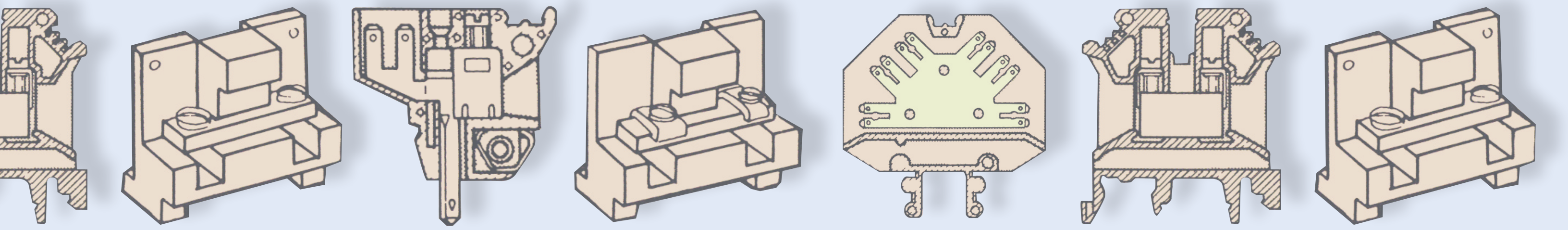

Basics of
Industrial connectivity

Industrial connectivity includes any component that is in the path of delivering power or control signals to do useful work. Typical connectivity components include connectors and terminal blocks, motor starters and relays.

Industrial connectors are divided into four categories based on operating environments: commercial, industrial, military, and hermetic. In commercial applications, outside temperatures and atmospheric conditions are the least critical facors affecting performance. Generic connectors merely maintain electrical continuity, allowing use of low-cost materials. Industrial connectors are devised to handle more rugged environments encompassing hazards that include thermal shock, corrosion, vibration, physical jarring, and sand and dust.

Designers can select from a number of different connector materials:

BRASS: Brass has excellent conductivity but cannot withstand many insertion and withdrawal cycles. Brass loses flexibility as it ages, and under repeated stress experiences crystallization, which significantly lowers conductivity. It is suited for noncritical, low-contact-force applications, and is easily crimped, soldered, welded, and brazed.

BERYLLIUM COPPER: Beryllium copper has excellent mechanical, electrical, and thermal properties and resists corrosion and wear. It is the best electrical conductor of any spring alloy of comparable hardness. Beryllium copper is stronger, more resistant to fatigue, and withstands more insertion and withdrawal cycles than any other copper-base spring alloy. But it is the most expensive of the basic contact materials.

NICKEL-SILVER ALLOYS: Nickel-silver alloys resist oxidation and do not always require plating. Nickel-silver is susceptible to stress corrosion, although not to the extent of brass.

GOLD: Gold is an excellent conductor and a highly stable plating material. It has the lowest contact resistance and provides the best protection from corrosion. Hard gold platings are recommended for contacts that experience frequent insertion/withdrawal cycles. For even greater cycling, gold can be impregnated with graphite with a minimal increase of contact resistance.

GOLD-OVER-SILVER: Gold-over-silver underplating is good for dry-circuit (millivolt, milliampere range) applications because it provides low contact resistance. But because its corrosion resistance is only moderate, the use of this combination is limited.

GOLD-OVER-NICKEL: Gold-over-nickel is a widely used plating combination because it provides the surface qualities of gold, while the hard underplating of nickel prevents migration of the base metal and minimizes the amount of gold required.

SILVER: Silver is a general-purpose plating for power contacts. However, shelf life is poor and silver tarnishes when exposed to the atmosphere, increasing contact resistance. Although this oxide coating is undesirable in low-level circuits, it does not affect contacts carrying higher currents.

NICKEL: Nickel has good corrosion resistance, fair conductivity, and is generally used as an undercoat for high-temperature environments to prevent migration of silver through gold. Nickel has good wear resistance, but it may crack during crimping if not properly plated onto the base metal.

Contents

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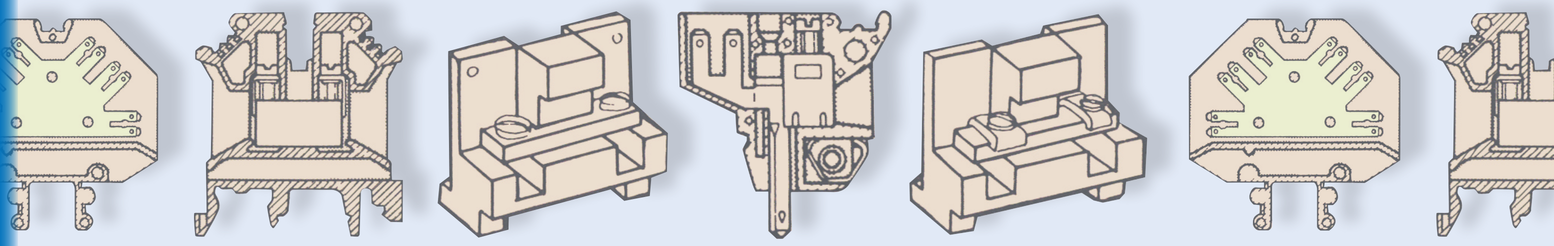


RHODIUM: Rhodium is used for its exceptional wear qualities. It has a lower conductivity than gold or silver, but on thin platings this higher resistance is acceptable.

TIN: Tin has good conductivity and excellent solderability. It is a low-cost finish with poor wipe resistance best suited for connections requiring very few mating cycles. Tin is not a noble metal and will corrode.

Rhodium-over-nickel provides maximum wear resistance and is suitable for high-temperature operation. However, this combination has higher contact resistance than other platings.

Terminal blocks

Terminal blocks require no wire preparation except stripping and are easily installed with a screwdriver. They accept a wide range of awg wire sizes, provide ready hookup of wires from different components, and ensure fast disconnection/reconnection during maintenance and troubleshooting.

Terminal bodies often are made from a copper alloy that has the same expansion coefficient as wire. This prevents loosening between metals with different thermal expansion rates and lower contact resistance. Corrosion, normally caused by electrolytic action between two different metals, is also eliminated.

There are two basic styles of terminal blocks, European (DIN) and North American. European terminal blocks are physically smaller than North American blocks having the same voltage and current ratings. And unlike hardware made in North America, all mounting hardware for European terminal blocks follows standard DIN format. Blocks from one vendor can be installed on rails from another.

Terminal blocks in the North American style generally are vendor specific. Blocks and rail hardware from one manufacturer usually do not work with equipment from others.

Another difference between North American and European blocks is in connection techniques. European wire terminations follow what is called a dead-front configuration. Termination hardware is recessed within the plastic block housing, isolating electrically live parts. Maintenance personnel can touch live blocks with minimal chance of shock or electrocution. North American blocks employ a more open design.

The simplest terminal blocks, called electrical blocks, merely join wires or cables. These devices accept wire sizes ranging from about 12 awg to 500 mcm with a maximum voltage rating of 600 V. The blocks either snap into a metal rail or are screw mounted on the panel of the control enclosure.

There are three styles of DIN rails: C (also called G or asymmetric), flat (also called symmetric), and mini rail. Flat and C rails are used in systems rated to 600 V. Terminal blocks on mini rails handle voltages to 300 V.

Special terminal blocks combine simple terminations with other functions found in the control panel, such as fusing and disconnects. Fusible terminal blocks are widely used and generally contain ferrule fuses rated at 3 to 5 A, although some devices contain up to 30-A fuses. Special terminal blocks may also incorporate circuits that perform visual annunciation, surge suppression, and voltage regulation.

Another type of terminal block is often called an electronic block. These devices typically work with smaller wire sizes common to electronic applications, 30 to 14 awg at 300 V or less. The blocks generally mount and solder onto printed-circuit boards. They transmit power or control signals to circuit components through solder pins that are mechanically connected to the clamping body.

Several wire entry angles and numerous pole and pin configurations are available. In addition, these devices can be obtained in two-tier versions. Two-tier blocks contain two sets of connection terminals stacked on top of each other, saving board space. The wire entries on the two-tier blocks are offset or staggered so that screwdriver access is facilitated to the lower tier, even if the upper tier is fully wired.

Special terminal blocks have been developed to provide a transition between discrete wiring of power devices to low-signal cables or controller connectors. The most common transition is to ribbon cables using IDC connections, or to D-subminiature connectors, or DIN harness assemblies.

Terminal block manufacturers now offer special housings that can hold small printed-circuit boards. These boards, in turn, can be connected to the block terminations. The configuration allows end users to define special functions on the terminal staff.

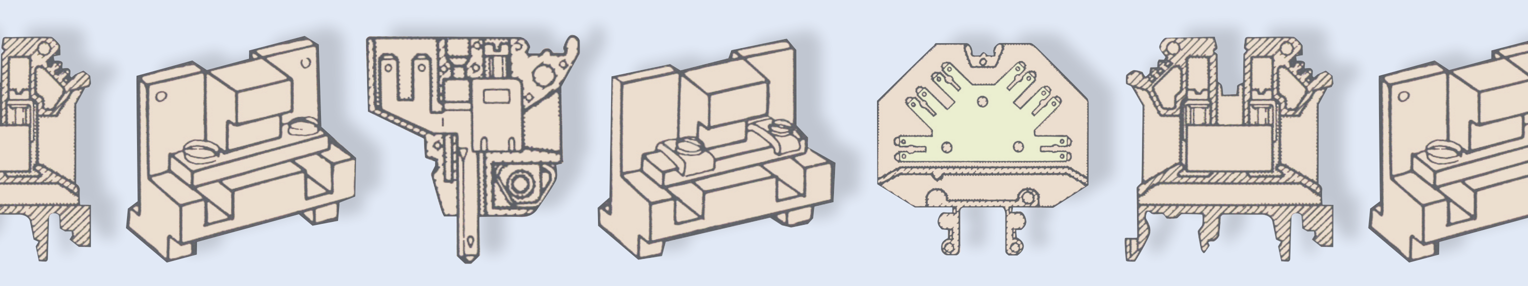
Creepage and clearance are terminal block distances that determine voltage ratings. Creepage is the path between terminals measured along the surface of the insulation. Clearance is the shortest through-air distance between terminals and from terminals to ground.

Accessories for terminal blocks include jumper straps for connecting adjoining contacts; channel clamps for holding sections in mounting channels; transparent plastic covers for protecting conductive parts while permitting inspection of the contacts and marking areas; and sectional fanning strips for connecting and disconnecting groups of wires.

Relays and contactors

Solid-state relays (SSRs) control load currents through use of solid-state switches such as triacs, SCRs, or power transistors. These elements are controlled by input signals coupled to the switching devices through isolation mechanisms such as transformers, reed relays, or optoisolators. Some solid-state relays also incorporate snubber circuits or zero-crossing detectors to reduce spikes and transients generated by load-current interruptions. Since semiconductor switches can dissipate significant amounts of power, solid-state relays must generally be heat sinked to minimize operating temperature. Typical SSR applications are those where rapid on/off cycling would quickly wear out conventional electromechanical relays. General-purpose SSRs have on/off cycle lifetimes as high as 100,000 actuations. SSRs that can be actuated with conventional CMOS and TTL logic-level voltages are available.

The chief failure mechanism of an SSR is mechanical



fatigue in the power semiconductor structure caused by thermal cycling. However, thermal-cycling effects can be controlled by matching the required load-cycling qualities to the relay. Heat sinks for most conditions are available or are a part of the SSR.

Relays open and close electrical contacts to operate other devices. They are often used because they cost less than corresponding electronic switches. But some inherent relay qualities are superior to those of solid-state devices, as well. For example, input and output circuits in relays are electrically isolated, unlike those in most solid-state devices. And relays can have numerous contacts electrically isolated one from another. In addition, electromechanical relays are becoming smaller, now available in PCB-mount and surface-mount packages that are suitable for automated soldering.

Another advantage of electromechanical relays over solid-state switches is that relays have much lower contact resistance. Contact capacitance is also less, which may benefit high-frequency circuits. Relays are less likely to be turned on by transients than are solid-state switches. And relays are less easily damaged by brief shorts or overloads.

Electromechanical relays differ in other important ways from solid-state switches. First, relay coils are highly inductive, and the inductance value is not constant. Inductance is low immediately after energization and rises as current approaches a steady-state level and the relay armature closes. In contrast, solid-state switches have mainly resistive inputs and a constant input current.

Second, relays have a much longer switching time than solid-state switches. Coil inductance is the primary cause, but the mass of armature and contact structures are also factors.

Third, relay coil inductance can produce unacceptably high-voltage transients when the device is de-energized. Protective circuits can reduce the transients to an acceptable level, but they delay relay drop-out as well.

Relays also can be a source of EMI. Arcs at the contacts, for example, are produced when a contact bounces on energization and when contacts open on de-energization. Transients produced by deenergizing the coil are another source. EMI can be severe when switching inductive loads at high current and voltage levels.

REED RELAYS: A reed relay consists of reed switches within an operating coil. The reeds can be any type of configuration, but the quantity is limited by the coil size. Most manufacturers limit coil size to handle 12 standard switches, maximum. To obtain additional contacts, relay coils are connected in parallel. Reed relays are available with contact forms from 1A to 12A, 1B to 8B, 1C to 4C, and combinations of these up to the maximum coil size. Coils may be wound with each magnet-wire size to create a large selection of operating parameters.

Reed-relay contacts typically produce 1 to 3 Vpp at 20 to 30 kHz. The voltage, which is produced by magnetostriction, generally decays about 3 msec after contact closure. Miniature reed relays in six-lead DIP and surface-mount packages are used for PC-board applications or wherever space is a constraint. Sensitive relays with coil pickup as low as 1.6 Vdc at 40 mW are available.

MERCURY-WETTED CONTACT RELAYS: Basically, a mercury-wetted contact relay consists of one or more glass switch capsules surrounded by a coil. These relays maintain their original resistance to within 1 mΩ throughout their lives. When two contacts wetted with mercury join, the area of contact between the surfaces is somewhat large because a fillet of mercury surrounds the mated surfaces. When the two surfaces are separated, the mercury stretches into a thin filament and then breaks at two points that isolate a thin rod of mercury in the middle. The thin and rod then snaps into a ball and drops to the bottom of the switch.

Mercury loss from the contacts disturbs the equilibrium of the capillary system, and more mercury is fed up the armature from the pool. Thus, in effect, the mercury-wetted contact relay provides a new contact surface for each closure.

ARMATURE RELAYS: Armature relays have pivoting armatures that actuate electrical contacts in response to small control signals.

AC RELAYS: Alternating current is widely available but is the least flexible power source for relay operation. However, most ac relays designed for 120-Vac line operation tolerate line fluctuations from 102 to 132 Vac. Most ac applications are for 60-Hz current. Telephone relays operate on 20-Hz current but are similar in construction. For 400-Hz current, as found in aircraft, a radical departure from the 60-Hz relay construction is necessary. Reliable performance is attained by rectifying the 400-Hz ac to dc and using a dc relay motor.

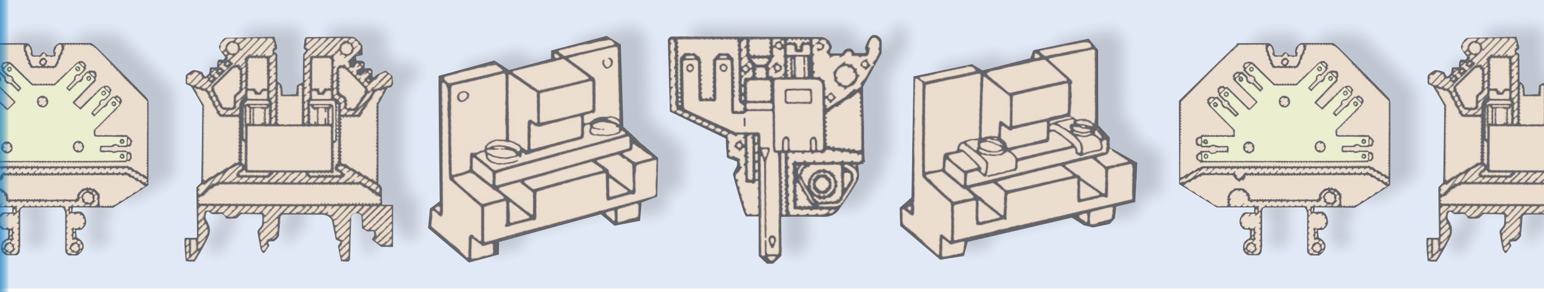
DC RELAYS: Relays operated on direct current have inherently greater mechanical life expectancy than ac relays. The most frequent source of dc is rectified ac. Often ac ripple influences relay operation. Some dc relays can tolerate ripple, others need filtering. When the power source is a rechargeable battery, voltage variations of 25% are possible. Relays are usually designed to operate at 75% of nominal voltage. Coils are designed not to overheat at 125% of pickup voltage.

PCB-mounted relays are generally armature devices. Typical devices are either spdt or dpdt and contain contacts rated at 0.5 A to 2 A. Typical operating voltages are 5 to 24 Vdc and 120 Vac. Power dissipation is in the range of 75 to 400 mW. These units are often available in sealed versions that can be immersion-cleaned during assembly.

RELAY STANDARDS: NEMA Class A and B relays are specified in the publication, **Industrial Control**, ICS-1970. These relays control and interlock starters, contactors, and other devices. Relay contacts are also used to open and close circuits to other relays and pilot devices. Relays do not control power-consuming devices, except motors and solenoids drawing under 2 A.

Many manufacturers use MIL-R-5757 as a standard and as a guide for producing government-acceptable relays. This specification covers relays with contacts capable of switching loads up to 10 A. In general, MIL-R-6106 covers and exceeds the requirements of MIL-R-5757. It also covers relays capable of switching currents in excess of 10 A.

CONTACTORS: Contactors are devices for repeatedly establishing and interrupting electric power circuits. Two types of contactors are defined by NEMA — electronic and



magnetic. Electromagnetic contactors are actuated by electromechanical means. They make and break power circuits to such loads as electric furnaces, lights, transformers, capacitors, heaters, and — when overload relays or inherent protectors are used — motors.

The magnet design of an ac contactor consists of a stationary core and a movable armature, as in NEMA-A and B control relays. Some contactors have a horizontal design; others have a hinged or pivoted clapper magnet. Coils are available in voltages up to 600 V, commonly in 110, 220, 240, 380, 440, 480, and 500 V for 25, 50, and 60 Hz.

A dc contactor operates like an ac contactor. However, while an ac magnet is laminated steel, a dc magnet is made of solid steel.

Because copper contacts are used on some contactors, the current rating for each size is an 8-hr open rating -- the contactor must be operated at least once every 8 hr to prevent copper oxide from forming on the tips and causing excessive contact heating. For contactors with silver to silver-alloy contacts, the 8-hr rating is equivalent to a continuous rating. This rating also applies to contactors mounted in the open without enclosures. Contactors installed in enclosures have a rating equal to 90% of the open rating because of reduced contactor cooling.

METER RELAYS: Meter relays provide an analog or digital panel indication of a measured variable together with a switching function at a preset level. There are four types of analog meter relays: magnetic contact, locking coil, optical, and solid state. These meters can be employed with the user's control circuitry, with a control module option, or with control circuitry contained in the meter.

Motor starters

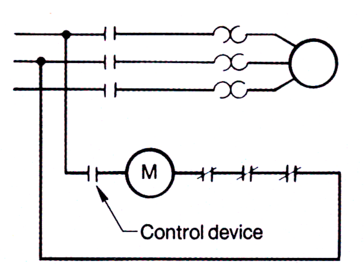
Single-speed squirrel-cage induction motors have starters that fall into two categories: full-voltage or across-the-line starters; and reduced-voltage starters.

Full-voltage starters (manual and magnetic) apply full voltage directly to motor terminals. Two other types, combination and reversing starters, consist of a starter, usually magnetic, with

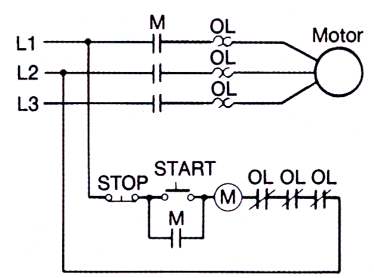
MOTOR STARTERS

For small motors, the usual means of start-up is through a manual starter that makes and breaks the motor circuit. This method is sometimes called direct-on-line start. A thermal protective circuit in the starter opens and de-energizes the motor if it gets too hot. Manual starters are generally limited to single-phase motors up to 5 hp at 230 V and three-phase motors up to 15 hp at 600 V.

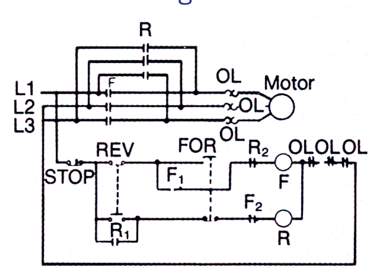
Two-wire control



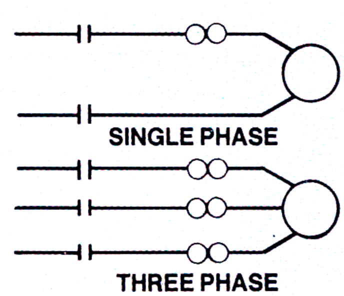
Three-wire control



Reversing starters



Manual starter



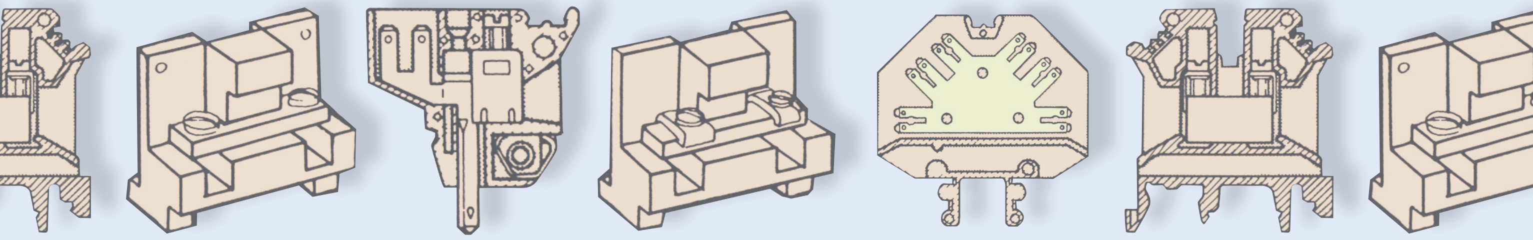
A magnetic starter contains a mechanism for opening and closing a set of contacts in the motor circuit and a thermal overload protective device. When the coil is energized, movable contacts complete the electrical circuit. De-energizing the coil opens the circuit. Magnetic starters are frequently controlled by pushbutton, limit switches, relays, timers, pressure switches, and float switches.

A magnetic starter combined with a disconnecting means is generally referred to as a combination starter. The disconnect can be a motor circuit switch, with or without fuses, or a circuit breaker.

One problem with all these methods is that they all produce a high motor starting current. A normal value is between 6 to 7 times the rated motor current but some motors can see values of up to 9 or 10 times the rated current. The values depend on the design and size of the motor, but in general, a smaller motor sees higher values than a larger one.

A characteristic of a three-phase squirrel-cage motor is that the direction of rotation can be changed by reversing any two power leads. This is done in reversing starters by adding another contactor and appropriate mechanical and electrical interlocking equipment to a basic starter.

A soft starter makes use of the fact that when the motor voltage is low during start, the starting current and starting torque is also low. Gradually, the voltage and the torque increase. This gradual increase is accomplished through use of semiconductor switches (usually thyristors) in the starter. A slow start is easier on internal motor components and also is more forgiving to driven machinery such as belts and gear drives. Another feature of the soft starter is a soft stop function, useful when stopping conveyor belts or pumps that might otherwise cause water hammering in a pipe system at direct stop.



added functions.

Some machines or loads may require a gentle start and smooth acceleration up to full speed. In addition to load demands, power company regulations may limit the current surge or voltage fluctuation that can be imposed on the power supply during motor starting. Variable-speed motor drives can provide such soft-start capabilities, but in some cases these controls can be overkill. This is particularly true when there is no energy efficiency advantage to be gained by running the motor at below rated speed. Here, basic motor starters can handle soft starts. Many starters apply reduced voltage to motor windings; primary resistor, primary reactor, autotransformer, and solid state. Part winding and wye-delta starters can also provide reduced-voltage starting, although technically they are not reduced-voltage starters.

Motor windings in multispeed squirrel-cage motors may require special starters. Starters for separate-winding two-speed motors consist of two standard three-pole starter units that are electrically and mechanically interlocked and mounted in a single enclosure. Additional units can be used for each speed. Although these are always electrically interlocked, it may not be practical to provide mechanical interlocks on more than two starters.

The starter for a consequent-pole two-speed motor requires a three-pole unit and a five-pole unit. The design of the particular motor winding determines whether the fast- or slow-speed connection is made by the five-pole unit.

For three-speed consequent-pole motors, a three-pole starter is used for the single-speed winding; a five-pole starter and a second three-pole starter handle the reconnectable winding. A four-speed consequent-pole motor requires two sets of three- and five-pole starters.

Different power circuits are needed for delta-type multispeed motors, because currents circulate within the inactive or unconnected windings. A pair of four-pole starters is required for a two-speed motor with separate open-delta windings. Another four-pole starter is required for each speed. Thus, three- and four-speed motors with open-delta windings require very complex starters.

Specific winding information is used to select the motor controls. Torque characteristics also deserve special attention to ensure selection of the proper control. Constant-horsepower motors require larger starters than either constant-torque or variable-torque motors of equal horsepower. Reversing and reduced-voltage operations can be incorporated in a multispeed motor starter.

Self-protecting starters (SPSs) were first introduced to the U.S. in the 1980s. A self-protected starter combines contactor, overload, and short-circuit protection in one package. It is sized according to motor load current and horsepower. Generally, a small interchangeable module protects against both thermal and magnetic overload. The self-protected starter can be used in single or multiple installations and satisfies Article 430 of the National Electric Code (NEC), which addresses the safe installation of motors, circuits, and controllers.

Power-control equipment comprises motor control, overload and short-circuit protection, and isolation. Before SPSs, these functions were handled by motor starter (contactor plus overload relay) wired to either fuses or circuit breakers. Depending on the use, location, and control sophistication required, three options were available for group or multiple motor installations. The first choice was a NEMA-rated starter. It was selected by a particular size classification that was suitable for switching motors and other kinds of loads such as capacitor banks. The second was an IEC (International Electrotechnical Commission—European Standard) starter rated by horsepower. The third choice was a horsepower-rated definite-purpose starter.

To add to the complexity, there are over six different classifications available for fuses, including H, J, K, RK, RK-1, and 5. Furthermore, short-circuit protection must be coordinated with the overload relay and the contactor to protect personnel and equipment. To ensure coordinated protection, an engineer must determine the available fault current, the corresponding fuse class, and the need for a single or dual-element device.

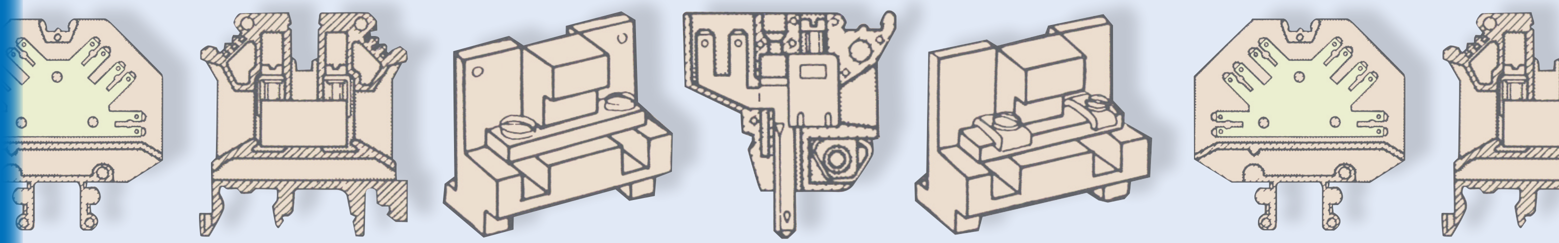
Choices for circuit breakers include thermal-magnetic, magnetic-only, solid-state, current-limiting, and standard or high interrupt capacity units. Thermal-magnetic devices were originally designed to protect wiring between circuit breakers and motors, according to code. But they frequently had to be oversized to handle high inrush current upon start-up. The magnetic-only circuit breaker was designed to protect motors, not wire. Thus, this device provides protection more in line with the overload relay and contactor ratings.

Solid-state circuit breakers are more commonly used on motors above 100 hp for economy. Special fuses used for motor protection have built-in time delays called dual-element time-delay fuses. It is a common practice to oversize short-circuit protection for fuses or breakers. This cuts down on frequent nuisance blowing or tripping. Even the NEC allows oversizing within prescribed limits.

Self-protected starters are sized for the horsepower and full-load current of the motor. A typical inrush current to start a motor is six to eight times normal running current. Some high-efficiency motors have inrush currents of eight to 10 times their running current. SPS devices eliminate nuisance tripping with adjustable protection of two types. First, adjustable overload protection for full-load current is provided. In any case, the overload setting should not be greater than the actual full-load current. Second, a magnetic-only trip coil, which is adjustable from six to 12 times full load, compensates for a variety of inrush currents.

When sizing motors, service factor rating is a necessary consideration. Most U.S.-made motors have a service life of 1.15, meaning they will handle 115% of normal running current indefinitely without damage. A service factor of 1.0 indicates the motor will tolerate nameplate running current only. This type of motor is being used more frequently, and needs overload protection that trips faster than the traditional Class 20 overload relay.

Class 10 overloads (trips within 10 sec at six times full-load motor current) for small motors work well with a 1.0 or 1.15 service factor. Some special applications with over 5 sec start-up times can cause early tripping.



TERMINAL BLOCK CONTACTS

Quick-connect contacts consist of a simple tab or flat blade designed to take a push-on connector installed on the end of the wire. Such a connector is a force-fit metal sleeve which is pushed over the tab. This type of contact is commonly used for awg 12 and smaller wires.

Tubular contacts consist of a length of metal tubing, rectangular in cross section, with a screw threaded through the top and sides of the tube at each end. Where the flat bottom of the screw is used to provide the pressure on the inserted wire, the contact is often called a tubular screw contact. Where a flat pressure plate is used under the screw, the contact is called a tubular clamp contact. Preferably, the clamp should be held captive to the screw. Clamp contacts are mainly used with fine stranded wires.

Feed-through contacts have studs through the mounting surface. These contacts are used where the wire leads must pass through a wall directly under the block or as close to the side of it as possible. Wires are connected as with strap-screw or stud contacts.

Two-part plug-in dead-front connectors can provide position interlocking for shock and vibration. Socket-mating springs on quality connectors may provide as many as seven points of contact on posts. Use of beryllium-copper wire protectors makes the connectors applicable to both single and fine-stranded wire termination. Special flush-mount designs are available to minimize the stress on board solder joints that happens when screw terminals are tightened.

A strap-clamp contact consists of a screw through each end of a flat strap, with a wire-clamping element under the screw head to exert pressure on the wire. Here again, bare wire is inserted in the pressure contact.

A strap-screw contact consists of a screw through each end of the connector strap. A wire is attached to the contact either with a ring or spade lug or by simply looping the wire around the screw and tightening it down.

A fuse block contains a fuse in series with the circuit. A typical unit has a contact as each end of the section, as do standard blocks. A clip connected to each contact accepts a cartridge-fuse plug, which facilitates fuse changing and provides each circuit identification.

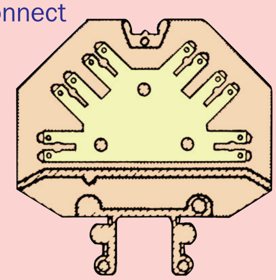
One-piece blocks incorporate one or more circuits, and contacts are mounted between barriers or in plain rigid insulating members. This type may have open barriers for easy contact accessibility or closed barriers (dad front) for contact protection. It is usually available in standard units 2, 4, 6, 8, or 12 circuits in a single base.

Short-circuit blocks are similar to one-piece blocks. By connecting a short-circuiting screw into a shorting strip, current may be shunted or directed to any desired circuit.

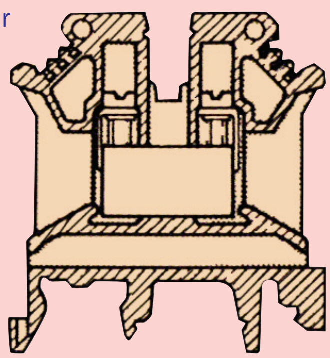
Section blocks consist of individual molded units with contacts. When assembled together with an end barrier, these units can make up a block with nearly any desired number of circuits. Assembly of sectional terminal blocks consists of snapping off or adding groups of contact sections, depending on the number of circuits in the preassembled lengths. The addition of an end piece completes the terminal block.

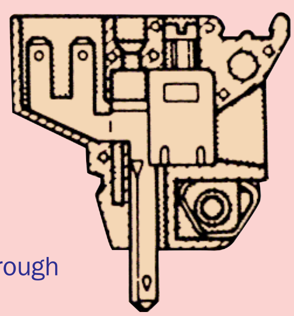
Interface blocks typically connect discrete wiring from power devices to cables from

Quick-connect



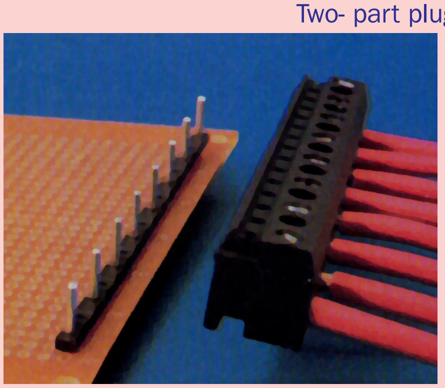
Tubular

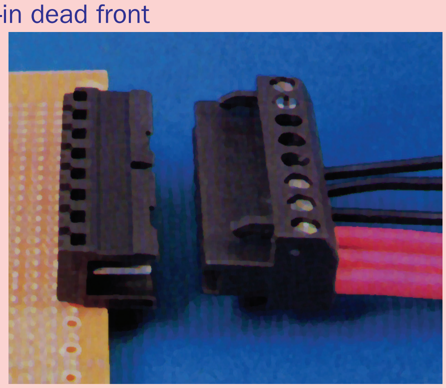


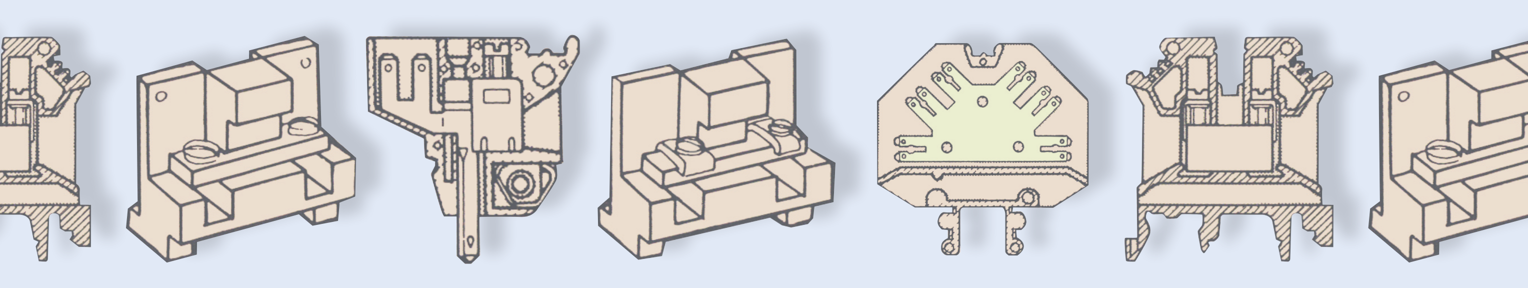


Feed-through

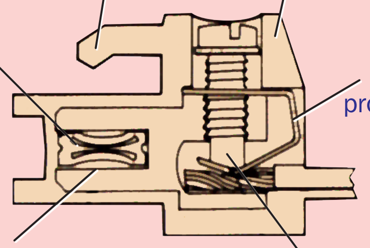
Two- part plug-in dead front







Terminal block contacts ... continued

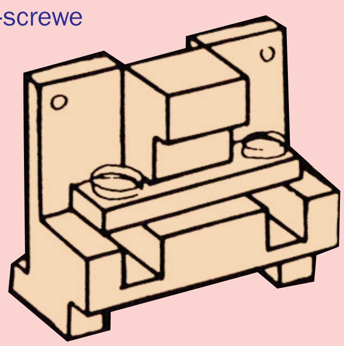


low-signal devices such as microcomputers. Dead-front wire terminals recess live metal connector parts in the plastic housing for safety. Two-tier configurations reduce the block side. Typical cable connections include those for flat ribbon, insulation displacement, D-Sub, and DIN connection headers.

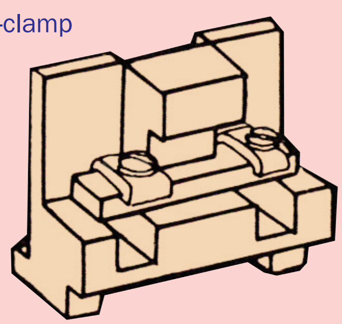
PCB blocks contain pins which are soldered directly to printed-circuit boards. These blocks have up to 12 awg capacity and typically come with a 10-A, 300-V UL/CSA rating. Terminals are designed to protect solder joints and tracks from breaking. These terminals are modular, may incorporate fuse block, or double-level blocks, and provide metric and decimal-pin spacing. Another common feature is a high-precision interlocking mechanism.

Switch blocks incorporate a means of isolating or disconnecting circuits. The block contains a knife-blade switch element, operated by an insulating handle attached to the blade.

Strap-screwe



Strap-clamp



At full locked-rotor current, the Class 10 overload relay trips in 10 sec or less, protecting motors without creating nuisance tripping. Relays do not trip because most motors reach full operating speed in less than 5 sec. This is particularly important with the trend toward smaller motors with short start-up times. Another advantage is that overload adjustments can be sealed or locked to prevent tampering.

Another factor to consider is phase imbalance during brownouts or phase loss. In the event one phase drops out in IEC devices like SPSs, there is a 57% increase in current across the other phases. Time is a critical factor in protecting motors from thermal damage, so these devices contain a differential bar that increases the speed at which the overload trips. This reduces the likelihood of motor damage or burnout.

For complicated installations using PLCs or similar controls, it is best to make sure the starter can handle accessories such as shunt trips and auxiliary contacts. If field upgrades and expansions are expected later, it is also wise to make sure that spare parts will be available and that installed units can accept accessories. For example, it is easier to add auxiliary contacts to a fusible switch in the field than to add a circuit breaker which must be factory installed.

PLC power interfacing

Communication or dialog with automated systems is an important feature of any control device. In most systems, this responsibility has typically been left to a programmable logic controller (PLC). Screw-in modules enable self-protected starters to both receive controls signals from PLCs and transmit status on trip conditions or signal normal operation. The SPS can also receive direct control signals from proximity, photoelectric, limit, or pushbutton switches.

In fully automated systems, an additional communication function enables the device to be reset from a remote panel or central control location. A shunt-trip enables tripping by external commands.

SPS starters can cut installation time by 33% compared with the time needed to mount NEMA-style starters. Self-protected starters are DIN rail mounted, which eliminates installation of additional protection components such as fuses and circuit breakers. And using SPSs in multiple motor-starter applications can reduce installation time as much as 80%.

The operational design of SPSs provides a clear visual indication of contact operation and trip status. A visual indicator on the face of the device confirms that the unit is operating. In overloads, the handle rotates to a trip position. In a short circuit, the device provides an additional optical indication of the trip.

Auxiliary contacts can provide PLCs with feedback from three independent signals: contactor status , short-circuit status, and overload status. PLCs can then trigger alarms in the event of trips.

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