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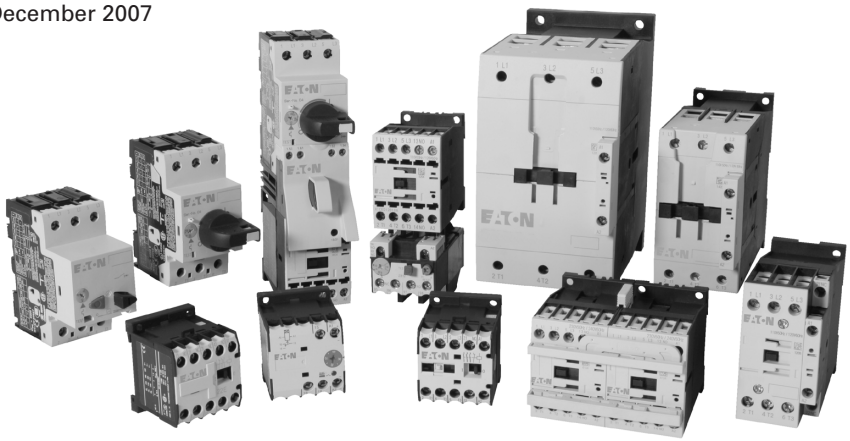
Use of IEC Contactors in UL, CSA and NEC Regulated Applications

Application Note

New Information
December 2007



IEC contactors are increasingly becoming the contactor of choice for power and motor control across the world. Contactors designed to IEC specifications provide a good balance of performance, size, accessories and low cost. However, there are several different governing standards, such as UL®, NEC®, CSA®, IEC and others, that dictate how IEC contactors should be applied in a panel. In order to apply correctly, it is important to understand the performance requirements for these various standards.

This application note discusses contactor application based on two common governing standards systems, UL/CSA/NEC and IEC. This application note is merely a guide and is not intended to replace or serve as a substitute for UL/CSA/NEC and IEC standards. Always consult the actual standards or local standards representatives to ensure correct interpretation and compliance.

UL, CSA, NEC and CEC

UL (Underwriters Laboratories) is an organization that develops standards and test procedures and certifies products with a significant focus on product safety. UL Standard 508 covers the contactor design and test requirements and UL Standard 508A covers requirements for the design of a control panel. UL also is a Nationally Recognized Test Lab (NRTL) under OSHA, and products certified by UL are accepted by almost all jurisdictions in the US. OSHA Safety Standards, which are US law, contain requirements for “approval” (i.e., testing and certification) of electrical equipment by an NRTL.

CSA (Canadian Standards Association) is a similar body in Canada. Contactors are certified to CSA C22.2 No.14. Installations in Canada are covered under the (CEC) Canadian Electrical Code, CSA C22.1. CSA is also an NRTL under OSHA.

The NEC (National Electrical Code, also known as NFPA 70) is a specification that establishes minimum standards for the safe installation of electrical wiring and equipment in the US. The NEC was created and is maintained by the National Fire Protection Association (NFPA). The NEC is frequently mandated by states and local jurisdictions, and it is possible for different jurisdictions to adopt different revisions of NEC code.

While there is some overlap in the NEC and UL standards, and the CEC and CSA standards, these specifications generally work together in concert to provide guidelines for safe design, application, and installation of electrical components and equipment, and often reference their counterpart's standards in their documentation.

Even though IEC contactors are designed and tested to the IEC standard, they must also be tested according to UL standards if they are to be used as a UL approved device. For motor applications, conformance to UL Standard 508 and/or CSA C22.2 No.14 verifies that contactors are designed to handle most common standard motor applications. Contactors that meet UL requirements are assigned various ratings based on tests, including motor horsepower ratings and a general purpose ampere rating, among others (see example rating label in **Figure 1** and **Table 1**).

On the ***XT*** contactor label, the UL information is found on the bottom half of the label. These ratings are used in the selection and application of the contactor.

According to the NEC, UL508A and CEC, the horsepower rating is used to size a contactor for a standard motor application. Although IEC contactors have ratings based on the IEC standard (such as the AC-3 current rating), these ratings are not recognized or considered when sizing according to UL508A, CEC or NEC applications. See example below:

Example

10 hp Type B motor with the following nameplate ratings for use in a standard duty application under UL508A and/or CEC and/or NEC:

- Rated Horsepower: 10 hp
- Rated Voltage: 460V 60 Hz
- Full Load Amperage: 14.0A

According to **Table 1**, The XTCE012B or the XTCE015B is appropriate for this application. The AC-3 rating cannot be considered when sizing this contactor for motors to UL/NEC/CEC because it is not a UL/CSA rating.

If motors are used in severe duty applications, such as plugging or jogging, contactors should be derated based on UL/NEC/CEC guidelines. For non-motor loads, the general purpose ampere rating is used to size the contactor.

The ***XT*** contactor was designed and tested to achieve the optimum UL horsepower rating. As a result, it often has a higher horsepower rating than competitive lines based on physical size, and thus is often smaller than competitive lines for the same horsepower rating. By using the ***XT*** contactor line, it is possible to design smaller, less expensive panels.

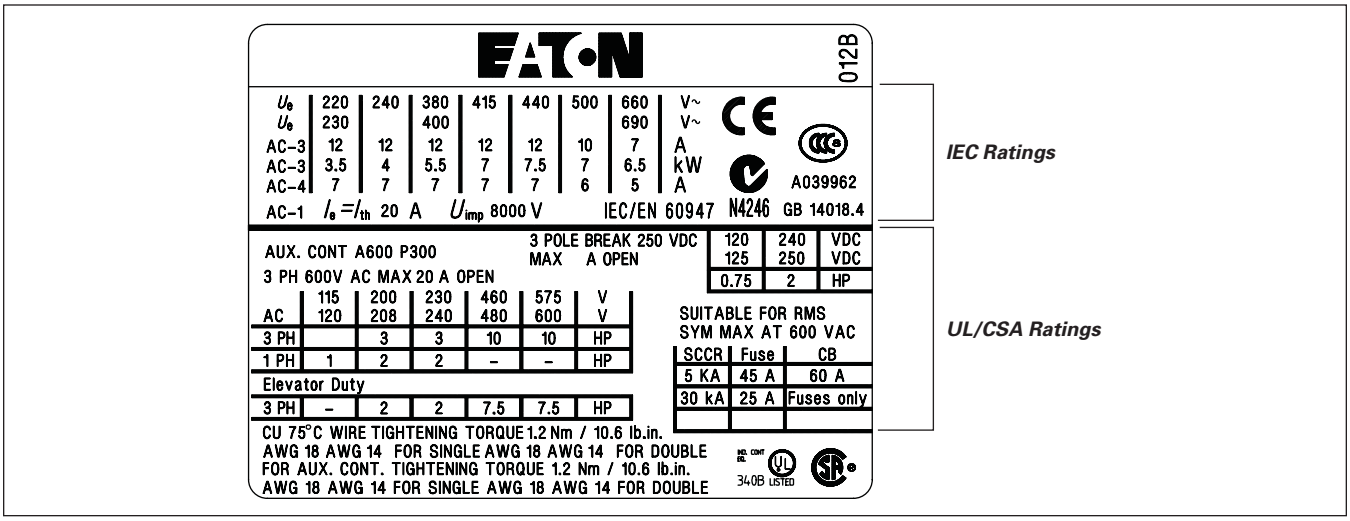


Figure 1. Rating Label for XTCE012B Contactor

Table 1. B Frame *XT* Contactor Ratings

IEC Ratings						UL/CSA Ratings							Auxiliary Contacts	Catalog Number — Screw Terminals
I_e (A)	$I_e = I_{th}$ (A)	Maximum kW Ratings AC-3				Maximum 3-Phase Motor Rating, UL/CSA								
AC-3	AC-1 (60°C)	3-Phase Motors 50 – 60 Hz				1-Phase hp Ratings			3-Phase hp Ratings					
		230/ 230V	380/ 400V	415V	600/ 690V	115V	200V	230V	200V	230V	460V	575V		
Frame B														
7	20	2.2	3	4	3.5	3/4	3/4	1	1-1/2	2	3	5	1NO	**XTCE007B10_**
7	20	2.2	3	4	3.5	3/4	3/4	1	1-1/2	2	3	5	1NC	**XTCE007B01_**
9	20	2.5	4	5.5	4.5	1/2	1	1-1/2	3	3	5	7-1/2	1NO	**XTCE009B10_**
9	20	2.5	4	5.5	4.5	1/2	1	1-1/2	3	3	5	7-1/2	1NC	**XTCE009B01_**
12	20	3.5	5.5	7	6.5	1	2	2	3	3	10	10	1NO	**XTCE012B10_**
12	20	3.5	5.5	7	6.5	1	2	2	3	3	10	10	1NC	**XTCE012B01_**
16.5	20	4	7.5	8	7	1	2	3	5	5	10	10	1NO	**XTCE015B10_**
15.5	20	4	7.5	8	7	1	2	3	5	5	10	10	1NC	**XTCE015B01_**

IEC Standard

IEC (International Electrotechnical Commission) is an organization based in Europe that establishes standards for the design and application of electrical components and equipment. IEC standards have been adopted by countries in Europe (known as European Norms or EN) and globally. It has become a common platform for the design of contactors across the world. Contactors tested to EN standards bear a CE mark.

IEC Contactors are designed and tested according to standard IEC/EN60947-4-1. This standard is designed around very specific applications (see example utilization categories in **Table 3**) and requires more sophisticated methods of device selection compared to UL, NEC and CEC. More ratings are provided in IEC based specifications as compared to UL/CSA. IEC ratings for the ***XT*** are located in the top portion of the contactor ratings label and in technical specification documentation. Because the contactor performance is specified based on additional applications, IEC test requirements may not be as severe as UL or CSA testing, and in many cases, a smaller contactor can be used in an IEC application than can be used for the same application in UL.

Selection of contactors based on the IEC standard begins with selecting the desired design life of the contactor. An electrical life between 1.2 to 1.5 million operations is a common choice. A higher electrical life may be chosen if the application requires a high operation frequency or if the contactor is desired to perform for a longer period of time. The following example shows how electrical life could be determined:

Example

- Motor operates every 1 minute for 8 hours per day, 300 days per year.
- The desired life is 10 years.

1 operation/minute x 60 minutes/hour x 8 hours/day x 300 days/year x 10 years = approx 1.4M Operations

Once the number of operations is known, the contactor is selected based on the application, the full load current, and number of operations. The contactor ratings (see example in **Table 2**), as well as electrical life curves (see example in **Figure 2**) are used to size the contactor. See the example in the next column.

Example

- Contactor is to start a squirrel cage motor and switch off while running.
- Motor nameplate is as follows:
  - Power: 4 kW
  - Voltage: 400V 50 Hz
  - Full Load Current: 8.8A
- Number of desired operations is 1.4M.

Based on the application, the utilization category is AC-3. From **Table 2**, the XTCE009B contactor is rated for 4 kW, 9A at 400V, which is appropriate based on the motor ratings. **Figure 2** shows that the XTCE009B will perform at around 1.4M operations at 8.8 amps, so this contactor is sized appropriately based on the application and desired contactor life.

In this example, if the desired life were 2M operations, a larger contactor size would have to be used. Using the data in **Figure 2**, the XTCE015B would be an appropriate contactor for nearly 2M operations based on 8.8 amp usage.

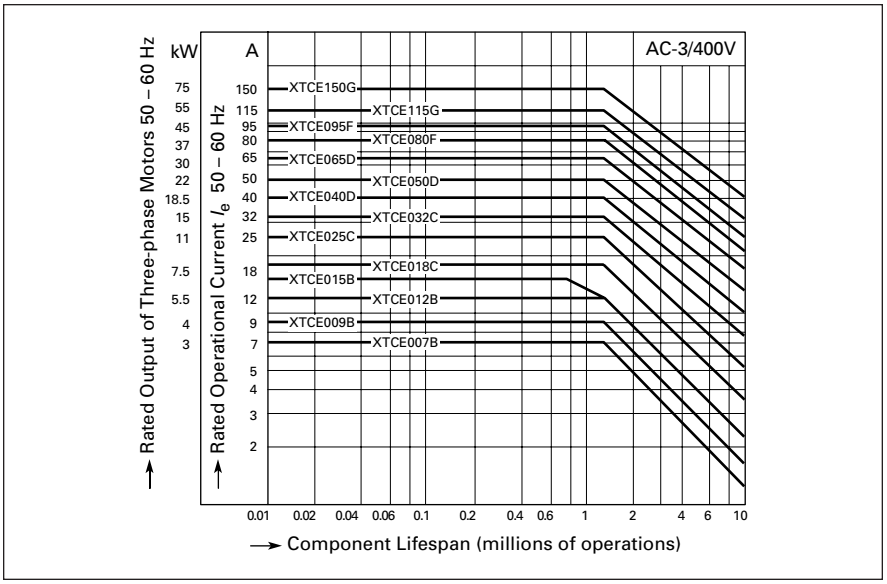


Figure 2. Electrical Life Curves for B – G Frame *XT* Contactors at 400V AC-3

Table 2. AC-3 Ratings for B & C Frame *XT* Contactors

Description	XTCE007B	XTCE009B	XTCE012B, XTCF020B	XTCE015B	XTCE018C	XTCE025C	XTCE032C
Rated Operational Current, 50/60 Hz ① (I_e) in amperes							
220/230V	7	9	12	15.5	18	25	32
240V	7	9	12	15.5	18	25	32
380/400V	7	9	12	15.5	18	25	32
415V	7	9	12	15.5	18	25	32
440V	7	9	12	15.5	18	25	32
500V	5	7	10	12.5	18	25	32
660/690V	4	5	7	9	12	15	18
1000V	—	—	—	—	—	—	—
Rated power (P) in kilowatts							
220/230V	2.2	2.5	3.5	4	5	7.5	10
240V	2.2	3	4	4.6	5.5	8.5	11
380/400V	3	4	5.5	7.5	7.5	11	15
415V	4	5.5	7	8	10	14.5	19
440V	4.5	5.5	7.5	8.4	10.5	15.5	20
500V	3.5	4.5	7	7.5	12	17.5	23
660/690V	3.5	4.5	6.5	7	11	14	17
1000V	—	—	—	—	—	—	—

① At maximum permissible ambient temperature.

Table 3. Examples of Utilization Categories for Low-Voltage Switchgear and Controlgear ①

Category	Typical Applications	Relevant IEC Product Standard
Nature of Current — AC		
AC-1	Non-inductive or slightly inductive loads, resistance furnaces	60947-4-1
AC-2	Slip-ring motors: starting, switching off	60947-4-1
AC-3	Squirrel-cage motors: starting, switching off motors during running	60947-4-1
AC-4	Squirrel-cage motors: starting, plugging ②, inching ③	60947-4-1
AC-5a	Switching of electric discharge lamp controls	60947-4-1
AC-5b	Switching of incandescent lamps	60947-4-1
AC-6a	Switching of transformers	60947-4-1
AC-6b	Switching of capacitor banks	60947-4-1
AC-7a	Slightly inductive loads for household appliances and similar applications	61095
AC-7b	Motor-loads for household applications	61095
AC-8a	Hermetic refrigerant compressor motor control with manual resetting of overload releases	60947-4-1
AC-8b	Hermetic refrigerant compressor motor control with automatic resetting of overload releases	60947-4-1
AC-12	Control of resistive loads and solid-state loads with isolation by optocouplers	60947-5-1
AC-12	Control of resistive loads and solid-state loads with optical isolation	60947-5-2
AC-13	Control of solid-state loads with transformer isolation	60947-5-1
AC-14	Control of small electromagnetic loads	60947-5-1
AC-15	Control of AC electromagnetic loads	60947-5-1
AC-20	Connecting and disconnecting under no-load conditions	60947-3
AC-21	Switching of resistive loads, including moderate overloads	60947-3
AC-22	Switching of mixed resistive and inductive loads, including moderate overloads	60947-3
AC-23	Switching of motor loads or other highly inductive loads	60947-3
AC-31	Non inductive or slightly inductive loads	60947-6-1
AC-33	Motor loads or mixed loads including motors, resistive loads and up to 30% incandescent lamp loads	60947-6-1
AC-35	Electric discharge lamp loads	60947-6-1
AC-36	Incandescent lamp loads	60947-6-1
AC-40	Distribution circuits comprising mixed resistive and reactive loads having a resultant inductive reactance	60947-6-2
AC-41	Non-inductive or slightly inductive loads, resistance furnaces	60947-6-2
AC-42	Slip-ring motors: starting, switching off	60947-6-2
AC-43	Squirrel-cage motors: starting, switching off motors during running	60947-6-2
AC-44	Squirrel-cage motors: starting, plugging ②, inching ③	60947-6-2
AC-45a	Switching of electric discharge lamp controls	60947-6-2
AC-45b	Switching of incandescent lamps	60947-6-2
AC-51	Non-inductive or slightly inductive loads, resistance furnaces	60947-4-3
AC-52a	Control of slip ring motor stators: 8 h duty with on-load currents for start, acceleration, run	60947-4-2
AC-52b	Control of slip ring motor stators: intermittent duty	60947-4-2
AC-53a	Control of squirrel-cage motors: 8 h duty with on-load currents for start, acceleration, run	60947-4-2
AC-53b	Control of squirrel-cage motors: intermittent duty	60947-4-2
AC-55a	Switching of electric discharge lamp controls	60947-4-3
AC-55b	Switching of incandescent lamps	60947-4-3
AC-56a	Switching of transformers	60947-4-3
AC-56b	Switching of capacitor banks	60947-4-3
AC-58a	Control of hermetic refrigerant compressor motors with automatic resetting of overload releases: 8 h duty with on-load currents for start, acceleration, run	60947-4-2
AC-58b	Control of hermetic refrigerant compressor motors with automatic resetting of overload releases: intermittent duty	60947-4-2
AC-140	Control of small electromagnetic loads with holding (closed) current ≤ 0,2 A, e.g. contactor relays	60947-5-2

① 60947-1 © IEC: 2004.
② By plugging is understood stopping or reversing the motor rapidly by reversing motor primary connections while the motor is running.
③ By inching (jogging) is understood energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.

Table 3. Examples of Utilization Categories for Low-Voltage Switchgear and Controlgear ① (Continued)

Category	Typical Applications	Relevant IEC Product Standard
Nature of Current — AC and DC		
A	Protection of circuits, with no rated short-time withstand current	60947-2
B	Protection of circuits, with a rated short-time withstand current	60947-2
Nature of Current — DC		
DC-1	Non-inductive or slightly inductive loads, resistance furnaces	60947-4-1
DC-3	Shunt-motors: starting, plugging ②, inching ③, Dynamic breaking of motors	60947-4-1
DC-5	Series-motors: starting, plugging ②, inching ③, Dynamic breaking of motors	60947-4-1
DC-6	Switching of incandescent lamps	60947-4-1
DC-12	Control of resistive loads and solid-state loads with isolation by optocouplers	60947-5-1
DC-12	Control of resistive loads and solid-state loads with optical isolation	60947-5-2
DC-13	Control of electromagnets	60947-5-1
DC-13	Control of electromagnets	60947-5-2
Nature of Current — AC		
DC-14	Control of electromagnetic loads having economy resistors in circuit	60947-5-1
DC-20	Connecting and disconnecting under no-load conditions	60947-3
DC-21	Switching of resistive loads, including moderate overloads	60947-3
DC-22	Switching of mixed resistive and inductive loads, including moderate overloads (e.g. shunt motors)	60947-3
DC-23	Switching of motor loads or other highly inductive loads (e.g. series motors)	60947-3
DC-31	Resistive loads	60947-6-1
DC-33	Motor loads or mixed loads including motors	60947-6-1
DC-36	Incandescent lamp loads	60947-6-1
DC-40	Distribution circuits comprising mixed resistive and reactive loads having a resultant inductive reactance	60947-6-2
DC-41	Non-inductive or slightly inductive loads, resistance furnaces	60947-6-2
DC-43	Shunt-motors: starting, plugging ②, inching ③, Dynamic breaking of DC	60947-6-2
DC-45	Series-motors: starting, plugging ②, inching ③, Dynamic breaking of DC	60947-6-2
DC-46	Switching of incandescent lamps	60947-6-2

① 60947-1 © IEC: 2004.
② By plugging is understood stopping or reversing the motor rapidly by reversing motor primary connections while the motor is running.
③ By inching (jogging) is understood energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.

Conclusion

Because various standards differ in design requirements, testing, and application categories of contactors, it is important to understand the selection criteria of the governing standards in order to select the right contactor. Selecting the right contactor is critical to ensure appropriate application and performance at the minimum cost.

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