EATON | Cutler-Hammer

IT. NEMA vs. IEC

Application Note

Rating Methods

There are two basic rating methods in common use in the Americas for Contactors and Starters — NEMA and IEC. They differ significantly in their requirements for design and test.

NEMA

NEMA Contactors and Starters are designed in standardized sizes from 00 to 9. Each of these sizes has a defined current, and a resultant voltage and frequency dependent horsepower rating. No matter who manufactures the device, the current and horsepower rating will be identical for a given size. If a standard motor is being used, once its horsepower rating is selected, the Contactor or Starter horsepower rating is simply matched to that of the motor.

The nameplate of the Contactor or Starter is labeled with the NEMA size, the various horsepower and voltage ratings assigned to the size, and its continuous current capability at which the NEMA Standard temperature rise will not be exceeded.

IEC

IEC Contactors and Starters are not designed to a standardized size. Instead a manufacturer certifies that he/she has designed the device to meet a number of defined applications referred to as Utilization Categories. To properly match the IEC Contactor or Starter to the application requirements, the user must know both the application requirements and the capability of the Contactor or Starter being selected. If the Contactor or Starter will not provide a reasonable operational life in the application, a larger device would need to be selected.

The nameplate of the Contactor or Starter is labeled with the maximum rating in kilowatts or horsepower for each operational voltage and specific Utilization Category (typically AC-3 as defined), rated thermal current (I_{th}), rated operational current (I_e), rated insulation voltage (U_i), rated operational voltage (U_e), and the IEC Standard to which the device was tested.

NEMA Rating

The size rating applied to a Contactor or Starter is specified by NEMA Standards. The standards require the device to be designed with sufficient margins to allow its use, in the majority of applications, without the need of assessing the impact of the application on the device's operational life. The capabilities are independent of who manufactured the device.

Normal Duty

Contactors and Starters are typically used in applications where a motor is periodically started at zero speed or stopped while running at full speed with a relatively long run or off time. The device is primarily only required to make locked rotor current and break full load current. A jog may occur to set up a machine, but it is very infrequent.

Plugging or Jogging Duty

Contactors and Starters can be used on applications which have a high occurrence of plugging or jogging, where a current in excess of locked rotor can be made and locked rotor current broken. The Contactor or Starter will have a lower rating for this type of duty than it would for a more normal duty application.

IEC Utilization Categories

A Contactor or Starter as specified under IEC Standards is designed for a particular grouping of Utilization Categories. As such, the device's operational life is dependent upon the load requirements with regards to the design Utilization Category. The two most common Utilization Categories for motor control are AC-3 and AC-4.

AC-3

Utilization Category AC-3 is typical for most common applications utilizing a standard squirrel cage induction motor. The Contactor or Starter is closed to line start the motor, and then opened while the motor is running to stop it. Opening the Contactor while the motor is running reduces the current the Contactor has to break to the motor's full load value. Under this condition only a low voltage is developed across the contacts as a result of the small difference between the motor's back EMF voltage and the line voltage. Many manufacturers are also combining a lesser used AC-2 slip ring motor starting and stopping Utilization Category with AC-3.

AC-4

Utilization Category AC-4 typically also applies to standard induction motors, but in this case the start and stop actions are more severe. The Contactor or Starter makes into the locked rotor current of the motor, but can be opened while the locked rotor current is still flowing, with a large voltage present across the contacts, because the motor's back EMF voltage is still low while starting. The combination of high current and voltage significantly reduces the life of the contacts. Typical applications require jogging or plugging. Plugging duty can be more severe because the motor is rotating in the reverse direction when one Contactor is opened and a second closed, potentially causing a much larger current to flow for a longer time period. If a Contactor or Starter carries both an AC-3 and AC-4 rating, the AC-4 operating life is usually a fraction of the AC-3 value.

NEMA and IEC Ratings Comparison

NEMA Contactors and Starters can be applied to AC-3 applications. They may also be applied at their normal standardized ratings to AC-4 applications where there will be no more than five openings per minute and no more than 10 openings during a 10-minute period. Beyond this level, NEMA provides a plug reversing and jogging duty table with modified ratings for improved operating life. Many IEC devices also have a NEMA rating. The manufacturer can advise on this.

Other Factors

The operational life of a Contactor or Starter may be affected by other factors not controllable by the manufacturer and independent of whether the device was designed per NEMA or IEC standards. These factors include such items as temperature, altitude, vibration, shock, humidity, and environmental issues such as dust, dirt or corrosive chemicals.

Additional Comparisons

The following table summarizes the key differences between NEMA and IEC devices.

Table 1. NEMA and IEC devices

Characteristic	NEMA	IEC
Rated by	Horsepower	Manufacturer determined current and Utilization Category (AC-1, AC-2, AC-3, AC-4…)
Size — Electrical	Standardized — 00 to 9	No standard
Jogging/Plugging	Standard product has some capability	Must use higher Utilization rating and possibly increased current rating
Interchangeability	Meets AC-3 and limited AC-4 operation	Many do not meet NEMA requirements
Fault Current	Meets NEC requirements	Usually has lesser fault current withstand
Mounting	Dimensions not standardized	Below 20 hp equivalent, standard DIN rail mounting is typical
Terminal Markings Power — In/Out Coil Control	L1, L2, L3 and T1, T2, T3 No standard No standard	1, 3, 5 and 2, 4, 6 A1, A2, A3, B1, B2 Two digits, first digit for sequence, second digit for type of contact: 1-2 for normally closed and 3-4 for normally open

References

For a more detailed discussion of the differences between NEMA and IEC devices, refer to NEMA Standard ICS 2.4 available as a free download at the NEMA website at www.nema.org.

Eaton Corporation
Cutler-Hammer business unit
1000 Cherrington Parkway
Moon Township, PA 15108-4312
USA
tel: 1-800-525-2000
www.cutler-hammer.eaton.com

Printed in USA
Publication No. AP03501001E
February 2002