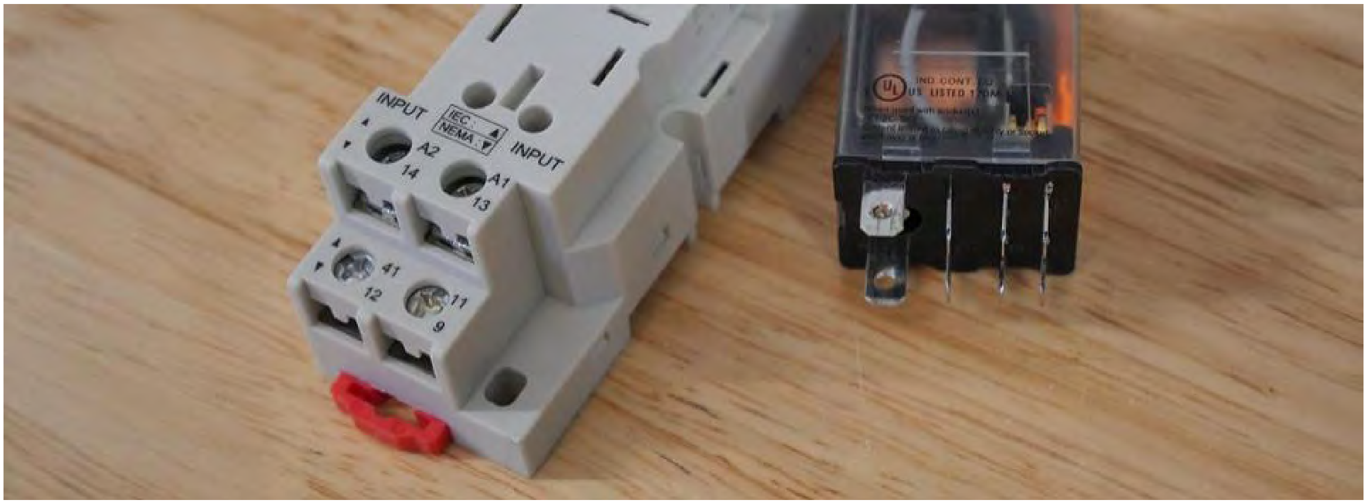
NEMA Relay Wiring Numbers

NEMA Ice Cube

Under NEMA standards, the terminal numbers are labeled 1-14 for the largest relays with four contact sets, terminal numbers 1-4 indicate the NC terminals. 5-8 indicate the NO terminals. 9-12 are the common leg terminals to supply voltage on a dry contact. Finally, terminals 13 and 14 always indicate the coil in the NEMA convention.

Since you are more likely to encounter a relay somewhat smaller than the 4PDT size, the numbers for a smaller DPDT will include some, but not all, of these 14 numbers. The DPDT arrangement includes 8 terminals, 1-5-9 indicating the first contact set, then 4-8-12 for the second contact set, and finally, 13 and 14 for the coil.

As an example, suppose you needed to connect a circuit to an NO set of contacts. You should expect to use terminals 5 and 9 or, alternatively, 8 and 12.



A DPDT relay socket with dual NEMA and IEC numbers.

For an NC connection, the choice would be 1 and 9, or 4 and 12.

Moving on to the smallest relays, we should expect an SPDT relay to have only terminals listed 1-5-9 plus 13-14. From the preceding description, it is now clear to see what each number represents.

NEMA Octal Base

A slight variation occurs in the NEMA convention for the circular keyed base with eight pins. For these relays, the numbers 1-8 orbit the base. Pins 2-7 connect to the coil, with 1, 3, and 4 being the first set of contacts (common, NO, and NC in that order) and the second set being 8, 6, and 5 (common, NO, and NC in that order).

Some of these circular base relays have 11 pins, indicating three sets of contacts (3PDT), and the numbering style for the contact sets follows the same pattern.

3PDT relay with 11 pins.

IEC Relay Wiring Numbers

The IEC numbers can be used more flexibly, and are therefore often found on relays with more than four poles.

Under this convention, terminals are always two-digit values, and both digits should be interpreted separately. The first digit identifies the set of contacts (or 'poles'), starting with 1. So any contact numbered 1x, such as 11, 12, or 13, must be a part of the first contact set.

The second digit identifies the function of the terminal, with four possible options as follows:

1 = Common for the NC contact, or for the common of a double-throw

2 = The NC terminal

3 = Common for the NO contact. Omitted in a double-throw contact set.

4 = the NO contact

The coil terminals are unique, as they are designated **A1** and **A2**, so they are not confused with output contacts.

A DPDT octal relay with socket numbers showing both NEMA and IEC standards.

IEC Double Throw (xPDT) Relays

According to this IEC convention, for the first contact set the common terminal would be labeled 11 (or, as might be more appropriate, we could say “one one”), the NC would read 12 (or “one two”), and the NO would read 14 (“one four”).

If there was a second contact set, the ordered numbers would be 21, 22, and 24. For the large 4PDT model, the numbers would end with the final set being 41, 42, and 44.

IEC Single Throw (xPST) Relays

Many multi-pole, single-throw relays, including auxiliary relays on motor contactors, contain a mix of both NO and NC contact sets.

Let us consider, for example, a 6PST relay, in which we should expect to find individual terminal numbers for contact sets 1 through 6.

Imagine that the first two terminals are labeled 13 and 14. The leading 1's indicate this is the first contact set. The 3 indicates the common terminal for the NO contact. The 4 indicates the NO contact terminal.

However, if we were to continue wiring and find contact set 5 consisting of terminals 51 and 52, we again reference the number key, and we would interpret this to be an NC contact set.

Specialty Industrial Relays

The concept of the industrial relay has, thus far, been quite simple at its foundation: to allow one circuit to complete another circuit. The importance of this concept is paramount in so many applications, but there are a few devices in which a special feature is included to enhance the standard relay operation. There are many of these special-purpose relays in existence, with a few standouts on the list. We'll investigate these standouts and what makes them so important in the world of control engineering.

Timer Relay / Time-Delay Relay

Due to the advent of PLCs with built-in timing functionality, the use of timer relays has diminished. These relays do still, however, appear in some installations where a PLC is overkill.

The timer relay, usually designated as an on-delay (TON) or off-delay (TOF) type, allows the input signal to affect the output, but not immediately. Timers are a great solution for either delaying when a load device turns on or delaying when the load device turns off.

A selection of timer and time-delay relay devices.

Proportional Output (SCR Control) Relay

In highly sensitive thermal processes, such as semiconductor wafer processing, PWM control may not provide sufficient regulation to maintain temperatures within specific setpoints. Whenever a thyristor based SSR control circuit is turned OFF, the thyristor will only turn OFF once the current waveform passes the zero-point. This results in a switching delay up to half a mains cycle. This is not an issue for most processes, but it may still give rise to some temperature deviation that can be critical to specific processes. Phase angle switching regulates the output of the SSR at every half mains cycle using an analog input control. This allows for the finest switching resolution and more precise temperature control.

The relays that capitalize on this control strategy must use some sort of variable input, most often an analog control signal. Common industrial analog signals are 4-20 mA, 0-10 V, or 0-5 V. These signals can be sourced from a controller or a physical analog device like a potentiometer.

These solid state relays make use of analog input controls for variable power loads, like a heater oran infrared lamp.

Monitoring Relay with Fieldbus Communication

While the function of a relay has remained fairly steady over the years, networking technologies allow us to get more data about field-level devices like relays. Some of the critical data we can gain from devices include the current, voltage, and power being delivered to the load, total energy consumption over time, as well as any faults and alarms from the devices. With this diagnostic and monitoring information on a network, downtime can be kept to a minimum, and future problems may be prevented by understanding the machine's performance (this is called preventive maintenance).

A fieldbus adapter and a bank of relay modules that can be linked as part of a monitoring and diagnostic relay network.

Contactor Relay

A robust version of the control relay that will not disappear anytime soon is the contactor, a main component of the motor starter for basic motor control circuits.

The contactor has a low-voltage coil, or at least lower than most motor (load) voltages. The coils may be powered from a typical 24 V control circuit, but they may be as high as 230 VAC. Since they are designed for three-phase motor load operation, there are three main NO contacts, with one or more additional auxiliary contacts which are used by the control circuit to verify proper operation.

Contactors can also be outfitted with diodes to prevent flyback, as well as safety overloads and additional auxiliary contacts for a highly modular motor-driving circuit.

Contactors are usually larger than their control relay counterparts.

Three-phase loads can also be controlled with solid state relays that are designed with three poles and the input terminal set, just like a electromechanical contactor.

Three-phase solid state relays with load and control terminals.

Which Relay is Best?

Each type of relay is built for a specific purpose, so we cannot generalize and state which relay is superior in all circumstances. There certainly are simple, cost-effective solutions for many scenarios, but the wrong choice of relay can result in risk to operators and equipment. A little research and knowledge can go a long way.

If you are unsure of the proper relay choice, be sure to consult subject matter experts during the design phase of equipment to be sure that you are making the proper selections of coils, contacts, thermal management, and any additional features that can make your design live up to reliable use far into the future.

Conclusion

Relays used for amplification or control are most likely to be a permanent fixture through the future of automation systems. Between solid state and electromechanical relays, plus the variety of special-purpose relays, there is a device that fits nearly every use case.

We would like to express our thanks once again to Carlo Gavazzi for the generous input of knowledge, time, materials, and images to create this valuable educational resource. We hope you are equipped with a newfound understanding of these devices that 'hand off' a small control voltage to the larger load voltage, ready to tackle an endless possibility of machine control system designs.

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The Guide to Solid State and Electromechanical Relays

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