GUIDE

Installation contactors

Modular DIN rail components

Available in a wide range from 16 to 100 A and featuring tool-free accessories, ABB's installation contactors are widely used for switching and controlling lighting, heating, ventilation, EV charging stations, motors, and pumps. Quiet and reliable with hum-free AC/DC coils, the ESB installation contactors offer peace of mind in noise-sensitive applications.

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Foreword

ABB is a pioneering technology leader in electrification products, robotics and motion, and industrial automation, serving customers in utilities, industry and transport, and infrastructure globally. Continuing a history of innovation spanning more than 130 years, ABB today is writing the future of industrial digitalization with two clear value propositions: bringing electricity from any power plant to any plug and automating industries from natural resources to finished products.

ABB offers a wide range of Installation Contactors. We realize that with all the standards, rules, listings, and codes, what, when, where, why, and how of Installation Contactors can appear complex.
The following information is provided to aid in the proper use of ABB Installation Contactors and all their capabilities.
This guide is written to be a general guide for people working with installation contactors applications, but also for those who are simply interested in learning more about the products, standards, and applications. All these are relevant for European applications (based on IEC) and North American applications (UL / CSA).

The guide is neither a complete technical guide nor a manual for all types of ABB's motor starting solutions. It is a complement to the catalog, data sheets and brochures available for our products and will provide a general overview of what to consider when working with Installation Contactors.

More information on Installation Contactors as well as other ABB products is available at:
https://new.abb.com/low-voltage/products/motor-protection/installation-contactors

All the information provided in this guide is only general and each application must be handled as a specific case. Be sure to always follow all national and local installation regulations/codes for your specific application.

Safety and warnings

	This symbol in conjunction with the signal word «DANGER» indicates an imminent electrical hazard. Failure to observe the related safety note may cause personnel injury or death or equipment damages.
	This symbol in conjunction with the signal word «WARNING» indicates a potentially dangerous situation. Failure to observe the related safety note may cause personnel injury or death or equipment damages.
	This symbol indicates a safety note: "ATTENTION! Hazardous voltage!" Installation by a certified service engineer only."
	This symbol in conjunction with the signal word «NOTE» indicates operator tips, particularly useful or important information for the use of the product. This symbol and wording do not indicate a dangerous situation.
	This symbol indicates a compulsory action: "Reading the instruction manual/booklet before starting work or before operating equipment or machinery.
	Recycle.
	Do not dispose of ordinary trash.

Installation contactors

A wide range of contactors take noise reduction to new levels

ABB's hum-free installation contactor designs now offer a wider range of ratings from 16 A to 100 A. Widely used in buildings for switching and controlling lighting, heating, ventilation, EV charging stations, motor and pumps, the installation contactors take noise reduction to a new level. With an innovative AC / DC coil design that eliminates hum, a broad selection of common accessories as well as manual and automatic versions, installation contactors offer peace of mind in noise-sensitive applications.

Optimum interface

Quiet and reliable in every application
ABB's hum-free contactors feature innovative AC / DC coils. The range covers ratings from 16 A to 100 A and offers accessories to suit customer requirements in every application. An integrated indicator makes diagnostics quicker and provides reliable information about the contactor's status at a glance.

Easy to install

Simple solution that saves time
Reduce installation time and stock levels, with a universal auxiliary contact block that can be attached to the contactors by hand. Installation contactors fit easily with ABB's System Pro M compact range, making them fully compatible with other modular DIN-rail components.

Global availability

Whatever you need, wherever you need it
Installation contactors are available in single and multi-packs to meet different customer needs and to optimize warehousing space. Every ABB product enjoys expert local support worldwide to make communication easier and delivery faster

1. Standards and approvals for Installation Contactors

All ABB low voltage devices are developed and manufactured according to the rules set out in the IEC (International Electrotechnical Commission). The IEC issues publications that act as a basis for the world market. The applicable standard is the IEC 60947 series for Europe and UL 60947 for North America. All devices are built according to this standard and in most countries, they are not subject to any other tests besides the manufacturer's responsibility. In some countries, the law requires additional certification.

1.1 European directives applicable for Installation Contactors

There are essential European directives:

- **Low Voltage Directive 2014/35/EU**
  Concerns electrical equipment from 50 to 1000 V AC and from 75 to 1500 V DC.
- **RoHS Directive 2011/65/EU**
  Restriction of the use of Certain Hazardous Substances in Electronic and Electrical Equipment

1.2 CE Marking

When a product is verified according to its applicable EN standard, the product is presumed to fulfill all applicable directives, e.g., the "Low Voltage Directive 2014/35/EU", and it is allowed to apply the CE marking on the product.
In this case, the CE marking does not cover the "Machinery Directive, Directive 2006/42/EC" which requires a special verification of the installation of the machine. The Installation contractors are an electrical device, with mainly electrical risks. It is instead covered by the low voltage directive.

The CE marking is not a quality label, it is proof of conformity to the European Directives concerning the product.

1.3 Standards for North America

Specifications for the North American and Canadian markets are quite similar but differ a lot from IEC standards and European specifications. In Chapter 7. Requirements for North America, this topic will be described in more detail.

The USA - UL Underwriters Laboratories Inc.
Canada - CSA Canadian Standards Association

There are different types of UL certification, including UL listed and UL component recognition. UL Listing means that UL has tested representative samples of the product and determined that it meets UL's requirements. UL's component recognition service, however, only covers the evaluation of components or materials intended for use in a complete product or system. All ABB Installation Contactors that have UL certification, are UL listed. Installation Contactors can also be cULus listed, meaning that they are UL listed to US and Canadian safety standards. All the requirements of both UL and CSA are covered by cULus, so the product is then suitable for use in the US and Canada.

1.4 CCC (China Compulsory Certification)

Since the Installation Contactors standard is listed according to the CCC regulation in China, it is mandatory to have the product approved and labeled with a CCC mark to be allowed to be put on the Chinese market. The Chinese GB14048.2 and GB14048.4 standards are based on the IEC-standard IEC 60947-2 and IEC 60947-4-1.

1.5 Other local approvals based on IEC-standard

In addition to IEC and UL standards, many countries have their local certifications. Some examples of the major ones besides the already mentioned CSA and CCC are listed below:

- **UKCA** – The **UK Conformity Assessment** is the product marking system intended to replace CE marking for the GB market (England, Wales and Scotland)
- **C MIM** – The CMIM MARKING for safety conformity of industrial products and toys in Morocco
- **EAC** – The **Eurasian Conformity** mark for Russia, Belarus, Armenia, Kazakhstan, Kyrgyzstan-etc.
- **RCM** – The **Regulatory Compliance Mark** for Australian & New Zealand
- **NOM** – The **Norma Oficial Mexicana**
- **KC** – The **Korea Certification** mark

1.6 Marine approvals

For Installation Contactors used on board ships, maritime insurance companies sometimes require different marine certificates of approval. Some examples include DNV GL (Det Norske Veritas together with Germanischer Lloyd), BV (Bureau Veritas), LR (Lloyds Register EMEA) which are based on the IEC standard, or from ABS (the American Bureau of Shipping) which is based on UL standards or some other independent certification organization. Typically, marine approvals have special requirements regarding shock, vibrations, and humidity.

1.7 Applied standards

Following standards are used or partly used for ABB's Installation Contactors.

International and European standards

IEC / EN 60947-1	Low-voltage switchgear and controlgear - Part 1: General rules
IEC / EN 60947-4-1	Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
IEC / EN 60947-5-1	Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices
IEC / EN61095	Electromechanical contactors for household and similar purposes
IEC / EN 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Standards for North America

UL 60947-1	Low-Voltage Switchgear and Controlgear - Part 1: General Rules
UL 60947-4-1	Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters

Standards for China

GB/T 17885-2016	Electromechanical contactors for household and similar purposes

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Table 1: Applied standards for the Installation Contactors

2. General product overview

2. 1 Basic function of installation contactors

Contactors are electromagnetically operated switches. The functional principle can be described as follows: when control power flows through the magnet coil of a contactor, the resulting magnetic field attracts the mechanical contact carrier. By interruption of the coil control circuit the mechanical contact carrier returns to the starting position. Installation contactors belong to the class of air-break contactors. If coil power is removed, an arc is created as the contacts open. Air-break contactors extinguish the arc by separating the contacts by a sufficient distance. Air-break contactors are more economic, because the price and the maintenance costs are lower than with other classes of contactors (e.g., oil immersed, vacuum).

The figure below shows the basic construction of a contactor. This contactor consists of a normally closed and normally open contact. Current is drawn into the coil when an energy supply is connected to coil connections (5). This current causes the coil to produce electromagnetic forces which draw the anchor (4) downward, opening the normally closed contact (2) and closing the normally open contact (1). When the magnetic circuit is interrupted, the contact spring (4) returns the contacts to their normal state.

The following chapters describe modular DIN rail components and the requirements for installation contactors.

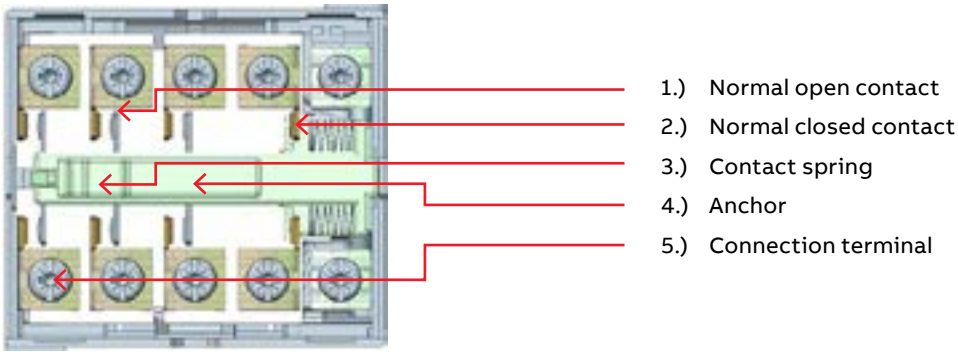
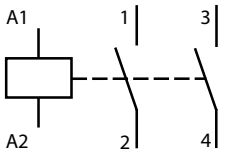
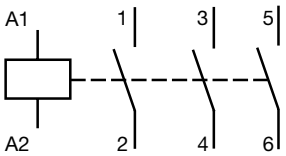


Figure 1: Construction of a contactor

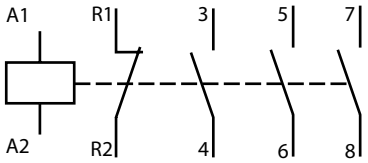
The following are some examples of mechanically contacting elements:



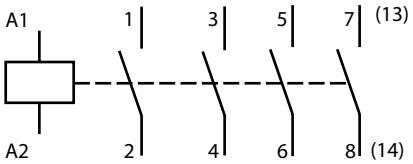
2-pole contactor 2 N.O.



3-pole contactor 3 N.O.



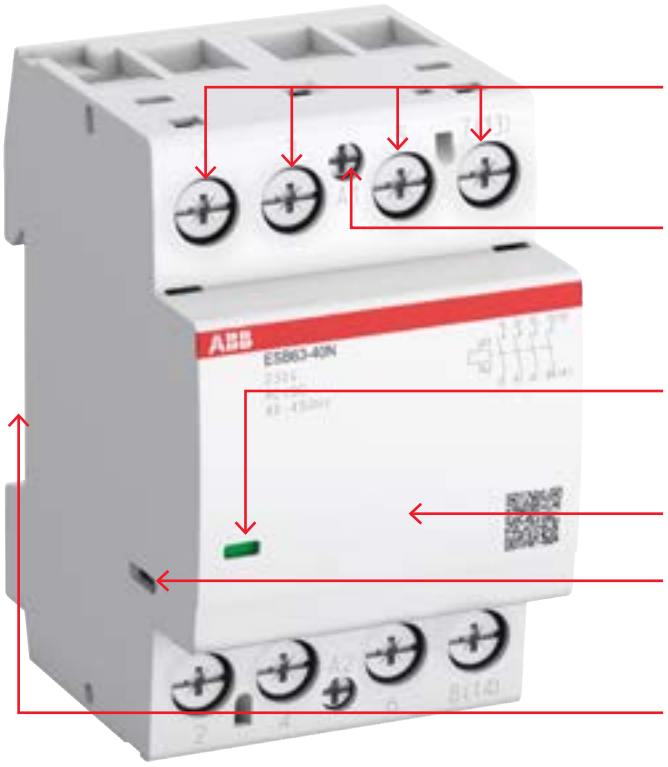
4-pole contactor 1 N.C. + 3N.O.



4- pole contactor 4 N.O.

2.2 General overview of the design

ABB´s installation contactors come with many features that make installation and maintenance easier. The mechanical Indicator with green and red color for status indication ensures a quick diagnostic of the system. Also, some specialty types feature a manual override functionality with a toggle switch to control independently from control source. Accessories can be mounted tool-free on the contactor, for example auxiliaries, space holders as well as security and safety covers.



Main pole terminals
Allow the connection of up to two conductors with different cross-sections for the main.

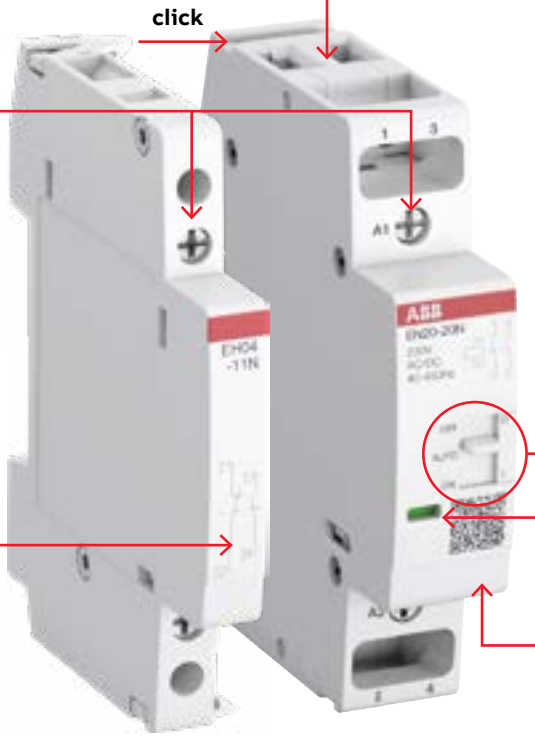
Coil control terminals

Easy status indication
Red: ON
Green: OFF

Field for label

Contact carrier for side
Linked to the coil positioning open or close, and leads the side-mounted accessories.

DIN mounting
Allows mounting of the device on DIN rails 35 × 7.5 mm, 35 × 15 mm or 75 mm



2.3 ESB technology

2.3.1 Operation mode EN-versions

EN types also include a special hand operating function. This provides customers with the following features:

- Manual control in case of failure
- Easier and faster commissioning
- Time savings on maintenance and testing of equipment

Function:

- Switch in „Auto“: standard control
- Switch in position „0“: Supply to coil interrupted
- Switch in position „I“: Manually switched on (a trigger signal to the coil terminal initiates the switch moving into „AUTO“ position)

Operation mode EN-versions

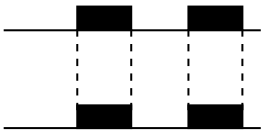
	Switch position O = OFF	Switch position AUTO	Switch position I = ON
Coil input Main contacts output			 automatic treturn to 'AUTO'
	Even if energy is provided to the coil, the contactor remains in a deactivated state and nothing will change until the switch will be moved to the position Auto or 1	The contactor behave like an ESB..N: when the coil receives energy, the carrier moves closing or opening the power contacts and it doesn´t change state until the coil is „active“	The device is working even if the coil is „not active“; as soon as energy is provided to the coil, the switch moves automatically to the position Auto

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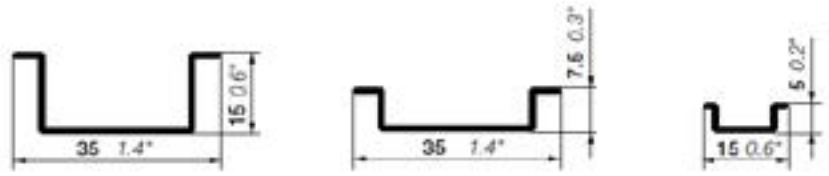
Table 2

2.3.2 Modular DIN rail components

Modular DIN rail components (MDRC) are devices designed to be used with a mounting rail. The mounting rail consists of metal and is standardized for electrical engineering. The term is derived from the original specifications published by the German Institute for Standardization (DIN) in Germany, which have since been adopted as European (EN) and international (ISO) standards. The mounting rail is specified by the DIN Norm EN 50022 with the dimensions 35 mm x 7.5 mm, seen in the Figure 2. Figure 2 shows several standardized mounting rail designs. Today, the standards for mounting rails are summarized in DIN EN 60715.

Modular DIN rail components are designed for a high degree of safety and finger protection. Their compact construction saves space and increases customer benefits in building installations. All MDRC products are designed using the concept of modular width, and are either a fraction of, or multiples of, a single “module”, which is standardized at 17.5 mm. These devices can be installed on mounting rails, and include products such as control relays, impulse relays, time switch relays, circuit breakers, series terminals and installation contactors. Installation enclosures include distribution panels, switchboards and distribution boxes. A distribution panel is shown in below.



2.3.3 Hum-free operation

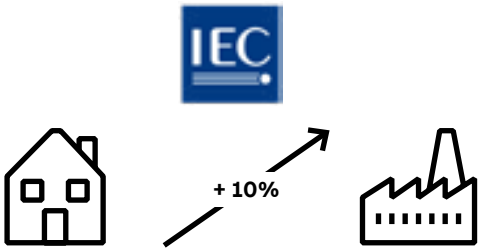
With an innovative AC / DC design that eliminates hum, the range meets the needs of applications demanding silent operation, for example hotel rooms and residential buildings.

2.3.4 Single and multiple packaging

The right packaging for your needs- our products are available in a choice of different packaging and delivery quantities. This allows you to ware-house according to your needs and save up to 50% on your inventory.

2.3.5 Wide application range

The ESB installation contactors range meets both the industrial standard IEC 60947-4-1 and the household standard IEC 61095 as well as pollution degree class 3. Due to multiple certification and inherent robustness, the contactors can be used in 10% more applications in both residential and industrial settings.



2.3.6 Built-in protective circuit

Protect the contactor without additional space-demanding components against remote lightning strikes and overvoltages.

2.3.7 Save up to 15% space with group mounting

ESB16..N, ESB/EN20..N and ESB100..N can be group mounted. There is no need for a distance piece in between contactors, saving both valuable space in cabinets and money.

2.4 Terms and ratings

Circuits	Auxiliary circuit	All the conductive parts of a contactor designed to be inserted in a different circuit from the main circuit and the contactor control circuits.
	Control circuit	All the conductive parts of a contactor (other than the main circuit and the auxiliary circuit) used to control the contactor's closing operation or opening operation or both
	Main circuit	All the conductive parts of a contactor designed to be inserted in the circuit that it controls
Coil operating range		Expressed as a multiple of the rated control circuit voltage Uc for the lower and upper limits.
Cycle time		This is the sum of the current flow time and the no-current time for the given cycle
	Electrical durability	Number of on-load operating cycles that the contactor is able to carry out. It depends on the operational current, the operational voltage, and the utilization category.
	Mechanical durability	Number of no-current operating cycles that a contactor is able to carry out
Endurance / durability	Electrical endurance	The number of on-load operating cycles (i.e. with the current on the main contacts) a contactor can achieve, varies depending on the utilization category
	Mechanical endurance	The number of off-loading operating cycles (i.e. without current on the main contacts) a contactor can achieve.
Load factor		Ratio of the on-load operating time to the total cycle time × 100 (%).
Inching		Energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.
Intermittent duty		Duty in which the main contacts of a contactor remain closed for periods of time insufficient to allow the contactor to reach thermal equilibrium, the current-carrying periods being separated by off-load periods of sufficient duration to restore equality of temperature with the cooling medium.
Rated breaking capacity; Rated making capacity		Value of RMS current a contactor can break or make at a fixed voltage value, within the conditions specified by the standards, depending on the utilization category.
Rated control circuit voltage U_c		Control voltage value for which the control circuit of the unit is sized.
Rated insulation voltage U_i		Voltage value which designates the unit and to which dielectric tests clearance, and creepage distances refer.
Rated impulse withstand voltage U_{imp}		The highest peak value of an impulse voltage of prescribed form 1.2/50, which does not cause breakdown under specified test conditions.
Rated operating current I_e		Current value stated by the manufacturer and considering the rated operating voltage Ue, the rated frequency, the rated
Rated operating voltage U_e		Voltage value to which utilization characteristics of the contactor refer, i.e. phase to phase voltage in 3-phase circuits.
Conventional thermal current I_{th}		Value of current the contactor can withstand with poles in closed position, in free air for an eight-hour period of duty without the temperature rise of its various parts exceeding the limits specified by the standards.
Making and breaking current		Current at contactor closing or opening.
Resistance to shocks		Requirements applicable that instance to vehicles, crane operation or switchgear slide-in module systems. At the quoted permissible „g" values, contactors must not undergo a change in switching state and overload relays must not trip.
Resistance to vibration		Requirements applicable to all the vehicles, vessels and other similar transport systems. At the quoted amplitude and vibration frequency values, the unit must be capable of achieving the required duty.
Times	Closing time	Time between energization of the coil and the moment the contacts of the first current path to be closed actually close.
	Opening time	Time between de-energization of the coil until the moment when the contacts of the last current path to be opened are open.
	Minimal operation time	Shortest control duration to ensure complete closing or opening of a contactor.
	Short time current permissible	Value of current which the contactor can withstand in closed position for a short time period and within specified conditions.
	Time constant	Ratio of inductance to the resistance: L/R = mH/Ohm = msec.
	Cycle duration	Total time of the on-load + off-load period.

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Table 3: Terms and ratings

3. Product offering

ABB offers a complete range of equipment for controlling and protecting electrical installations in buildings such as hotels, hospitals, shopping centers, office centers and residences.

ESB and EN installation contactors are designed to match the Modular DIN rail components (MDRC) for use in dedicated panels providing high safety and finger protection.

3.1 The ESB installation contactor range

The ESB range includes 4 ratings from 20 A to 63 A in 2 to 4-pole versions. The EN contactor range offers 3 types from 20 A to 40 A with an additional manual switch on the front.

								
Type		**ESB16..N**	**ESB20..N EN20..N**	**ESB25..N EN25..N**	**ESB40..N EN40..N**	**ESB63..N**	**ESB63-40N-DC-B**	**ESB100..N**
Opening/closing time		≤40 ms	≤40 ms	≤40 ms	≤40 ms	≤40 ms	≤7/≤20 ms	≤40 ms
Power consumption holding @50 Hz		2.5 V/A	2.5 V/A	4 V/A	4.5 V/A	4.5 V/A	1 W*	7.5 V/A
AC-1/AC-7a (A)		16	20	25	40	63	63	100
Modular Width		1	1	2	3	3	3	3/6
Accessories								
Auxiliary contact blocks 	2 NO	EH04-20N	EH04-20N	EH04-20N	EH04-20N	EH04-20N	EH04-20N	EH04-20N
	1 NO + 1 NC	EH04-11N	EH04-11N	EH04-11N	EH04-11N	EH04-11N	EH04-11N	EH04-11N
Distance piece 	up to 40 °C	Nothing has to be done						
	Between 40 °C and 55 °C			ESB-DIS**	ESB-DIS**	ESB-DIS**		
Covers 				ESB-PLK24	ESB-PLK40/63	ESB-PLK40/63		

* Holding with 0.5 x Uc
** If several contactors are mounted adjacently and the duty time is longer than one hour, every second contactor needs a distance piece, Type ESB-DIS (1/2 module). This is not necessary at an ambient temperature ≤ 40 °C .

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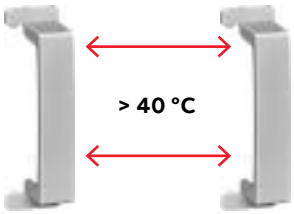
Table 4: ESB installation contactor range

3.2 Overview accessories for ESB installation contactors

Tool-free accessories
Speed up installation and maintenance time by mounting accessories tool-free to the contactor. Auxiliaries, security safety covers and space holders are easily and quickly installed

Distance pieces
If the ambient temperature in your control cabinet exceeds 40 °C and the duty time is longer than an hour, you need to use a distance piece between each second contactor for the ESB25..N to ESB63..N.



Sealing covers
Protect the security of your employees/customers installation with sealing covers. They are available in different sizes and can be clipped on easily.

Auxiliary contact blocks
ABB´s new range of auxiliary contact blocks are mounted on the left side of the contactors. Simply clip them on - no tools required! Valuable inventory space can be saved with the new auxiliary contact block which is designed to fit all contactors of the range.

4. Load types

Although the name suggests that their suitable application is limited only to motors, Installation Contactors can additionally be used for controlling and protecting other types of loads, such as heaters. When combined with an additional controller, the applications for Installation Contactors are even broader. The table below shows the tested ratings for ABB Installation Contactors.

Alternating current main ratings	Direct current main ratings
AC-1: Non-inductive or slightly inductive loads, resistance furnace	DC-1: Non Inductive or slightly inductive loads, resistance furnaces, heaters
AC-3: Squirrel-cage motors: starting, switching off motors during running, reversing	DC-3: Shunt-motors, starting, plugging, inching, dynamic braking of motors
AC-3e: Squirrel-cage motors with higher locked rotor current: starting, switching off motors during running, reversing	
AC-5a: Electric discharge lamps (ballast)	
AC-5b: Incandescent lamps	
AC-6A: Transformer switching	
AC-7a: Slightly inductive loads in household appliances: examples: mixers, blenders	
AC-7b: Motor-loads for household appliances: examples: fans, central vacuum	

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Table 5: Load types

The requirements for the installation contactors are fixed by the characteristics of the loads to be controlled, along with the application conditions. The making and breaking currents also have high importance.

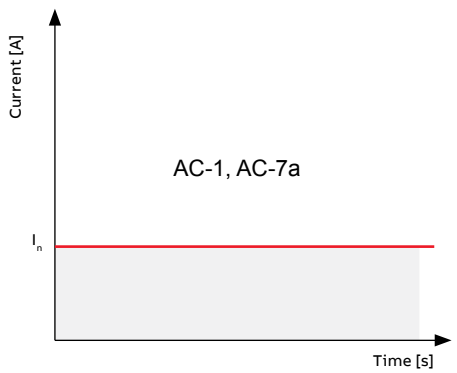
The making and breaking capacity of an installation contactor must comply with the requirements for the utilization category. These categories outline the conditions and number of operations over which the making and breaking currents must be switched without failure of the device. Furthermore, the conventional operational performance of the installation contactors must correspond to the conditions according to Table 4. The load test, which shows the circuit behavior under normal use, covers conventional operational performance. The installation contactor must be able to switch on and switch off under agreed conventional conditions and an agreed number of cycles without failure of the device.

4.1 AC-1 Non-inductive or slightly inductive loads (and AC-7a)

A typical application for the utilization category AC-1 is electric heating. Utilization category AC-1 covers all non-inductive and slightly inductive loads. AC-1 refers to non-inductive or weakly inductive loads (cos phi>0.95). An example of a low-inductance load in a household appliance would be a heater.

AC-7a refers to low-inductance loads for household and similar applications. An example of a low-inductance load in a household appliance would be a blender.

For this utilization category, the inrush current and the nominal current are the same, shown in below. This utilization category can cause installation contactors to generate excess heat, which can limit their rated capacity.



4.2 Motors

Due to their high inrush peaks, locked rotor currents, and high potential for overheating, motor loads represent one of the most demanding load types. The figures below show an overview of an across-the-line motor start-up. The starting current is a characteristic of the motor. The starting time is a function of the load torque, inertia and motor torque and is influenced by the motor technology. As the starting current ratio (6-13 x Ie) is higher than the rated operational current Ie, an excessively long starting or braking period can cause an overload (temperature rise) in the motor. This can create electromechanical stresses or damage the motor's insulation if it is not properly protected.

There are many different manufacturers represented on the market, selling at various prices. Not all motors have the same performance and quality as motors from ABB, for example. High efficiency enables significant savings in energy costs during the motors' normal endurance. In the IEC 60034-30 standard for rotating electrical machines, four different efficiency classes have been defined.

The classes are called IE1, IE2, IE3 and IE4, where motors belonging to IE4 are the most efficient. See the graph below for details. A low level of noise is something else that is of interest today, as well as the ability to withstand severe environments. There are also other parameters that differ. The design of the rotor affects the starting current and torque and the variation can be quite large between different manufacturers for the same power rating.

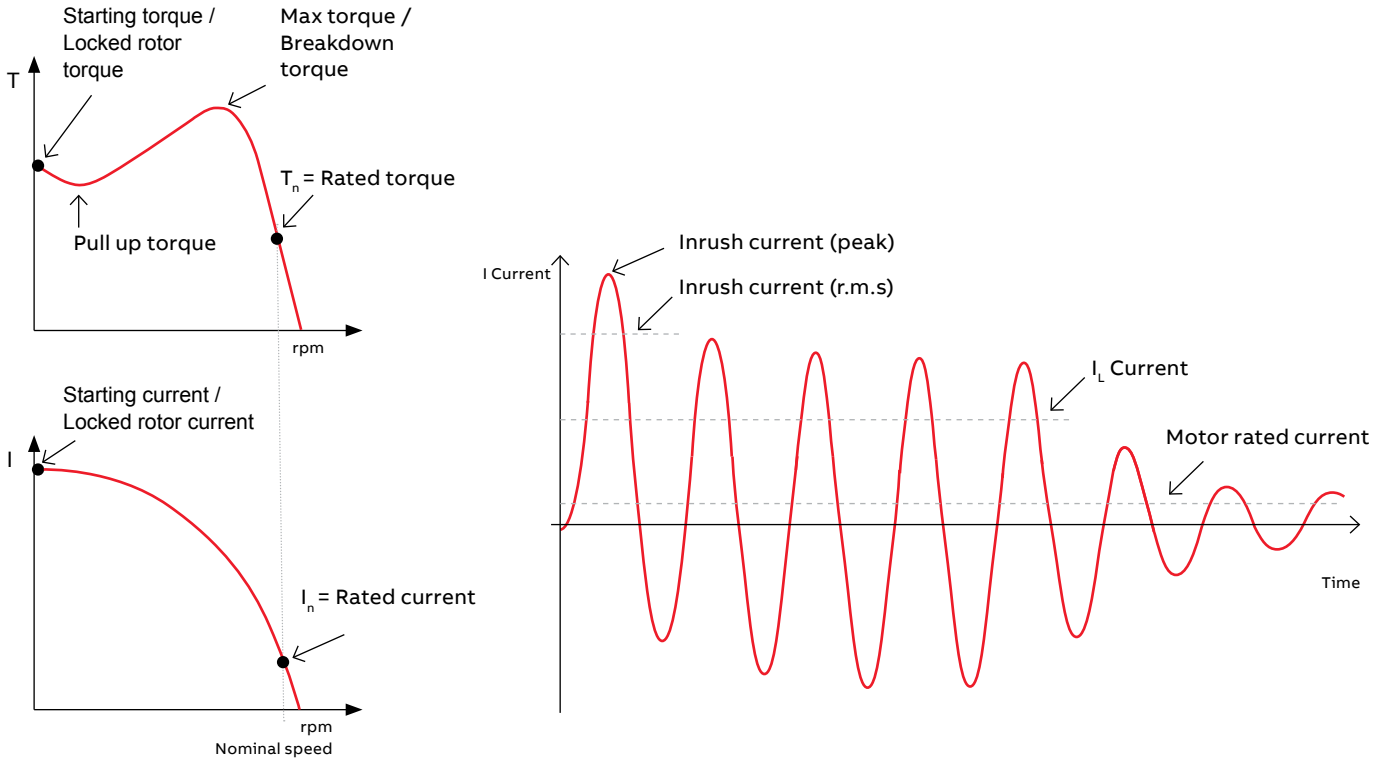


Figure 2: Diagrams of the different currents at the start-up of a motor.

4.2.1 About motors

Modern electrical motors are available in many different forms, such as single-phase motors, three-phase motors, brake motors, synchronous motors, asynchronous motors, special customized motors, two speed motors, three speed motors, and so on, all with their own performance and characteristics. For each type of motor there are various mounting arrangements, for example foot mounting, flange mounting or combined foot and flange mounting.

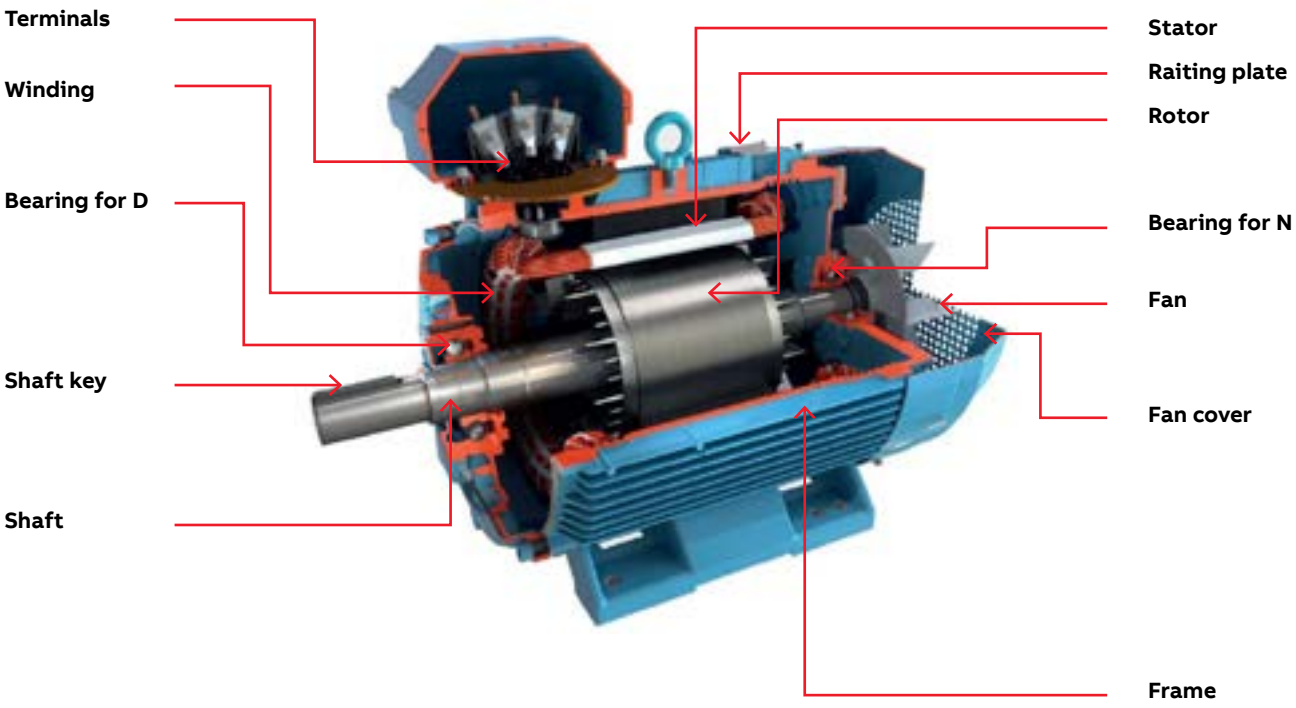
The cooling method can also differ, from the simplest motor with free air self-circulation to a more complex motor with totally enclosed air-water cooling with an interchangeable cassette type of cooler.

To ensure a long life for the motor it is important to select it with the correct degree of protection when operating under heavy-duty conditions in a severe environment.

The two letters IP (International Protection) state the degree of protection followed by two digits, the first of which indicates the degree of protection against contact and penetration of solid objects, whereas the second states the motor's degree of protection against water.

The end of the motor is defined in the IEC-standard as follows:

- The D-end is normally the drive end of the motor
- The N-end is normally the non-drive end of the motor



—
Figure 3: Inside a motor with all the main components.

For more information on the international motor efficiency standards and regulations and the new AC-3e utilization categories, please see our Application (here).

4.2.2 Squirrel cage motors

The squirrel cage motor is the most common type of motor on the market. It is relatively cheap, and the maintenance costs are usually low. There are many different manufacturers represented on the market, selling at various prices. Not all motors have the same performance and quality as, for example, motors from ABB.

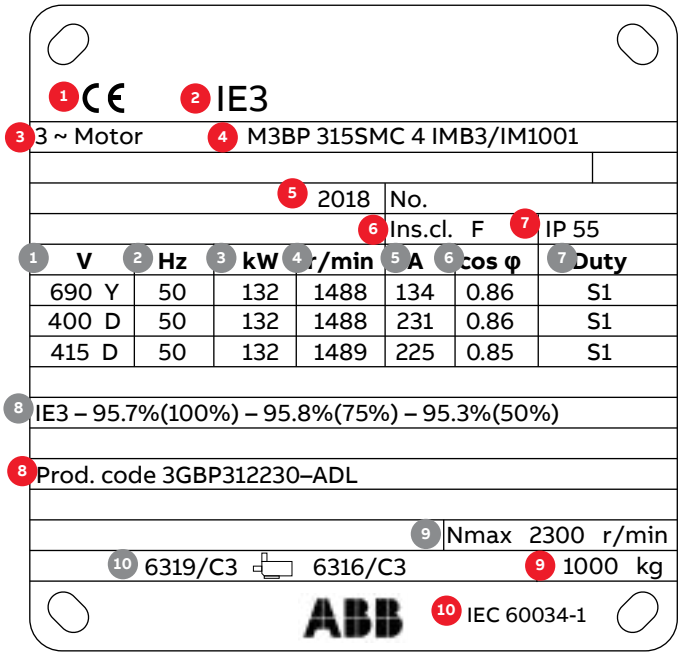
The starting current is a characteristic of the motor. The starting time is a function of load torque, inertia and motor torque and is influenced by the motor technology. As the starting current (6-13 x I_e) is always a lot higher than the rated operational current I_e, an excessively long starting or braking period will cause an overload (temperature rise) in the motor. This could lead to electromechanical stress or damage the motor's isolation.

The lifetime of an electrical engine is linked to the temperature stress. As a rough guide, the lifetime of the winding isolation is reduced by half each time the temperature exceeds 10°C. Even slight temperature increases can reduce the life time of an electrical engine significantly.

4.2.4 Rating plate of a motor

The rating plate details on a motor provide the user with information relating to the construction and performance characteristics of the motor. On the rating plate it is necessary to indicate the IE code and nominal efficiency of the motor at full load 100 %, 3/4 load 75 % and 1/2 load 50 %, as required by IEC 60034-30-1.

Here is an example of a rating plate:



Basic information:

1. Certification label
2. Efficiency Code – IE
3. Number of phases
4. ABB motor type
5. Manufacturing date
6. Insulation class
7. Degree of protection
8. Product code
9. Motor weight
10. IEC Standard

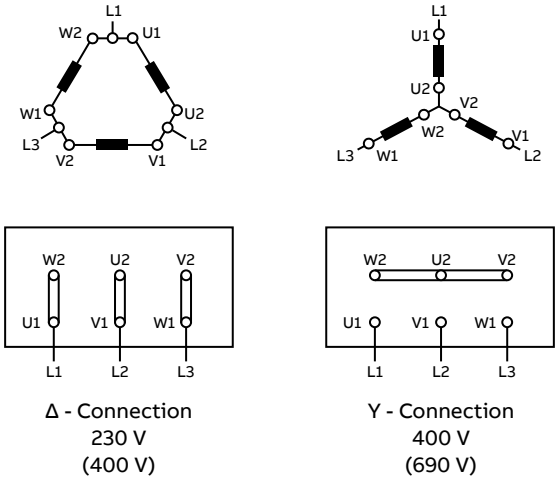
In-/output information:

1. Rated operating voltage
2. Frequency
3. Motor rated power
4. Full load speed
5. Rated operating current
6. Power factor
7. Service factor
8. Partial load efficiencies
9. Rotation speed
10. Drive end bearing type and amount of grease (where applicable) and non-drive end bearing type and amount of grease (where applicable)

4.2.5 Voltage

Three-phase single speed motors can normally be connected for two different voltage levels. The three stator windings are connected in star (Y) or delta (D) configurations. If the rating plate on a squirrel cage motor indicates voltages for both the star and delta connections, it is possible to use the motor for both 230 V AC, and 400 V AC as an example.
The winding should be a delta configuration if connected at 230 V AC and if the main voltage is 400 V AC, a star connection is used.

When changing the main voltage, it is important to remember that for the same power rating the rated motor current will change depending on the voltage level. The method for connecting the motor to the terminal blocks for star or delta connection is shown in the picture below.



Δ - Connection
230 V
(400 V)

Y - Connection
400 V
(690 V)

—
Figure 4: Voltage connection at the motor.

4.2.6 Current

The rated current of the motor, which can be found on the motor nameplate, is the current used by the motor when fully loaded and while up in full speed. An unloaded motor will use far less current and an overloaded motor will use more current. During a direct on-line start, the current used by the motor is far higher than the rated current.

This is usually between 6-13 times the rated current (for IE3 motors), but it can be more than 10 times the rated current. This can be clearly seen in a speed-current diagram for the motor. As the motor accelerates the current will drop and when reaching the rated speed, the current will have dropped to the rated current.

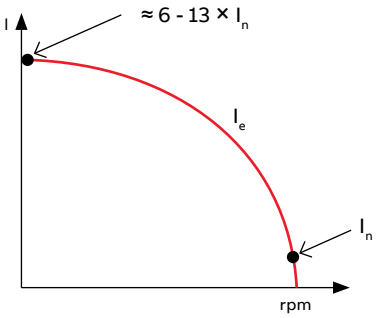


Figure 5: Diagram of the current vs. speed.

The required increase in efficiency of the IE3 motors is usually achieved by lower rated currents of the motors. In the small power ranges, the required increase in efficiency is greater, so that the deviation of the rated current is greater there. The higher the power, the lower the deviation of the rated currents compared to IE1 / IE2 motors.

Increasing starting current conditions

The starting current conditions (ratio of the starting current to the rated current, steady state, stalled rotor) increase with an increasing IE class.

Amplitude of inrush current

The amplitude of the inrush current from IE1 to IE2 and IE3 / IE4 depends on the following factors in the respective application:

- The structure of the motor
- Network conditions (in particular the size of the short-circuit power of the transformer and thus the voltage stability)
- The length and routing of the motor cables
- The switch-on phase position in the respective phase

4.2.7 Power factor

A motor always consumes active power, which it converts into mechanical action. Reactive power is also required for the magnetization of the motor, but it does not perform any action. In the diagram below the active and reactive power is represented by P and Q, which together give the apparent power S.
The ratio between the active power P (kW) and the apparent power S (kVA) is known as the power factor, and is often designated as the cos ϕ. A normal value is between 0.7 and 0.9. When running, where the lower value is for small or low loaded motors and the higher for large ones.

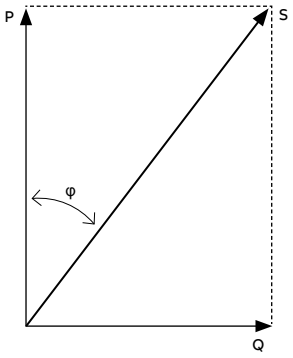


Figure 6: Diagram indicating P, Q, S and cos Φ.

4.2.8 Torque

The starting torque for a motor differs significantly depending on the size of the motor. A small motor, e.g., ≤ 30 kW, normally has a value of between 1.5 and 2.5 times the rated torque, and for a medium size motor, say up to 250 kW, a typical value is between 2 to 3 times the rated torque. Very large motors tend to have a low starting torque, sometimes even lower than the rated torque. It is not possible to start such a motor fully loaded, not even a direct online start.

T_n = Rated torque (Nm)
P_r = Rated motor power (kW)
N_r = Rated motor speed (rpm)

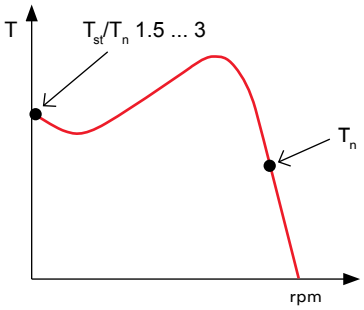


Figure 7: Diagram of the torque vs. speed.

Different load conditions

All motors are used for starting and running different applications. These applications will result in different load conditions for the motor. This is a direct braking force on the motor shaft. To be able to accelerate, the motor must be stronger than the load. The accelerating torque is the difference between the available motor torque and the load toque. Many starting methods will reduce the torque of the motor and thereby reducing the accelerating torque which will give a longer starting time. The accelerating torque = the available motor torque – the braking load torque. The load curve can have different characteristic depending on the application. Some of the common load types can be seen below.

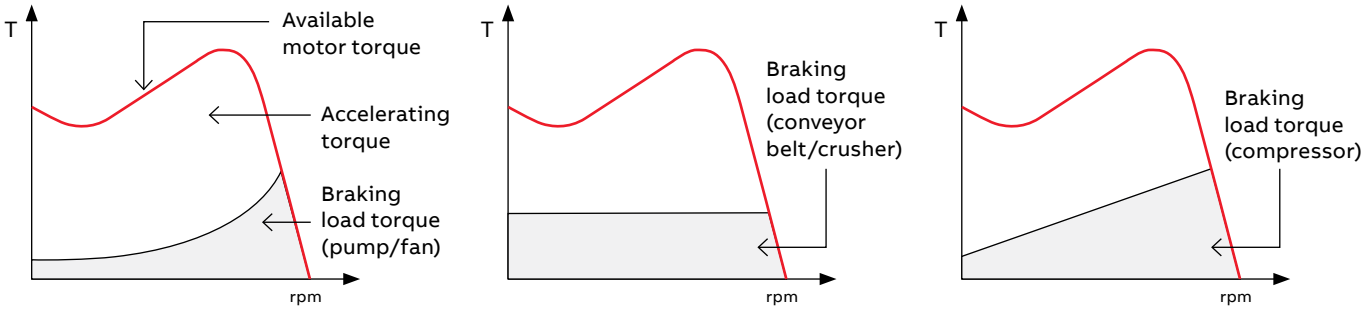


Figure 8: Diagram of the torque vs. speed for different load conditions.

Many applications are started unloaded, and the load is applied first when the motor has reached the rated speed. This will reduce the load torque to about 10-50% of the load torque of a loaded start.

Manual motor starters are well suited for both the control and protection of motors, including high-efficiency types. Since the tests for IEC utilization category AC-3 and UL/CSA “AC Motor” have yet to be fully harmonized, manual motor starters carry both ratings to ensure international acceptability.

4.2.9 Starting methods

The most common motor starting methods are direct-on-line and star-delta starting.
Connection transients It is important to remember that the term 'starting current' refers to a steady-state root-mean-square (rms) value. This is the value measured when, after a few cycles, the transient phenomena have died out.

4.2.9.1 Direct-on-line (DOL) starting

The simplest way to start a squirrel cage motor is to connect it directly to the mains supply. In this case, a switch gear e.g. a contactor is the only starting equipment required. However, the limitation of this method is that it results in a high starting current, often several times the rated current of the motor. Also, the starting torque is very high, and may result in high stresses on the couplings and the driven application. Even so, it is the preferred method except when there are special reasons for avoiding it.

4.2.9.2 Star-delta starting

If it is necessary to restrict the starting current of a motor because of supply limitations, the star-delta (Y/Δ) method can be employed. When a motor wound for 400 V/Δ, for instance, is started with winding Y connected, this method will reduce the starting current to about 30 % of the current reached with DOL, and the starting torque will be reduced to about 25 % of its DOL value. However, before using this method, it must be determined whether the reduced motor torque is sufficient to accelerate the load over the motor's speed range.

4.3 AC-5a Switching of discharge lamps

Utilization category AC-5a covers glow-discharge lamps. This includes high-pressure discharge lamps, halogen metal vapor lamps, fluorescent lamps with EVG (Electronic ballast) and LEDs with EVG.
A sodium vapor high-pressure lamp has a starting current of approx. 25 % above the nominal current, which can last for a period of 6 to 10 minutes. The start process is shown in below.

A mercury vapor high-pressure lamp has a similar approach behavior; however, this approach lasts about 5 minutes and has a starting current of approx. 40 % above the nominal current. Figure below shows this approach behavior.
Halogen metal vapor lamps have a similar approach behavior with a 3-to-5-minute duration and a 40 % inrush peak.
The activation behavior of a fluorescent lamp with EVG and a compact fluorescent lamp are similar and consist of an inrush current peak up to the 10 times the nominal current. This inrush current peak is a result of the memory condenser of the EVGs.
LEDs also utilize an EVG, and have similar making and breaking capacities to fluorescent lamps.

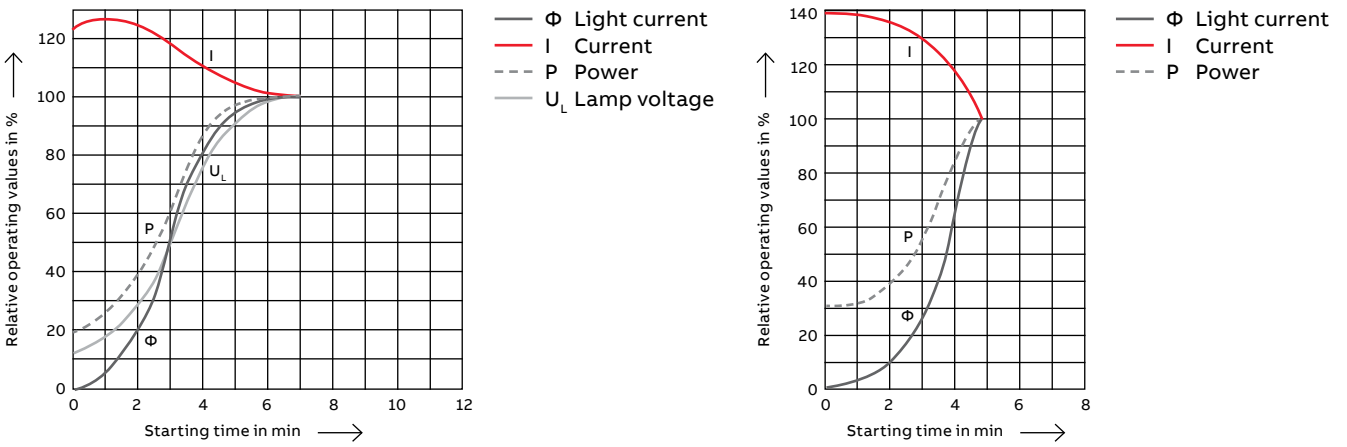


Figure 9

The switching of lamps covered by utilization category AC-5a can be difficult due to the high inrush current putting burden on the switching devices. In addition to the higher inrush currents, the approach times for high-pressure discharge lamps must also be taken into consideration.

4.4 AC-5b Switching of incandescent lamps

Utilization category AC-5b covers electric light bulbs, halogen electric light bulbs and mixed lamps.
The load is highest at start for electric light bulbs, because in their cold state the glow filament has a very small ohmic resistance, leading to an inrush current peak. This inrush current peak can equate to the 15 times the nominal current but fades within milliseconds back to the nominal current. A mixed light lamp behaves like an electric light bulb, again caused by small ohmic resistance causing a high inrush current peak.

The difference between utilization category AC-5b and utilization category AC-5a is based on the fact that the loads under the utilization category AC-5b have inrush currents lasting only a few milliseconds, making the requirements for the switching devices lower than for the utilization category AC-5a. Utilization category AC-5a requires, in addition to the higher inrush current, a longer starting duration of up to 10 minutes, during which the starting current can amount to a value of 40 % above the nominal current.

4.4.1 Lamp load table

Please note that switching lamps is a capacitor load application where high inrush current peaks could occur. These are influenced by the length and cross section of the wire as well as the type of power supply unit and specifications of the lamp brand. For example, long cables can increase the possible number of lamps per pole. The table shows the allowed max. current, at 230 V AC, for one pole and considers already the startup current peaks.

The following selection table shows **the current values** and the maximum switchable capacitor load for compensated lamps. These two limits have to be considered in the selection of contactors.

		ESB16..N	ESB20..N EN20..N	ESB25..N EN25..N	ESB40..N EN40..N	ESB63..N	ESB100..N
Permitted compensating capacity per phase Cmax [µF]		45	75	100	350	500	650
Lamp types		**Maximum load of the current paths during switching of electric lamps I_e [A]**					
Incandescent and halogen lamps		4	6	7	20	30	45
Mixing lamps without ballast		4	6	7	20	30	45
Fluorescent lamps with conventional ballast	single lamp uncompensated	14	18	22	36	56	90
	single lamp parallel compensated	2	3	3.5	10	15	22
	series compensation, duo circuit	14	18	22	36	56	90
Fluorescent lamps with electronic ballast or CFL		4	6	7	20	30	45
LED lamps		4	6	7	20	30	45
High pressure mercury-vapor lamps	single lamp without compensation	7	9	11	18	28	45
	single lamp with parallel compensation	2	3	3.5	10	15	22
Halogen metal-vapor lamps	single lamp without compensation	7	9	11	18	28	45
	single lamp with parallel compensation	2	3	3.5	10	15	22
High pressure sodium-vapor lamps	single lamp without compensation	7	9	11	18	28	45
	single lamp with parallel compensation	2	3	3.5	10	15	22
Low pressure sodium-vapor lamps	single lamp without compensation	7	9	11	18	28	45
	single lamp with parallel compensation	2	3	3.5	10	15	22

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Table 6: ESB installation contactor range

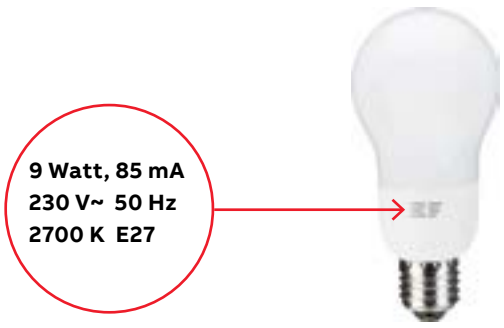
Example for lamp load calculation

Due to many varieties of lamps and ballasts we advise to take the current load as base for reference. The lamp table considers already the inrush peaks and other lamp parameters. Please see the following examples for a reliable project lamp calculation.

Fluorescent lamp with conventional ballast, uncompensated the lamp operating current I = 1.5 A, voltage U = 230 V
1 pole of ESB25..N can be loaded with max. 22 A, see lamp table => 22 A/1.5 A = 14.66 => 14 lamps
1 pole of ESB20..N can be loaded with max. 18 A, see lamp table => 18 A/1.5 A = 12 lamps

Please use the referring value in the table stated above and divide it with the current stated on the lamp.
This will lead to the number of lamps which can be switched.

Example with picture: ESB25..N used for LED lamps: 7 A (= 7000 mA) / 85 mA = 82.23 => 82 lamps



4.4.2 Lamp load table

When using mixed lamp loads, many facts must be considered in order to make an accurate consideration. These include the technical data of the ballasts or drivers used, especially the inrush current.

There are other factors that must be considered in the calculation, such as compensation. Compensation means that a capacitor compensates for the reactive power of the lamps. This is often used with several HPS lamps, which are usually compensated in parallel, for this the values in the table "High pressure sodium lamps - single lamp with parallel compensation" can be used as a reference. When using single lamps without compensation and LED lamps, the LED values can be used as a reference.

If different lamps without drivers are used, the values "Mixing lamps without ballast" line can be used from the table above. If different lamps with drivers are used (e.g., LED or fluorescent lamps), the values for the LED lamps can be used as a reference value. If different compensated lamps are used, each individual case must be considered.

It is important to note that each application must be considered individually. In some cases, it is recommended to measure the rated currents and inrush currents in a real environment beforehand, because cable lengths can also influence inrush currents.

4.5 AC-7a and AC-7b Household appliances

The norms of the utilization categories AC-7a and AC-7b are standardized in IEC 61095. The definitions of these utilization categories are shown in Table 5.

IEC 61095 applies to electromechanical air brake contactors for household and similar purposes provided with main contacts intended to be connected to circuits the rated voltage of which does not exceed 440 V a.c. (between phases) and with rated operational currents less than or equal to 63 A for utilization category AC-7a and 32 A for utilization categories AC-7b and AC-7c, and rated conditional short-circuit current less than or equal to 6 kA.

Utilization categories [a]	Typical applications
AC-7a	Slightly inductive loads
AC-7b	Motor loads [b]
AC-7c	Switching of compensated electric discharge lamp control [c]

[a] Contactors may have other utilization categories, in which case they shall comply with the requirements of IEC 60947-4-1 for such categories.
[b] The AC-7b category may be used for occasional inching (jogging) or plugging for limited time periods: during such limited time periods the number of operations should not exceed 5/min or more than 10 in a 10-minute period
[c] This category is similar to a capacitive switching category AC-6b as defined in IEC 60947-4-1 for the switching of capacitor banks, the characteristic being very dependant on the capacitance value of the lamp circuit.

—
Table 7: AC-7a and AC-7b overview

For the conventional operational performance, the requirements for the installation contactor are shown in the table below:
Conventional operational performance – Making and breaking

Categories	Making and breaking conditions					
	I_c/I_e	U_r/U_e	Cos ϕ	On-time [a] in s	Off-time in s	Number of operating cycles
AC-7 a	1.0	1.05	0.80	0.05	[b]	30 000
AC-7b	[d]	[c]	0.45	0.05	[b]	30 000
AC-7c [e]	1.0	1.05	0.90	0.05	[b]	30 000

I_c is the current made and broken, expressed in r.m.s. symmetrical values, but it is understood that the actual peak value in the making operation may assume a higher value than the symmetrical peak value
I_e is the rated operational current
U_r is the power frequency recovery voltage
U_e is the rated operational voltage
Cos ϕ ist the power factor of the test circuit

a Time may be less than 0,05 s provided that contacts are allowed to become properly seated before re-opening.
b These OFF times shall be not greater than the values specified in Table 8.
c Ur/Ue = 1,0 for making and Ur/Ue = 0,17 for breaking.
d Ic/Ie =6,0 for making and Ic/Ie = 1,0 for breaking.
e The test shall be done on a specific test circuit (see 9.3.3.5.2, item d) 2))

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Table 8: AC-7a and AC-7b current, voltage and time

The utilization category AC-7a can be compared to the utilization category AC-1, but the slightly inductive loads find their use in household conditions, and the switching devices must therefore conform to the standards of the IEC 61095. The motor loads, which are covered under the utilization category AC-7b, correspond to motors covered under the utilization category AC-3, but under household conditions.

4.6 DC-1 Non-Inductive or slightly inductive loads, resistance furnaces, heaters

The DC1 utilization category of a contactor or relay tells how many amperes of DC current are permanently conducted across the contacts and safely disconnected when the load is a resistive or low inductive load.In the case of DC currents, the magnitude of the DC voltage must be considered. When a DC circuit is disconnected, an arc is initiated which can damage the contacts of the contactor or even cause a fire. Reliable separation of the dangerous arc is achieved by maintaining appropriately large clearances and multiple separations.

The time constant L/R of DC1 loads should be less than 1ms. This means that the settling time of the circuit connected by the contactor must be very short. The transient time of a circuit is determined by the relationship between its inductance and its resistance. The greater the proportion of R resistance, the shorter the settling time and thus the time constant (e.g., less than 1 ms). The larger the inductance L, the longer the settling time and i.e. longer time constant above 1ms.

The characteristic features of DC1 loads are short settling times, which is only possible with low inductance and a predominantly resistive resistance. Some typical applications could be heating devices, electric heating rods, resistors, incandescent lamps.

4.7 DC-3 Shunt-motors, starting, plugging (1), inching (2), dynamic braking of motors

The utilization category DC-3 of a contactor or relay describes how many amperes of DC current can be permanently conducted across the main contacts and what DC voltage can be safely and reliably switched off if the load is an inductive load, e.g., a DC machine. Typical applications are switching of induction coils, electromagnets, DC electric motors.

DC3 utilization categories include the sizing of pure load torques such as starting, reversing, jogging, counter-current braking, resistance braking. Common applications are switching shunt motors, shunt machines, for example, asynchronous motors, so such electric motors are often found in, for example, conveyor belts, hoists with fluctuating load torques.

If a DC circuit is interrupted, a dangerous arc will occur. Safe separation of the dangerous arc is achieved by maintaining appropriately large air gaps, multiple separation, and adapted device selection.

4.8 Summary of the utilization categories

A complete overview of the above mentioned utilization categories and their inrush current is shown in the table below:

Utilization category		Inrush current value	Inrush time
AC-1	Resistive loads AC-1	Inrush current = operating current	
AC-2	Slip-ring motors, plugging, inching	Multiple 6...7 of operating current	4...6 s
AC-3	Squirrel-cage motor loads		
	standard motors	Multiple 6...7 of operating current	4...6 s
	high performance motors	Multiple 8 of operating current	
	high efficiency motors	Multiple 10...17 of operating current	
AC-5a	Switching of lamp loads fluorescent lamps, sodium vapor lamps etc.	Multiple 3...6 of operating current	
AC-5b	Switching of lamp loads incandescent lamps	Multiple 15...20 of operating current	
AC-6A	Transformer switching	Multiple 15...20 of operating current	
AC-7a	Resistive and slightly inductive loads for household	Inrush current = operating current	
AC-7b	Motor loads for household	Multiple 6...7 of operating current	

—
Table 9: Overview of the inrush currents of the utilization categories

4.9 Mixed Loads

The switching of mixed loads entails that multiple requirements for the installation contactors are met and are typically required for houses and flats. The application of installation contactors in households follows special standards, so here the requirements for the utilization categories AC-7a and AC-7b must be respected. A more specialized application includes installation on a ship. Mixed loads include a variety

of different inrush currents. As all loads are centrally controlled in the switch cabinet, the switching devices should be of the same design. This is offered by the installation contactors because these are built in the MDRC design.
The installation contactors also offer the possibility to be integrated into the existing power supply system of a house, because they are tested with a voltage of 230 V. The number of contacts, and therefore the connection possibilities, also plays an important role.

5. Selection criteria with ABB e-Configure

ABB's e-Configure online product catalog helps customers search, find, and individually configure low-voltage products. It covers ABB's entire low-voltage product portfolio.

e-Configure leverages ABB's engineering and product expertise for user guidance, enabling intuitive navigation through our product portfolio. If needed, the tool offers recommendations during the selection process to make the process as efficient as possible. Customers can search by part number, type, or description, as well as make selections based on product categories and filtering options.

To make the work as clear as possible, there is the possibility to easily create new BOMs or adapt existing lists, these can be exported as Excel or PDF files. Your advantages:

- More than 100,000 low-voltage products and systems are in the online product catalog.
- With just a few clicks, devices and accessories can be selected from the ABB portfolio and customized, as-assembly-friendly solutions configured
- Only suitable accessories can be selected
- Export the configuration as Excel or PDF file

By integrating the ABB e-Configure platform into the EPLAN Data Portal, ABB components can be easily selected and configured within EPLAN projects.

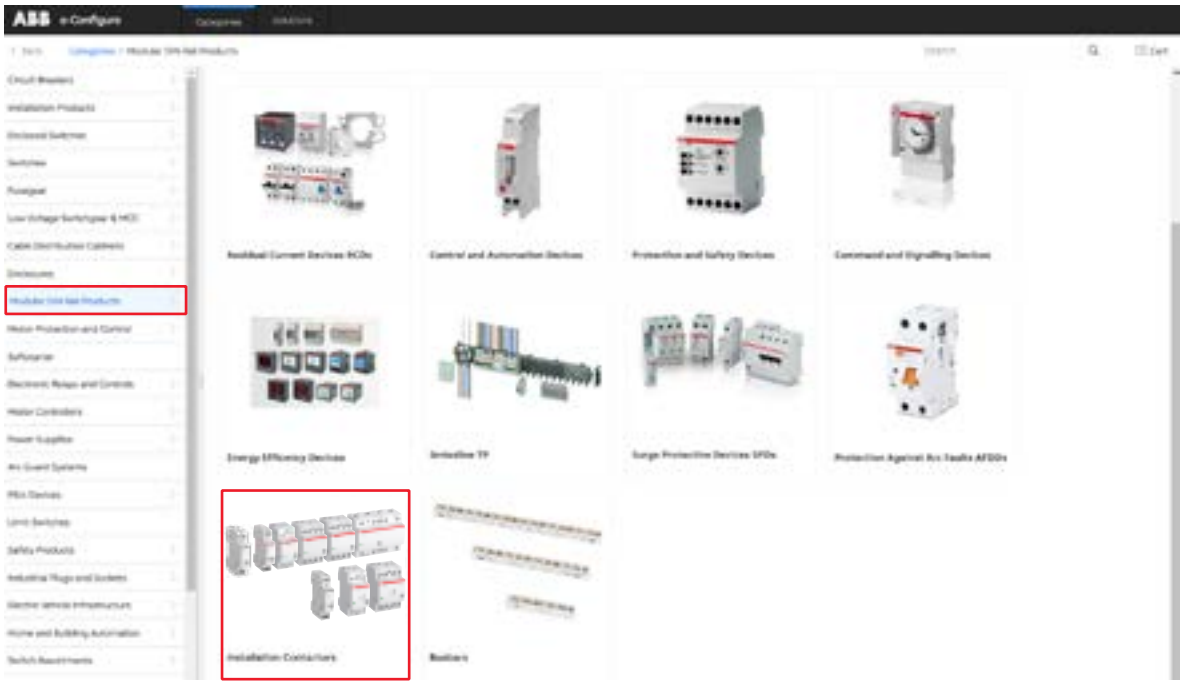

Figure 10: Screenshot from e-Configure

The customer can select the suitable installation contactor for his application. The program guides the user intuitively through the product selection and already provides the possible choice. Here the customer gets a quick overview of the different device types and can make his selection at the same time.

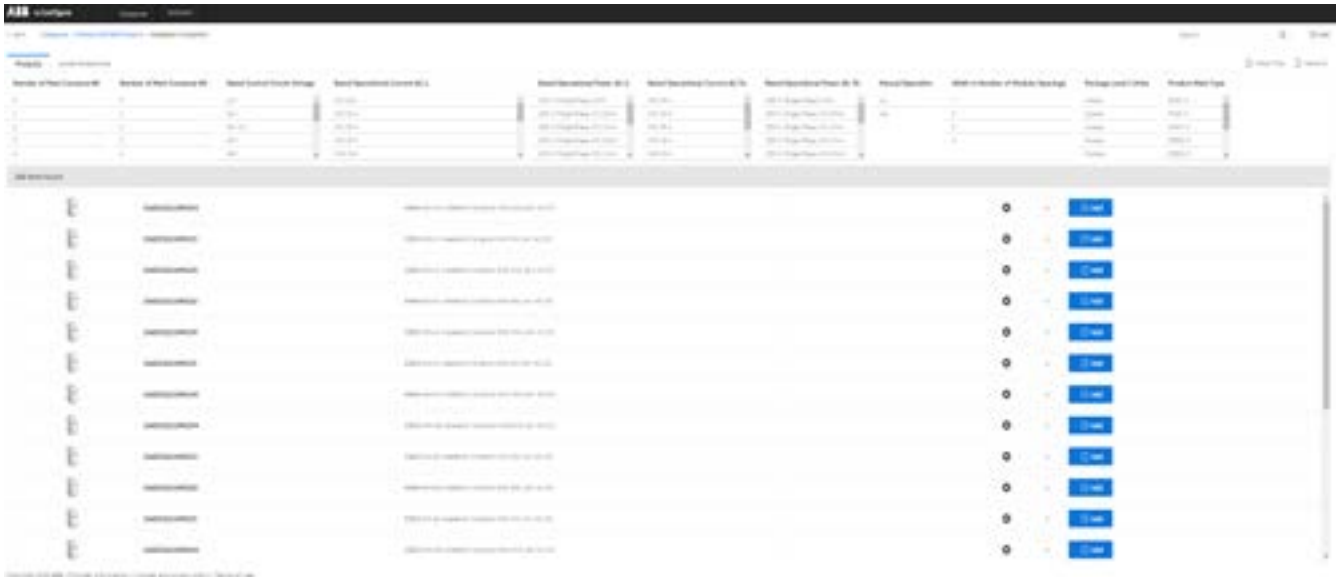

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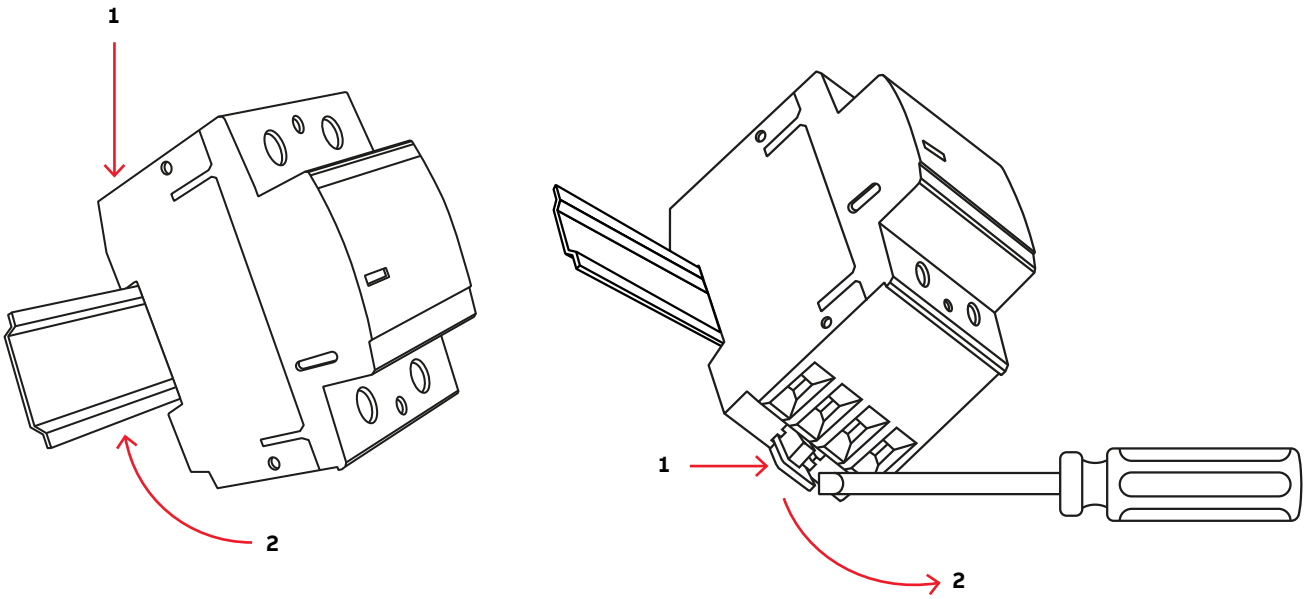
Figure 11

6. Installation and commissioning

6.1 Mounting

ESB contactors can be mounted fixed on a 35 mm top hat rail according to DIN EN 60715 (35 x 15 or 35 x 7.5 mm).



Mounting

Place the device on the upper edge of the 35 mm DIN rail and push it downwards (1), until it snaps onto the lower edges of the DIN rail (2).

Disassembly

To disassemble, use a slotted screwdriver to push down the clip on the lower part of the device (1) and remove the contactor with one movement (2).

—

Figure 12: Mounting of a manual motor starter.

6.1.1 Mounting position and minimum distances

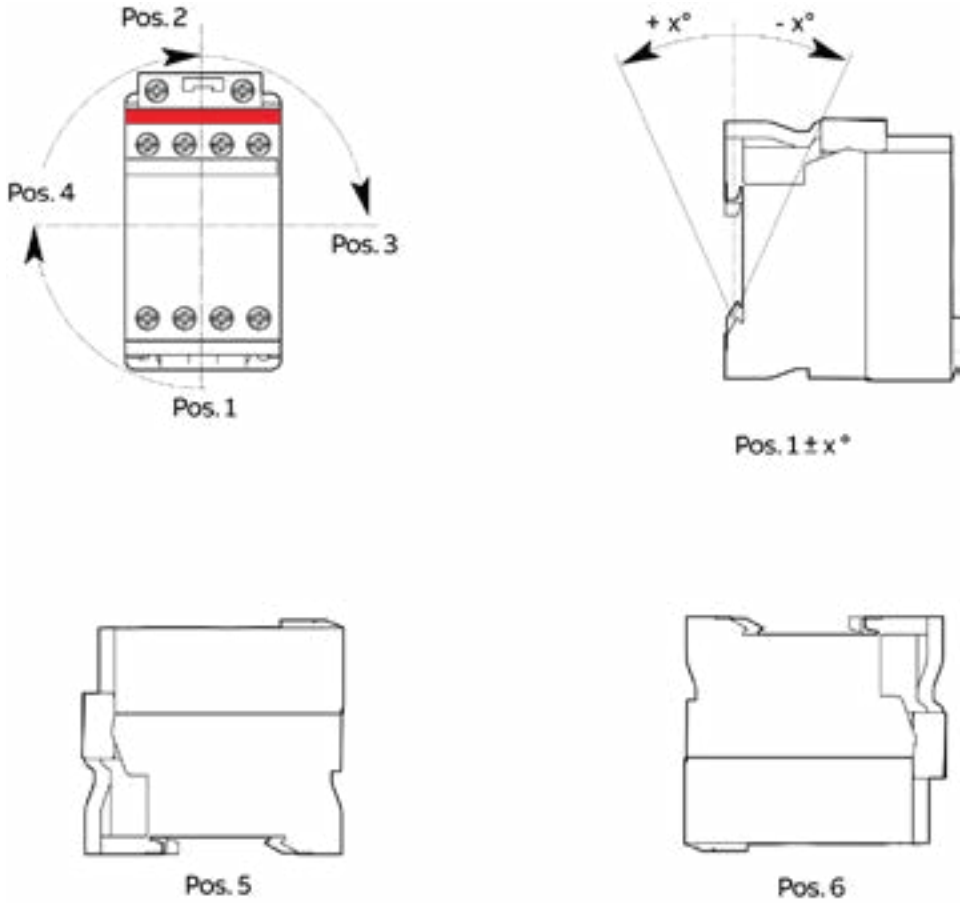
The following table shows the minimum distance to other units of the same types and also to an electrically conductive wall (earthed).

By ambient temperature: ≥ 40 °C and duty time ≥ 1 hours	ESB-DIS*
ESB16-xxN /ESB20-xxN, EN20-xxN, ESB100-xxN	not necessary
ESB25-xxN/EN25-xxN, ESB40-xxN/EN40-xxN, ESB63-xxN	must be used after each 2nd contactor

* An accessory „ESB-DIS spacer“ to be ordered separately.

6.1.2 Mounting positions

Mounting positions 1 until 6 are permitted for the ESB Contactors.



—
Figure 13

6.2 Connection

The ESB Contactors are available with screw terminals. The following diagram shows the assembly of a cable in a contact block:

- Insert the cable into the opening provided after the cross-sections.
- Using the screwdriver provided for this purpose, tighten the screw according to the table below.

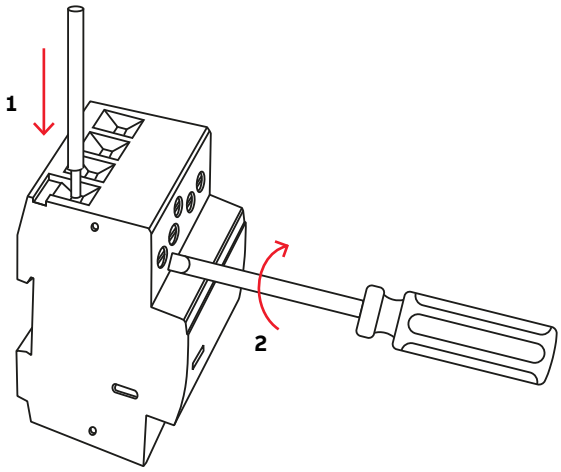


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Figure 14

6.2.1 Connection cross-sections for screw connection

The following tables show the permissible conductor cross-sections for the connections.

ESB16-xxN ESB20-xxN EN20-xxN		1.2 Nm	ø 5.0 mm	PZ1	1 x 1 ... 10 mm² 2 x 1 ... 4 mm²	1 x 1 ... 6 mm² 2 x 1 ... 4 mm²	1 x 1 ... 6 mm² 2 x 1 ... 1.5 mm²	10 mm
ESB25-xxN EN25-xxN		1.0 Nm	ø 5.0 mm	PZ1	1 x 1.5 ... 10 mm² 2 x 1.5 ... 4 mm²	1 x 1.5 ... 10 mm² 2 x 1.5 ... 4 mm²	1 x 1.5 ... 10 mm² 2 x 1.5 mm²	10 mm
ESB40-xxN EN40-xxN ESB63-xxN		2.5 Nm	ø 7.5 mm	PZ2	1 x 1.5 ... 25 mm² 2 x 1.5 ... 10 mm²	1 x 1.5 ... 16 mm² 2 x 1.5 ... 10 mm²	1 x 1.5 ... 16 mm² 2 x 1.5 ... 10 mm²	13 mm
ESB100-xxN		3.0 Nm	ø 7.5 mm	PZ2	1 x 10 ... 50 mm²	1 x 10 ... 35 mm²	1 x 10 ... 35 mm²	15 mm
EH04-xxN		0.9 NM	ø 5.0 mm	PZ1	1 x 1 ... 4 mm² 2 x 1 ... 1.5 mm²	1 x 1 ... 2.5 mm²		≤ 1.5 mm² => 7 mm > 1.5 mm² => Upper: 17 mm Lower: 9 mm
16 A, 20 A		0.9 Nm	ø 5.0 mm	PZ1	1 x 1 ... 4 mm² 2 x 1 ... 1.5 mm²	1 x 1 ... 2.5 mm² 2 x 1 ... 1.5 mm²	1 x 0.75 ... 2.5 mm² 2 x 0.75 ... 1 mm²	7 mm
25 A, 40 A, 63 A, 100 A						1 x 1 ... 4 mm² 2 x 1 ... 2.5 mm²		

—
Table 10

6.3 Technical requirements

The technical requirements for switching devices, including installation contactors, are since electric circuits require the possibility for interruption. The contacts of the installation contactors consist of metallic, conductive materials. These contacts must fulfil two duties: the opening and closing of the circuit (moving contact), and the transference of the electric energy as freely of loss as possible (fixed contact). The demands for the fixed contact include a low voltage drop and, for the moving contact, a light and low-wear operation. In the following section the temperature requirements of the contacts, which is fixed in the norm IEC 60947-1, will be explained.

6.3.1 Temperature

A technical requirement on switching devices includes the temperature of the touchable parts and connections. The temperature development which is fixed after the norm IEC 60947-1 is dependent on the surrounding ambient temperature. The range of the surrounding temperature in which the installation contactor was tested includes from -25 to +55 °C, with an air humidity of max. 95 %.

The heating of the installation contactor is a result not only of the surrounding ambient temperature, but also of the connected load, which must be added to the surrounding temperature. The temperature of the installation contactor can be influenced by ventilation and cooling, so that the temperature can be reduced by heat removal. If no sufficient heat removal exists, as the material heats up a steady increase in the resistance of the contact results. The increased resistance of the contact and of the installation contactor increases the temperature.

The maximum allowed temperatures of the surfaces and connections is fixed in the norm IEC 60947-1. The temperature-rise limits of the terminals are shown for different materials in the Table 1. Table 2 contains the temperature-rise limits of different accessible parts. The surface temperature is measured directly on the product. The surrounding ambient temperature (air) is measured around the product and does not correspond to the product surface temperature.

Terminal material	**Temperature-rise limits [a, c] in Kelvin [K]**
Bare copper	60
Bare brass	65
Tin plated copper or brass	65
Silver-plated or nickel-plated copper or brass	70
Other metals	b

as the use in service of connected conductors significantly smaller than those listed in Tables 9 and 10 could result in higher terminals and internal part temperatures and such conductors should not be used without the manufacturer's consent since higher temperatures could lead to equipment failure.
b Temperature-rise limits to be based on service experience or life tests but not to exceed 65 K.
c Different values may be prescribed by product standards for different test conditions and devices of small dimensions, but not exceeding by more than 10 K the values of this table.

—
Table 11: Table 2 from IEC 60947-1 Temperature-rise limits of terminals

Accessible parts	**Temperature-rise limits a in Kelvin [K]**
Manual operating means:	
Metallic	15
Non-metallic	20
Parts intended to be touched but not hand-held:	
Metallic	30
Non-metallic	40
Parts that need not be touched during normal operation b:	
Exteriors of enclosures adjacent to cable entries:	
Metallic	40
Non-metallic	50
The exterior of enclosures for resistors	200b
Air issuing from ventilation openings of enclosures for resistors	200b

A: Different values may be prescribed by product standards for different test conditions and devices of small dimensions but not exceeding by more than 10 K the values of this table.
B: The equipment shall be protected against contact with combustible materials or accidental contact with personnel. The limit of 200 K may be exceeded if so, stated by the manufacturer. Guarding and location to prevent danger is the responsibility of the installer.

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Table 12: Table 3 from IEC 60947-1 Temperature-rise limits of accessible parts.

The maximum temperatures are calculated as follows:
Temperature rise + ambient air temperature = maximum temperature limit

Example:
- the air temperature is 30 °C
- the temperature rise of the terminal is 50 °C
- the temperature rise of the accessible parts is 40 °C
- the terminal material is bare copper
- the accessible part is the product surface, which need not be touched for normal operation and is non-metallic

Temperature of the terminal:
50 °C + 30 °C = 80 °C

Temperature limit of the terminal:
60 °C + 30 °C = 95 °C

Result: The terminal temperature of 80 °C is under the temperature limit of 95 °C and is therefore acceptable.

Temperature of the product surface:
40 °C + 30 °C = 70 °C

Temperature limit of the product surface:
50 °C + 30 °C = 80 °C

Result: The product surface temperature of 70 °C is under the temperature limit of 80 °C and is therefore acceptable.

6.4 Installation instructions

Installation instructions for Installation Contactors can be accessed from the ABB Download Center https://library.abb.com. All Categories > Products > Low Voltage Products and Systems > Control Product > Installation Contactors

6.5 2D drawings and 3D models

2D and 3D drawings for Installation Contactors and accessories can be accessed from the ABB CAD download portal (http://abb-control-products.partcommunity.com/portal/portal/abb-control-products).

7. Additional Information

7.1 Listing of additional documents

Document Kind, Title	Document No.	
Application Note Installation contactors for EV Charging	1SAC200296W0001	LINK
Control and protection products for Household Applications	1SBC101441D0201	LINK
Low voltage control and protection products in high altitudes	1SAC200234W0001	LINK

8. Glossary

AC	Alternating current
Active power	The power consumed by the motor is converted into mechanical action.
Ambient temperature	Ambient temperature is the temperature of the water, air or surrounding medium where the equipment is used or stored.
DC	Direct current.
Delta connection	The connection type of a motor where the windings are connected in a delta.
Efficiency	The ratio between mechanical output and electrical input. The percentage given indicates how effective the motor is at converting electrical energy to mechanical energy.
Frequency	The number of periodic cycles per unit of time.
I_e	The tripping characteristic of the instantaneous short-circuit releases is based on the rated operational current I_e.
LED	Light-emitting diode.
Operational voltage	The voltage that is fed to the motor, is usually 3-phase.
U_e	Rated operation voltage, see also Chapter: 2.2.1 Rated operational voltage (Ue).

9. Revisions

Revision	Page	Description	Date
1.0	45	ESB installation contactor Guide, first revision	04.2023

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