STD.NEMA ICS 2 PART 8-ENGL 1998 6470247 0518448 658

NEMA STANDARDS PUBLICATION

ICS 2, PART 8

INDUSTRIAL CONTROL AND SYSTEMS CONTROLLERS, CONTACTORS, AND OVERLOAD RELAYS RATED NOT MORE THAN 2000 VOLTS AC OR 750 VOLTS DC

PART 8: DISCONNECT DEVICES FOR USE IN INDUSTRIAL CONTROL EQUIPMENT



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NEMA Standards Publication ICS 2-1996

INDUSTRIAL CONTROL AND SYSTEMS
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RATED NOT MORE THAN 2000 VOLTS AC OR 750 VOLTS DC

PART 8: DISCONNECT DEVICES FOR USE IN INDUSTRIAL CONTROL EQUIPMENT

Published by

National Electrical Manufacturers Association
1300 North 17th Street
Rosslyn, Virginia 22209

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Part 8
DISCONNECT DEVICES FOR USE IN INDUSTRIAL CONTROL EQUIPMENT

1 GENERAL

1.1 Scope

The standards in this part cover AC motor-circuit switches rated 600 volts used in industrial control equipment. Also included are separable or accessory operating mechanisms and handles for the external operation of motor-circuit switches, circuit breakers, and molded-case switches. The devices covered by this standard are for application in combination starters, motor control centers, and industrial control panels. See Figure 8-1-1. Excluded are the operating mechanisms that are an internal or integral part of motor-circuit switches, circuit breakers, or molded-case switches.

Horsepower-rated switches mounted separately in their own enclosures, commonly called "safety" or "enclosed switches" or "miscellaneous "switches," are not included in the scope of this standard. Although ANSI/NFPA 70 (NEC) permits devices not rated in horsepower, such as circuit breakers, molded-case switches, general-use switches, and snap switches to serve as the disconnecting means in industrial control equipment under specified circumstances, such disconnecting means are not covered by this standard. Also excluded are manual motor controllers, pullout switches, and wiring devices rated in horsepower.

This standard does not address the suitablility of manual motor controllers intended for use as disconnecting means.

1.2 Application Basis

Disconnect devices should be applied by qualified persons in accordance with ANSI/NFPA 70 (NEC) and properly operated and maintained in accordance with the safety practices of ANSI/NFPA 70E (Electrical Safety Requirements for Employee Workplaces), and 29 CFR Part 1910.147 (OSHA lockout/tagout rules).

1.3 Normative References

The definitions and standards of NEMA Standards Publications ICS 1, ICS 6, KS 1, and AB 1 also apply to this part.

2 DEFINITIONS

For the purposes of this part, the following definitions apply:

available fault current: The maximum current that the power system can deliver through a given circuit point to any negligible-impedance short circuit applied at that point. Available fault current is also known as prospective current.

circuit breaker: A device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overcurrent, without injury to itself when properly applied within its rating. (NEMA AB 1)

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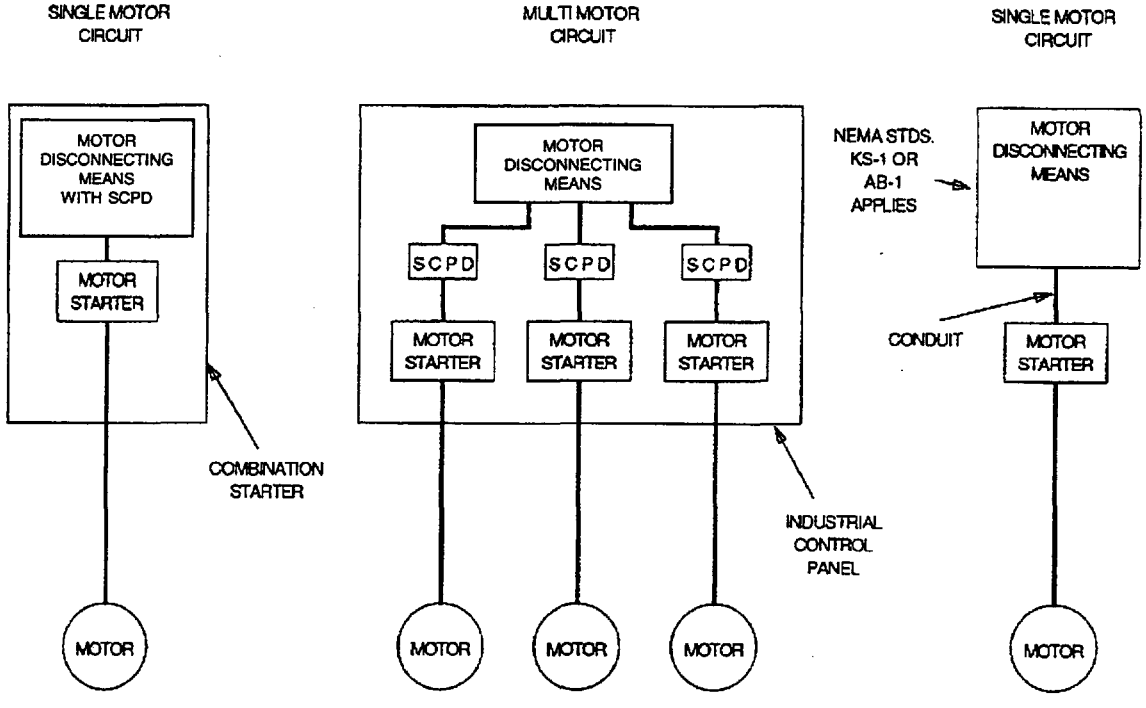


Figure 8-1-1
DISCONNECT DEVICES FOR MOTOR SERVICE

circuit breaker, instantaneous-trip: (Also called a motor circuit interrupter or motor circuit protector)—A circuit breaker intended to provide short circuit protection with no overload protection. Although acting instantaneously under short circuit conditions, instantaneous breakers are permitted to include a transient damping action to ride through initial motor transients. (NEMA AB1)

circuit breaker, inverse-time: A circuit breaker that operates instantaneously in response to a high fault current, and in a time period that is inversely proportional to current for overcurrents less than the instantaneous-trip current. (NEMA AB 1)

fuse: A protective device which opens by the melting of a current-sensitive element during specified overcurrent conditions. A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit. Fuses may be of the time-delay or nontime-delay type. (NEMA FU 1)

fuse, nontime-delay: A fuse that operates in a time period that is inversely proportional to the overcurrent it is carrying, without intentional time delay.

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fuse, time-delay: A fuse that operates in a time period that is inversely proportional to the overcurrent it is carrying, with an intentional time delay to permit motor acceleration.

independent manual operation: A stored energy operation of a mechanical switching device where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator.

molded-case switch: A switch that is assembled as an integral unit in a supporting and enclosing housing of insulating materials. A molded-case switch is generally constructed in a manner similar to a molded-case circuit breaker, but is marked to show that it does not provide overcurrent protection. See NEMA AB 3 and UL 1087.

motor-circuit switch: A switch, rated in horse-power, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage. (NEC)

rated insulation voltage: The voltage rating that determines the clearance and creepage distance required for the device and to which dielectric tests are referred.

short-circuit withstand rating: The maximum potential fault conditions under which a device that does not have a short-circuit interrupting rating may be installed in accordance with Sections 110-9 and 110-10 of ANSI/NFPA 70 (NEC). For a device that is not designed to interrupt short-circuit currents, the short-circuit withstand rating is expressed as maxi-mum available fault current, maximum nominal application voltage, and the designation of an associ-ated short-circuit protective device (SCPD) required for the rating. This designation includes the type or class of SCPD and its maximum current rating.

short-circuit interrupting rating: A rating based on the highest rms AC current that the short-circuit protective device (SCPD) is required to interrupt under conditions specified. For a SCPD, such as a circuit breaker, the short-circuit interrupting rating is expressed as maximum available fault current in rms symmetrical amperes and maximum nominal application voltage.

switch: A device, manually operated, unless otherwise designated, for opening or closing or for changing the connection of a circuit. (NEMA KS 1)

3 CLASSIFICATIONS

A disconnect device for use in industrial control equipment and its external operating handle may be classified by its:

a. type (motor-circuit switch, circuit breaker or molded-case switch)
b. number of poles
c. ratings
d. suitability for service entrance
e. suitability for specified enclosure types in accordance with ICS 6

4 CHARACTERISTICS AND RATINGS

4.1 Circuit Breaker Ratings

Voltage, current, and interrupting ratings of circuit breakers are established by NEMA AB 1.

4.2 Molded-Case Switch Ratings

Voltage, current, and withstand ratings of molded-case switches are established by NEMA AB 1.

4.3 Motor-Circuit Switch Ratings

4.3.1 Horsepower Ratings

Motor-circuit switches shall have ratings as specified in Table 8-4-1 and Table 8-4-2. These switches may be used with or without fuse holders.

These ratings are equivalent to the enclosed switch maximum horsepower ratings specified in KS 1. The continuous current rating of each switch is equal to, or greater than, 115 percent of the nominal motor full-load currents corresponding to its horsepower ratings. See Annex B.

4.3.2 Short-Circuit Withstand Rating

Each motor-circuit switch shall have a minimum short-circuit withstand rating of 10,000 amperes, rms symmetrical, at 600 volts AC. In addition, switches may have greater short-circuit withstand ratings.

For each short-circuit withstand rating, the type or class, and the voltage and current rating of the short-circuit protective device (SCPD), must be specified. The short-circuit withstand rating of a motor-circuit switch shall not be greater than the interrupting rating of the fuse used to establish the rating.

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Table 8-4-1
THREE-PHASE RATINGS OF MOTOR-CIRCUIT SWITCHES

Continuous Current Rating, Amperes	Fuseholder Sizes*, Amperes	Horsepower at 60 Hz				Associated NEMA Class A Controller Size
		200 V	230 V	460 V	575 V	
30	30 and 60	7.5	7.5	15	20	00 - 1
60	30, 60 and 100	15	15	30	50	2
100	100 and 200	25	30	60	75	3
200	200 and 400	50	60	125	150	4
400	400 and 800	100	125	250	350	5
400	600, 800, and 1200	150	200	400	500	6

* Switches with fuse holders having an ampere rating greater than the ampere rating of the switch are suitable for use only in motor branch circuits that include overload relays to protect the branch circuit conductors against overcurrent in accordance with their ampacity. The larger fuse sizes may be necessary to permit motors to accelerate to their rated speed.

Table 8-4-2
SINGLE-PHASE RATINGS OF MOTOR-CIRCUIT SWITCHES

Continuous Current Rating (Amperes)	Fuseholder Sizes*, (Amperes)	Horsepower at 60 Hz		Associated NEMA Class A Controller Size
		115 V	230 V	
30	30 and 60	2	3	00 - 1
60	30, 60 and 100	3	10	1P - 2
100	100 and 200	7.5	15	3
200	200 and 400	10	25	4

* Switches with fuse holders having an ampere rating greater than the ampere rating of the switch are suitable for use only in motor branch circuits that include overload relays to protect the branch circuit conductors against overcurrent in accordance with their ampacity. The larger fuse sizes may be necessary to permit motors to accelerate to their rated speed.

4.4 Rated Insulation Voltage

The rated insulation voltage of motor-circuit switches shall be 600 volts. The voltage rating of circuit breakers and molded-case switches shall be in accordance with NEMA AB 1.

5 PRODUCT MARKING, INSTALLATION, AND MAINTENANCE INFORMATION

5.1 Marking

The complete open disconnect device for installation in industrial control equipment shall include the information from 5.1.1.

5.1.1 Shown on Device Nameplate, or Label Attached to the Motor-Circuit Switch

a. the manufacturer's name or trademark
b. catalog or type designation
c. horsepower rating
d. rated operational voltage
e. rated continuous current
f. rated frequency
g. wire limitations, e.g., "for use with 75°C wire"
h. ON-OFF position on the external operating handle assembly
i. ON-OFF status indication on the switch unit if switch unit does not incorporate a visible contact gap
j. terminal identification
k. when applied as service entrance equipment must be marked in accordance with the NEC

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5.1.2 Shown on Nameplate of, Label Attached to, or Instruction Material Packaged with, the Motor-Circuit Switch

a. the mark "NEMA" or the NEMA logo and the words "motor-circuit switch" if the manufacturer claims compliance with this standard

b. short-circuit withstand rating(s)

c. conductor sizes, where applicable

d. tightening torque

e. suitable enclosure types, where applicable

5.2 Exception

Where a motor-circuit switch is incorporated into other equipment (e.g., a combination starter) the marking requirements for that equipment shall apply.

5.3 Other Disconnect Devices for Motor Service

The marking of circuit breakers and molded-case switches shall comply with NEMA AB 1.

5.4 Marking Limitations

No ratings or characteristics that conflict with this standard shall be shown.

5.5 Operating Handles Sold Separately

Each operating handle sold separately shall be marked to show the disconnect device and enclosure type(s) for which the handle is suitable for use.

6 SERVICE AND STORAGE CONDITIONS

See ICS 1, clause 6.

7 CONSTRUCTION

7.1 Clearances and Creepage Distances

Motor-circuit switches shall have the clearances and creepage distances specified in Table 8-7-1. Circuit breakers and molded-case switches shall comply with AB 1.

Table 8-7-1
MOTOR-CIRCUIT SWITCH SPACINGS
MINIMUM SPACINGS IN INCHES* (mm)

Voltage Between Parts Involved	Between Uninsulated Live Parts of Opposite Polarity+		Between Uninsulated Parts and Any Grounded Dead Metal	
	Clearance (Through Air)	Creepage Distance (Over Surface)	Clearance (Through Air)	Creepage Distance (Over surface)
0 - 600	1.000 (25.4)	2.000 (50.8)	0.500 (12.7)	1.000 (25.4)

* Adopted from NEMA KS 1-1990, "Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)".
+ Also applies between live parts of the power circuit and live parts of the control circuit.

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7.2 Minimum Air Gap In Open Position

Motor-circuit switches shall have an open contact air gap of not less than 0.375 inch (9.5 mm) between the line and load terminals.

7.3 Mechanical Design of Operating Handle and Mechanism

The design and construction of disconnecting devices including the operating handle and operating mechanism shall be such as to assure ample strength and rigidity. Screws and nuts serving to attach operating parts to cross bars or other movable members shall be upset or otherwise locked to prevent loosening under the jarring of continued use. Stops shall be provided if required to remove undue strain from switch parts. Materials shall be suitable for the particular application.

All metal parts, unless of corrosion resistant material, shall be galvanized, plated, enameled, painted, or otherwise treated to prevent corrosion.

7.4 External Operating Handles for Disconnect Devices

A suitable operating handle shall be provided for safe and convenient operation of the disconnect device when mounted in an industrial control enclosure.

All parts of a conducting material accessible to the operator with the enclosure closed shall be electrically connected to the enclosure or insulated from energized parts in such a manner so as to reasonably preclude any opportunity of their becoming energized.

A metal shaft within a bearing which in turn is electrically connected to the enclosure or a metal shaft using the wall of the enclosure as a bearing shall be considered to be in electrical connection with the enclosure.

7.5 Status Indication

Under normal operating conditions, the position of the contacts of an enclosed disconnect device shall be indicated by the position of the external operating handle. There shall be definite indication of the ON and OFF positions of the handle, and the design of the operating mechanism shall be such that the handle cannot be left readily at or near the OFF position when the switch blades or contacts are in the closed position.

With the enclosure door open, unless constructed with a visible contact gap, a disconnect device shall be plainly marked to indicate the ON and OFF positions, in addition to the ON and OFF markings on the handle.

Where handle movement is in a vertical plane, the upper position shall be ON. An operating handle which moves in a horizontal plane or a rotary actuator must clearly indicate the ON and OFF positions.

When the contacts of an enclosed disconnect device are welded or blocked in the closed position and the external handle can be forced to the OFF position, the handle must return to a position other than OFF when released, or the closed position of the contacts must be reliably indicated by separate means.

In the case of a circuit breaker, a tripped position location of the handle or an indicator may be provided at the option of the manufacturer.

7.6 Operating Mechanism for Disconnect Devices

Means other than friction or gravity shall be provided to hold an installed disconnect device in the ON or OFF position.

Disconnect devices shall be designed for independent manual operation, as defined in clause 3.

The design of the operating mechanism in conjunction with the contact structure shall be such that, in normal operation, the person operating the device cannot restrain the operation of the contacts after they have initially touched or parted when closing or opening the device.

7.7 Mechanical Interlock with Door(s)

The operating mechanism of a disconnect device shall provide mechanical interlocking with the main door of the enclosure (and, where provided, an auxiliary door giving access to the main fuses) which (1) normally prevents the door being opened when the device contacts are closed, and (2) normally prevents the disconnect device contacts from being closed when the door (and auxiliary cover) of the enclosure is open.

The mechanical interlock for the operating mechanism shall be provided with an interlock release (defeater) by which a qualified person (1) using a tool can open the door to inspect the device in the ON position, and (2) can close the contacts with the door open only by operating the interlock release.

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The interlocking shall be reactivated automatically when the enclosure door(s) is closed.

The operating handle or other member which indicates the position of the disconnect device blades or contacts (closed or open) shall be designed so that the door, front, or cover cannot be closed and secured in place in the intended manner with the handle or member indicating OFF when the disconnect device blades or contacts are in the closed position.

7.8 Padlocking Provisions

Provisions for padlocking shall be provided on the external operating handle to positively lock each enclosed disconnect device when its contacts are in the open position (OFF).

Such means shall accommodate at least three padlocks with shackle diameters within the range of 3/16 inch (4.8 mm) through 5/16 inch (7.9 mm). Any single padlock shall provide locking.

7.9 Additional Construction Requirements for Disconnect Devices

Provision for padlocking the external operating handle in the ON position shall require a conscious modification by the user, such as the drilling of the hole for the shackle.

7.10 Fuse Mounting

Motor-circuit switches may be without fuse mounting provisions or with fuseholders. Where provided as fusible devices, motor-circuit switches shall include fuse clips or fuse mounting means for cartridge fuses which comply with KS 1. See Table 8-4-1 and Table 8-4-2.

8 PERFORMANCE AND TEST

8.1 Circuit-Breaker and Molded-Case Switch Type Tests

The testing of circuit breakers and molded-case switches as components (without external operating mechanisms) shall be in accordance with AB 1. In addition, the external operating handle and mechanism strength test of 8.3 applies.

8.2 Motor-Circuit Switch Type Tests

The testing of motor-circuit switches shall be in accordance with KS 1. In addition, the external operating handle and mechanism strength test of 8.3 applies.

8.3 Verification of the Strength of External Operating Handle, Mechanism, and Position Indicating Device

The minimum strength requirement of an external operating handle and its associated mechanism shall be verified from the full ON position by the following procedure:

a. Mechanically (e.g., by welding or bolting) connect the movable blade (movable contact part) to the stationary part (contact) of that pole of a disconnect device farthest from the external operating handle center.

b. Apply a 45 pound force (200 newtons) normal (90 degrees) to the external operating handle at the point of maximum leverage for one minute, or apply sufficient force to move the handle to the full OFF (lockable) position for one minute, whichever is less.

c. After the test, when the test force is no longer applied, the operating handle being left free, the OFF position shall not be wrongly indicated by the device, by the separate indicator where applicable, or by the operating handle where the handle is the only means of indication.

d. After the test, the equipment shall not show damage such as to impair proper operation.

9 APPLICATION

9.1 Application of Circuit Breakers

An inverse-time circuit breaker (thermal-magnetic) or an instantaneous-trip circuit breaker (magnetic-trip-only) may be used as the disconnecting means in a motor branch circuit. An instantaneous-trip circuit breaker must have adjustable trip provisions and be used with overload relays, and be part of a listed combination controller. Circuit breakers are constructed and tested in accordance with NEMA AB 1. See NEMA AB 3 for additional application information for circuit breakers.

9.2 Protection of Nonfused Motor-Circuit Switches

Nonfused motor-circuit switches in combination starters and industrial control panels are often mounted

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on or adjacent to machines under circumstances where the short-circuit protective device (SCPD) is located in a remote switchboard, panelboard, or motor control center. Such nonfused equipment will include a listing of one or more short-circuit withstand ratings based on a variety of SCPD's identified by class, type and rating. The short-circuit protection must be provided by fuses or a Inverse-time circuit breaker rated in accordance with ANSI/NFPA 70 (NEC) and must be one of the SCPD's listed for use with the switch.

9.3 Safety Procedure for Verifying Deenergized Condition

Disconnect devices for motor service are subject to the safety requirements of ANSI/NFPA 70E "Electrical Safety Requirements for Employee Workplaces," which includes lockout-tagout procedures. This safety standard, in addition to meeting the lockout-tagout provisions, requires that reliance not be placed on the disconnect device position indication but rather on the following two acts to verify deenergization of the circuit.

9.3.1 Verify that Equipment Cannot be Restarted

Operate the equipment operating controls such as push buttons, selector switches, and electrical interlocks, or otherwise verify that the equipment cannot be restarted.

9.3.2 Verify that Circuit and Equipment are Deenergized

Test the circuits and equipment by use of appropriate test equipment to verify that the circuits and equipment are de-energized. Check the test equipment used for proper operation immediately before and immediately after this test.

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