



APPLICATION NOTE

# Control and protection products for household applications



- Requirements for devices in household appliances.

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**Proper use of control and protection products in household appliances.**

**Electromechanical devices are typically designed for specific applications. The correct design of the product is based on the specific standard. Therefore, it is essential to follow this standard to ensure proper functionality and safety.**



# Scope

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

This application note has been written as a general guide for people working with the development and construction of household appliances.

ABB participates in international groups and task forces that work on updating relevant product standards. ABB is constantly monitoring changes in the market for low voltage products to ensure timely adaptation of relevant products to the requirements of many application cases.

ABB control and protection products are typically designed for industrial applications, but in this document, we would like to show that a dedicated part of the relevant portfolio is designed to be used in household appliances. All the information provided in this application note is only general and each application must be handled as a specific case. Be sure to always follow all the national and local installation regulations/codes for your specific application.

## **Harmonization of the standard in Europe and North America**

In North America, IEC 60335-1 has been used as the basis for a standard by the United States (UL 60335-1), Canada (CAN/CSA-C22.2 No. 60335-1), and Mexico (NMX-J-521/1-ANCE). In the United States, UL 60335-1 is harmonized with IEC 60335-1 as part of participation in the HOUS category of the IECEE CB Scheme. However, not all Part 2 standards are recognized in the United States. The requirements of Part 2 take precedence over the general requirements specified in Part 1.

In Europe, the harmonized standard is EN 60335-1 and specifies how equipment can comply with European directives, such as the Low Voltage Directive. Unlike the United States, the EU recognizes most, if not all, of the more than 100 Part 2 standards that apply to specific products.

# Household appliance standard IEC 60335

The IEC 60335-1 international standard requires an even higher level of fire safety for electrical appliances operated unattended in the household compared to general industrial standards. To achieve this, the requirements for the glow wire resistance of plastics used to insulate or support current-carrying components have been tightened. Fires in household appliances can be caused by overcurrents (glowing components), faulty components, poor electrical connections, arcing of switching contacts, etc.

The household appliance standard IEC 60335, "Safety of household and similar electrical appliances", is split into two parts:

- Part 1** (IEC 60335-1 "Household and similar electrical appliances - Safety - Part 1: General requirements") is the basis, covering the safety of household and similar electrical appliances whose rated voltage does not exceed 250 V for single phase appliances and 480 V for three phase appliances, including direct current powered appliances and battery powered appliances.
- Part 2** (IEC 60335-2-xx) is the standard that specifies additional requirements for some specific types of equipment and governs the special characteristics and definition. These standards define the test procedures, tests for improper operation, and clearances with pollution degree specifications. Due to the variety of appliances that can be found in a household, more than 100 types of appliances were mentioned in Part 2.

| Standard       | Household and similar electrical appliances - Safety – Part 2 Title   |
|----------------|---|
| IEC 60335-2-5  | Part 2-5: Particular requirements for dishwashers   |
| IEC 60335-2-6  | Part 2-6: Particular requirements for stationary cooking ranges, hobs, ovens and similar appliances   |
| IEC 60335-2-7  | Part 2-7: Particular requirements for washing machines  |
| IEC 60335-2-9  | Part 2-9: Particular requirements for grills, toasters and similar portable cooking appliances  |
| IEC 60335-2-12 | Household and similar electrical appliances - Safety - Part 2-12: Particular requirements for warming plates and similar appliances                 |
| IEC 60335-2-14 | Part 2-14: Particular requirements for kitchen machines   |
| IEC 60335-2-24 | Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice makers  |
| IEC 60335-2-30 | Part 2-30: Particular requirements for room heaters   |
| IEC 60335-2-36 | Part 2-36: Particular requirements for commercial electric cooking ranges, ovens, hobs and hob elements   |
| IEC 60335-2-40 | Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers  |
| IEC 60335-2-51 | Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations                                     |
| IEC 60335-2-60 | Part 2-60: Particular requirements for whirlpool baths and whirlpool spas   |
| IEC 60335-2-89 | Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor |

Examples according to household appliances standard, Part 2

**Note:** IEC 60335-1 has to be used in conjunction with the appropriate part 2 of IEC 60335. Part 2 contains clauses to supplement or modify the corresponding clauses of part 1 in order to provide relevant requirements for each type of appliance.

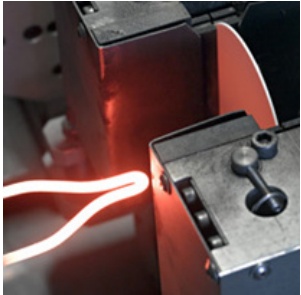
# IEC 60335-1 General requirements

This standard deals with reasonably foreseeable hazards, coming from the equipment to which users may be exposed. IEC 60335-1 contains instructions for production tests of electrical appliances for household use and similar purposes. The routine tests listed in this standard are considered to be a necessary minimum to cover the essential safety aspects according to IEC 60335.

In general, it can be said that the industrial requirements are in some facts similar to the household requirements, but if you take a closer look, differences can be noticed. For example, if we look at the requirements for clearances and creepage distances, the industrial standard IEC 60947-1 (table 13 and 15) has different requirements for the dimensions of pollution degree 1 to 4. On the other hand, IEC 60335-1 section 29 refers to the insulation coordination standard IEC 60664-1. Here are different requirements for pollution degree 1 to 3 specified. The dimensions for pollution degree 4 share the same specifications as for pollution degree 3. The only difference is that the distances are divided into more granular steps. However, the dimensional values specified in both standards, i.e. IEC 60947-1 and IEC 60664-1, are the same for pollution degree 1 to 3.

Therefore, only a few additional requirements must be taken into consideration for industrial products in order to use them in household appliances. For ABB control and protection products the most relevant section in the household standard IEC 60335-1, is the section 30 "Resistance to heat and fire - Parts of non-metallic material shall be resistant to ignition and spread of fire".

## Resistance to heat and fire



Plastics used in the field of household appliances or for similar purposes according to the standard must pass a test of fire resistance. The exact values that must be achieved depend on the current and whether the device is operated under supervision or unattended.

As in many standards, also in IEC 60335-1 the fire resistance of the insulating material is tested by using the glow wire tests according to IEC 60695.

The fire resistance test for plastics in accordance with IEC 60335-1 is split into three types: Glow Wire Ignition Temperature (GWIT), Glow Wire Flammability Testing Index (GWFI), and Glow Wire Temperature (GWT).

### Glow Wire Ignition Temperature (GWIT) acc. to IEC 60695-2-13

The GWIT is measured at the test plate (round disc) and is a value for the ignition of a plastic when exposed to, a glowing wire or an overheated resistor. During the determination of the ignition temperature, the sample must not ignite during the entire test. Ignition is defined as a fire appearance greater than 5 seconds. The GWIT is then defined as the temperature that is 25 °C higher than the highest temperature at which ignition does not yet occur. *The GWIT is specified by the manufacturer for flame retardant materials and is listed on the Yellow Card.*

### Glow Wire Flammability Index (GWFI) acc. to IEC 60695-2-12

The GWFI is also measured on the test plate (round disc) and is a measure of the flame behavior of plastics against the effect of a glowing wire or an overheated resistor. The test sample is pressed against a heated glow wire for 30 seconds with a force of 1 Newton. The penetration depth of the glow wire is limited to 7 mm. The test is passed if the sample burns for less than 30 seconds after the glow wire is removed and if a tissue paper lying under the sample does not ignite. *The GWFI is specified by the manufacturer for flame-retardant materials and is also listed on the Yellow Card.*

### Glow Wire Temperature (GWT) analog to IEC 60695-2-11

The GWT is measured on the complete and finished component. In contrast to IEC 60695-2-11, different test criteria apply within the household appliance standard the ignition temperature is determined. When determining the ignition temperature, the sample must not ignite during the complete test. Ignition is defined as a fire appearance greater than 2 seconds. This special feature of the GWT test applies exclusively to IEC 60335-1. In the IEC 60695-2-11, the GWT test corresponds to a GWFI test performed on the finished part. Since the GWT is a finished part test and thus depends on the geometry, material combinations and metal inserts, it cannot be directly correlated with the GWIT.

# ABB control products for the household appliance standard

ABB offers a big range of devices for use in household appliances.

A rough overview can be found here.

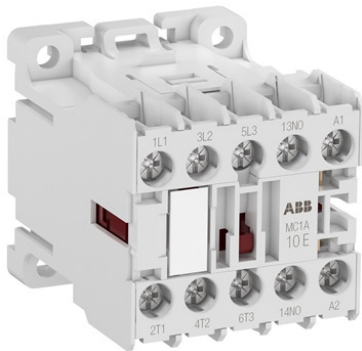
## Contactors

Contactors for household appliances and similar purposes

ABB offers several contactor series that can be used for household appliances or similar purposes according to IEC 60335-1. They are therefore ideal for use in portable appliances, washing machines, heaters, and heating systems. But they can also be used in kitchen machines or automatic baking machines.

## M mini contactors

The M mini contactors range is a performance-dimension optimized solution. High reliability, even in extreme conditions, combined with small dimensions and the safe connections lead to easy design and compact panels.



### Main Benefits

- High performances even when installed side by side.
- Wide set of coils available.
- Up to 6 auxiliary contacts can be mounted.
- Fast operation.

### Main Features

- Up to 5.5 kW - 400 V AC-3.
- 20 A - 400 V AC-1 and 20 A (600 V AC) - general use.
- 7.5 hp - 480 V.
- 2 terminal types available: screw terminals, specific screw terminals for ring tongue ferrules
- Standard DC versions with extended operating limits coils.
- Complete range of accessories including front or side mounting auxiliary contact blocks, surge suppressors and electronic timers,



Thanks to the fact that plastic materials used in M mini contactors comply to IEC 60335-1 section 30, they can not only be used for industrial applications, but also for household appliances. Hence, M mini contactors are for example ready to be used in the domestic heating system, because these contactors fulfill the requirements of the glow wire tests according the IEC 60695:

- Glow Wire Flammability Testing (GWFI) at 850°C
- Glow Wire Ignition Temperature (GWIT) at 775°C

# ESB Installation contactors

ABB's hum-free installation contactor design offers a wide range of ratings up to 100 A. They are widely used in buildings, e.g., for switching and controlling lights, heating, ventilation or motors and pumps. ABB's installation contactors take noise reduction to a new level. With an innovative AC/DC design that eliminates humming, a selection of tool-free accessories as well as manual (EN) and automatic versions (ESB), ABB installation contactors offer peace of mind in noise-sensitive applications.

## Main Benefits

- Hum-free operation peace of mind in noise-sensitive environments.
- Tool-free accessories - auxiliaries, space holders and sealing covers can be mounted 100% tool-free.
- Group mounting - no need for a distance piece in between contactors ESB16..N and ESB/EN20..N.
- Single- and multipackaging – the right choice according to your needs.
- Easy warehousing – one auxiliary contact block, AC/DC control and EAN code on the devices.

## Main Features

- Comprehensive solution – one range from 16 A to 100 A.
- Wide application range - all relevant standards such as IEC 60947-4-1, **IEC 61095** and various certifications are available, including marine.
- Built-in protective circuit protecting the control circuit against remote lightning strikes and other overvoltages.
- Automatic/manual operation - EN versions feature a manual override functionality with a toggle switch.



ABB installation contactors are suitable for household appliances according to the IEC 61095

“Electromechanical contactors for household and similar purposes” standard and can therefore also be used in many household appliances. Similar to EC 60335-1, IEC 61095 references to the same glow wires tests specified in IEC 60695.

# AF contactors

Featuring AF technology as standard, AF contactors establish the industry benchmark. The integrated electronically controlled coil offers multiple benefits over conventional alternatives, and together with ABB's wide product offering, an optimal configuration, every time.



## Main Benefits

- Optimize logistics and cut administration costs with fewer product variants to handle.
- Access global support and use the same products in all parts of the world: the 100 ... 250 V AC/DC coil covers all standard network voltages.
- Push-in Spring terminals offer only one push for extremely fast wiring: faster than ever installation, easier than ever wiring, reliable as ever connections.
- A reduction of the coil's energy consumption by 80% lets you save energy.
- Secure your uptime by letting the AF technology overbridge voltage drops and sags.

## Main Features

- Up to 200kW - 400 V AC-3, 300hp - 480 V / 600 A - 1000 V AC-1
- Limited number of coils to cover 24 V - 500 V AC and 20 V - 500 V DC + dedicated 24 V DC low consumption coil (1.7 W) for direct control by PLC-output (> 250 mA)
- Screw and Push-in Spring connection types
- Built-in surge suppression
- Connection sets and interlock unit for reversing and star-delta starter for an easy, fast and secure assembly of starters\*

ABB AF contactors : **AF** and **AF..Z** meet some of the IEC 60335-1 requirements. For generic requirements these products are compliant to IEC 60947-4-1. For the specific requirements of heat and fire resistance, our analyses and plastic test reports confirm that these products meet section 30 of IEC60335.

Furthermore, regarding **AF** and **AF..Z**, for the specific resistance to abnormal operating conditions of electronic control, our analysis and test reports show that these products meet section 19 of IEC60335.

For complete IEC 60335 section compliance, following protection is required.

- Supply line powering the coil must be limited to a short circuit current  $I_k < 1kA$ .
- For contactors with coil codes 11, 21, 22, 23 and 30, the contactor must be protected by :  
10A gG type fuse or  
2A MCB (Type S201-Z2 / Code 2CDS251001R0278) or lower rating.
- For contactors with coil code 12, 13, and 14 coil consumption must be limited below 0.05A.
  - Coils 12 and 13. Suggested fuse: 0.15A time delay (slow blow) class T fuse.
  - Coil 14. Suggested fuse: 0.10A fast acting (fast blow) type F fuse.

\*For accessories compliance, please contact ABB



# Pilot Devices

ABB pilot devices are engineered for total reliability. Our products are tested to extremes and proven in the toughest environments. Their innovative design simplifies the entire process, from selection to installation. Enclosures, signal towers and signal beacons complete the portfolio.



## Main Benefits

Pilot devices are designed with protection degree of up to IP69K and 4X, guaranteeing reliability in extreme environments.

ABB's core offering includes the pilot devices most in demand, so product selection is easier, stock management is simpler and product availability is higher.

The unique design of ABB's modular ranges enable tool-free installation that is quick and simple. It provides high flexibility for last-minute changes. With its all-in-one construction, the compact range reduces installation space and saves time.

## Main Features

Longer lifetime, this pilot devices are engineered and tested to sustain frequent use over time in any environment.

Tested to achieve mechanical lifetime of up to 10 million operations providing high mechanical durability.

Self-cleaning contacts ensure reliable operation without the need for maintenance, increasing uptime.



Thanks to the fact that plastic materials used in ABB Pilot devices comply to IEC 60335-1 section 30, they can not only be used for industrial application, but also for household appliances. Hence pilot devices are for example ready to be used in ice-cream appliances and ice makers as they fulfill the requirements of the glow wire tests according the IEC 60695.

# Special requirements of IEC 60335-2-40

## Requirements for electrical heat pumps, air-conditioners, and dehumidifiers.

IEC 60335-2-40 contains special requirements for electrical components installed in heat pumps, air conditioners and dehumidifiers that utilize refrigerants of safety category A2L. Refrigerants come in a variety of forms. In households, they can be found in air-conditioners, heat pumps or refrigerators. The most important task of refrigerants is to absorb heat at low temperatures and low pressure and to release it at higher temperatures and high pressure. They are classified in terms of flammability and toxicity according to ASHRAE, ISO 817 and DIN EN 378:

| Low toxicity | High toxicity |                     |
|--------------|---------------|---------------------|
| A3           | B3            | Higher flammability |
| A2           | B2            | Flammable           |
| A2L          | B2L           | Low flammability    |
| A1           | B1            | No flammability     |

The most commonly used refrigerants in such applications belong to the safety category A2L, which indicates low flammability and low toxicity. Refrigerants in this category have many different important properties, but when evaluating components according to IEC 60335-2-40, the burning velocity is one of the most relevant. A2L are lower flammability refrigerants with a maximum burning velocity of 10 cm/s. Refrigerants of safety class A2L include, among others, the following:

| Designation of refrigerants | Burning velocity (Su) [cm/s] |
|-----------------------------|------------------------------|
| R32                         | 6.7                          |
| R454A                       | 2.4                          |
| R454C                       | 1.5                          |
| R455A                       | 1.6                          |
| R1234yf                     | 1.5                          |
| R1234ze                     | 1.2                          |

Clause 22.116 of IEC 60335-2-40 explains the requirements that electrical components must meet in order to be used in equipment with flammable refrigerants. For A2L safety group refrigerants, electrical components are not considered to be potential ignition sources if they are in correspondence with Annex JJ. Annex JJ of IEC 60335-2-40 explains the permissible openings of relays and similar components to prevent the ignition of A2L refrigerants. The Harmonized UL 60335-2-40, approved by ANSI/SCC, is the North American standard for electric heat pumps, air conditioners and dehumidifiers. It is also a binational standard for the U.S. and Canada, based on the international standard IEC 60335-2-40.



In this regard, it provides a definition of the maximum size of openings in relays and similar components that prevent flame spread to the outside. A relay and similar components that meet the requirements of this appendix are not considered a potential ignition source for A2L refrigerant. The resulting analysis shows that considering the maximum allowed opening and the burning velocity of the refrigerant in concern, the following ABB components may be used in combination with the A2L refrigerants:

| Device   | R32  | R454A | R454C | R455A | R1234yf | R1234ze |
|--|------|-------|-------|-------|---------|---------|
| ESB..N / EN..N<br>Installation contactors  | X(1) | X(1)  | X     | X     | X       | X       |
| MS116<br>Manual motor starters   | X    | X     | X     | X     | X       | X       |
| MS132 / MO132<br>Manual motor starters   | X    | X     | X     | X     | X       | X       |
| B6 / B7 / K6 / CA6 / CAF6<br>Mini contactors   | X    | X     | X     | X     | X       | X       |
| MC1 / MC2<br>Mini contactors   | X    | X     | X     | X     | X       | X       |
| AF(C)09(Z)-30... AF(C)96-30<br>AF(C)96-30<br>Contactors (2)  | X    | X     | X     | X     | X       | X       |
| T16, TF42, TF65, TF96<br>Thermal overload relays   | X    | X     | X     | X     | X       | X       |
| NF(C)(Z)<br>Contactor relays (2)   | X    | X     | X     | X     | X       | X       |
| CA4 (1 and 4-pole), CC4, CAT4, CAL4, TEF4<br>accessories 2 (valid when used on AF(C)09(Z)...96) and<br>NF(C)(Z)) | X    | X     | X     | X     | X       | X       |
| AF116 .... AF146(B)-30 or -30RT<br>Contactors  | X    | X     | X     | X     | X       | X       |
| AF190 .... AF205(B)-30 or -30RT<br>Contactors  | X    | X     | X     | X     | X       | X       |
| AF265 .... AF370-30 or -30RT<br>Contactors   | X    | X     | X     | X     | X       | X       |
| CAL19-11(B)(-RT)<br>Auxiliary contact blocks   | X    | X     | X     | X     | X       | X       |

(1) ESB25..N, 40..N and 63..N compliant only with variants equipped with 4 poles and in combination with PLK sealing covers

(2) Contactors, contactor relays and accessories only with screw terminals for standard ferrules.

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# Stay tuned!



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To find the coordination tables for motor protection,  
please see :

<https://www.lowvoltage-tools.abb.com/soc/>

Stay updated on motor protection products.



<http://new.abb.com/low-voltage/products/motor-protection>



<http://new.abb.com/low-voltage>



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**You can find the address of your local sales organization  
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<http://www.abb.com/contacts> > Low-voltage products