Approvals, directories After Sales Service

This closing chapter of the Main Catalog Industry 2010 from Eaton contains all the essential information that does not refer directly to specific products or product groups. The details are found to the right in the table of contents.

Eaton After Sales Service

Testing switching devices in compliance with regulations applicable to this technology
→ 22/02

Technical instructions
Terminal capacities +++ Power Conversion Equipment nach UL +++ Rated motor currents of three-phase motors

After Sales Service
Fast and competent help when devices or installations fail +++ Support during commissioning minimizes risk of failure +++ Extended warranty minimizes damage in case of malfunction +++ Inspection and maintenance minimize risk of failure

Switchgear for North America
Everything you need to know to deploy devices in North America +++ Substantial safety increase through selection of the correct devices +++ Valuable tips for the correct documentation of devices, machinery and installations intended for deployment in North America +++ A comprehensive, complete description of the subject that has yet to find its equal

Eaton and Moeller worldwide
You may find the current addresses of Eaton representatives worldwide on the Internet:
www.moeller.net/address

mm²

Appendix

Helpline

24/7 Hotline

Unscheduled machine and plant downtime, system faults and device failures: Get round-the-clock expert advice (without contractually agreed services):
+49 (0)180 522 3822 (24/7)

0.12 € per minute from within the Deutsche Telekom telephone network

Help desk

During business hours, we support you in commissioning, application queries right through to fault analysis, which can also be carried out by remote diagnosis.
+49 (0)228 602 3640

Monday to Friday between 8:00 and 16:00 hours. E-mail:
AfterSalesEGBonn@eaton.com
Fax: **+49 (0)228 602 61400**

Online diagnostics

We can provide special assistance if you wish to analyze and rectify faults on products. You can carry out interactive troubleshooting via the Internet with direct access to the After Sales Service database.

http://www.moeller.net/aftersales

Onsite Service

Troubleshooting onsite

You can also obtain onsite troubleshooting. Qualified service technicians and specialists can visit you to rectify faults quickly and reliably.

Installation and commissioning support

Contact us for expert support with installation and commissioning. Specialists are at hand to support you with hardware and software issues.

Conversions and expansions

Whether automation equipment, circuit breakers or other components: we help you make sure that your machines and plants are always up-to-date. This applies specially for equipment that can no longer be repaired. A failure of these components would result in costly production downtimes.

Inspection and maintenance

Reliable operation of power distribution systems is vital for uninterrupted production and personnel protection. Our experiences team supports you with the inspection and maintenance of low-voltage distribution systems and the testing of circuit breakers.

For flatrate prices please inquire.

Thermography

At low cost and using specialist hardware, our specially trained experts locate weak spots in running operation to help you avoid expensive production downtimes. This saves you the cost of expensive measuring equipment and personnel training.

Measurement and system testing

Every technician knows that electronic controllers can fail, or circuit breakers trip without apparent reason. And replacing the offending device does not solve the problem.

To avoid lengthy, expensive troubleshooting, it makes sense to perform a network analysis over a longer period of time. We can support you with this.

Repairs

Direct exchange

Unexpected machine and system downtimes incurring considerable costs can arise on account of device failures. Replacing defective components on time can help significantly cut these costs.

Selected products of current and discontinued ranges are available with the Direct Exchange service of our After Sales Service.

Repair

The repair of products in our Service Center is an inexpensive option for fault rectification.

Service agreements

Telephone fault advice

Installation and commissioning support

Conversions and expansions

Inspection and maintenance

Spare parts

Basic agreements for all contract types according to customer requirements.

Extended warranty

Our After Sales Service offers two versions of the Extended Warranty service product. It extends the standard warranty for drives and soft starters by 12 months if the devices have been commissioned by our After Sales Service or an authorized service provider. The flat-rate commissioning charge depends on the device's rating.

The Extended Warranty can be extended up to 24 months.

Working on live equipment

To carry out testing on systems that must remain live for operational reasons, our After Sales Service cooperates with a service partner.

Hourly charges

Charges are calculated according to the hourly or daily rates listed below and, where applicable, according to the relevant regulations of the federal wage agreement for the special working conditions of installation personnel in the iron, metal and electrical industries (BMTV), and the associated wage agreement for subsistence allowances and aggravation bonuses.

The remaining time is calculated as working time.

All listed rates are net without deductions.

Germany

(Other countries please enquire)

Standard rates, personnel	€/hour
Installation and commissioning support in power distribution systems	85.00 €
Inspection and maintenance of plants and circuit breakers	107.00 €
Repairs and troubleshooting of circuit breakers/Arcon	127.00 €
Software creation for drives and automation	127.00 €
Commissioning/troubleshooting for automation equipment and drives, application optimization	142.00 €

Normal working hours

Workdays Monday to Friday, 7 hours each between 7:00 and 19:00 hours.

Overtime and aggravation surcharges

For working times or working conditions requiring surcharges, the following surcharges apply for commissioning and installation:

25%	for the first two hours of overtime per day beyond the normal working times, and from 6:00 to 7:00 hours and from 19:00 to 20:00 hours
25%	Saturdays for the first two hours
50%	for any further remaining overtime
50%	for overtime between the hours of 20:00 and 6:00 (night-time work)
50%	for overtime worked following night-time work up to the start of the normal day-time shift
70%	for work on Sundays
100%	for work on Good Friday, Easter Monday, Ascension Day, Pentecost, Corpus Christi, 3 October, 1 November, and 26 December
150%	for work on 1 January, Easter Sunday, 1 May, Whitsunday, 25 December, late work on 24 December between the hours of 17:00 and 20:00, and night-time work in the nights immediately preceding 25 December and 1 January.

Tripping

According to the applicable tax regulations within Germany/abroad.

Accommodation costs are charged at flat rate or on evidence.

The starting point for the calculation of subsistence allowances is the business location.

Travel costs

Car	0.80 € per kilometer traveled, calculated from the business location.
Rail	First class ticket plus any surcharges
Air	Business Class

Plus any costs for regional/local transport, telephone and costs related directly with the journey

Return journeys

For return journeys scheduled according to tariff, the rates for other travel days plus additional expenses for reserving accommodation apply.

Abroad: Charges contractually agreed.

Transport costs

For transport of travel luggage, tools, measuring instruments and other material generally 20.00 €

Surcharges for air travel on verification of costs.

Instruments

The above rates include the furnishing of simple measuring instruments and standard tools. For measuring and other instruments exceeding the normal equipment, a flat rate of 360.00 € is charged per started week. The evaluation of measurement results is charged separately.

Emergency service flat rate

Outside normal working hours 165.00 € plus material costs.

Courier journeys are charged separately.

Important: Goods ordered and delivered as part of the emergency service can not be returned!

Hired equipment

For hired equipment, a flat rate depending on the equipment is charged for the first week, and thereafter 2.1 % of the gross list price per started week.

Cost estimate

Cost estimates for on-site equipment repairs are calculated at a rate of 165.00 €. For all other cost estimates please inquire.

Warranty

The warranty period for all repairs, replacement devices and services provided is 12 months from the date of delivery or performance.

In their basic version, the Moeller-branded Eaton devices are approved for use throughout the world, including the USA and Canada. As such, they can be used without restriction as devices for world markets.
The standard versions of some devices, such as circuit breakers, can be used worldwide except in the USA and Canada.
For export to North America, numerous devices are available in special UL- and CSA-approved versions.
For currently available approvals, see our website:
https://wss.moeller.net/approbationen/step1.do

Eaton's Moeller-branded low-voltage switchgear and switchgear assemblies conform to national and international specifications, making it possible to construct control systems that will conform to the national and international specifications of any country in the world.
This, of course, means that due consideration must be given to the national standards of the respective country, such as those concerning installation, operation, installation materials and methods, as well as any pertaining to circumstances such as severe environmental conditions.
The device rating data given in this catalog for 220 – 240 V, 380 – 440 V, 500 V, 600 V, and 690 V covers virtually all existing three-phase systems worldwide.
Deviating requirements for the USA and Canada are given in detail in each chapter of this catalog. Read also the detailed description "Switchgear for North America" from Page 22/13.
For the worldwide use of switchgear, special installation standards and approval requirements must also be observed in addition to the widely differing system conditions:
Where screw fuses are used in a control system, some European countries – such as Denmark, Finland, the Netherlands, Norway and Sweden – require gage screws. In this case, "FORM P" fuse bases must be used. Switzerland no longer requires the use of gage screws, but they are still often requested by customers.
The majority of countries permit the import of switchgear assemblies and devices on the manufacturer's undertaking that they have been constructed in accordance with the pertinent specifications. In some countries, such as the USA and Canada, however, there is a legal obligation to obtain official approval. In these countries, devices and enclosures – sometimes even complete control systems – are tested and approved by independent bodies.
In Scandinavia and in Switzerland, an official approval for low-voltage switchgear and controlgear had to be sought to some extent. For industrial switchgear, this legal obligation has now been abolished, provided the devices have been manufactured and tested in accordance with harmonized European standards (such as IEC/EN 60947). There is then no longer a requirement for them to carry their country's own approval mark. Eaton develops switchgear to international standards, such as IEC/EN 60947 and applies the corresponding marks. Devices that conform to the European Low-Voltage Directive and are sold within the European Union must contain the CE mark.

Europe, Conformité Européen (CE)

The CE mark indicates that the device corresponds with all relevant requirements and standards. Mandatory marking allows unrestricted use of marked devices within the European economic area.
Devices sold within the European union must comply with the Electromagnetic Compatibility (EMC) Directive. Eaton has performed the required tests for all Moeller-branded products subject to this Directive and applied the CE mark, which demonstrates compliance with the EMC Directive.
Because devices bearing the CE mark comply with the harmonized standards, approval and the associated marking is no longer required in the following countries: Belgium, Denmark, Finland, France, the Netherlands, Norway, Sweden, and Switzerland.

An exception is installation material. In some areas, miniature circuit breakers and residual current device must still be labeled and therefore carry the corresponding approval mark.

Belgien, Comité Electrotechnique Belge/Belgisch Elektrotechnisch Comité (CEBEC)

Germany, Verband Deutscher Elektrotechniker (VDE)

France, Union Technique de l'Electricité (UTE)

Austria, Österreichischer Verband für Elektrotechnik (ÖVE)

Switzerland, Schweizerischer Elektrotechnischer Verein (SEV)

Devices for export to the USA and Canada have either additional UL and CSA approval or are available in a separate version with UL and CSA approval.

USA, Underwriters Laboratories (UL) - Listing

USA, Underwriters Laboratories (UL) - Recognition

Canada, Canadian Standards Association (CSA)

Approval for electrical products is also required in Argentina, China, Russia, South Africa, and the Ukraine. Marking is partly mandatory for these countries. As in other European countries, the IEC rating data is accepted here.
Romania requires that components that are to be used in public buildings must be approved by the Romanian test authority ICECON.

Russia
Devices for Russia must bear the appropriate marking.

Russia, Goststandart (GOST-R)

Ukraine
Devices for the Ukraine must bear the appropriate marking.

Ukraine, Goststandart (Ukrain-GOST)

China
Devices for China must bear the appropriate marking.

China, China Compulsory Certification (CCC)

South Africa
In South Africa approval is mandatory for circuit breakers and busbar trunking systems: These devices must bear the appropriate marking.

South Africa, South African Bureau of Standards (SABS)

Argentina
In Argentina, mandatory approval is based on Resolution 92/98. From April 01, 2001, miniature circuit breakers and residual-current circuit breakers are subject to mandatory approval.
As of this date, circuit breakers up to I_e = 63 A and $U_{e\ max}$ = 440 V must carry the following marks:

Argentinien, Instituto Argentino de Normalización y Certificación (IRAM)

Selection of devices
In addition to the required approvals and conformance with applicable regulations, the design of devices and systems themselves must be suitable for the target market.
Points to keep in mind when selecting switchgear for export include:

Motor-protective circuit breakers
Use auto-protected circuit breakers, which are capable of controlling the highest prospective fault levels at the point of installation without the need for back-up protection.

Advantages
Can be positioned anywhere and are fully independent of the local circuit-protection system; no spare part problems

Circuit-breakers
Use makes with visible contacts, and quick-make and quick-break operation as standard. For high short-circuit levels, use current-limiting circuit breakers. Selective switches are recommended for the selective graduation of networks.

Advantages
Independence from local accident prevention regulations requiring visible contacts, and safety from faults caused by inexperienced operating personnel. The effects of short-circuits are kept to a minimum. Fuseless installations offer greater safety and reliability in plant operation. In the event of a fault, only the faulty section of the system is isolated.

Contactors
Use contactors whose entire range provides consistently reliable operation in the event of voltage drops (80 % Un should be aimed for) and whose contact system will not assume an indeterminate position on closing or opening under these conditions.

Advantages
During the electrification work in areas such as Africa and the Middle East, an insufficient voltage stability is – at least for a certain time – likely in many applications (for example due to long spur lines or small local generators). The use of devices that fulfil the above requirements will eliminate one of the main failure causes related to contactors.

Enclosures
Use insulated enclosures with transparent covers (i.e. "totally insulated" enclosures).

Advantages
Total insulation is the best possible protective measure from the user's point of view, avoiding, reliance on the possibly doubtful skills of unknown installation personnel. Furthermore, protective measures based on grounding are often extremely difficult, if not impossible (in the Middle East, for example, due to the dryness of the ground).
Insulated enclosures completely eliminate the need for any additional protection against corrosion. The transparent covers contribute significantly to the correct operation of a system, because switchgear operation can be monitored even with the doors or covers closed, thus virtually eliminating the possibility of these being left open through carelessness. The transparent cover is an important contribution to safety, especially where exports to areas of uncertain skills are concerned.

Overcurrent protection devices
Always use circuit breakers or motor-protective circuit breakers and avoid fuses wherever possible.

Advantages
The operational reliability of a system is especially important for export contracts. Circuit-breakers and motor-protective circuit breakers provide this reliability in full measure since they can be immediately reclosed once a fault has been cleared, they disconnect all poles, they have ideal protection through high tripping accuracy and they can be used for selective operation. Because they have no fuses or other consumables, they also greatly reduce the problem of obtaining replacement parts. The advantages of fuseless design for export are especially evident in this case. No complicated investigation is needed to find out which fusing system is used in the respective location and which specifications have to be followed to select the correct fuses. Often several different fuse systems with widely varying characteristics are used side-by-side in the same country. For the uninitiated, it may be almost impossible to find the right fuse in these circumstances. These problems do not arise where a circuit-breaker is used.

Main switch and safety switch
Use devices with positive contact separation and clear switch position indication.

Advantages
The mechanical coupling of the actuating element with the contacts ensures that the Off position is indicated only when all main contacts are separated by the prescribed distance, and only in this position can the switch be padlocked. This ensures safety when carrying out maintenance and repair work on the installation or machinery.

Shipping classifications
Many Moeller-branded Eaton devices are approved by all important shipping associations: Germanischer Lloyd, Lloyd's Register of Shipping, Bureau Veritas, Russian Maritime Register of Shipping, Registro Italiano Navale, Det Norske Veritas, Polski Rejestr Statków, etc.
Because the status of currently valid shipping approvals is subject to significant variations, this Catalog does not provide an overview, as this would quickly be out of date.

Please see our corresponding, up-to-date information on the Internet.
https://wss.moeller.net/approbationen/schiff.do

	Country Test authorities				
	USA **UL**	CDN **CSA**	RUS **GOST-R**	PRC **CCC**	UA **Ukrain -GOST**
SmartWire-Darwin					
EU5…	○	○	–	N	–
SWD…	○	○	–	N	–
M22-SWD…	○	○	●	N	–
Pilot devices					
FAK…/I	●	●	●	●	●
RMQ16	●	●	●	●	●
RMQ-Titan	●	●	●	●	●
SL signal towers	●	●	●	●	●
Position switches					
LS...	●	●	–	–	–
LS-...-...-ZB	●	●	●	●	●
LS-...-...-ZBZ/...	●	●	●	●	●
Pressure switches					
MCS…	–	●[1]	N	N	●
Cam switches					
T…	●	●	●	●	●
Contactor relays					
DILER	●	●	●	●	●
DILA	●	●	●	●	●
DILA-XHI	●	●	●	N	●
Contactors					
DILM7, DILM9, DILM12, DILM15	●	●	●	●	●
DILM17, DILM25, DILM32, DILM38	●	●	●	●	●
DILM40, DILM50, DILM65, DILM72	●	●	●	●	●
DILM80, DILM95, DILM115, DILM150, DILM170	●	●	●	●	●
DILMP20	●	●	●	●	–
DILMP32, DILMP45	●	●	●	●	–
DILMP63, DILMP80	●	●	●	●	–
DILMP125, DILMP160, DILMP200	●	●	●	●	–
DILM…-XHI	●	●	●	N	●
DILM…-XMV	●	●	●	N	●
DILM...-XS1	●	●	●	N	●
DILM...-XP1	●	●	●	N	●
DILEM(-12)(-G)	●	●	●	●	●
DILM250, DILM300A	●	●	●	●	●
DILM185, DILM225, DILM250	●	●	●	●	●
DILM300, DILM400, DILM500	●	●	●	●	●
DILM580, DILM650, DILM750, DILM820, DILM1000	●	●	●	●	●
DILL	●	●	●	–	–
DILMF	●	●	●	–	–
DILK12 … DILK50	●	●	●	–	–
Overload relays					
ZB32	●	●	●	●	●
ZB65	●	●	●	●	●
ZB150	●	●	●	●	●
ZE-...	●	●	●	●	●
Z5-…	●	●	●	●	●
Z5-.../FF225A	●	●	●	–	●
Z5-.../FF250	●	●	●	–	●

	Country Test authorities				
	USA **UL**	CDN **CSA**	RUS **GOST-R**	PRC **CCC**	UA **Ukrain -GOST**
ZW7-...	●	●	●	–	–
ZEB	●	●	–	–	–
ZEV	●	●	–	●	●
Thermistor relay for machine protection					
EMT 6	●	●	●	●	●
Motor-protective circuit-breakers					
PKZM01	●	●	●	●	●
PKZM0...	●	●	●	●	●
PKZM0-T	●	●	●	–	●
PKE	○	○	●	●	–
PKZ2.../ZM...	●	●	●	●	●
PKZ2/.../S-SP...	●[2]	●[2]	●	●	●
PKZM4-...	●	●	●	●	●
P-SOL…	○	○	–	N	–
PKZ-SOL...	○	○	–	N	–
Soft starters and accessories					
DS4-340	●	●	–	N	●
DS6-340	●	●	–	N	●
DE4-KEY-2	●	●	–	N	●
DE4-COM-2X	●	●	–	N	●
DE4-NET-DP2	●	●	–	N	●
Electronic timing relays					
ETR 4-...	●	●	–	N	●
DIL ET	●	●	●	N	●
EMR4-...	●	●	–	N	●
Measuring and monitoring relays					
EMR4...	●	●	–	N	●
Control relays easyRelay					
easy...	●	●	●	N	●
Programmable logic controllers					
EC4P-…	●	●	●	N	–
I/O expansion easy					
EASY618-AC-RE	●	●	●	N	●
EASY618-DC-RE	●	●	●	N	●
EASY620-DC-TE	●	●	●	N	●
EASY202-RE	●	●	●	N	●
Coupling modules easy					
EASY2…	●	●	●	N	●
Ethernet module					
EASY209-SE	●	●	●	N	●
Multi-function displays					
MFD-80...	●	●	–	N	●
MFD..CP8...	●	●	–	N	●
MFD..CP4...	●	●	–	N	●
MFD..R...	●	●	–	N	●
MFD-T...	●	●	–	N	●
MFD-T(A)P...	●	●	–	N	●
Switched-mode power supply units easy					
EASY200-POW	●	●	●	N	●
EASY400-POW	●	●	●	N	●
Series-connected device					
EASY256-HCI	●	●	●	N	●

Notes

● Approved or accepted
○ Applied for
N Approval or acceptance not required
– Not approved or accepted

1) Form CDN.
2) Switchgear for North America.
3) Approved devices please enquire.
4) Switchgear for North America in surface mounting enclosure
5) As supplementary protectors up to 40 A only.
6) Applies only for standard CI types; not for North America versions

	Country Test authorities				
	USA **UL**	CDN **CSA**	RUS **GOST-R**	PRC **CCC**	UA **Ukrain -GOST**
Safety relays					
ESR...	●	●	–	N	●
Control relay suitable for safety circuits					
easySafety	–	●	●	N	●
I/O systems					
XIOC	●	●	●	N	●
XIO-EXT121-1			●	N	●
Transformers					
STI/STZ	●	●	N	N	N
DTI/DTZ	●	●	N	N	N
UTI	●	●	N	N	N
SASY60i	●	●	–	–	–
Circuit breakers					
NZM1-4	●[2]	●[2]	●	●	●
IZM	–[3]	–[3]	–	–	–
Switch-disconnectors					
N1-4	●[2]	●[2]	●	●	●
IN	–[3]	–[3]	–	–	–

	Country Test authorities				
	USA **UL**	CDN **CSA**	RUS **GOST-R**	PRC **CCC**	UA **Ukrain -GOST**
P1, P3	●[4]	●[4]	●	●	●
P5	●	●	–[3]	–[3]	–
Supplementary protectors					
FAZB..., FAZC..., FAZR..., FAZS...	●	●	–	–	–
Circuit-breakers					
FAZ…	●	●	●	●	●
FAZ-HK	●	●	●	●	●
FI...	●	●	●	●	●
ASA, USA	●	●	–	–	–
FAZ-NA, FAZ-RT	●	●	–	–	–
FAZ-K/S/Z	●	●	–	–	–
Combination circuit breakers PKNM	–	–	●	–	–
Fuse-switches VLC14, VLC22	●	●	–	–	–
Insulated enclosures CI					
CI..-...-NA, CI..-.../(2)T-NA	●	●	N[6]	–	●[6]
CI..X-...-NA, CI..X-.../T-NA	●	●	N[6]	–	●[6]
Small enclosures CI-K					
CI-K...-NA	●	●	N[6]	–	●[6]

Notes

● Approved or accepted
○ Applied for
N Approval or acceptance not required
– Not approved or accepted

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3) Approved devices please enquire.
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Eaton's Moeller devices - Shipping classifications

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https://wss.moeller.net/approbationen/schiff.do

The reason that the selection pages for all product groups and this chapter of the main catalog contain specific information about approvals and devices for use in North America is that:

- through the activities of machine and panel builders a large percentage of the products are indirectly destined for export;
- North American codes and standards that are less well known and that deviate significantly from the IEC and EN standards must be observed;
- for export projects, devices approved for NA must always be used;
- NA-approved devices often have different ratings and sizes and are often used and combined in ways that differ from usual IEC and EN practice;
- the customs and standard practices in the North American market must also be taken into consideration;
- with the information in this catalog customers striving to build machines for the world market can see that they can largely use the same Eaton devices for all markets;
- interesting new products are now available for this field of business;
- customers expect or are demanding a supportive business relationship.

Because Eaton wants to make export as simple as possible for its customers, we have made comprehensive improvements to this catalog following intensive discussions with our exporting customers. Although the catalog contains mainly Moeller products, Eaton's sales companies can, in some cases – for example circuit breakers – supply other **Eaton-branded products** approved for North America.

This article provides only a summary of this topic[1]. For further information about approvals for export to North America, see Moeller's detailed Technical Essays[2]. For an explanation of special terminology, see the glossary in this catalog on page 22/22. "North America" or "NA" always refers to the USA and Canada.

In the USA the legally binding OSHA[3] and the NEC[4] require an approval of devices and plants. The necessary testing and certification can be performed by various "Nationally Recognized Testing Laboratories" (NRTL), of which the Underwriters Laboratories (UL)[5] are the best-known and most widely accepted. Alternatively, approvals and approval marks can be issued by approved subsidiaries of German Technische Überwachungsvereine (TUV)[6] or by ETL-Intertek[7], which is also active within Germany. Approvals can not be based on testing by the manufacturer only. Testing and approval by an independent third-party is always required.

In Canada, all electrical apparatus must comply with the CEC[8], which requires that all equipment and installations have been approved by CSA[1] or equivalent bodies.

In addition to the normal UL and CSA approvals, the trade regulations resulting from the NAFTA agreements[10] allow vendors to apply for a joint UL and CSA approval at all approval organizations. The devices then carry a logo that should be recognized in both countries. To date, Eaton, and previously Moeller, have rarely made use of this approval method because these combined approvals are still not fully recognized by local inspectors and end users. Eaton strives to help its customers avoid problems with approved devices in North America.

A special characteristic of the North American market is that, with few exceptions, electrical equipment must be acceptance-tested on-site by so-called Authorities Having Jurisdiction (AHJ). These authorities check that all components have the required approvals. In addition, the components must be approved for their application according to the standard applicable in each case, i.e. they must be correctly dimensioned, combined and used according to the NEC or CEC codes as well as any applicable standards. Device combinations approved on behalf of the component manufacturer – for example motor starter combinations – usually exhibit better technical data than combinations of individual devices that are not tested as combinations. The reason for this is that the components support each other in their switching tasks. This is an important aspect, for example, for the "Overall Short Circuit Current Rating"[11]. Many machine and panel builders have their end products (such as machines)approved already at the point of manufacture, while some even have their own approved workshops.

The codes and standards of the USA and Canada differ – to some extent significantly – from those of other industrial countries, which use the IEC/EN standards[12]. Keep in mind that the USA and Canada publish their own, independent standards, which do not always have an identical content, and which may require different approvals. Eaton offers two groups of electronic, switching and protective devices approved for North America:

1) Preferably as **world-market devices** with the following key characteristics:

World-market devices fulfil all device and product standards and feature all relevant approvals (see approvals overview from page 22/5), including the North American approvals, and can be used throughout the world.

World-market devices have rating plates with all important technical data for worldwide use and for use in in the USA and Canada. IEC/EN rating data has no relevance for use in North America.

For unrestricted sale in European Union member states, world-market devices contain the CE mark.

Examples of **world-market devices** include:

Pilot (control circuit) devices, cam switches, position switches, contactors, motor-protective circuit breakers, overload relays, measurement and protective relays, electronic devices and systems, user-programmable PLCs. These are, on the whole, the devices covered by standards UL 508 and CSA C22.2 No. 14-05.

2) **Device versions** for North America

Where the combination of the requirements of all codes and standards in a single product range is uneconomical or not possible, these devices have been developed by modifying existing IEC/EN devices. In some cases, the cost of approval depends on the devices' production quantity, which is viable only for products that will be exported.

The devices Eaton terms **"NA devices"** (Listed Components) or **"CNA devices"** (Recognized Components) have the following key characteristics:

These products have been approved to UL and CSA and can be used in the USA and Canada as well as in other countries if the end client requires UL and CSA approvals or conformance with with the North American standards[13].

They have ratings plates containing at least all important data for use in the USA and in Canada. But because these devices will also be exported from the USA or Canada, their rating plates usually also contain data to IEC and EN standards. Devices with IEC/EN data also carry the CE mark and the CCC mark for China.

They are largely identical with the IEC/EN devices of the same series but differ in their detail design or feature slightly lower ratings, depending on the approval requirements. If the reduced technical data does not present a problem, these devices can, like world-market devices, be used throughout the world. Some major customer do this to reduce the number of versions.

With rare exceptions, the IEC/EN and the NA versions have the same external dimensions and can usually (depending on approvals) be equipped with the same accessories, such as auxiliary contacts or shunt releases.

The existing approvals for the USA and Canada are included in the devices' part numbers as a part number suffixes, and are indicated on rating plates by the corresponding approval marks as follows:

Eaton has special **North America versions** for:

Circuit breakers NZM, molded case switches NS…-NA and miniature circuit-breakers FAZ (see additional information about FAZ, FAZ-NA, FAZ-RT in Chapter 19 of this catalog).

Recognized Components are frequently and incorrectly used without regard for the additional Conditions of Acceptability (CoA) contained in the product standards. This is known to the inspectors, who, for this reason, are particularly thorough in checking the correct use of these devices. Incorrect usage of Recognized Components is likely to be noticed and will result in a denial of commissioning until corrective measures have been taken. Special care should therefore be taken here.

Technical data and approval status for North America

This main catalog contains all approved technical data for the North American market for engineering switchgear systems, such as control panels for the electrical equipment of machines and plants[14]. Power distribution systems are rarely exported, and further approvals would be required for them[15]. When engineering switchgear systems for North America, the applicable North American standards should be obtained under all circumstances.

For the first time in this catalog, the selection pages include a clear, precise indication of each product approved for the North American market, using flag symbols for the USA and Canada. This level of attention is paid to the approvals for North

Part no. suffix	Type of approval	Approval mark
-NA	For use in the USA the device is approved as a single device as **"Listed Component"**; in Canada it is a **"Certified Component".**	
-CNA	For use in the USA the device is approved as a **"Recognized Component"**; for Canada as a single device it is a **"Certified Component".**	
	For use in the USA, additional **"Conditions of Acceptability (CoA)"** must often be adhered to according to North American standards.	

Notes

1) Date of described Codes and Standards, and development and approval status: January 2010
2) See: http://www.moeller.net/de/company/news/publications/index.jsp, The papers are also available free of charge in print
3) Occupational Safety and Health Administration, http://www.osha.gov
4) National Electrical Code
5) UL, http://www.ul.com
6) e.g. TUV Rheinland of North America, Inc., http://www.tuv.com/us
7) http://www.intertek.com, http://www.intertek.de
8) Canadian Electrical Code
9) Canadian Standards Association, http://www.csa.ca
10) North American Free Trade Agreement, between USA, Canada and Mexico
11) SCCR, short-circuit strength of the switchgear systems
12) International Electrical Commission, http://www.iec.ch, EN = European standards
13) e.g. in offshore area, or if the plant is to be used in different locations throughout the world
14) e.g. Industrial Control Panels for Machinery, UL 508A and NFPA 79
15) For example testing in specific distribution board enclosures

America because of the significant export share of these devices and because standards, selection and usage criteria that differ from IEC and EN must be specially considered. In engineering, North American practices must often be observed (for example regarding operating elements for main switches). Where all articles on a page or double page are approved, the whole page or double page is marked only once with the flag symbols in the page header. If a page or double page also contains articles that are not approved for North America, the approved articles are indicated with flags as groups or per article in column "Std. pack". In this column, articles are sometimes grouped together with stylized parentheses.

Unfortunately mere marking with flags and approval marks on the devices is not always sufficient proof of approval for inspectors. Occasionally, doubts may arise as to the admissibility of the use of the approved devices for specific tasks. In such cases, the the numbers of the certification reports, or even the reports themselves, must be available. To facilitate this, the ordering pages of this catalog provide information relevant for export to North America, which include the UL and CSA certification report numbers as well as the relevant Category Control Numbers (UL)[1] or Classes (CSA)[2].

Customers can find the most important excerpts from the certification reports for most of the NA-approved articles by entering the product group, e.g. DILM..., and the approval organization in the approvals database for Eaton's Moeller-branded products[3]. Unfortunately the approval records not drawn up by Eaton Moeller are often poorly structured and hard to read. In some cases, the part numbers of the approved products are given with varying degrees of accuracy. The approval organizations' Inspectors can also access the full approval records through their organizations.

In the event of difficulties, which often arise out of misunderstandings, please contact Eaton. We are continually working to improve and complete the approvals situation, which will therefore change in this catalog's validity period. Eaton Electric's database and online catalog[4] will, however, be regularly updated with all changes. In the online catalog, you can dynamically create up-to-date data sheets for products to save as PDF files and print out.

You can also access the certification reports through the databases of the approvals organizations:

- Access to the UL database is through the address http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html
- For CSA , visit http://directories.csa-international.org/.

For CSA, the certification report numbers in the CSA database do not always correspond with the numbers of the approval records issued to Eaton or Moeller. To find the required record, you should therefore always enter the name "Moeller" and the Class Number (from the selection page in the catalog).. Do not use "Eaton" here yet.

For products with approvals s world-market devices, the technical data is given at the end of each chapter of the catalog, where you can also find the IEC/EN data. Although the contactors and motor starters are also approved as world-market devices, they have special selection pages to take into account the North American voltages and HP ratings. Because motors rated in kW are often used for exported plants and machines, it must be remembered that inspectors convert kW into HP ratings[5] and reading the standard currents for the next largest standard motors rated in HP from the NEC or CEC. This can result in the need to use larger conductor cross-sections. Design engineers should also follow this practice when dimensioning systems. When working to North American codes and standards, further correction factors for dimensioning components and cables must also be observed.

For the North America versions of circuit breakers NZM and molded case switches NS...-NA the main catalog contains comprehensive selection information. Those pages contain, for example, switches with fixed overload releases (NZM…-AF…-NA), which, in the USA, are combined to motor starters for higher-rated motors with a contactor and overload relay. Switches of this kind are not common in IEC/EN countries. The switches of construction size NZM...2…-NA also cover the current ranges of switches NZM...1…-NA. In all, the range of models for the North American market is greater than that for the IEC/EN market. The selection pages for the special devices for the NA market contain the data required for selecting the appropriate switches. Further, less frequently required data for engineering is included under "Technical data" at the end of the chapter. Because more information is required for the complex circuit breakers than for other devices, the information for North America contains further important details, such as whether their use in feeder and/or branch circuits is permissible, or whether the switches are approved as current-limiting devices. For circuit breakers with part number suffix "-CNA" (Recognized Component), a stated Condition of Acceptability (CoA) is that these devices must always be combined with a contactor and an overload relay. See also the motor starter selection table (page 8/30). Only these complete combinations have a specified, stated short-circuit current rating (SCCR).

Voltage types and network configurations in North America

For the use of some devices, such as motor-protective circuit breakers and some motor starters, the maximum permissible "full voltage"[6] (e.g. 480 V, 600 V) or "slash voltage"[7] (e.g. 480Y/277 V, 600Y/347 V) must be observed. Devices for which slash voltages are mandatory, must be used only with star networks with solid grounding. These networks can be installed with or without neutral conductor. In North America three-phase networks are usually three-pole. Devices for full voltages can be used in star and delta networks, irrespective of the type of grounding. In combination, some devices can also be approved for smaller full voltages and larger slash voltages. The decisive factor for the permitted network configuration in this case is the actually used voltage. If only a single device in a switchgear system can be used for a slash voltage, this slash voltage must be stated on the switchgear system's rating plate.

Some devices can not be used with the 600 V often found in Canada. This may be true even if these devices are IEC/EN-approved for up to 690 V. This restriction is due to the differing test conditions specified by the North American standards. For exports to Canada, many customers use 600/480 V or 600/400 V matching transformers to avoid any restrictions due to the high voltage of 600 V at the engineering stage. When using transformers with separate windings, a separate, grounded star network can be connected to the transformer's output side to allow the use of devices approved only for slash voltages.

Most North American component standards currently specify a maximum of 600 V for l.v. systems. It has become apparent that these voltages are no longer sufficient for new technologies with high ratings, such as photovoltaics or wind power. New standards are currently being developed that will, in future, allow higher voltages. These changes will also have to be made, for example, in the UL 489.

When using switching and protective devices, the voltage indications, such as 115 V or 120 V, 230 V or 240 V, 460 V or 480 V, 575 V or 600 V, often cause irritation. The higher of the two stated voltages in each case is the rated service voltage[8]. The lower of the two values is the Utilization Voltage[9], which is the voltage between the point of connection[10] to the consumer system to the point at which the apparatus is connected. To a mains supply with a rated voltage of, for example,**480 V** motors dimensioned for **460 V** can be connected. The same applies for the other voltage pairs. To simplify device selection, Eaton has included both voltage values in its NA motor starter tables, even though motors with, for example, 480 V are not usual.

In connection with approvals, a great deal of information must be made available to users. The most important information is contained on the devices' rating plates and in the catalog. For some devices, further details that are relevant mainly for installation, are included in the installation instructions[11] included with the devices. The required information is specified in the standards or, in some individual cases, by the approval organizations in the approval documents. To ensure the large clearances and creepage distances for feeder circuits, circuit breakers must always be fitted with insulating components and covers. To limit the vendor's liability, the installation instructions for the device and for the switchgear systems in which it is installed should be handed on to the end customer and the operator.

Codes and standards in North America

As with IEC and European standards, North American standards can be divided into those that apply to individual products and those that apply to assembled installations. Product-related standards, such as UL 489, UL 508, UL 508C, and UL 1077) apply mainly to component manufacturers, while system-related standards, such as UL 508A and NFPA 79 are relevant mainly for companies that process these components. Canada dos not have installation-related standards in some cases. The statutory requirements are not incorporated in the CEC and CSA standards as clearly. In these cases, it is advisable to use the US installation-related standards as a guideline for engineering, as these have similar requirements. Component manufacturers and machine/system builders that use third-party components should each be familiar with the respective other type of standard. Note that, in addition to the national US and Canadian standards, member states or provinces and larger cities may have additional legal requirements that must be met by system builders when supplying to these regions. In the USA, the latest NEC standards do not always apply in all states.

Device types in North America

This main catalog takes into account the fact that a distinction is made in Canada and the USA between Distribution Equipment and Industrial Control Equipment:

Distribution equipment

This includes for example:

- Circuit-breakers (UL 489, CSA-C22.2 No. 5-09).
- Load interrupters (UL 489, CSA-C22.2 No. 5-09).
- Switch-disconnectors (UL98, CSA-C22.2 No. 4-04).
- Fuses (UL 248, CSA-C22.2 No.248).
- Fuse switch-disconnectors (UL98, CSA-C22.2 No. 4-04).

Notes

1) System of categorization in the USA, corresponds with UL White Book, UL 508A
2) System of categorization in Canada, corresponds with CSA
3) **https://wss.moeller.net/approbationen**
4) **de.ecat.moeller.net**
5) HP = horse-power
6) Voltage between phases
7) Voltage between phase and neutral
8) Service Voltage
9) Point of Connection, Point of Common Coupling
10) Utilization Voltage
11) AWA = Moeller nomenclature: Installation instructions, IL = Eaton nomenclature: Instructional Leaflet

These devices are of a rugged design and have larger insulating clearances than other switching devices (for 301 to 600 V: 1 inch = 25.4 mm air distance and 2 inches = 50.8 mm creepage distance).

In power distribution equipment (switchgear, switchboards, panelboards), only these devices must be used for power supply and tap-off. In addition, these components are also used, for example, as main switches or circuit breakers in motor and other load circuits in industrial control systems.

Testing of these devices is specially stringent, with running production being subject to regular checks by test authority inspectors. The type tests for UL- and CSA-approved circuit breakers are among the world's strictest. Eaton's NA circuit breakers have passed all of these tests.

Industrial control equipment

These include, for example, devices to UL 508, CSA-C22.2 No. 14-05:

- Contactors.
- Contactor relays.
- Overload relays.
- Motor protective circuit breaker.
- Cam switch.
- Pilot devices.
- Electronic devices and systems.
- User-programmable PLCs

These devices have smaller physical dimensions and the insulating clearances are not as great as those of power distribution devices. Here, too, running production is monitored by test authority inspectors, but the inspection requirements are not as extensive as those for circuit breakers.

This industrial control equipment is used mainly in industrial control panels, motor circuits and consumer circuits of all types, in motor control centers (MCC) and in power distribution systems. In industrial control panels, it can be combined directly with power distribution devices, for example with circuit breakers as main switches or in a motor feeder.

Circuit types in North America

In North America, main circuits are classified into "feeder circuits"[1] and "branch circuits"[2]. In feeder circuits, large clearances and creepage distances are required, for example according to UL 489. The boundary between these two circuit types is the "branch circuit protective device (BCPD)"[3], which are required to have large clearances and creepage distances at least on their feeder side. Typical BCPDs are circuit breakers NZM…-NA, PKZM4…-CB, FAZ…-NA, and FAZ…-RT, and fuses. In North America, circuit breakers must be marked with their conduction direction (LINE or LOAD) unless they are approved for both conduction directions. The circuit breakers must then be fed only from above and the specified infeed side must be marked "LINE". The Eaton circuit breakers do not have this limitation. We often receive inquiries about this, even though it is stated in the technical data. As BCPDs, motor starters of UL 508 Types E and F can be used only for individual motors, not for any other load type. In motor control centers (MCC) the control voltage is often generated per withdrawable unit.

Ratings data for industrial switchgear

Note that the IEC/EN rating data on devices or in this catalog must not be used for selecting devices for use in North America. Use only the approved data. As with the IEC and European standards, which define utilization categories for l.v. switchgear, US and Canadian standards define "duty types" for various types of switched loads. The type of load for each duty type is indicated on the device's ratings plate or in its technical specifications and defines is application purpose. The following table provides an overview of these assignments:

Contactors

In North America, Contactors are classified as industrial control equipment according to UL 508 and CSA-C 22-2 No. 14-05). For the North American market, contactors must have so-called "NEMA-sizes"[4], unless they are used for switching motors, for which orders will specify ratings in HP. For the NEMA-sizes, corresponding HP motor ratings and continuous thermal currents are assigned to all North American standard voltages.

Chapters 5 and 8 of this catalog list the contactors and motor starters with the HP ratings approved for North America. The table on a Page 5/84 provides an overview of the NEMA sizes in relation to the HP ratings and continuous currents.

Combination "contactor and overload relay" ("Non Combination Motor Starter")

First of all, it is important to know that when North American customers speak of "non-combination motor starters" they mean what in Europe is referred to as a "contactor and overcurrent relay" combination and will give the same ordering information as for contactors. Complete contactor and overcurrent relay combinations can be assembled as per page 8/30. In addition, a short-circuit protection device, i.e. a fuse or circuit-breaker is required. The highest permissible rating for this protective device is given in each case in this catalog.

Motor starters ("Combination Motor Starters")

The European-type motor starter that contains all devices for short-circuit protection, overload protection and operational switching of the motor (such as circuit-breaker, contactor and overload relay), is called "combination motor starter" in North America. This type of motor starter must be engineered like a small control system complete with all associated individual devices. The contactor and overload relay are selected as described on page 8/xx.

With its devices, Eaton offers different versions for electrical, and to some extent also for mechanical connection of the motor starters' components. The most convenient connection method is provided by the tool-less plug connection wiring kits. All connection methods with wires or elements of different types are approved for North America. This also goes for surface mounting the motor starters on busbar adapters of the SASY 60i system.

IEC/EN motor protective circuit breakers

In North America, motor-protective circuit breakers can not be used irrespective of make, as is customary in IEC and EN standard systems. According to current US and Canadian standards, these devices are classified merely as "manual motor controllers" or "manual motor protectors". These devices are subject to the special conditions described below, which must be observed.

The integrated short-circuit protection function and the isolating functions of these motor-protective circuit breakers is not recognized in North America. According to UL 508 and CSA C 22.2 No. 14-05, approved motor-protective circuit breakers must be protected against short circuits with UL- or CSA-approved circuit breakers or fuses. In the event of a short-circuit, the motor-protective circuit-breaker's short-circuit release will, of course, also trip.

The additional short-circuit protective device can protect individual motor starters or – if approved for use in "group installations" – a group of motor starters. Motor-protective circuit breakers PKZM0, PKZM4 and PKE are additionally approved as "tap conductor protectors".

Motor protective circuit breakers PKZ, PKE (Chapter 7)

In North America, these devices are industrial control equipment to UL 508 and CSA-C 22.2 No. 14-05) and are used as manually operated motor starters in controllers or separately as

Duty type

		Load marking on the apparatus/device
1)	**Motors**	Horsepower (HP)
2)	**Coils** (in auxiliary and control circuits)	Coils: Volts, Frequency Control Circuit Contacts: Standard Pilot Duty or Heavy Pilot Duty.
3)	**Resistance (heating)**	Amperes, resistance only
4)	**Incandescent lamps**	Amperes or Watts, Tungsten
5)	**Ballast** (electric discharge lamps)	Amperes, ballast (A, reactors)
6)	**General Use**[1]	Amperes (A)

[1] The "General Use" group corresponds with IEC/EN Category AC-1.

Notes

1) In NA, the term "feeder circuits" is used in the widest sense
2) Feeder circuits
3) BCPD = branch circuit protective device
4) NEMA = National Electrical Manufacturers Association (USA, http://www.NEMA.org)

discrete devices. They are rated in HP and – if they are equipped with auxiliary contacts – they contain duty type information for use as controlgear (pilot duties). The devices have fixed or adjustable magnetic or electronic short-circuit releases[1] and adjustable bimetallic or electronic releases for motor overload protection. They can be used for switching motor circuits, and their auxiliary contacts for switching control circuits. In the PKE system, the modular plug-in trip blocks can be exchanged depending on the size of the connected motor. The electronic releases have a wide adjustment range. The PKE system also allows motor starters to be networked through the NA-approved SmartWire-Darwin system. PKZ and PKE must be used only for protecting and switching motors in North America and not, like in IEC/EN, for other types of load. The circuit breakers can optionally equipped with undervoltage or shunt releases.

Although PKZ motor-protective circuit breakers have an inherent short-circuit withstand capability at small currents, they must, according to North American standards, always be operated with an upstream short-circuit protection device (exceptions: UL 508 Types E and F). For most devices the specifies short-circuit protection can also be used to protect a group of motor-protective circuit breakers. In North America this characteristic is referred to as group protection. When forming groups and choosing cables, special rules of the codes and standards must be observed. If the motor starters' cable dimensions vary significantly, the groups are difficult to coordinate and some devices can be used only with separate protective devices in this case. Motor-protective circuit breakers with upstream protection can also be used without limitation in delta and ungrounded star networks.

Motor starters without additional short-circuit protection, UL 508 type E starters

According to a supplement to UL 508, motor starters can be tested as "type E combination motor controllers"[2], for which an additional short-circuit protection is not required (self-protected combination motor controller). This starter type is also CSA-recognized for Canada. Type E starters must be used only in solidly grounded star networks, for example at slash voltage 480Y/277 V. They must be used only for switching and protecting motors and for no other load types.

For the protection of motors and frequency inverters, the frequency inverters must be tested and approved by their manufacturers together with these Type E starters (at the time of print, this possibility is being planned and not yet officially included in the standards).

All components for a complete motor starter, including full short-circuit protection, are contained in a single device. This reduces the required space and eliminates the wiring between the components. These devices are used in motor control centres (MCC), in controllers and enclosed discrete equipment. Up to the specified switching capacity, these devices do not need additional short-circuit protection.

In the PKZ2 system, these devices are available with type designation PKZ2/ZM-.../S-SP. These devices feature large clearances and creepage distances. In individual motor outgoers they can perform the BCPD function without additional upstream protection. They can be tripped by optional undervoltage or shunt releases and remotely switched on and off with optional remote operators. The PKZ2 system also includes a trip block version that actuates a relay output on overload instead of tripping the circuit-breaker through the breaker mechanism[3]. This version allows separate signaling of overloads and short-circuits. On overload, the circuit-breaker does not have to be closed again after the fault is rectified. These breakers are used when the overload is self-canceling or can be easily remedied by operating personnel. This avoids the need to call in an electrician.

UL 508 manual Type E starters

In addition, the "type E combination motor controllers" comprise the "manual self-protected starters", which, if no upstream short-circuit protective devices are used, require larger clearances and creepage distances, for example according to UL 489 or CSA-C 22.2 No. 5-09. These devices are suitable only for manual switching of motors. They must be used only in solidly grounded star networks, for example at slash voltage 480Y/277 V. In individual motor outgoers they can perform the BCPD function without additional upstream protection. They must be used only for switching and protecting motors and for no other load types.

Manual self-protected combination motor controllers are implemented as a modular system with a PKZM0, PKZM4 or PKE with a special additional incoming terminal BK25/3-PKZ0-E or BK50/3-PKZ4-E. For use in Canada these devices must, in addition, be lockable, i.e. the starters must be fitted with operating handle AK-PKZ0. It is permissible to connect several PKZM at their input side with three-phase commoning links, for example B3…-PKZ0, and to connect this group through only a single incoming terminal BK….

UL 508 Type F remote-switchable starters

By combining a "manual type E starter" with a contactor, a "type F combination motor controller" can be constructed. These starters also do not need additional short-circuit protection. Type F starters can be combined and used as shown on page 8/xx. These combinations can also be used exclusively in solidly grounded star networks, for example at slash voltage 480Y/277 V. They must be used only to switch motors and no other types of load. Type F starters are accepted in Canada, although they are not yet described in the standards there.

Here, too, three-phase commoning links with a single incoming terminal can be used. Alternatively, the devices can be mounted on busbar adapters and busbar systems. The adapters and busbar systems SASY 60i are also approved for use in North America. The Eaton devices offer this very effective "two-component starter" with up to 52 A. Up to the specified switching capacity, these starters do not need additional short-circuit protection.

Motor starters for higher-rated motors

At their basic equipment level, circuit breakers are not suitable for motor protection in North America. Like the conventional IEC/EN-standard circuit breakers, these breakers lack a motor protection characteristic for overload releases that meets the requirements of current North American codes and standards. Later in this section, a new circuit-breaker as motor-protective circuit-breaker NZM… -ME…-NA will be introduced, with a motor protection characteristic that comforms to UL 508.

In North America, motor starters for higher-rated motors (for Eaton devices > 52 A) are assembled from three components: A circuit-breaker, a contactor and an additional overload relay. The circuit breakers used have

- with fixed overload releases (NZM…-AF…-NA)
- or with adjustable overload releases (NZM…-A…-NA)
- or without overload release (NZM..-S…-NA).

The overload relays optionally feature thermal bimetallic or electronic trip blocks. The configurable tripping behavior of electronic overload relays can be optimized for the motors' startup behavior under adverse load, for example for heavy starting duty.

Motor-protective circuit breakers NZM…-ME…-NA

These novel devices are fully-featured circuit breakers in North America (molded-case circuit breakers to UL 489 and CSA-C22.2 No. 5-09) and, in addition, like overload relays contain an overload release calibration (to UL 508 and CSA-C22.2 No. 14-05). They are used mainly in controllers and motor control centers (MCC). They are short-circuit rated in kA and – if they are equipped with auxiliary contacts – contain duty type information (pilot duties). These circuit breakers can optionally be equipped with and tripped by shunt or undervoltage releases or be switched on and off with remote operators.

These devices feature adjustable electronic short-circuit releases and adjustable electronic wide-range releases for motor overload protection[4]. The adjustable tripping class allows the devices to be adapted to the starting characteristics of various different motors and load types. They can be used as separate, manual breakers, for protecting and switching motor circuits, and their auxiliary contacts for switching control circuits.

In combination with a downstream contactor, they are classified as a "Type C combination motor starter", in which the contactor, acting as motor controller, switches and regulates the motor current with a high, reliable operating frequency and the NZM provides protection. For these Type C combination motor starters the HP ratings indicated on the contactors then apply. These combinations then form "two-component motor starters", which require less space and fewer components and engineering resources, and have lower thermal losses than three-component motor starters. This is specially advantageous for the compact withdrawable MCCs.

Motor-protective circuit breakers NZM…-ME…-NA can be used with or without contactor in motor circuits up to the stated switching capacity without additional short-circuit protection. With just three models, they cover a current range from 45 to 200 A. The circuit breakers are "100 % rated", meaning that their entire current range can be utilized. Their setting ranges overlap with the two-component motor starters up to 52 A that are formed with the Type E or Type F versions of circuit breakers PKZM0, PKZM4 or PKE. Covering currents up to 200 A, the two-component motor starters can now be used to cost-effectively protect and switch more than 95 percent of all motors.

Circuit-breakers without overload protection, NZM..-S(E)..-CNA

In North America, these devices are circuit breakers (instantaneous-trip only molded-case circuit breakers according to UL 489 and CSA-C 22.2 No. 5-09) and are used mainly in motor control centres (MCC), controllers and enclosed discrete equipment. They are rated in amperes and – if they are equipped with auxiliary contacts – contain duty type information (pilot duties).

The devices have adjustable magnetic or electronic short-circuit releases, no overload releases and can be used for switching motor circuits, and their auxiliary contacts for switching control circuits. They also provide short-circuit protection in motor circuits. They can optionally be tripped by shunt or undervoltage releases or be switched on and off with remote operators.

Circuit-breakers NZM..-S(E)..-CNA are UL-approved as Recognized Components. They are not used as discrete devices; they are always combined to a "combination motor starter" with a downstream contactor and overload relay, in which the contactor performs operational switching and regulation of the motor current, the overload relay acts as overload protective device and the circuit-breaker acting as short-circuit protection device. This combination has the added benefit of allowing a separate tripped indication on overload through the overload relay's auxiliary contacts or on short-

Notes

1) Observe previous paragraph
2) Motor starter construction Type E
3) ZMR-…-PKZ2, overload is signaled only; the circuit-breaker does not trip
4) The overload releases are, in addition, calibrated like overload relays in compliance with UL 508 and CSA-C 22.2 No. 14-05

circuit through the circuit-breaker's auxiliary contacts. In North America, combinations of this type are used in motor control centres (MCC) and as discrete starters in separate enclosures. Electronic overload relays also provide protection for motors with heavy starting duty. For this duty type, such combinations are also used in IEC/EN-standard switchgear systems.

For the switches alone, no short-circuit rating is given. At locations with short-circuit currents up to the switching capacity specified for the complete "combination motor starter", they can be used without upstream short-circuit protection device.

Circuit-breakers NZM...A(E)...-NA, NZM...A(E)F...-NA, NZM...VE...-NA, NZM...V(E)F...-NA

In North America these devices are inverse-time molded-case circuit breakers to UL 489 and CSA-C22.2 No. 5-09)[1]. They are the normal switches for power distribution systems, but can also be used in motor control centres (MCC) and controllers. All versions of construction sizes NZM1...-NA, NZM2...-NA[2] and NZM3...-NA are approved as current-limiting devices and marked accordingly on their rating plate. They are rated in A, their short-circuit switching capacity is given in amperes and – if they are equipped with auxiliary contacts – contain duty type information (pilot duties).

These devices have adjustable magnetic or electronic short-circuit releases and fixed-current or adjustable bimetallic or electronic trip blocks for overload protection for non-motor outgoing circuits. They can be used as short-circuit protection devices and for switching motor circuits[3], and their auxiliary contacts for switching control circuits. At mounting locations with short-circuit currents up to their switching capacity, they can be used without upstream short-circuit protection device.

In main current outgoing and incoming lines, they can be used as main switches. The letter "E" in the part number indicates versions with electronic releases. The letter "V" indicates electronic releases with adjustable, tripping times with adjustable delay. They can optionally be tripped by shunt or undervoltage releases or be switched on and off with remote operators. In North America circuit breakers with fixed overload releases are often used to reduce the required cable cross-sections. Example: A circuit is to carry 150 A. If the adjustable switch has a rated operational current of 250 A, it must be wired for 250 A in North America (for the highest adjustable current). A switch permanently set to 150 A must be wired only for 150 A. At least for large currents and long lines, this consideration can also be of interest for IEC/EN-standard systems.

Circuit-breakers PKZM4- ...-CB

From motor-protective circuit-breaker PKZM4 a fully-featured circuit-breaker to UL 489 has been derived. These circuit breakers are larger than their motor-protective counterparts because of the large clearances and creepage distances required at their input- and output-side main power connections. These devices can be used as branch circuit protective devices.

This circuit-breaker has been developed with the aim of offering devices for smaller rated operational currents than are possible with circuit breakers NZM yet with a high switching capacity. These circuit breakers have a switching capacity that is comparable with that of circuit breakers FAZ...-NA. The need for these protective devices is that non-motor loads must be protected with fuses or with circuit breakers. These loads often have only low currents. This also applies for the protection of frequency inverters, although here, too, the load is a motor. Exporters prefer the use of circuit breakers and similar fuseless solution, which is also Eaton's recommendation. In North America, systems commonly contain a large number of fuses, even though standard NFPA 70 E[4] presacribes very complex safety measures for replacing defective fuses.

Switch-disconnectors N, PN

For North America the switch-disconnectors N and PN, which are derived from circuit breakers NZM and which have a proven track record in the IEC/EN market, have been replaced with molded-case switches NS...-NA to comply with North American practices.

Molded case switches NS...-NA

Molded-case switches NS...-NA, to UL 489 and CSA-C22.2 No. 5-09 are the typical North American switch-disconnectors. They are the normal switches for power distribution systems, but can also be used in motor control centres (MCC) and controllers, for example as main switches. where they are the normal switches for power distribution systems, but can also be used in motor control centres (MCC) and controllers. They are rated in amperes, their short-circuit switching capacity is given in kA and – if they are equipped with auxiliary contacts – contain duty type information (pilot duties).

These devices feature fixed short-circuit releases and no overload release. The short-circuit releases are intended only for intrinsic protection of the circuit-breaker. They can not be used as short-circuit protection for downstream protecting and switching devices. Their auxiliary contacts can be used for switching control circuits. At mounting locations with short-circuit currents up to their switching capacity, they can be used without upstream short-circuit protection device. They can optionally be tripped by shunt or undervoltage releases or be switched on and off with remote operators. The North American standards regard these devices are switch-disconnectors, while the IEC/EN standards consider them circuit breakers of category CBI-X[5]. It should be noted that molded-case switches NS...-NA have a tripped position that the switch-disconnectors do not have. After tripping, they must be reset.

Current limitation

Current limitation is a feature of modern circuit breakers that interrupt short-circuit currents very quickly and of some fuse types. With specially developed contact systems, these circuit breakers interrupt short-circuit currents before the breaker mechanism can respond. The current is interrupted long before it reaches its limit value. This is referred to as dynamic contact disengagement through magnetic force fields around the conducting parts of the breaker mechanism. The fast interruption of the short-circuit currents results in much lower let-through currents and energies.

According to IEC/EN the switching and protective elements connected downstream of a current limiter are dimensioned only for these reduced let-through characteristics. According to the North American standards the current-limiting effect in industrial control panels for machinery can be used only partially to UL 508A Part 2 and NFPA 79. Annex SB of UL 508A does mention these current-limiting protective devices in the context of the determining the short-circuit current rating (SCCR), but demands that all branch circuit protective devices (BCPD)[6] downstream of the current-limiting protective device have at least the same switching capacity as the current limiter itself. This, in effect, ignores the physical effect, making the plants unnecessarily expensive. In reality, the load on the entire installation after the current limiter is significantly reduced. For dimensioning apparatus in the control panel arranged on the consumer side downstream of the BCPD[7] the let-through characteristic of the current limiter can then be expected again.

All circuit breakers of construction sizes NZM1...-NA, NZM2...-NA[8] and NZM3...-NA, and the small circuit breakers FAZ...-NA and FAZ...-RT are designed and approved as current limiters and marked accordingly on their rating plate.

Circuit-breakers NZM4...-NA have single-pole-interrupting contact systems that are optimized for current selectivity. For selectivity at higher currents and for installation away from short-circuits, contacts that remain closed as long as possible are required. The selectivity requirements exclude the current-limiting effect.

Series connection of circuit breakers, back-up protection (series rating)

If, according to IEC/EN standards, the switching capacity of a circuit-breaker is not sufficient for short-circuit currents that may occur in specific applications, a further protective device with a higher switching capacity is connected upstream of the circuit-breaker. Together, the two series-connected circuit breakers can handle the higher short-circuit currents. If the additional protective device protects or supports a group of lower-rated protective devices, this is referred to as group protection.

According to the North American standards, this interaction of several protective devices in power distribution systems (distribution equipment) is also permissible. For the industrial control panels for machinery (ICP) to UL 508A and NFPA 79 that are dealt with here, a series connection of circuit breakers, fuses or a combination of the two is not permissible if the series connection is intended to increase switching capacity. Circuit-breakers FAZ...-NA and FAZ...RT, which are popular in IEC/EN installations, have a rated current dependent switching capacity of 10 or 14 kA. These circuit breakers are often used in ICPs. According to the North American standards it is not currently possible to increase the switching capacity with a series-connected protective device (circuit-breaker or fuse). In an ICP a circuit-breaker must always provide the required switching capacity by itself. While it is possible to connect two circuit breakers in series as main switch and outgoing circuit-breaker, this does not increase the overall switching capacity. The switching capacity of every protective device must always be equal to or greater than the highest expected short-circuit current.

Operating elements for circuit breakers and molded case switches

Operating elements of the upstream switches that are used in industrial control equipment for machines currently attract the particular attention of inspectors. This applies specially to the operation of main switches with door coupling rotary handles and to door interlocks. Here follows a brief explanation of the complex requirements. A more detailed Technical Essay on this subject is also available[9].

North American standards UL 508A, Part 2, Industrial Machinery[10] and NFPA 79[11] demand that the operating elements of main switches (supply circuit disconnecting (isolating) means)[12] are permanently connected with these switches to allow switch operation at any time and irrespective of the control panel door's position. The operating elements must also be lockable to prevent their operation (closing). A further requirement is that

Notes

1) The term "inverse time" is usually omitted. It expresses that the tripping time is inversely proportional to the current.
2) Except NZM...2-ME...-NA
3) In combination with an overload relay
4) NFPA 70 E, "Standard for Electrical Safety in the Workplace"
5) Category CBI-X circuit breakers are molded case circuit-breakers without overload release. According to IEC/EN switch-disconnectors must not contain a current-dependent trip block.
6) Circuit-breakers for individual branches
7) e.g. contactors or frequency inverters
8) Except NZM...2-ME...-NA]]
9) http://www.moeller.net/binary/ver_techpapers/ver966de.pdf
10) UL 508A, UL Standard for Industrial Control Panels
11) NFPA 79, Electrical Standard for Industrial Machinery; subject comparable with IEC/EN 60204-1
12) Supply Circuit Disconnecting (Isolating) Means

the main switch can be switched on only when all control panel doors are closed and that all doors are mechanically and/or electrically interlocked with the switch that the doors can not be opened when the main switch is closed[1].

A simple interlock with a shunt release that simply trips the main switch when a door is opened should be avoided, as this can lead to critical or dangerous situations for plant and personnel[2]. A defeat mechanism, with which specialists can temporarily disable the door interlock to correct faults is permissible[3], as faults can often be determined only in a live system. If more comprehensive measures are required to rectify faults, the plant should be shut down for the duration of the work.

To ensure the permanent connection between operating elements and switches, main switches with handle mechanisms are the preferred choice. The switch handles are fitted directly to the sides of the switches or more flexibly connected with a bowden cable. The fronts of North American control panels typically feature a fixed flange over the panel's entire height, into which the handle is installed, so that they can also be operated when the panel door is open. These handles are referred to an flange-mounted handle[4] in North America. These handles are, in addition, connected to all control panel doors with a mechanical interlock. Eaton supplies these handles[5] with a standard drilling template and with bowden cables of various lengths – see page 17/xx. Lever handles do not fulfil the requirements of IEC/EN standards and do not contain the CE mark. They must therefore be used only in North America. Panel builders working to IEC/EN standards normally use these operating elements and the special control panels only by customer request.

In distribution equipment switches with toggle lever mechanisms are often used, while in industrial control panels[6] switches with rotary mechanisms are preferred. For main switches, door coupling rotary handles with a high protection type are usually used, since these must be operable when the control panel door is closed. With the panel door open, the handle is on the outside of the door so that the switch can not be operated without tools. An additional handle[7] can therefore be fitted to the switch axis inside the panel. According to the standards, this handle must be operable only through deliberate action[8]. To fulfil this requirement, Eaton's handles must, with the panel door opened, be rotated through about 15 degrees, then pushed and at the same time turned further to close the switch. Switching off does not require any special measures.

With this unique solution, Eaton's offers a clear competitive advantage on the European market because the high degree of protection[9] of the door coupling handles and control panels are preserved. With the approved additional handle, the switch contains two operating elements, two switch position indicators and two locking facilities – one each for closed and for open doors. These handles are also recommended for IEC/EN standard panels, to which the described issues also apply.

When using switches with door coupling rotary handles and several control panel doors, an electrical door interlock is required. This interlock can be defeated by specialists and must automatically become active again when the last door is closed. For the electrical door interlock, our customers prefer position switches with mechanical locks. This solution more closely resembles a mechanical door interlock and provides a high level of safety. On control panels with only one door, this door can be directly mechanically interlocked with the switch through the door coupling rotary handle. The mechanical door interlock can also contain a defeat mechanism[10].

As alternative to door coupling rotary handles, Eaton offers side-wall and rear-mounted switch mechanisms, which provide a permanent mechanical connection between handles and switches. Because of the versatile installation options of these mechanisms, an electrical door interlock must be provided for each switch[11].

Door coupling rotary handles for North America

With door coupling rotary handles NZM..-XTVDV.. for NZM and NS…-NA, used mainly outside North America, the mechanically interlocked control panel door can be opened when handle and switch are in their OFF position. With the NA version of these handles – NZM..-XTVDV..**-NA**, the interlocked panel door can not be opened in the OFF position: The handle must be rotated further, beyond the OFF position to release the door. This is standard North American practice. Both door coupling rotary handle types are approved for North America.

Cam switches T, switch-disconnectors P1 and P3

In North America, these switches are industrial control equipment according to UL 508 and CSA-C 22.2 No. 14-05). Switch-disconnectors P1 and P3 are a 3-pole design and have two switch positions. They are used mainly in controllers and as single devices in motor circuits. They are rated in HP and – if they are equipped with auxiliary contacts – they contain duty type information (pilot duties). The switches have no short-circuit switching capacity and must therefore be fuse-protected. They can be used for switching motor circuits and other main circuits, and their auxiliary contacts for switching control circuits. Cam switches T can be manufactured with up to eleven contact units[12] and with more than two switch positions. They are therefore used mainly as control switches, for example as operating mode or measuring device selector switches. They are rated in HP and can also be used in motor circuits.

According to UL 508 the devices described above can be used as locally installed switch-disconnectors if the control panel contains a branch circuit protective device (BCPD) and the switch is, in addition, regarded as motor disconnect according to UL 508 and CSA-C22.2 No. 14-05 and marked accordingly on its rating plate. Eaton's T- and P-type switches fulfil these requirements. For the required line fuse ratings, see the catalog or the rating plates of the switches.

Fuse bases and fuses

For the following reasons, the use of circuit breakers, selected according to the above criteria, is preferable to the use of fuses:

- In North America only North American fuse types must be used; IEC/EN standard fuses are not acceptable.
- Fuse bases for North American fuses are very large and take up a lot of space.
- NZM circuit breakers provide current isolation, short-circuit protection, overload protection and fault signaling in a single device and are much less expensive and smaller than a combination of fuse base, fuses and overload relay.

If the use of fuses is unavoidable, we recommend that you observe the following points:

- North American fuses are classified according to physical size, breaking capacity and current–time characteristics. The above table provides a rough overview.
- Motor circuits:
  When using time delay fuses[13]:
  Rated current of the max. line fuse= 1.75 × motor rated current or next higher fuse current rating (max. 2.25 × motor rated current).
  When using non-time delay fuses[14]:
  Rated current of max. line fuse = 3 × motor rated current or next higher fuse current rating (max. 4 × motor rated current).
- "Circuits with non-motor loads:
  For these consumers line fuses are to be selected according to the consumer manufacturer's instructions. This also applies for frequency inverters, even if motors are connected to the frequency inverters. In these cases the frequency inverters are regarded as consumers.
- "Switchgear:
  For switchgear requiring line fuses for inherent short-circuit protection, the fuse ratings are to be obtained from the technical data in the catalog or from the devices's rating plates. For short-circuit protection of the combination of Eaton contactor and overcurrent relay, see page 8/35 for the max. line fuse ratings.

To ensure both trouble-free motor starting and short-circuit protection of all devices within a circuit, select the smallest fuse required according to criteria 2b), 2c) and 2d). Regarding the short-circuit current rating (SCCR) non-time delay fuses can have advantages over circuit breakers.

Supplementary protectors FAZ

In North America, these devices are industrial control equipment and protectors (supplementary protectors according to UL 1077 and CSA-C22.2 No. 235)[15]. They are used mainly in controllers. They can also be used as additional protective device in electrical devices whose incomer is already short-circuit protected. Eaton also provides an approved DC switching capacity in addition to the switch's AC switching capacity. They can therefore also be used in DC circuits.

Supplementary protectors FAZ are Recognized Components according to UL standards. This type of protective element is often used incorrectly. FAZ must be used only as additional protective device and never for branch circuit protection (BCPD). They have non-adjustable magnetic short-circuit releases for short-circuit protection and fixed-current overload relays for overload protection. Eaton supplies supplementary protectors with a range of IEC/EN-compliant tripping characteristics. The characteristic is selected according to the protected load type.

Supplementary protectors FAZ are specially suitable for fuseless protection of control circuits on the output side of control transformers. These protectors can also be used for input-side protection of control transformers, but not on the input side of power transformers.

Circuit-breakers FAZ…-NA, FAZ…-RT (Miniature Moulded Case Circuit Breakers, MCCB)

Circuit-breakers FAZ…-NA and FAZ…-RT are a further development of supplementary protectors FAZ. They feature large clearances and creepage distances in the connection area. and, as miniature molded-case circuit breakers (MCCB), comply with standards UL 489 and CSA-C22.2 No. 5-09. They are Listed Components according to the UL standards and

Notes

1) In North America, electrical switching and protective devices are not generally designed with protection against accidental contact
2) The Stop categories to IEC/EN and NFPA 79 must be observed
3) Defeat mechanisms are usually operated with a tool (screwdriver)
4) Also referred to as "side-mounted handle"
5) e.g. NZM-XSHGVR12-NA, plus further components
6) Industrial Control Panels to UL 508A and NFPA 79
7) e.g. NZM…-XHB-…-NA
8) Deliberate action
9) Or protection type – an important aspect with regard to the approval of switchgear systems/panels
10) Operated by turning a screw on the handle with a screwdriver
11) Also on panels with only one door
12) Eleven contact units correspond with 22 contacts
13) Also called "dual element time delay fuses"
14) "Non-time-delay fuses"
15) Protective devices for additional protection (in addition to a BCPD), e.g. splitting of circuits after a BCPD

Classified Components according to CSA. They have non-adjustable magnetic short-circuit releases for short-circuit protection and fixed-current overload relays for overload protection. They are approved as

Available accessories are auxiliary contacts, shunt releases and three-phase commoning links with large clearances and creepage distances are available.

manufacturers and users reduce their parts stock and provide optimized solutions more quickly.

The standardized continuous currents and switching duties for AC and DC for auxiliary switches are assigned

Motor protection must be provided by an overload relay. For dimensioning the motor outgoer with soft starter, use the selection tables in this catalog.

Eaton's soft starters (DS4, DS6, DS7) are UL-listed and CSA-certified (DS7

Part no. or design in: USA	Canada	Standards UL, CSA	Fuse characteristics	SCCR	Typical values in A	Fields of application		Notes
Class **H**, "Code"	Class **H**, No. 59 "Code"	UL 248-6/7, C22.2 248-6/7	Fast	10 kA, 250 VAC 10 kA, 600 VAC	0…600	Primarily domestic		Types H, K and No. 59 "Code" fit the same bases and are therefore interchangeable. There is therefore a risk that they may be incorrectly used! See also note on K.
Class **CC**	Class **CC**	UL 248-4, C22.2 248-4	Fast Time-lag	200 kA, 600 VAC	0.5…30	**Fast**: Protection from resistive and inductive loads. Circuits for heating, lighting, feeders and branches for mixed loads.	**Time-lag:** Protection from inductive and highly inductive loads. Circuits for motors, transformers, lighting etc.	Extremely compact design. **Current limiter** to UL/CSA.
Class **G**	Class **G**	UL 248-5, C22.2 248-5	Fast Time-lag	100 kA, 480 VAC	21…60			Compact design. **Current limiter** to UL/CSA. All other fuse types do not fit into bases.
				100 kA, 600 VAC	0.5…20			
Class **J**	Class **J** HRCI-J	UL 248-8, C22.2 248-8	Fast Time-lag	200 kA, 600 VAC	1…600			Compact design. **Current limiter** to UL/CSA. All other fuse types do not fit into bases.
Class **K** K1, K5	Class **K** K1, K5	UL 248-9, C22.2 248-9	Fast Time-lag	50 kA/100 kA/ 200 kA, 600VAC	0…600			**Not current limiter** to UL/CSA. In the USA, the K types are therefore being increasingly replaced by the RK part numbers.
Class **L**	Class **L**	UL 248-10, C22.2 248-10	Fast Time-lag	200 kA, 600 VAC	601…6000			**Current limiter** to UL/CSA. All other fuse types do not fit into bases.
Class **R** RK1, RK5	Class **R** HRCI-R RK1, RK5	UL 248-12, C22.2 248-12	Fast Time-lag	50 kA/100 kA/ 200 kA, 600VAC	0…600			**Current limiter** to UL/CSA. Types RK1, RK5 and HRCI-R fit the same bases. All other fuse types do not fit into these bases. RK1 fuses have lower let-through values than RK5.
Class **T**	Class **T**	UL 248-15, C22.2 248-15	Fast	200 kA, 300 VAC 200 kA, 600 VAC	0…1200		–	Extremely compact design. **Current limiter** to UL/CSA. All other fuse types do not fit into bases.

current limiters and marked accordingly on their rating plates. This means that their rated current can be fully utilized. They are rated in amperes, their short-circuit switching capacity is given in kA and – if they are equipped with auxiliary contacts – contain duty type information (pilot duties). Eaton also provides an approved DC switching capacity for single-pole 48 V and two-pole 96 V in addition to the switches' AC switching capacity[1].

These miniature circuit breakers can be used as branch circuit protective devices (BCPD) in feeder circuits and branch circuits. Up to a rated current of 32 A, FAZ…-NA and FAZ…-RT must be used only in star networks with solid grounding and a slash voltage of up to 480Y/277V. FAZ…-NA and FAZ…-RT for higher current values can be used up to 240 V AC, irrespective of network configuration and grounding. Part number suffix "-RT" stands for Ring Terminal. On these versions the terminal screws can be fully turned out to allow the connection of ring cable lugs.

These circuit breakers are available with one, two or three poles and with IEC/EN tripping characteristics B, C and D. The characteristic is selected according to the protected load type.

Accessories, such as auxiliary contacts and shunt releases

In North America, approvals were, for a long time, available only for complete, unalterable devices. For the practice common in Europe of allowing customers to retrofit devices with auxiliary contacts, undervoltage releases, shunt releases and other accessories, the corresponding UL and CSA approvals can now be issued. This applies even for changes in the main current area, for example different main current terminal types. The permissible versions must, of course, have been described, tested and approved. Permissible alternative connection blocks must be indicated on the device's rating plate. Observe the installation instructions and do not omit any parts only because their purpose is not clear. These parts ensure the required clearances and creepage distances, prevent short-circuits between phases due to faulty insulation and improve protected against accidental contact.

The tried-and-tested modular design method allows the field of application of contactors, circuit breakers, motor-protective circuit breakers, position switches and control circuit devices to be cost-effectively extended with add-on functions. It also helps reduce

according to the standards to the characteristic values and switching duty types indicated in the devices' technical specifications and on their ratings plates. These pilot duties are given in the table for auxiliary contacts in AC and DC circuits on page 5/xx. Auxiliary contacts are approved mainly for heavy pilot duty, and on some devices for standard pilot duty. For detailed information, see the technical data for the device groups. The ratings plate on some auxiliary switches contains information such as "600 V, same polarity". This means that adjacent auxiliary contacts of the same auxiliary switch or switch block must be connected only to the same control voltage source.

Soft starters and frequency inverters

Soft starters DS4, DS6, DS7

Like IEC/EN 60947, North American standards regard soft starters largely like contactors. These devices are developed, tested and approved to UL 508, CSA-C22.2 No. 14-05 and CSA-C22.2 No. 0-M91. Circuit-breakers or fuses provide short-circuit protection. The North American standards do not currently include protection through UL 508 Type E starters or the treatment of these devices as contactors, i.e. as UL 508 Type F starters.

as of Summer 2010) for an operational voltage of up to 480 V 50/60 Hz (full voltage). They are used in branch circuits. In practice, the soft starters are bypassed with a built-in bypass after the motor has started up. This reduces heat losses and thyristor load. Any short-circuit currents in the motor outgoer do not flow through the thyristors in the event of a fault. This increases the soft starters' reliability. On some models the soft starters switch two phases and the third phase is fed through. One of of the competitive advantage of Eaton's soft starters is that they have terminal types that are adapted to the switchgear. At currents up to 41 A the same terminal types are used as for circuit breakers, whose accessories can therefore also be used.

Frequency inverters M-Max and H-Max

Frequency inverters are developed, tested and approved according to North American standards UL 508C and CSA-C22.2 No.14-05. Short-circuit protection is provided by circuit breakers or fuses. It is currently not yet clear whether UL 508 Type E or Type F starters can be used as protective devices. Frequency inverters can be used only in combination with the tested, manufacturer-assigned

Notes

[1] For additional approved versions for single-pole 125 V DC and two-pole 250 V DC please enquire

protective devices. Overload protection of a single, directly connected motor can be provided directly by the frequency. For drives with several motors and bypass circuits the motors must be individually overload-protected with overload relays.

The frequency inverters are used in branch circuits. They can be used with three-phase rated operating voltages of up to 480Y/277 V, 50/60 Hz. Because of their suppressor circuit, solidly grounded star networks with neutral conductor are always required.

Radio interference suppression measures (EMC) in frequency-controlled power drive systems (PDS) are not specified in the North American standards. To ensure interference-free operation, the EMC measures laid out in IEC/EN 81600-3 should be carried out for machines and plants for export to North America.

Control relays easyRelay and MFD silver

Electronic control relays easyRelay and multi-function displays MFD-Titan have all UL 508 and CSA-C22.2 No.142 approvals. They are also approved to CSA (Class 1, Div. 2) for use in hazardous locations to CSA-C22.2 No. 213-M1987(R2008)[1].

All technical details for the North American market in this catalog, in the installation instructions and in the manuals are also given in American units, such as inches, lb, and degrees Fahrenheit. The relay data are given in pilot duties B300, R300, and make/break. The operational DC voltage of 24 V is also the common voltage for electronic components and systems in North America.

easyRelay and MFD-Titan are programmed in programming language ladder diagram. The easySoft software is also capable of representing North American ANSI contact sequences.

Control relays easyRelay and multi-function displays MFD-Titan are therefore fully equipped as control components/systems for the North American market.

Protection types for enclosures (degree of protection)

- The binding design and degree of protection requirements for enclosures for the USA are defined in NEC = NFPA 70, in UL 508(A) and in UL 50(E). For Canada they are specified in CSA-22.2 No. 14-05 and in CSA-C 22.2 No. 94. The degrees of protection are given as NEMA types or as identical UL/CSA types. Because the UL/CSA types must be third-party certified, they have largely superceded the NEMA types. Many inspectors demand UL/CSA types. Where products with third-party certified UL/CSA types are available, they should be used in preference.
- The enclosures used by Eaton are accepted for use in North America, since they are approved with UL/CSA types and meet the requirements regarding contact protection, corrosion protection and ingress protection against solids and liquids. See the information about degree of protection on the selection pages or in the technical specifications for the product groups.
- The IEC/EN standard ingress protection (IP) types include protection against ingress of solids and water. The comparable standards in Canada and the USA go further, also covering protection against ingress of oil and coolant, and corrosion protection of the enclosure; they therefore also define its place of installation. The table on a Page 22/xx ((17/18)) provides an overview of the requirements in Canada and the USA and a comparison with the IP ratings.
- IP protection type information has no relevance for use in North America and can not replace missing information about NEMA/UL/CSA types. The NEMA/UL/CSA types cover the corresponding IP ratings but not the other way round.

When exporting to North America, particular attention must be paid to the selection and implementation of the correct degree of protection for enclosures and installed apparatus. The inspectors are known to check very thoroughly for adherence to the degrees of protection. In almost every case, plants fail the inspection on this aspect and must be rectified. This results in lost time and additional costs. Always choose enclosures with the right degree of protection from the start. Every opening subsequently made in an enclosure puts its degree of protection into question. The degree of protection remains intact only when each of these enclosures is sealed again to the same degree. This can be done, for example, by installing a control circuit device or switch handle with the same or a higher degree of protection. Likewise, all openings that are not immediately apparent because they are hidden by other components must be sealed. In most cases the assembly personnel knows exactly where work was performed with less than 100 percent accuracy. Hoping that this will not be noticed will usually result in severe problems. To obtain acceptance, these locations will later have to be improved at great cost. Improvements carried out at the customer's site are specially expensive. Here, too, it should be remembered that this work has to often be performed by a North American vendor and can not be carried out by the manufacturer, who can then, at best, take on the role of supervisor.

Sheet-steel enclosures and installation technique

Sheet steel enclosures can be used for all types of controllers. In North America, and specially in power distribution systems cables are commonly laid in metal conduits. Into these conduits, individual strands, not whole cables, are laid. The conduits are bolted together along their entire length to act as continuous grounding conductor. They are connected to the enclosure flanges with suitable metal glands. Enclosures with metal flanges ensure an uninterrupted conducting connection between incoming and outgoing conduits, so that the enclosures are included in the grounding measure. Sheet steel enclosures with metal or insulating flanges are also suitable for connecting plastic conduits and cables, which are connected with commercial glands. In this configuration, protective grounding must be provided with a ground conductor routed with the cabling. This cable routing type has established itself in many modern installations and is today the preferred choice, for example for machines. On machines, only the input wiring to the main switch is often installed with metal conduits. Regarding the configuration and space utilization of cable trays, cable ducts and wiring ducts in control panels, the limitations imposed by the Electrical Codes must be observed. The permissible space utilization lies some way below that usually specified by the IEC/EN standards. Inspectors usually investigate this aspect in great detail. Where cable trays and ducts are secured to the building, extensive regulations of the Electrical Codes must be observed. Consistent grounding of all components that must be included in the grounding system will be thoroughly inspected and objections are not infrequent. The required grounding conductor cross-sections must be adhered to under all circumstances.

Another important aspect is the protection of the insulation of electrical cables where the cables are routed through openings or are exposed to movement during machine operation (for example trailing cables). Cables that are mechanically protected in IEC/EN installations must, of course, also be protected in plants destined for export to North America. The cables as well as all materials used for routing and securing them must be verifiably approved. Always observe the installation and dimensioning instructions of the Electrical Codes.

Wall-mounting enclosures CS

Eaton now supplies a new enclosure system with approvals for the USA and Canada. Wall-mounted enclosures in 45 enclosure sizes ranging from 250 × 200 × 150 mm (h × w × d) to 1200 × 800 × 300 mm are available. The smaller enclosures are ideal for enclosing individual devices or small combinations, such as motor-starter combinations or frequency inverters complete with the additionally required components. The larger enclosures are suitable for constructing small to medium-sized machine controllers. It is advisable, wherever possible to fix the enclosures to the machine. This has the added advantage that the machine can be delivered ready for connection and fully function-tested. If the enclosures and installation are mounted on the building, the extensive installation regulations of the Electrical Codes must be observed. The enclosures have a high degree of protection (IP65 UL/CSA Types 1 and 12, indoor use only). The surrounding rain channel profile offers protection against the ingress of liquid such as water or oil as well as dirt when the door is opened. A powder-coated textured surface provides abrasion-resistant corrosion protection. The enclosures feature galvanized sheet steel mounting plates. Sheet steel bottom plates for self-assembly are available. The enclosure can be turned through 180° for cable entry from above or below.

Insulated enclosures CI-...-NA

Enclosures CI-…-NA fulfil the statutory North American requirements for the construction and degree of protection, which is laid out in UL 508(A) for the USA and in CSA-C22.2 No. 14-05 for Canada. They are therefore suitable for enclosing motor starters and miniature and small controllers for installations and machinery. With their complete corrosion-resistance they are ideally suited for humid or corrosive environments. The enclosures are suitable for the connection of cables and both metal and plastic conduits, which are connected with commercial screwed glands. Because the "total insulation" that Eaton offers for its enclosures is not recognized for insulating enclosures in the USA and Canada, the enclosures must be grounded according to the enclosed installation instructions.

Enclosures CI-...-NA are approved both with and without insulated flanges. For the full range of CI enclosures with UL/CSA approvals see Chapter 20.

Busbar systems SASY60i

Busbar systems are an essential part of IEC/EN installations and of modern control systems. In North America they are still relatively new. There, power distribution to switching and protective devices is frequently still implemented using power distribution blocks, which are less well known in the rest of the world. In 2007, when Moeller began to introduce the busbar system SASY 60i, the system's components received only approvals as UL Recognized Components and CSA Certified Components. In the meantime, most of the system's key components are approved as UL Listed and CSA Certified Components – see the markings on the selection pages. This was an important step, as Listed Components no longer have to be included at additional cost into the certification reports for switchgear systems. In the next edition of UL 508A the busbar system are expected to also be included in "Component Requirements" SA1, Table SA1.1.

Initially, the busbars were approved only for peak loads of 1000 A/inch² or 1.55 A/cm², which is about half of the load capability according to IEC/EN. In the meantime, the busbars have been tested and approved with IEC/EN loads. This was a major step for machine and panel builders that want to supply world-market machines and control panels.

Notes

[1] Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations]

Summary

This chapter of the main catalog briefly introduced the topic of approvals for North America as well as the various switchgear and protective devices and their normal usage in conformance with the North American codes and standards. Further information about equipping machines and installations to UL 508A and NFPA 79 is available from Eaton in a range of technical essays. Eaton also holds workshops on this subject.

Some users still think that they can avoid compliance with the North American standards and codes. There may be a few exceptions, in which an installation is not inspected for compliance, and in even fewer cases adherence to the North American codes and standards is not required. If you have experienced such a case, you should not assume it to be the normal situation. The electrical codes have the same status as to North American law.

We regularly receive calls from machine and panel builders whose products are not accepted in North America and who are desperately looking for solutions for their sometimes serious mistakes. Rectifying these can be very expensive, cost a considerable amount of time and results in lost image. What is more, in North America some modifications must be performed by North American companies and can not, therefore be carried out by the manufacturer.

For companies that supply the North American market only occasionally and who do not wish to expand this market region, it may be more efficient to commission an experienced subcontractor with supplying and installing the electrical equipment. These vendors can re-engineer IEC/EN installations to North American codes and standards and build installations that are already accepted and approved at the place of manufacture. Eaton Electric GmbH itself does not provide engineering services because we do not want to compete with our customers.

This information does not replace the detailed study and implementation of the North American codes and standards. It has been compiled by Wolfgang Esser and other Eaton specialists to our best knowledge and belief based on the product situation and state of the standards at the beginning of 2010.

The binding documents are always the original North American codes and standards and, for the described products, the applicable Eaton main catalog and Eaton's approval documents for its products.

Switching duty of auxiliary contacts, rating data for three-phase contactors to NEMA

	Code number[1]	Conventional free air thermal current I_{th}	Maximum switching duty									
			120 V AC		240 V AC		480 V AC		600 V AC		≦ 600 V AC	
			ON	Off	ON	Off	ON	Off	ON	Off	ON	Off
		A	A	A	A	A	A	A	A	A	VA	VA
Auxiliary contacts in AC control circuits												
Heavy pilot duty[2]	A 150	10	60	6	–	–	–	–	–	–	7200	720
	A 300	10	60	6	30	3	–	–	–	–	7200	720
	A 600	10	60	6	30	3	15	1.5	12	1.2	7200	720
Standard pilot duty[3]	B 150	5	30	3	–	–	–	–	–	–	3600	360
	B 300	5	30	3	15	1.5	–	–	–	–	3600	360
	B 600	5	30	3	15	1.5	7.5	0.75	6	0.6	3600	360
	E150	0.5	1.8	0.3	–	–	–	–	–	–	216	36

	Code number[1]	Conventional free air thermal current I_{th}	Maximum switching duty			
			125 V DC On/Off	250 V DC On/Off	310 ≦ 600 V DC On/Off	< 600 V DC On/Off
		A	A	A	A	VA
Auxiliary contacts in DC circuits						
Heavy pilot duty[2]	N 150	10	2.2	–	–	275
	N 300	10	2.2	1.1	–	275
	N 600	10	2.2	1.1	0.4	275
Standard pilot duty[3]	P 150	1.1	–	–	138	–
	P 300	5	1.1	0.55	–	138
	P 600	5	1.1	0.55	0.2	138
–	Q 150	2.5	0.55	–	–	69
	Q 300	2.5	0.55	0.27	–	69
	Q 600	2.5	0.55	0.27	0.1	69
–	R 150	1	0.22	–	–	28
	R 300	1	0.22	0.11	–	28

Notes

1) The values 150, 300 and 600 indicate die maximum voltage for which an auxiliary contact can be used.

2) "Heavy Pilot Duty" = High switching duty

3) "Standard Pilot Duty" = normal switching duty

4) Rating data for 3-phase contactors, for single-speed motors, without inching, reversing or regenerative braking.

Type[1]	construction[1] in USA	Canada	Tripping characteristic[1]	Switching capacity $kArm_s$	Applications[1]	For use in	
H		–	Fast	10	Primarily domestic	USA, Canada	Types H, K and No. 59 "Code" fit the same bases and are therefore interchangeable. In the USA, the K types are therefore being increasingly replaced by the RK types. Rated operational current: 1 … 600 A
		No. 59 "Code"	Fast	10	Primarily domestic	Canada, USA	
K P	K1/K5	–	Fast	100 – 200	Protection of circuits for heating, lighting and feeders and outgoers for mixed loads.	USA	
		–	Time-lag	100 – 200	Protection of circuits for motors, transformers, heating and lighting.	USA	
J		–	Fast	200	See item 2 above.	USA, Canada	Compact design. Types J and HRCI-J fit the same bases, all other types numbers do not fit into these bases. Rated operational current: 1 … 600 A
		–	Time-lag	200	See item 3 above.	USA, Canada	
		HRCI-J	Fast	200	See item 2 above.	USA, Canada	
			Time-lag	200	See item 3 above.	USA, Canada	
RK	RK1/RK5	–	Fast	100 – 200	See item 2 above.	USA, Canada	Types RK1, RK5 and HRCI-R fit the same bases, all other types numbers do not fit into these bases. Rated operational current: 1 … 600 A
		–	Time-lag	100 – 200	See item 3 above.	USA, Canada	
		HRCI-R	Fast	100 – 200	See item 2 above.	Canada, USA	
			Time-lag	100 – 200	See item 3 above.	Canada, USA	
		HRCII-R	Time-lag – Fast	100 – 200	5. Protection of motor circuits	Canada	All other fuse types do not fit into bases for HRCII-R.
CC(CD)		–	Fast	200	See item 2 above.	USA, Canada	Very compact design; all other fuse types do not fit into these bases. Rated operational current: CC 1 … 30 ACD 31 … 60 A
			Time-lag	200	See item 3 above.	USA, Canada	
L		–	Fast	200	See item 2 above.	USA, Canada	"Code" fuses for higher ratings Rated operational current: 601 … 6000 A
			Time-lag	200	See item 3 above.	USA, Canada	

Notes

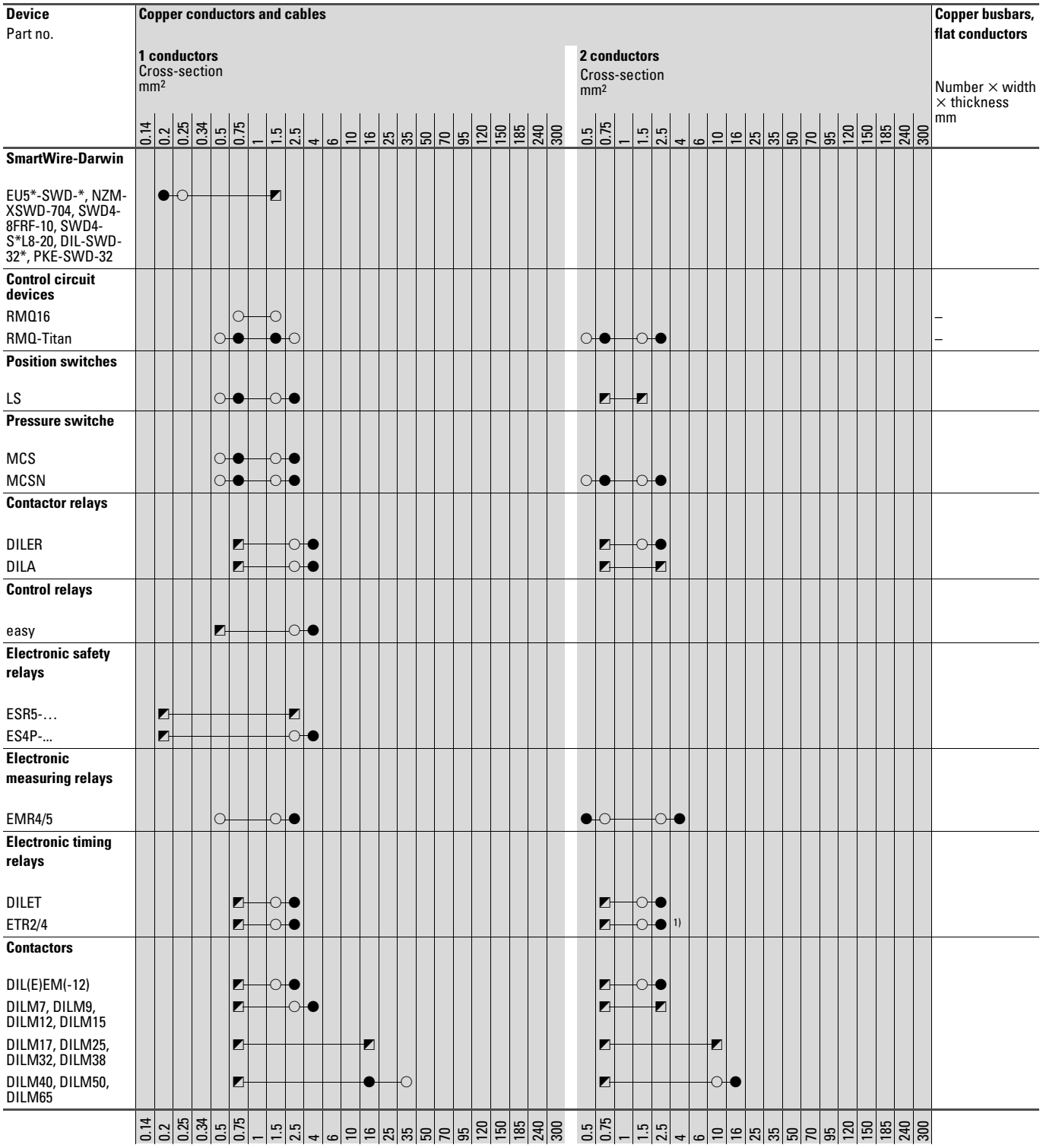
[1] The trip types data and the assigned field of applications are a rough overview only. In practice, it is always advisable to find out both this information and the required fuse type from the North American end customer.

Degrees of protection of enclosures to NEC (NFPA 70), UL, CSA, NEMA

Enclosure Enclosure and protection type marking to NEC NFPA 70[1] NEMA No. 250–1997, Appendix A[2] UL 50 CSA-C 22.2 No. 94	Location	Type of protection	Comparable degree of protection IP[3]
Type 1 General purpose	Indoor installation	Protection against accidental contact with live parts and against a limited amount of falling dirt.	IP20
Type 2 Drip-proof	Indoor installation	Protection against limited amounts of falling water and dirt	IP22
Type 3 Dust-tight, rain-tight, resistant to sleet and ice	Outdoor installation	Protection against wind-blown dust and wind-blown rain. Undamaged by formation of ice on the enclosure	IP54
Type 3R Rain-tight, resistant to hail and ice, dust-tight	Outdoor installation	Protection against falling rain; undamaged by formation of ice on the enclosure	IP54
Type 3S Dust-tight, rain-tight, resistant to sleet and ice	Outdoor installation	Protection against hail wind-blown dust and wind-blown rain. External mechanisms remain operable while ice laden.	IP54
Type 4 Dust-tight, water-tight, rain-tight	Indoor or outdoor installation	Protection against falling rain, splashing water and hosed water. Undamaged by formation of ice on the enclosure	IP56
Type 4X Dust-tight, water-tight,corrosion-resistant, rain-tight	Indoor or outdoor installation	Protection against falling rain, splashing water and hosed water. Undamaged by formation of ice on the enclosure, corrosion protection	IP56
Type 6 Rain-tight, water-tight, immersible, resistant to hail and ice	Indoor or outdoor installation	Protection against dust and hosed water. Protection against entry of water during temporary limited submersion. Undamaged by formation of ice on the enclosure.	IP67
Type 6P Rain-tight, water-tight, immersible, corrosion-resistant	Indoor or outdoor installation	Protection against entry of water during prolonged submersion at limited depths; corrosion-resistant.	IP67
Type 5 Drip-tight, dust-tight, corrosion-resistant	Indoor installation	Protection against limited amounts of falling water and dust, corrosion-resistant.	IP52
Type 12 For use in industry, drip-tight, dust-tight	Indoor installation	Protection against dust and dripping water	IP52
Type 12K[4] As type 12	Indoor installation	As part no. 12	IP52
Type 13 Dust-tight, oil-tight	Indoor installation	Protection against entry of dust, splashing water, oil and non-corrosive fluids.	IP54

Notes

1) NEC = National Electrical Code
2) NEMA = National Electrical Manufacturers Association
3) The IP rating provided as an approximate comparison. A more accurate comparison is not possible, since different ingress protection tests and assessment criteria apply.
The NEMA types cover the corresponding IP ratings but not the other way round. In general, NEMA/UL enclosure protection testing is subject to stricter criteria.
4) For enclosures with knockouts.



–
–
1)

Instructions

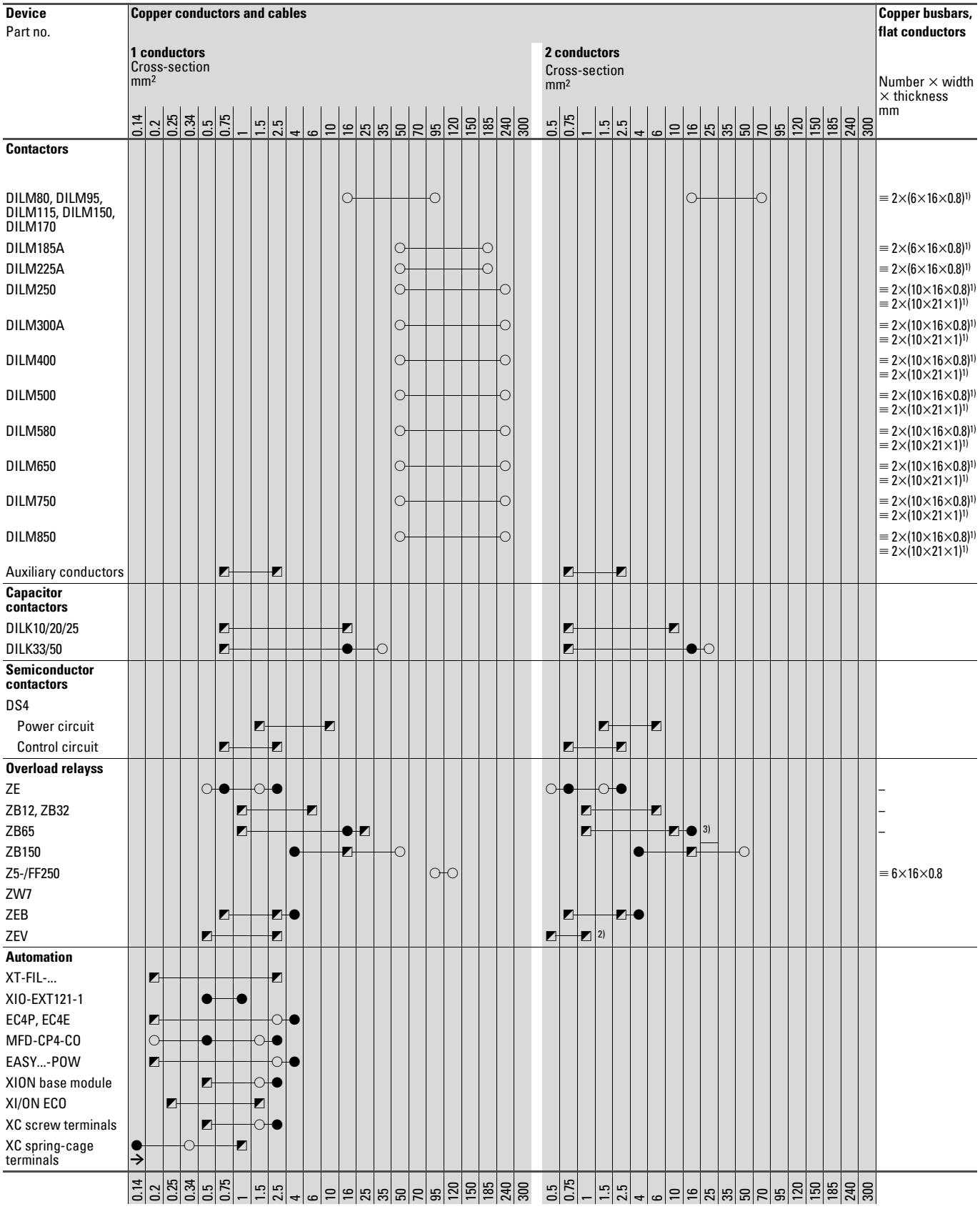
- ● Solid (s)
- ○ Stranded (st) Flexible (f)
- ◩ Solid or stranded or flexible

min. max.

Busbar
≡ Flat conductor

Flexible with ferrule up to 16 mm² to DIN 46 228

1) Use only equal cross-sections.



Instructions

- ● Solid (s)
- ○ Stranded (st)
  Flexible (f)
- ◩ Solid or stranded or flexible

min. max.

- ●—● Solid (s)
- ○—○ Stranded (st) Flexible (f)
- ◩—◩ Solid or stranded or flexible

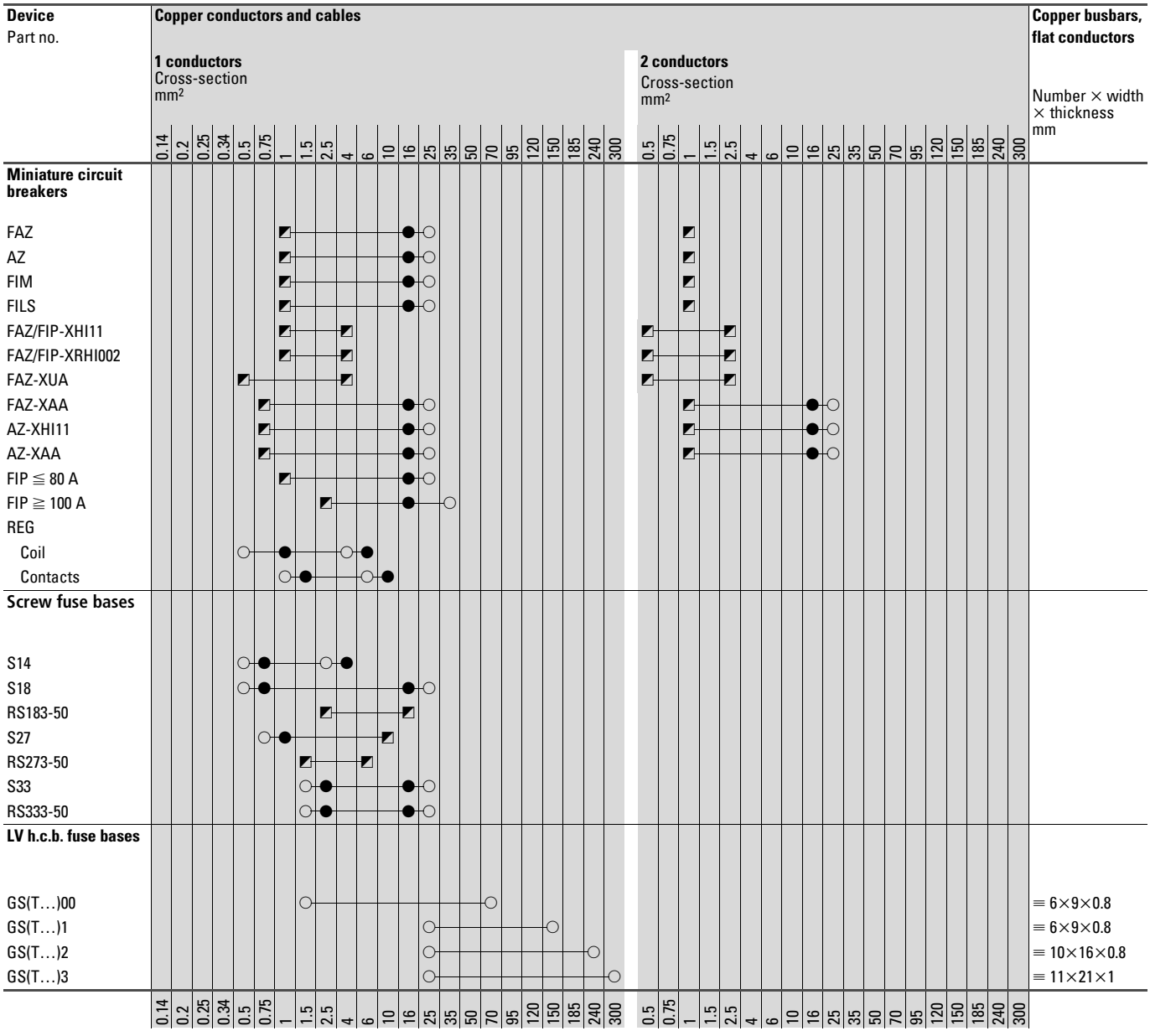
Flexible with ferrule up to 16 mm² to DIN 46 228

- ■ Busbar
- ≡ Flat conductor

1) Use box terminals

2) When connecting two conductors, only the following combinations are permitted:
0.5 and 0.75 mm², 0.75 and 1 mm², 1 and 1.5 mm²

3) With two conductors, use the same cross-section.



Instructions

● Solid (s)
○ Stranded (st)
Flexible (f)
◩ Solid or stranded or flexible

min. max.

Busbar
≡ Flat conductor

Flexible with ferrule up to 16 mm² to DIN 46 228

This glossary contains short definitions of technical terms used in this catalog. Because the terms used in IEC/EN 60947 can be open to interpretation, it is always advisable to also refer to the relevant standard. This applies in particular to the American National Electrical Code (NEC, NFPA 70) and the US standards UL 508, UL 489, UL 508A, and NFPA 79.

The Canadian Electrical Code (CEC) contains equivalent terms in standards CSA-C 22.2 No. 5 and CSA-C 22.2 No. 14.
The American English terms are appended to the glossary in a new block. The German equivalents of the American terms are not definitive equivalents; they are intended merely as an aid to understanding. Because these terms often describe concepts that are not defined in the IEC world, there is no authorized German equivalent for them. The explanations apply to the use of components in particular in industrial control panels for machinery to UL 508A and NFPA 79. Each technical term contains a reference to the corresponding standard, e.g. IEC/EN 60947-1. For the correct translation, the IEV No. of the electrotechnical glossary (IEC 50: International Electrotechnical Vocabulary) is specified, e.g. IEV 441-17-31.

Altitude

The density of air decreases with increasing altitude, and this reduces its insulating capacity as well as its heat transfer capability. This affects the rated operational voltage and rated operational current of switching devices, conductors and motors, as well as the tripping behavior of thermal overload relays. On request, Eaton can supply information about the suitability of equipment for operation at altitudes above the standard-specified 2000 m.

Ambient temperature, enclosed

(cf. IEV 441-11-13) Temperature at which the switchgear is capable of being operated within a closed housing. The elevated temperature inside the enclosure due to the switchgear's heat dissipation must be taken into account here.

Ambient temperature, open

(cf. IEV 441-11-13) Room temperature (for example of the shopfloor or control room) in which the switching device is located.

Auxiliary contact

(IEC 60947-1/IEV 441-15-10) A contact which is included in an auxiliary circuit and is mechanically operated by the switching device.

Auxiliary switch

(IEC 60947-1/IEV 441-15-11) Switch containing one or more control or auxiliary contacts and which is mechanically operated by a switching device. Auxiliary switches can be retrofitted in modular systems of contactors, circuit breakers and motor-protective circuit breakers, or they are a fixed component of a switching device, e.g. contactor relay.
They are designated according the functions

- Making contact as a normally closed contact, normally open contact, changeover contact or fleeting contact.
- Function as normal, early, late, drive or trip indicator switches.

Back-of-hand proof

Switchgear is considered as back-of-hand proof if its conductive parts cannot be touched with a ball with a diameter of 50 mm.

Busbar tag shroud

Design measures incorporated into equipment to prevent direct contact (i.e. without tools) with live parts of a system (finger-proof, back-of-hand proof).

Clearance in air

(cf. IEC/EN 60947-1; 2.5.46/IEV 441-17-31) The distance between the two conductive parts at the point at which they are closest to each other. The clearance in air is determined by the rated impulse withstand voltage, the overvoltage category and the pollution degree.

Closing delay

The interval of time between the instant of command and the first make operation of the contacts of the first pole to close. The closing delay is made up of the response time and the closing time.

Control circuit reliability

The probability with which switching states arise during the lifespan of a contact that would be interpreted as faults by downstream electronic controllers (PLCs). Control circuit reliability is expressed in values based on tests using standard limit values for signals to IEC/EN 61131-2.

Conventional thermal current I_{th}

(cf. IEC/EN 60947-1; 4.3.2.1) The maximum value of current that a device is capable of carrying for a maximum of 8 hours without thermal overloading. As a rule, it corresponds to the maximum rated operational current.

Coordination type

State of a switchgear assembly (motor starter) during and after testing at rated conditional short-circuit current:

Type “1” coordination:

- No hazard to persons and systems.
- No immediate operational readiness necessary.
- Damage to the starter permissible.

Type “2” coordination:

- No hazard to persons and systems.
- Starter is suitable for further operation.
- No damage to the starter except slight welding of the switch contacts if these can be separated easily without significant deformation.

Creepage path/distance

(cf. IEC/EN 60947-1; 2.5.51/IEV 151-03-37) Shortest distance between two conducting parts along an insulating material. Is determined by the material’s rated insulating voltage, the pollution degree and the creepage resistance.

Damp heat, constant

This test subjects the equipment to an ambient temperature of 40 °C at a constant humidity of 93 %. At set intervals during the test, the electrical and mechanical function of the equipment are examined.

Damp heat, cyclic

This test subjects the equipment to cyclically changing climatic conditions. A cycle applies 40 °C at 93 % relative humidity for 12 hours, followed by 12 hours of 25 °C ambient temperature. At set intervals during the test, the electrical and mechanical function of the switching device are examined.

Emergency stop

(cf. Machinery Safety Directive 2006/42/EC) Stopping in an emergency; an action that stops a process or motion that causes danger.

Emergency stop system

Arrangement of components to avert arising or to reduce existing hazards to persons, damage to machinery or to work in progress. The Emergency-Stop function must be designed such that machine operation and dangerous machine motion are halted in an appropriate manner without causing additional danger and without further action being required from any person. (emergency stop function EN ISO 13850)

Emergency stop system

(EN ISO 13850) Manually operated controlgear used for manually triggering an emergency stop function.

Emergency switching off

Switches off the electrical energy supply to a complete installation or part of an installation as soon as there is a risk of electric shock or an other risk caused by electric current.

Finger-proof

A switching device is to be considered as finger-proof if its live parts cannot be touched when actuating the operating elements. This also applies when operating adjacent switchgear. The finger-proof area of a push-actuated operating medium is a circular area of at least 30 mm radius around the actuating element, and vertical to the direction of actuation. Within this area, hazardous parts should be fitted at least 80 mm below the level of the actuating area.

Interlocked opposing contacts

(cf. IEC/EN 60947-5-1, Appendix L) Combination of N/O and N/C contacts in contactor relays that are mechanically connected in such a way that N/C and N/O can never be closed at the same time. A contact spacing of at least 0.5 mm must be maintained throughout the contacts’ entire lifespan, even in the event of a fault (for example welded contacts).

Isolating function

(cf. IEC/EN 60947-1; 2.1.19) Devices are deemed to possess this isolating function if, in the open position, their switching contacts achieve the separation distance specified for the isolation of electrical circuits, and their creepage paths and clearance distances are of the required magnitude. This allows the power supply of the entire installation or a section of the installation to be isolated for safety reasons, for example during maintenance.

Losses

(cf. IEV 151-03-18) The difference between the input power and the output power of a device. The main type of loss in switching devices and electrical power distribution equipment is current heat loss.

Main switches

Correctly called “mains isolating device”. Hand-operatable switch. Mandatory for machines with electrical equipment. Its purpose is to disconnect the electrical equipment in order to exclude hazards occurring when cleaning, repairing or maintaining the machine or during longer downtimes. A power disconnecting device must:

- Be an operating element that is externally accessible.
- Have only one OFF and one ON position with assigned limit stops.

- Have the switch positions marked “0” and “I”.
- Be lockable in the OFF position.
- Cover the connection terminals against accidental contact.
- Have a minimum switching capacity for load disconnectors and motor switches for AC-23.

Mechanical shock resistance

The ability of a device to withstand pulse-like movement without changing its operating state or sustaining damage. No contact lifting must take place on devices in the On position, the main contacts must not knock against one another in the Off position. A circuit-breaker must not trip, and control circuit switches must not change their switching state.

Minimum command time

Minimum period of time for which a trip-initiating factor (such as a control pulse or a short-circuit current) must be present to cause the corresponding reaction, for example the short-circuit duration necessary to initiate tripping.

Mirror contact

(cf. IEC/EN 60947-4-1 appendix F) A mirror contact is an auxiliary break contact that can not be closed at the same time as the contactor's main make contacts.

Motor rating

(cf. IEC/EN 60947-1; 4.3.2.3) Motor output that can be switched by a switching device at the assigned rated operational voltage, depending on the utilization category, e.g. a contactor of utilization category AC-3: 37 kW at 400 V.

Opening delay

(cf. IEV 441-17-36) The interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles. The opening delay is the sum of the tripping delay and the inherent delay of the contacts.

Overvoltage category

(cf. IEC/EN 60947-1; 2.5.60) Classification for prospective overvoltages at the point of installation, such as might be caused by the effect of lightning or switching processes. The overvoltage category for industrial switchgear is III. According to the overvoltage categories, the use of switchgear is permissible in the following areas:

Overvoltage category I:

Apparatus for connection to circuits with overvoltage protection, e.g. electronic devices.

Overvoltage category II:

Consumers for connection to fixed installations, such as household appliances or electrical tools.

Overvoltage category III:

Apparatus with special serviceability requirements for connection in fixed installations that are protected by overvoltage diverters, e.g. switches in low-voltage distribution systems or in control systems for industrial use.

Overvoltage category IV:

Use immediately at the the connection point of the installation (direct lightning impact possible), for example on an overhead power line connection.

Pollution degree

(cf. IEC/EN 60947-1; 5.5.58) Classification for the likely amount of conductive dust and humidity, which can lead to a reduced electric strength of a switching device. The pollution degree is described by the following influencing factors:

Pollution degree 1:

If soiling occurs, pollutants are usually only dry or non-conductive. The soiling does not affect electric strength.

Pollution degree 2:

Usually only non-conductive pollutants. Temporary conductivity due to condensation is to be expected, however.

Pollution degree 3:

(Switchgear for industrial use) Conductive pollution or dry, non-conductive pollution that is made conductive through condensation.

Pollution degree 4:

Pollution leading to continuous conductivity, for example conductive dust, rain or snow.

Positive/enforced operation/actuation

This describes an arrangement where a mechanical link between the actuator and the switching element ensures that the force exerted on the actuator is exerted directly, onto the switching element, i.e. without the use of spring-loaded parts.

Positive opening

(cf. IEC/EN 60947-1; 2.4.10 / IEV 441-16-11) An opening operation which ensures that the main contacts of a mechanical switching device have attained the open position when the actuator is in the Off position.

Power disconnecting device

→ Main switch

Rated actuating voltage U_c

(cf. IEC/EN 60947-1; 4.5.1) Voltage applied to the actuation N/O contact in a control circuit. May deviate from the rated control voltage due to the presence of transformers or resistors in the control circuit.

Rated breaking capacity

(cf. IEC/EN 60947-1; 4.3.5.3) The r.m.s. value that a switching device is capable of breaking according to its utilization category. This value refers to the rated operational voltage and the rated operational current. Equipment must be capable of breaking of current up to and including its specified rated breaking capacity.

Rated conditional short-circuit current I_q

(cf. IEC/EN 60947-1; 2.5.29/IEV 441-17-20) The short-circuit current that a switching device, e.g. a contactor, protected by a short-circuit protective device, such as a motor-protective circuit-breaker, can carry for the duration of the tripping delay of the protective mechanism.

Rated control voltage U_s

(cf. IEC/EN 60947-1; 4.5.1) The voltage applied to the input terminals of the control circuit of a switching device. Due to the presence of transformers or resistors in the control circuit, this voltage may differ from the rated control circuit voltage.

Rated frequency

(cf. IEC/EN 60947-1; 4.3.3) The frequency for which a switching device is designed and to which the other characteristics relate.

Rated impulse withstand voltage U_{imp}

(cf. IEC/EN 60947-1; 4.3.1.3) Measure of the stability of the internal clearances of a switching device against overvoltage peaks. The utilization of suitable switchgear can ensure that overvoltages are prevented from transferring from the mains to de-energized system sections within it.

Rated insulation voltage U_i

(cf. IEC/EN 60947-1; 4.3.1.2) Voltage to which insulation tests and clearances relate. The highest rated operational voltage must not be greater than the rated insulation voltage.

Rated making capacity

(cf. IEC/EN 60947-1; 4.3.5.2).The current that a device is capable of making in accordance with the utilization category and at the rated operational voltage.

Rated operational current I_e

(cf. IEC/EN 60947-1; 4.3.2.3) The current that a switching device is capable of carrying, taking into account the rated operational voltage, duration of operation, utilization category and ambient air temperature.

Rated operational current I_n (of a circuit-breaker)

(cf. IEC/EN 60947-2; 4.3.2.3) For circuit breakers, this current value is equal to the rated uninterrupted current and the conventional free air thermal current.

Rated operational voltage U_e

(cf. IEC/EN 60947-1; 4.3.1.1) Voltage to which the characteristic values of a switching device relate. The highest rated operational voltage must not be greater than the rated insulation voltage.

Rated service short-circuit breaking capacity I_{cs}

(cf. IEC/EN 60947-2; 4.3.5.2.2) The short-circuit current that a circuit-breaker is able to interrupt repeatedly; dependent on the rated operational voltage (test O-CO-CO, previously P-2). After breaking the short-circuit, the circuit-breaker is able to carry the rated uninterrupted current again with increased self-heating, and to trip in the event of an overload.

Rated short-circuit breaking capacity I_{cn}

(cf. IEC/EN 60947-1; 4.3.6.3) The maximum current that a switching device can break at rated operational voltage and frequency without sustaining damage. It is expressed as an r.m.s. value.

Rated short-circuit making capacity I_{cm}

(cf. IEC/EN 60947-1; 4.3.6.2) The maximum current that a switching device can make at a certain rated operational voltage and frequency without sustaining damage. In contrast to other characteristic values, it is expressed as maximum prospective peak value.

Rated short-time withstand current I_{cw}

(cf. IEC/EN 60947-1; 4.3.6.1) The short-time withstand current that a device is capable of carrying for a specified time without damage, e.g. due to excessive heating.

Rated ultimate short-circuit breaking capacity I_{cu}

(cf. IEC/EN 60947-2; 4.3.5.2.1) Maximum short-circuit current that a circuit-breaker can interrupt (test O-CO; formerly P-1). After short-circuit breaking, the circuit-breaker is able to trip in the event of an overload with increased tolerances.

Rated uninterrupted current I_u

(cf. IEC/EN 60947-1; 4.3.2.4) Current that a switching device can carry in continuous operation (for weeks, months or years).

Rating

(cf. IEC/EN 60947-1; 4.3.2.3) The power output of a motor at its rated operational voltage.

Safe isolation

(cf. IEC 536) Isolation of circuits not carrying hazardous voltage, e.g. protective extra-low voltage, from circuits in which hazardous voltage flows. Such isolation is achieved by means of reinforced or double insulation, which reliably prevents voltage transfer from one circuit to another, for example between main and auxiliary switchgear circuits or the primary and secondary sides of a safety transformer. Safe isolation is required mainly for safety and functional extra-low voltage circuits.

Stopping in case of emergency

(EN ISO 13850) Function intended to prevent hazards or minimize existing risks for people or of damage to machines or running processes, and which is triggered by a single action by one person.

Tamper-proof

An Emergency-Stop switching device is regarded as tamper-proof if it cannot be reset without tools or using specified procedures after tripping. The switching device locks in its tripped position. Accidental or controlled manipulation (inching) is not possible.

Utilization category

cf. IEC/EN 60947-1; 2.1.18/IEV 441-17-19) A combination of specified requirements relating to the condition in which the switching device or fuse fulfills its purpose and selected to represent a characteristic group of real-life applications. The specified requirements may, for example, relate to the values of making and breaking capacity and other characteristic values, data concerning associated circuits and the applicable conditions of use and operational behavior.
(cf. IEC/EN 60947-2; 4.4) For circuit breakers, the utilization category denotes whether the equipment is designed for selectivity using time delay (category B) or not (category A).

Accessible, Readily

NEC, Article 100) Readily accessible for operations, replacement or inspection without having to breach or remove obstacles or having to use steps, etc.

Ampacity

(NEC, Article 100) Current in amperes that a conductor can continuously carry under operational conditions without exceeding its permissible temperature.

Approved

(NFPA 79, Chapter 3) Acceptable for the Authority having Jurisdiction (AHJ).

Authority Having Jurisdiction

(NEC, Article 100) Organization, authority or person responsible for implementing the stipulations of the Codes or Standards, or for approving equipment, materials, installations or procedures.

Branch Circuit

Here the applicable standards deviate. NEC has highest priority, but the UL definition appears to be closer to reality. In any case, "branch circuit" denotes everything that comes after the last overcurrent protective element.
(NEC, Article 100) Conductor in a circuit between the last overcurrent protection element that protects the circuit and the apparatus.
(UL 508A, Part 1, Introduction, 2) Conductors and components after the last overcurrent protection element that protects a load.

Branch Circuit Overcurrent Device (BCOD)

(NEC, Article 100) Device suitable for protecting supply, feed and outgoer circuits or apparatus across the whole range of overcurrents between the rated current and its switching capacity. BCODs must have a breaking capacity appropriate for its use, but no less than 5 kA.

Branch Circuit Protective Device

(UL 508A, Part 1, Introduction, 2) Fuses or circuit breakers that have been assessed according to a safety standard with respect to the provision of overcurrent protection.

Circuit Breaker, CB

(NEC, Article 100) Device developed for non-automated opening and closing of a circuit and which automatically opens a circuit at a fixed overcurrent without itself being damaged if used correctly within its rated data.

Adjustable (if applicable for the circuit-breaker)

A qualifying term which indicates that the CB can be adjusted to variable trip values of current, time or both within a particular range.

Instantaneous Trip (if applicable for the circuit-breaker)

A qualifying term which indicates that the CB is designed to trip without a delay.

Inverse Time (if applicable for the circuit-breaker)

A qualifying term which indicates that the CB is designed to trip with a delay such that the delay decreases with increasing current.

Non adjustable (if applicable for the circuit-breaker)

A qualifying term which indicates that the CB's tripping current or delay can not be adjusted.

Setting (of circuit breakers)

The set current or time value, or both, at which an adjustable circuit-breaker is to trip.

Combination Motor Controller

(UL 508A, Part 1, Introduction, 2) One or several devices that have been fitted to be able to isolate the conductors of a circuit from their power supply (disconnecting means), to protect the branch circuit (branch circuit protection), to switch the motor (motor control) and to provide motor over-load protection for an individual motor circuit.

Device

(NEC, Article 100) Assembly within an electrical system whose primary function is to carry or control electrical energy.

Disconnecting means

(NEC, Article 100) Device or group of devices or other means through which the conductors of a circuit can be isolated from their power supply.

Emergency Switching Off

(NFPA 79, Chapter 3) Emergency actuation that switches off the electrical power supply to the installation or parts thereof.

Enclosed Industrial Control Panel

(UL 508A, Part 1, Introduction, 2) Factory-provided industrial control system supplied within an enclosure or control panel.

Feeder

(NEC, Article 100) All conductors of a circuit between the incoming unit of the source of a separate system or other power supply equipment and the last branch circuit overcurrent device (unofficial definition, not from NEC: viewed from consumer to energy source).

Feeder Circuit

(UL 508A, Part 1, Introduction, 2) Conductor and switchgear on the supply side of a branch circuit protective device (BCPD).

Field Installed Equipment

(UL 508A, Part 1, Introduction, 2) Devices that have been installed only after the production of an indust-rial control panel and the application of an approval label.

Field Wiring

Conductors that are connected (on-site) by other persons to connect the industrial control panel with power sources, remote control devices (local devices) and consumers.

Fuse, Branch Circuit Type

(UL 508A, Part 1, Introduction, 2) Fuses of Classes CC, G, H, J, K, L, R and T. Can provide branch circuit protection.

Fuse, Semiconductor Type

(UL 508A, Part 1, Introduction, 2) Fuses developed for protecting semiconductor devices. Can protect motor circuits containing frequency inverters (Low Voltage Fuses - Part 13: Semiconductor Fuses, UL 248-13).

Fuse, Supplementary Type

(UL 508A, Part 1, Introduction, 2) Various different fuses and device protection fuses (fine-wire or micro fuses). Can be used only in addition to branch circuit protective devices.

General Use Rating

(UL 508A, Part 1, Introduction, 2) Rated operational data expressed in V and A and assigned to a device designed for switching a load with a continuous current or peak inrush current whose rated values do not exceed the device's rated operational current.
With AC the load can have a power factor between 0.75 and 0.8 (inductive).
With DC the load must be resistive (non-inductive).

Industrial Machinery (Machine)

(NFPA 79, Chapter 3) Powered machine (or group of machines that work together in a coordinated fashion) that is not portable while in operation and which is used to process material by cutting, forming, pressing, by electrical, thermal or optical means, coating or through a combination of these processes. The machine can include associated equipment used for material transport, tool provision, securing, joining, disassembling, inspection or testing, or packaging. (The full associated electrical equipment, including software, sensors and actuators, is to be regarded as part of the machine.)

Industrial Manufacturing System

(NFPA 79, Chapter 3) Systematic arrangement of one or more industrial machines that is not transportable by hand and which encompasses conveying of the associated material, processing, calibration, measurement, or inspection and testing equipment.

Interrupting Rating

(NEC, Article 100) The highest current at rated operating voltage which the device is designed to interrupt under standard test conditions.

Labeled

(NEC, Article 100) Apparatus or materials with applied markings, symbols or other identification signs of organizations that are acceptable for AHJs are termed "labeled". The term "labeled" includes the inspection and testing of products as well as periodic inspection of their production. With labeling the manufacturer indicates the product's conformance with applicable standards or its production by defined means.

Listed

(NEC, Article 100) Apparatus, materials or services contained in a list published by an organization that is acceptable for AHJs and which confirms that the products or services have been tested and that the production of the listed products or performance of the listed services is subject to periodic investigation. The listing verifies that the products, materials or services comply with the applicable standards or that they have been tested and deemed suitable for specific purposes.

Load

(UL 508A, Part 1, Introduction, 2) Device (load) that is connected with the main circuit outside the indust-rial control panel.

Low-Voltage Limited Energy Circuit

(UL 508A, Part 1, Introduction, 2) Control circuit with a peak voltage in the open circuit of not more than 42.4 V (DC or peak). Is supplied from a battery or an insulated secondary circuit whose current is limited by an overcurrent protective device. This can be a fuse, the power of a transformer's secondary side, or a power supply unit, a secondary winding and an impedance.
A current being tapped by a mains voltage circuit through a resistor, and which is intended to limit the current and voltage in a series connection with power supply circuit is not regarded as low-voltage limited energy circuit.

Mandatory Rules

(NEC, Article 90) Mandatory rules in the Code, which identify actions that are specifically prescribed or prohibited. Identified with the terms "shall" or "shall not".

Motor Starter

(UL 508A, Part 1, Introduction, 2) Combination of a contactor and an overload relay.

Overcurrent

(NEC, Article 100) Any current exceeding the rated current of apparatus or the load rating of cables. The overcurrent can result from an overload, a short circuit or a ground fault.

Overload

(NEC, Article 100) Operation of equipment above its normal full-load rating or the rated capacity of cables. If the overload condition persists for a certain time, damage or dangerous heating occurs. Faults such as short circuits or ground fault are not over-loads.

Permissive Rules

(NEC, Article 90) Rules in the Code, which identify actions that are allowed but are not mandatory. They normally describe options or alternative methods. Identified with the terms "shall be permitted" or "shall not be required".
For further definitions see Article 100, Definitions, of the National Electrical Codes of the USA (NEC, NFPA 70), Standards NFPA 79, Chapter 3 and UL 508A.

Pilot Duty Rating

(UL 508A, Part 1, Introduction, 2) Rated values assigned to a relay or auxiliary contact that actuates the coil of another relay or switchgear.

Power Circuit

(UL 508A, Part 1, Introduction, 2) Conductors and components of branch circuits (load branch circuits) or feeder circuits.

Self-Protected Combination Motor Controller

(UL 508A, Part 1, Introduction, 2) Combination motor controller incorporating coordinated short-circuit and overload protection, an isolating function and a remote-controllable motor switch (e.g. a contactor). If it does not already exist, coordinated protection must be implemented through the correct selection of components or additional parts according to the manufacturer's instructions.

Shall

(NFPA 79, Chapter 3) Mandatory condition.

Short-Circuit Current

(NFPA 79, Chapter 3) Overcurrent resulting from a short-circuit, which, in turn, is caused by a fault or a faulty connection in an electrical circuit.

Short-Circuit current rating (SCCR)

(NEC, Article 100) Prospective symmetrical fault current at nominal voltage at which a device or a system can be connected without incurring damage that exceeds defined acceptance criteria.

Should

(NFPA 79, Chapter 3) Identifies a recommended characteristic that is not mandatory.

Supplementary Overcurrent Protective Device

(NEC, Article 100) Device intended to provide limited overcurrent protection for particular applications and apparatus, such as lighting and non-industrial consumers. This limited protection is provided in the load circuit in addition to the protection provided by the branch circuit protective device (BCPD).

Supplementary Protection

(UL 508A, Part 1, Introduction, 2) Device arranged behind a branch circuit protection device to provide additional protection. Such devices are not, themselves, regarded as branch circuit protective devices (BCPD).

Voltage, Nominal

(NEC, Article 100) Rating assigned to a circuit or system to indicates its voltage in a suitable manner (e.g. 120/240 V, 480Y/277 V, 600 V). The actual voltage with which the circuit works may deviate from the nominal voltage within a range that permits satisfactory operation of the equipment.

Symbol	Meaning
DF	Duty factor
I_{cm}	Rated short-circuit making capacity
I_{cn}	Rated short-circuit breaking capacity
I_{cs}	Rated service short-circuit breaking capacity
I_{cu}	Rated ultimate short-circuit breaking capacity
I_{cw}	Rated short-time withstand current
$I_{\Delta n}$	Response value of earth-fault release
I_e	Rated operational current
I_g	Response value of earth-fault release
I_i	Response value of non-delayed short-circuit release
I_{sc}	Transformer initial short-circuit AC current
I_L	Load monitoring response value
I_n	Rated operational current
I_{NT}	Transformer rated operational current
I_{PK}	Rated peak withstand current
I_q	Rated conditional short-circuit current
I_r	Overcurrent release set value
I_{rm}	Response value of non-delayed short-circuit release
I_{rmf}	Response value of fixed, non-delayed short-circuit release
I_{rmv}	Response value of short-time delayed short-circuit release
I_{sd}	Response value of short-time delayed short-circuit release
I_T	Response value of earth-fault release
I_{th}	Conventional free air thermal current
I_{the}	Conventional thermal current of enclosed devices
I_u	Rated uninterrupted current
S_{NT}	Transformer rating
t_g	Delay time when the earth-fault release trips
t_r	Delay time when the overload release responds
t_T	Delay time when the earth-fault release trips
t_v	Time delay of short-circuit release response
U_c	Rated excitation voltage
U_e	Rated operational voltage
U_{imp}	Rated insulation voltage
U_{imp}	Rated surge voltage invariability
u_k	Transformer short-circuit voltage
U_s	Rated control voltage

Meaning	Symbol
Conventional free air thermal current	I_{th}
Conventional thermal current of enclosed devices	I_{the}
Delay time when the earth-fault release trips	t_g
Delay time when the earth-fault release trips	t_T
Delay time when the overload release responds	t_r
Load monitoring response value	I_L
Overcurrent release set value	I_r
Rated conditional short-circuit current	I_q
Rated control voltage	U_s
Rated excitation voltage	U_c
Rated insulation voltage	U_{imp}
Rated operational current	I_e
Rated operational current	I_n
Rated operational voltage	U_e
Rated peak withstand current	I_{PK}
Rated service short-circuit breaking capacity	I_{cs}
Rated short-circuit breaking capacity	I_{cn}
Rated short-circuit making capacity	I_{cm}
Rated short-time withstand current	I_{cw}
Rated surge voltage invariability	U_{imp}
Rated ultimate short-circuit breaking capacity	I_{cu}
Rated uninterrupted current	I_u
Response value of earth-fault release	$I_{\Delta n}$, I_g, I_T
Response value of fixed, non-delayed short-circuit release	I_{rmf}
Response value of non-delayed short-circuit release	I_i
Response value of non-delayed short-circuit release	I_{rm}
Response value of short-time delayed short-circuit release	I_{rmv}
Response value of short-time delayed short-circuit release	I_{sd}
Time delay of short-circuit release response	t_v
Transformer initial short-circuit AC current	I_{sc}
Transformer rated operational current	I_{NT}
Transformer rating	S_{NT}
Transformer short-circuit voltage	u_k

Full-load motor-running currents in amperes corresponding to various AC horsepower ratings

HP	110 - 120 V			220 - 240 V[a,b]			360 - 380 V		440 - 480 V			550 - 600 V		
	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase	Single phase	Three phase	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase
1/10	3.0	–	–	1.5	–	–	1.0	–	–	–	–	–	–	–
1/8	3.8	–	–	1.9	–	–	1.2	–	–	–	–	–	–	–
1/6	4.4	–	–	2.2	–	–	1.4	–	–	–	–	–	–	–
1/4	5.8	–	–	2.9	–	–	1.8	–	–	–	–	–	–	–
1/3	7.2	–	–	3.6	–	–	2.3	–	–	–	–	–	–	–
1/2	9.8	4.0	4.4	4.9	2.0	2.2	3.2	1.3	2.5	1.0	1.1	2.0	0.8	0.9
3/4	13.8	4.8	6.4	6.9	2.4	3.2	4.5	1.8	3.5	1.2	1.6	2.8	1.0	1.3
1	16.0	6.4	8.4	8.0	3.2	4.2	5.1	2.3	4.0	1.6	2.1	3.2	1.3	1.7
1-1/2	20.0	9.0	12.0	10.0	4.5	6.0	6.4	3.3	5.0	2.3	3.0	4.0	1.8	2.4
2	24.0	11.8	13.6	12.0	5.9	6.8	7.7	4.3	6.0	3.0	3.4	4.8	2.4	2.7
3	34.0	16.6	19.2	17.0	8.3	9.6	10.9	6.1	8.5	4.2	4.8	6.8	3.3	3.9
5	56.0	26.4	30.4	28.0	13.2	15.2	17.9	9.7	14.0	6.6	7.6	11.2	5.3	6.1
7-1/2	80.0	38.0	44.0	40.0	19.0	22.0	27.0	14.0	21.0	9.0	11.0	16.0	8.0	9.0
10	100	48.0	56.0	50.0	24.0	28.0	33.0	18.0	26.0	12.0	14.0	20.0	10.0	11.0
15	135	72.0	84.0	68.0	36.0	42.0	44.0	27.0	34.0	18.0	21.0	27.0	14.0	17.0
20	–	94.0	108	88.0	47.0	54.0	56.0	34.0	44.0	23.0	27.0	35.0	19.0	22.0
25	–	118	136	110	59.0	68.0	70.0	44.0	55.0	29.0	34.0	44.0	24.0	27.0
30	–	138	160	136	69.0	80.0	87.0	51.0	68.0	35.0	40.0	54.0	28.0	32.0
40	–	180	208	176	90.0	104	112	66.0	88.0	45.0	52.0	70.0	36.0	41.0
50	–	226	260	216	113	130	139	83.0	108	56.0	65.0	86.0	45.0	52.0
60	–	–	–	–	133	154	–	103	–	67.0	77.0	–	53.0	62.0
75	–	–	–	–	166	192	–	128	–	83.0	96.0	–	66.0	77.0
100	–	–	–	–	218	248	–	165	–	109	124	–	87.0	99.0
125	–	–	–	–	–	312	–	208	–	135	156	–	108	125
150	–	–	–	–	–	360	–	240	–	156	180	–	125	144
200	–	–	–	–	–	480	–	320	–	208	240	–	167	192
250	–	–	–	–	–	602	–	403	–	–	302	–	–	242
300	–	–	–	–	–	–	–	482	–	–	361	–	–	289
350	–	–	–	–	–	–	–	560	–	–	414	–	–	336
400	–	–	–	–	–	–	–	636	–	–	477	–	–	382
500	–	–	–	–	–	–	–	786	–	–	590	–	–	472

[a] To obtain full-load currents for 200 and 208 V motors, increase corresponding 220 - 240 V ratings by 15 and 10 percent, respectively.
[b] To obtain full-load currents for 265 and 277 V motors, decrease corresponding 220 - 240 V ratings by 13 and 17 percent, respectively.

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