

Low Voltage Switch Gear

Appendix

Precautions

■ Notice

Use under rated condition, otherwise contactors will not only cause malfunction, but also cause a fire or damage the contactor.

Life period of contactor depends on the operating application. Please check the electrical life under real application in advance.

If you continue to use malfunctioning contactor, a fire or breakdown may occur.

Do not miss-wire or miss-charge the power supply, otherwise the contactor does not work correctly.

Do not operate in places with explosive or flammable gas, otherwise a fire or explosion may occur by arc or heating from contactor.

Make sure to use the circuit well considered about safety, in case there is any possibility to cause secondary disaster by contact trouble (welding, faulty contact).

Do not supply short-circuit current to electromagnetic switch (contactor with thermal relay). Doing so may result failure in heater of thermal relay. Please use short-circuit protection like fuse or protective circuit breaker.

Do not use a contactor or thermal relay which has been dropped or dismantled. Doing so may cause malfunction or a fire.

Make sure to shut off power supply to contactors before wiring or replacing.

Do not operate the actuator of a contactor manually. Doing so may cause contact welding by chattering or burn out by arc.

Unless otherwise stated in the catalogue, modifications, especially those of stated values, sizes and weights are subject to alternation.

Diagrams and tables are subject to alternation and not to be regarded as binding drawings.

■ Correct use

General use

Unexpected malfunction may occur in real application. Please carry out as many tests as possible.

Ratings in this catalogue measured under the condition according to IEC unless otherwise specified. In cases of check by real application, please carry out the test under the same condition as expected in the actual application.

Selection

Coil specification

Please select suitable coil to circuit design, otherwise malfunction may occur or coil may have a burn out by overvoltage etc.

Type

Please check contact ratings, switching capacity, thermal characteristics etc. when selecting product type.

Thermal relay

Motor current differs by supplier, type, number of poles, frequency. Please confirm operational current level.

Coil surge suppressor

Coil surge suppressor type should be selected by contactor type, auxiliary relay type and applied voltage. Make sure to use defined each contactor.

In case of installing coil surge suppressor, please check the actual circuit because the release time will be delayed.

Electrical life expectancy

Electrical life expectancy tests in this catalogue are based on IEC.

Circuit design

Supplied voltage waveform for input

Make sure to apply and remove the voltage instantly. Do not use under the condition that the coil voltage waveform increases or decreases gradually.

In case of DC contactor use (input voltage ripple)

Please use DC contactor input voltage with a ripple ratio less than 5%. Excessive ripple (pulsating current) may cause contact welding.

Fluctuation of input voltage

Make sure to supply sufficient voltage to actuate contactors properly. Continuous supply of insufficient voltage results in excessive heating and may cause burn out of coil.

Maximum applied voltage

Do not supply the voltage over the maximum rated voltage, otherwise burn out or insulation failure may occur.

The temperature inside control panel has much influence to the coil temperature, so make sure not to exceed the specified value in the catalogue.

Basically rated voltage should be supplied to coil. To supply higher voltage than rated would result in shorter electrical life, even if it is lower than the maximum rated voltage.

Reverse

Make sure to use reversible contactors for reverse operation.

Make sure to use interlock device in reverse operation by two contactors, otherwise short circuit current may burn out or give damage to contactors and motors.

Installation

Mounting

Make sure to use specified wire size, mounting screw size, mounting screw number, and DIN rail size.

Tightening Screw

Tighten each screw securely by specified tightening torque. Loose tightening may cause a fire by excessive heating.

Combination

Please use only OMRON product combinations in case of thermal relay, timer block and auxiliary contact block etc.

Wrong-combinations may result in damage to contactors.

Mounting direction

Some products have a defined specific mounting direction. Please refer to datasheet before use.

Operation ambience

Dust

Dust on the surface of the contacts could result in contact malfunctioning. Take countermeasure in excessive dusty surrounding.

Temperature, humidity

Use contactors within the temperature and humidity conditions specified in datasheet. To use or store contactor in excessive temperature or humidity may result in malfunction of contact by organic film composed by sulfication and oxidation on the surface of the contacts.

Use contactors within the temperature and humidity conditions specified in the datasheet, to prevent contactors from insulation resistance failure by condensation or insulation resistance deterioration by tracking.

Gas

NH₃, H₂S, SO₂, Cl₂, Si and NO₂ have bad effects on a contactor.

With these gases, a corrosive metal film is generated on the surface of the contacts and could result in contact malfunctioning. Use a contactor in low humidity and no corrosive gas surroundings.

Oil

Do not use a contactor in places where oil is sprayed onto the contactor. It will cause cracks on polymer parts.

Shock and vibration

Do not use a contactor in places where there is excessive shock or vibration. It may cause malfunctioning.

Storage

Store contactors in a place with no direct sunshine or ultraviolet rays. It will cause crack on polymer parts.

When contactors are to be stored for a long time, they must be stored with care. Though it generally depends where contactors are stored, deterioration of contacts may occur after long storage. Please check the characteristics before use after long time storage.

European Standards

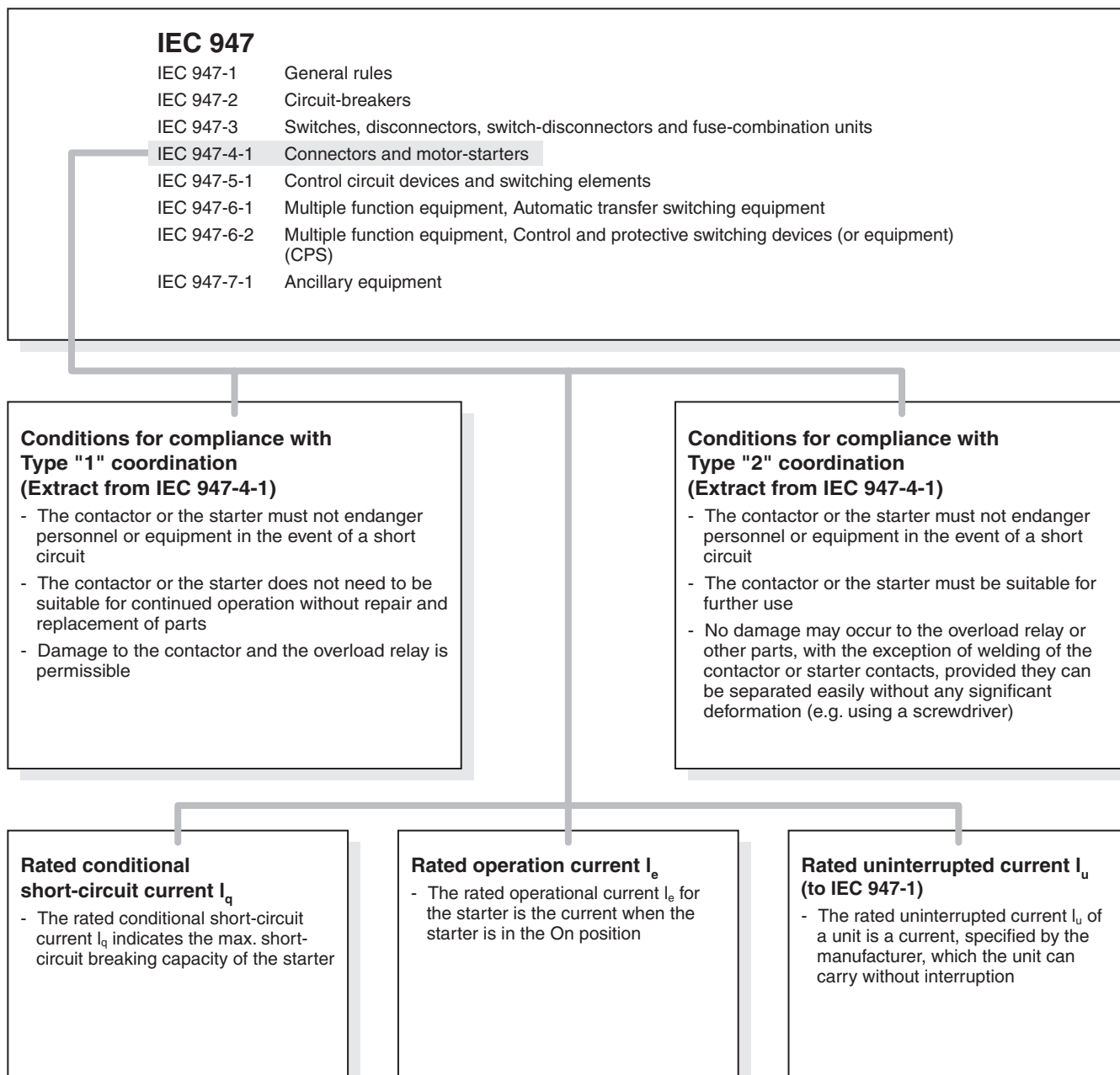
■ IEC 947, EN 60947

European Standards for Low-Voltage Switchgear

For Europe and most other industrial countries of the world, the new IEC 947 and EN 60 947 specifications for low-voltage switchgear have unified the regulations which previously varied from nation to nation.

This required the introduction of new terms, and new test methods and utilization categories. The new specifications are aimed primarily at manufacturers. However, the user also will come across new technical terms and data in the manufacturers' catalogues and on the devices themselves which are important for the selection and application of the devices. The present paper deals with the currently published specifications. Further specifications and supplements are in preparation.

Since 1993, all low-voltage switchgear purchased in Europe had to satisfy the EN 60 947 European Standard. Installations in existence prior to 1993 are not affected by the standard and need not to be refitted with new devices. Devices constructed and tested to the IEC standards and EN standards can be used worldwide, with the exception of the USA and Canada. In these countries UL and CSA specifications continue to apply. Switchgear which conforms to IEC 947 and EN 60 947 and which has, in addition, UL- and CSA approvals, in the meantime has entered the market. Such 'world market' devices offer the advantage that they can be used throughout the world, including the USA and Canada.



Overview

The following table shows in summarized form both the previous and the new IEC, EN and DIN VDE standards.





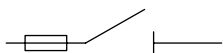


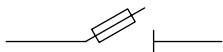

Previous specification		New specification		Content
IEC	DIN VDE	IEC	EN 60947 DIN VDE	
-	-	947-1	60947-1 0660, Part 100	Low-voltage switchgear, General rules
157	0660, Part 101	947-2	60947-2 0660, Part 101	Low-voltage switchgear, Circuit-breakers
406	0660, Part 107	947-3	60947-3 0660, Part 107	Low-voltage switchgear, Switches, Disconnectors, Switch-disconnectors, Fuse-combination units
158 292-1 292-2 292-3	0660, Part 102 0660, Part 104 0660, Part 106 0660, Part 301	947-4-1	60947-4-1 0660, Part 102	Low-voltage switchgear, Control circuit devices and switching elements
337	0660 Part 200 to Part 205	947-5-1	60947-5-1 0660, Part 200	Low-voltage switchgear, Multiple-function equipment, Automatic transfer switching equipment
-	-	947-6-1	60947-6-1 0660, Part 114	Low-voltage switchgear, Multiple-function equipment, Control and protective switching devices (CPS)
-	0611 Part 1 and 2	947-7-1	60947-7-1 0611, Part 1	Low-voltage switchgear, Ancillary equipment (e.g. terminal blocks)

Switches, disconnectors, switch-disconnectors and fuse combination units (IEC 947-3, EN 60947-3)

These devices must now be labelled with the product function designated by the manufacturer. This means placing clearly visible symbols on the device itself.

Devices with an isolating function are subject to special safety requirements. They must for example have greater creepage distances and clearances across the opened contacts than is necessary for other devices.

Device functions and corresponding symbols

Making/breaking	Isolating	Making/breaking + isolating
Switch 	Disconnector 	Switch-disconnector 
Switch-fuse 	Disconnector-fuse 	Switch-disconnector-fuse 
Fuse-switch 	Fuse-disconnector 	Fuse switch-disconnector 

OMRON equipment is designed for the world's markets

It is manufactured and tested in accordance with national and international specifications, the most important of which are listed below:

IEC 947-..., EN 60947:	Low-voltage switch gear and control gear
IEC 664:	Insulation co-ordination including clearances and creepage distances for equipment
IEC364:	Electrical installations of buildings
IEC 204-..., EN 60204-....:	Electrical equipment of industrial machines
DIN VDE 0105:	Operation of electrical power installations
IEC 536:	Protection against electric shock

Utilization categories for contactors to IEC 947-4-1 and EN 60947

Type of current	Utilization category	Typical examples of application I = current made, I _c = current broken I ₀ = rated operational current U = voltage before make U ₀ = rated operational voltage U _r = recovery voltage	Verification of electrical endurance						Verification of rated making and breaking capacities							
			Make			Break			Make			Break				
			I _e	I ₋	U ₋	cos φ	I _c	U _r	cos φ	I _e	I ₋	U ₋	cos φ	I _c	U _r	cos φ
A	I _e	U _e		I _e	U _e		A	I _e	U _e		I _e	U _e				
AC	AC-1	Non-inductive or slightly inductive loads, resistance furnaces	All values	1	1	0.95	1	1	0.95	All values	1.5	1.05	0.8	1.5	1.05	0.8
	AC-2	Slip-ring motors: starting, switching off	All values	2.5	1	0.65	2.5	1	0.65	All values	4	1.05	0.65	4	1.05	0.65
	AC-3	Squirrel-cage motors: starting, switching off motors during running ⁴	I _e ≤ 17 I _e > 17	6 6	1 1	0.65 0.35	1 1	0.17 0.17	0.65 0.35	I _e ≤ 100 I _e > 100	10 10	1.05 1.05	0.45 0.35	8 8	1.05 1.05	0.45 0.35
	AC-4	Squirrel-cage motors: starting, plugging, inching	I _e ≤ 17 I _e > 17	6 6	1 1	0.65 0.35	6 6	1 1	0.65 0.35	I _e ≤ 100 I _e > 100	12 12	1.05 1.05	0.45 0.35	10 10	1.05 1.05	0.45 0.35
	AC-5A	Switching of electric discharge lamp controls	-	-	-	-	-	-	-	-	3.0	1.05	0.45	3.0	1.05	0.45
	AC-5B	Switching of incandescent lamps	-	-	-	-	-	-	-	-	1.5 ²	1.05 ²	0.45 ²	1.5 ²	1.05 ²	0.45 ²
	AC-6A ³	Switching of transformers	As given by the manufacturer	-	-	-	-	-	-	-	-	-	-	-	-	-
	AC-6B ³	Switching of capacitor banks	As given by the manufacturer	-	-	-	-	-	-	-	-	-	-	-	-	-
	AC-7A	Slightly inductive loads in household appliances and similar applications	As given by the manufacturer	-	-	-	-	-	-	-	1.5	1.05	0.8	1.5	1.05	0.8
	AC-7B	Motor-loads for household applications	As given by the manufacturer	-	-	-	-	-	-	-	8.0	1.05 ¹⁾	0.8	8.0	1.05 ¹⁾	0.8
AC-8A	Hermetic refrigerant compressor motor control with manual resetting of overload releases ⁵	As given by the manufacturer	-	-	-	-	-	-	-	6.0	1.05 ¹⁾	0.8	6.0	1.05 ¹⁾	0.8	
AC-8B	Hermetic refrigerant compressor motor control with automatic resetting of overload releases ⁵	As given by the manufacturer	-	-	-	-	-	-	-	6.0	1.05 ¹⁾	0.8	6.0	1.05 ¹⁾	0.8	

Type of current	Utilization category	Typical examples of application I = current made, I _c = current broken I ₀ = rated operational current U = voltage before make U ₀ = rated operational voltage U _r = recovery voltage	Verification of electrical endurance						Verification of rated making and breaking capacities							
			Make			Break			Make			Break				
			I _e	I ₋	U ₋	L/R	I _c	U _r	L/R	I _e	I ₋	U ₋	L/R	I _c	U _r	L/R
A	I _e	U _e	ms	I _e	U _e	ms	A	I _e	U _e	ms	I _e	U _e	ms			
DC	DC-1	Non-inductive or slightly inductive loads, resistance furnaces	All values	1	1	1	1	1	1	1	1	1	1	1	1	
	DC-3	Shunt motors: starting, plugging, inching, dynamic braking	All values	2.5	1	2	2.5	1	2	All values	4	1.05	2.5	4	1.05	2.5
	DC-5	Series motors: starting, plugging, inching, dynamic braking	All values	2.5	1	7.5	2.5	1	7.5	All values	4	1.05	15	4	1.05	15
	DC-6	Switching of incandescent lamps	-	-	-	-	-	-	-	-	1.5 ²⁾	1.05 ²⁾	0.45 ²⁾	1.5 ²⁾	1.05 ²⁾	0.45 ²⁾

- Note 1:** cos φ = 0.45 for I_e ≤ 100 A; cos φ = 0.35 for I_e > 100 A.
Note 2: The tests are to be carried out with an incandescent light load.
Note 3: The test data are to be derived from the test values for AC-3 or AC-4 according to Table VIIb, EN 60947-4-1.
Note 4: AC-3 category may be used for occasional inching (jogging) or plugging for limited time periods such as machine set-up; during such limited time periods the number of such operations should not exceed five per minute or more than ten in a ten minute period.
Note 5: A hermetic refrigerant compressor motor is a combination consisting of a compressor and a motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, the motor operating in the refrigerant.

Utilization categories for control switches to IEC 947-5-1 and EN 60947

Type of current	Utilization category	Typical examples of application I = current made, I _c = current broken I ₀ = rated operational current U = voltage before make U ₀ = rated operational voltage U _r = recovery voltage U = voltage before make t _{0.95} = time in ms to reach 95 % of the steady-state current P = U _e x I ₀ = rated power consumption in watts	Normal conditions of use						Abnormal conditions of use					
			Make			Break			Make			Break		
			I _e	I ₋	U ₋	cos φ	I _c	U _r	cos φ	I _e	I ₋	U ₋	cos φ	I _c
A	I _e	U _e		I _e	U _e		A	I _e	U _e		I _e	U _e		
AC	AC-12	Control of resistive and solid state loads as in opto-coupler input circuits	1	1	0.9	1	1	0.9	-	-	-	-	-	-
	AC-13	Control of solid state loads with transformer isolation	2	1	0.65	1	1	0.65	10	1.1	0.65	1.1	1.1	0.65
	AC-14	Control of small electromagnetic loads (≤ 72 VA)	6	1	0.3	1	1	0.3	6	1.1	0.7	6	1.1	0.7
	AC-15	Control of electromagnetic loads (> 72 VA)	10	1	0.3	1	1	0.3	10	1.1	0.3	10	1.1	0.3

Type of current	Utilization category	Typical examples of application I = current made, I _c = current broken I ₀ = rated operational current U = voltage before make U ₀ = rated operational voltage U _r = recovery voltage U = voltage before make t _{0.95} = time in ms to reach 95 % of the steady-state current P = U _e x I ₀ = rated power consumption in watts	Normal conditions of use						Abnormal conditions of use					
			Make			Break			Make			Break		
			I _e	I ₋	U ₋	t _{0.95}	I _c	U _r	t _{0.95}	I _e	I ₋	U ₋	t _{0.95}	I _c
A	I _e	U _e	ms	I _e	U _e	ms	A	I _e	U _e	ms	I _e	U _e	ms	
DC	DC-12	Control of resistive and solid state loads as in opto-coupler input circuits	1	1	1 ms	1	1	1 ms	-	-	-	-	-	-
	DC-13	Control of electromagnets	1	1	6xP ¹⁾	1	1	6xP ¹⁾	1.1	1.1	6xP ¹⁾	1.1	1.1	6xP ¹⁾
	DC-14	Control of electromagnetic loads having economy resistors in circuits	10	1	15 ms	1	1	15 ms	10	1.1	15 ms	10	1.1	15 ms

- Note 1:** The value "6 x P" results from an empirical relationship which is found to represent most DC magnetic loads to an upper limit of P = 50 W, viz 6 x P = 300 ms. Loads having power consumption greater than 50 W are assumed to consist of smaller loads in parallel. Therefore, 300 ms is to be an upper limit, irrespective of the power consumption value.

Utilization categories for switches, disconnectors, switch-disconnectors, and fuse combination units to IEC 947-3 and EN 60947

Type of current	Utilization category	Typical applications I = current made, I _c = current broken I ₀ = rated operational current U = voltage before make U ₀ = rated operational voltage U _r = recovery voltage	Verification of electrical endurance						Verification of switching capacity							
			Make			Break			Make			Break				
			I _e	I ₋	U ₋	cos φ	I _c	U _r	cos φ	I _e	I ₋	U ₋	cos φ	I _c	U _r	cos φ
A	I _e	U _e		I _e	U _e		A	I _e	U _e		I _e	U _e				
AC	AC-20 A(B) ²	Connecting and disconnecting under no-load conditions	All values	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾	All values	1 ¹⁾	1.05	1 ¹⁾	1 ¹⁾	1.05	1 ¹⁾
	AC-21 A(B) ²	Switching of resistive loads, including moderate overloads	All values	1	1	0.95	1	1	0.95	All values	1.5	1.05	0.95	1.5	1.05	0.95
	AC-22 A(B) ²	Switching of mixed resistive and inductive loads, including moderate overloads	All values	1	1	0.8	1	1	0.8	All values	3	1.05	0.65	3	1.05	0.65

Utilization categories for switches, disconnectors, switch-disconnectors, and fuse combination units to IEC 947-3 and EN 60947																
Type of current	Utilization category	Typical applications I = current made, I _c = current broken I _o = rated operational current U = voltage before make U _o = rated operational voltage U _r = recovery voltage	Verification of electrical endurance						Verification of switching capacity							
			Make				Break		Make				Break			
			I _o A	I - I _o	U - U _o	cos φ	I _c - I _o	U _r - U _o	cos φ	I _o A	I - I _o	U - U _o	cos φ	I _c - I _o	U _r - U _o	cos φ
	AC-23 A(B) ²	Switching of motor loads or other highly inductive loads	All values	1	1	0.65	1	1	0.65	I _o ≤ 100 I _o > 100	10 10	1.05 1.05	0.45 0.35	8 8	1.05 1.05	0.45 0.35

			I _o A	I - I _o	U - U _o	L/R ms	I _c - I _o	U _r - U _o	L/R ms	I _o A	I - I _o	U - U _o	L/R ms	I _c - I _o	U _r - U _o	L/R ms
DC	DC-20 A(B) ²	Connecting and disconnecting under no-load conditions	All values	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾	1 ¹⁾	All values	1 ¹⁾	1.05	1 ¹⁾	1 ¹⁾	1.05	1 ¹⁾
	DC-21 A(B) ²	Switching of resistive loads, including moderate overloads	All values	1	1	1	1	1	1	All values	1.5	1.05	1	1.5	1.05	1
	DC-22 A(B) ²	Switching of mixed resistive and inductive loads, including moderate overloads (e.g. shunt motors)	All values	1	1	2	1	1	2	All values	4	1.05	2.5	4	1.05	2.5
	DC-23 A(B) ²	Switching of highly inductive loads (e.g. series motors)	All values	1	1	7.5	1	1	7.5	All values	4	1.05	15	4	1.05	15

Note 1: If the switching device has a making and/or breaking capacity, the figures for the current and the power factor (time constants) must be stated by the manufacturer.
2: A: frequent operation, B: infrequent operation.

Protection against electrical shock, to IEC 536

IEC 536 covers the setting up of electrical apparatus, and its arrangement in electrical installations with rated voltages up to 1000 VAC and 1500 VDC, with regard to protection against direct contact where operating elements such as push-buttons and switches are located in the vicinity of live parts.

“Finger-proofing” relates only to the operating device, and only in the normal direction of operation. A clearance of at least 30 mm radius from the centre point of the device to any live parts, must be ensured.

The IP 20 degree of protection is superior to “finger-proofing” in that it embodies protection against contact with electrical apparatus in any direction. Devices which are “finger-proof” and of IP 00 degree of protection can be provided with further protection against contact in the form of shrouding, if so desired.

Damp heat, constant, to IEC 68 Part 2-3

In this test, the effects of a constant high level of humidity (93 +2/-3%) and a constant temperature (40 ±2)°C over a prescribed duration, are observed.

Damp heat, cyclic, to IEC 68 Part 2 - 30, Test Db

This test is used to assess the suitability of electrical products for operation and storage at high relative humidity levels, in conjunction with cyclic temperature fluctuation. A test cycle consists of 12 hours at 40 ±2°C, with relative humidity of 93 ±3%, and 12 hours at 25 ±3°C, with the relative humidity of at least 95%.

Ambient temperature

Ambient temperature is the temperature of the room (e.g. factory bay or switchgear room), in which the open or enclosed device is installed, a prerequisite being that this temperature is not significantly influenced by the heat losses from the device.

Glossary of standard terms

This Glossary offers brief explanations of some of the standard terms used in this catalogue. However, it must not be regarded as a substitute for the actual text of the standard, especially where the new terms used in IEC 947 are concerned.

Reference is therefore made alongside each such term to the relevant section of the standard, e.g. IEC 947-1 in addition, IEV numbers are given to enable you to find foreign language equivalents in the International Electrotechnical Vocabulary (IEG 50), if required.

Rated conditional short-circuit current I_q (IEC 947-1; 2.5.29/IEV 441-17-20)

The prospective current which a switching device, e.g. a circuit-breaker, protected by a short-circuit protective device such as a motor-protective circuit-breaker, can carry for the duration of the protective device tripping time.

Minimum command time

Minimum duration for a trip-initiating factor (control pulse, short circuit) to effect the corresponding reaction, e.g. the short-circuit duration necessary to initiate tripping.

Rated breaking capacity (IEC 947-1; 4.3.5.3)

The r.m.s. value of current which a switching device is capable of breaking according to its utilization category. The rated breaking capacity is stated by reference to the rated operational voltage and the rated operational current.

The equipment must be capable of breaking any value of current up to and including its rated breaking capacity stated.

Rated actuating voltage U_c (rated control circuit voltage) (IEC 947-1; 4.5.1)

The voltage which is applied to the actuating make contact in a control circuit. Due to the presence in the control circuit of transformers or resistors, this voltage may differ from the rated control supply voltage.

Rated service short-circuit breaking capacity I_{cs} (IEC 947-2; 4.3.5.2.2)

The prospective short-circuit current which, depending on the rated operational voltage, a circuit-breaker is capable of breaking repeatedly (test cycle: O - CO - CO; previously P-2). After interrupting this current value, the circuit-breaker must be capable, despite its own thermal level having increased, of continuing to carry and disconnect in the event of overloading, the rated uninterrupted current.

Rating or rated power (IEC 947-1; 4.3.2.3)

The rated operational power which an equipment is capable of switching at the associated rated operational voltage in accordance with the utilization category.

For example:
motor contactor utilization category AC-3: 37 kW at 400 V.

Rated operational voltage U_e (IEC 947-1; 4.3.1.1)

The voltage to which the characteristics of an equipment are referred. The rated operational current must not in any case exceed the rated insulation voltage.

Rated operational current I_e (IEC 947-1; 4.3.2.3)

The current which an equipment is capable of carrying taking into account the rated operational current, duration of operation, utilization category and ambient temperature.

Rated uninterrupted current I_u (IEC 947-1; 4.3.2.4)

The value of current which an equipment can carry in uninterrupted duty (i.e. for weeks, months or years).

Rated making capacity (IEC 947-1; 4.3.5.2)

The value of current which an equipment is capable of switching On in accordance with the utilization category and at the rated operational voltage.

Rated frequency (IEC 847-1; 4.3.3)

The frequency for which an equipment is designed and to which the other characteristic values are referred.

Rated ultimate short-circuit breaking capacity I_{cu} (IEC 947-2; 4.3.5.2.1)

The maximum prospective fault current which a circuit-breaker is capable of interrupting (test cycle: O - CO; previously P-1)

Rated insulation voltage U_i (IEC 947-1; 4.3.1 .2)

The voltage to which insulation tests and creepage distances of an equipment are referred. The maximum operational voltage must not in any case exceed the rated insulation voltage.

Rated short-circuit breaking capacity I_{cn} (IEC 947-1; 4.3.6.3)

The maximum value of current which an equipment is capable of switching Off at rated operational voltage and rated frequency, and without sustaining damage. It is expressed as r.m.s. value.

Motor rating (IEC 947-1; 4.3.2.3)

Power output of a motor at the associated operational voltage.

Rated control supply voltage U_s (IEC 947-1; 4.5.1)

The voltage applied to the input terminals of the control circuit of an equipment. Due to the presence of transformers or resistors in the control circuit, this may differ from the rated actuating (control circuit) voltage.

Rated impulse withstand voltage U_{imp} (IEC 947-1; 4.3.1 .3)

Measures the stability of the internal clearances of an equipment against overvoltage peaks. The utilization of suitable switchgear can ensure that overvoltages are prevented from transferring from the mains to deenergized system sections within it.

Rated current I_n (of a circuit-breaker) (IEC 947-2; 4.3.2.3)

For circuit-breakers, this current value is equal to the uninterrupted current and the conventional free air thermal current.

Protection against direct contact

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

Control circuit reliability

Measures the probability of switching states arising during the lifespan of a contact, which 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 signal inputs.

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 ambient temperature at 93% relative humidity for 12 hours, followed by 12 hours of 25°C at 95% relative humidity. At set intervals during the test, the electrical and mechanical function of the equipment are examined.

Finger proof

An equipment whose live parts cannot be touched by the operator during actuation is termed finger proof. This also affects operator activity on neighbouring switching devices. 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 circular area, touch-critical parts must be located at not less than 80 mm depth under the actuating level.

Utilization category (IEC 947-1; 2.1 .18/IEV 441-17-19)

A combination of specified requirements relating to the condition in which the switching device or the fuse fulfills its purpose, selected to represent a characteristic group of practical applications. The specified requirements may concern, e.g. the values of making capacities, breaking capacities and other characteristic values, data concerning associated circuits, and the relevant conditions of use and behaviour.

(IEC 947-2; 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).

Back-of-hand proof

An equipment whose live parts cannot be touched by a sphere of 50 mm diameter, is regarded as back-of-hand proof.

Altitude

The density of air decreases with increasing altitude, and this reduces its insulating capacity as well as its heat transfer capability. The rated operational voltage and current of switching devices, conductors and motors as well as the tripping behaviour of thermal overload relays are affected by this.

Upon request, OMRON ELECTRONICS will supply information as to the suitability or otherwise of switchgear for operation at altitudes above the 2000 m limit specified by the standard.

Conventional free air thermal current (IEC 947-1; 4.3.2.1)

The maximum value of current which an equipment is capable of carrying for a minimum of eight hours without thermal overloading. As a rule, it corresponds to the maximum operational current.

Creepage path (IEC 947-1; 2.5.51/IEV 151-03-37)

The shortest distance along the surface of the insulating material between two conductive parts. The creepage distance is determined by the rated insulation voltage, the pollution degree and the creepage current resistance of the material used.

Clearance (IEC 947-1; 2.5.46/IEV 441-17-31)

The distance between two conductive parts along a string stretched the shortest way between these conductive parts. The clearance in air is determined by the rated impulse withstand voltage, overvoltage category and pollution degree.

Emergency-stop switching device

Switching device within an emergency-stop circuit which is intended to prevent danger to persons, damage to machinery or working materials.

Opening delay (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 time is the sum of the tripping time and the inherent delay of the contacts.

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 delay and the closing time.

Shock resistance

The capacity of an equipment to withstand pulse-like motions without changing its operating status or sustaining damage. No contact lifting must take place on devices in the On position, the main contacts must not knock against each other in the Off position. A safety switch must not trip, and control circuit switches must not change their switching status.

Safe isolation (IEC 536, DIN VDE 0106 Part 101)

Isolation of circuits not carrying dangerous voltages (e.g. protective extra-low voltage) from circuits in which dangerous voltages flow. Such isolation is achieved by means of reinforced or double insulation which reliably prevents voltage transfer from one circuit to another. This might otherwise take place between main circuits and control circuits in switching devices or between transformer primary and secondary. "Safe isolation" is a priority requirement for safety circuits and functional low-voltage circuits.

Isolating function (IEC 947-1; 2.1.19)

Equipments are deemed to possess this isolating function provided their switching contacts when in the open position, achieve the separation distance prescribed for the isolation of electrical circuits, and their creepage paths and clearance distances are of the required size. The power supply to the entire installation or a section of the installation can thus be cut off for safety reasons, e.g. during maintenance.

Tamper proof

An emergency-stop switching device is regarded as tamper proof provided it cannot be reset without tools or via a prescribed procedure, after tripping has taken place. The device latches in the tripped position. Accidental or deliberate manipulation (inching) is thus ruled out.

Overvoltage category (IEC 947-1; 2.5.60)

Conventional number for prospective overvoltages at the point of installation, as might be caused for example by the effect of lightning or switching processes. The overvoltage category applicable to industrial switchgear is III. The applicability of switchgear according to the overvoltage categories is defined as follows:

Overvoltage category IV:

Use allowed directly at the termination point of the installation (directly affected by any lightning), e.g. at an overhead line connection point.

Overvoltage category III:

Operating media with special requirements as to the serviceability for connection in fixed installations, which are protected by overvoltage diversion measures, e.g. circuit-breakers in low-voltage distribution systems or in control systems for industrial use.

Overvoltage category II:

Power consumers for connection to fixed installations, e.g. household appliances, electrical tools.

Overvoltage category I:

Operating media for connection to circuits containing overvoltage protection schemes, e.g. electronic devices.

Ambient temperature, open (IEV 441-11-13)

Room temperature for example of the workshop or switch room in which the switching device is located.

Ambient temperature, enclosed (IEV 441-11-13)

Temperature at which the switching device is capable of being operated within a closed housing. For this purpose, it must be taken into account that the heat losses of the device will add to the internal temperature rise within the enclosure.

Losses (IEV 151-03-18)

The difference between the input power and the output power of a device. The main type of loss in electrical power distribution switchgear and operating media is current heat loss.

Pollution degree (IEC 947-1; 6.1.3.2)

Conventional number for the prospective quantities of conductive dust and humidity which can lead to a reduction in the control circuit reliability of a device. The pollution degree is described by the following influencing factors:

Pollution degree 1:

No pollution or only dry, non-conductive pollution occurs. The pollution does not affect the control circuit reliability.

Pollution degree 2:

Usually, only non-conductive pollution. However, transient conductivity through condensation is to be expected.

Pollution degree 3: (switchgear for industrial use)

Conductive pollution or dry, non-conductive pollution which is rendered conductive through condensation.

Pollution degree 4:

The pollution leads to long-term conductivity, e.g. pollution by conductive dust, rain or snow.

Coordination type

Status of a switchgear combination (motor starter) during and after testing at **rated conditional current**:

Coordination Type “1”:

- No risk to persons or installations
- No requirement for immediate readiness for renewed operation
- Damage to the starter is permissible

Coordination type “2”:

- No risk to persons or installations
- Starter is capable of renewed operation
- No damage to the starter with the exception of a slight welding of the contacts, provided they can be separated without significant deformation.

Positive opening operation (IEC 947-1; 2.4.11/IEV 441-16-12)

This opening operation is designed to ensure that auxiliary contacts of a switching device are always in the respective positions corresponding to the open or closed position of the main contacts. The contacts of a contactor are **interlocked opposing contacts**, pro-

vided they are mechanically linked in such a way as to ensure that normally open and normally closed contacts can never be closed simultaneously.

This arrangement must also ensure that minimum contact separation of 0.5 mm is maintained over the entire lifespan of the device, even during a fault, e.g. the welding of one contact.

The relevant German Trade Association requires the use of contactors with interlocked opposing contacts for control systems on power presses in the metal processing industry.

Positive/enforced operation/actuation

This describes an arrangement where a link between the actuator and the switching element ensures that the force exerted on the actuator is transferred directly, i.e. without the intervention of sprung parts, onto the switching element.

Positive opening (IEC 947-1; 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.

Symbols used in Technical Data and Formulae

DF	Duty factor	I_{th}	Conventional free air thermal current
I_{cn}	Rated short-circuit breaking capacity	I_{the}	Conventional thermal current of enclosed devices
I_{cs}	Rated service short-circuit breaking capacity	I_u	Rated uninterrupted current
I_{cu}	Rated ultimate short-circuit breaking capacity	S_{NT}	Transformer rating
I_e	Rated operational current	U_c	Rated actuating voltage
I''_{sc}	Transformer initial short-circuit current AC	U_e	Rated operational voltage
I_n	Rated current	U_i	Rated insulation voltage
I_{NT}	Rated transformer current	U_{imp}	Rated impulse withstand voltage
I_q	Rated conditional short-circuit current	u_k	Transformer short-circuit voltage
I_r	Set value of overcurrent release	U_s	Rated control voltage
I_{rm}	Response value of non-delayed short-circuit release		

Additional ordering information for contactors

CE-Marking

The manufacturer has to sign his products with the CE-Marking. With the CE-Marking the manufacturer confirms the accordance with the different EEC Directives. The CE-Marking is absolutely necessary to sell the products in the EEC.

Attached you find the EEC Directives concerning our products.

Low Voltage Directive (73/23/EEC)

EMC Directive (89/336/EEC)

Declarations of Conformity art. no. D586.. on request.

Test Authorities, Registration Mark, Approvals















OMRON Low voltage switchgear is built and tested to national and international specifications. All devices suit all important specifications without any test obligation, like VDE, BS and also relative to IEC Recommendations and to European Standards like IEC 947 and EN 60947.



It is for this reason OMRON Low voltage switchgear is used all over the world. In order to provide special versions, limitations to the max. voltages, currents and power ratings or special markings are sometimes necessary.

OMRON Low voltage switchgear is also suitable for applications in marine environments.

They are classified in "Lloyd's Register of Shipping" and in the "Maritime Register of Shipping" (GUS). The "American Bureau of Shipping" does not claim a general approval for single components, the complete electrical equipment on board has to be approved. The devices should have UL- and CSA-approvals. Further information for Guide-No. and File-No. (CSA, UL) you will find on page 95.

For approved values see technical data of the devices.State deputy

Country	Canada	USA	Switzerland	Denmark	Norway	Sweden	Finland	Poland	Slowakia	Czech	Hungary
State deputy or private examination (state admitted)	CSA UL	UL	SEV	DEMKO	NEMKO	SEMKO	SETI	SEP	SKTC	EZU	MEEI
Label marking of examination boards		 									
Duty of approvals	All switchgear	 or  Approval of switchgear commendable	No approval since 1.1.1994 Our devices are according to the harmonised European Standards e.g. EN 60947 (IEC 947, VDE 0660) and can be used generally								
Specification	UL is authorised for approvals acc. to Canadian Standards		Marking with approbation label is no longer necessary								

*1 CSA-approvals are replaced by UL-approvals valid for USA and Canada. From 1. 1. 2000 switchgear will be marked with the combined approval. UL-mark  or  only.

Explanations for choice and supply of low voltage switchgears in Canada and USA

Marking of auxiliary contacts



At several devices in UL-data are two voltages for auxiliary contacts mentioned (e. g.: 600 volts at same potential, 150 volts at different potentials). That means, if the voltage is higher than 150 volts, the control voltage applied to input terminals must be at the same potential



Low voltage switchgear for auxiliary circuits (e. g. contactor relays, control units, auxiliary contacts in general) usually approved for "Heavy Duty" or "Standard Duty" UL and besides these marked with the admissible max. voltage or with short codes (see table).

Marking of auxiliary contacts according to CSA and UL	Max. rated values per pole				Contact Rating Code Designation
	Voltage V	Current		Cont. Current A	
		Make A	Break A		
Heavy Duty (HD or HVY DTY)	AC 120	60	6	10	A150
	AC 240	30	3	10	A300
	AC 480	15	1,5	10	A600
	AC 600	12	1,2	10	A600
	DC 125	2,2	2,2	10	N150
	DC 250	1,1	1,1	10	N300
	DC 600	0,4	0,4	10	N600
Standard Duty (SD or STD DTY)	AC 120	30	3	5	B150
	AC 240	15	1,5	5	B300
	AC 480	7,5	0,75	5	B600
	AC 600	6	0,6	5	B600
	DC 125	1,1	1,1	5	P150
	DC 250	0,55	0,55	5	P300
	DC 600	0,2	0,2	5	P600





Marking of auxiliary contacts according to CSA and UL	Max. rated values per pole				Contact Rating Code Designation
	Voltage V	Current		Cont. Current A	
		Make A	Break A		
-	AC 120	15	1,5	2,5	C150
	AC 240	7,5	0,75	2,5	C300
	AC 480	3,75	0,375	2,5	C600
	AC 600	3	0,3	2,5	C600
	DC 125	0,55	0,55	2,5	Q150
	DC 250	0,27	0,27	2,5	Q300
	DC 600	0,1	0,1	2,5	Q600
-	AC 120	3,6	0,6	1	D150
	AC 240	1,8	0,3	1	D300
	DC 125	0,22	0,22	1	R150
	DC 250	0,11	0,11	1	R300
-	AC 120	1,8	0,3	0,5	E150

Discernment at UL-Standards

Recognized Component Industrial Control Equipment	Listed Industrial Control Equipment
UL issues yellow "Guide cards" with Guide- and File-No.	UL issues white "Guide cards" with Guide- and File-No.
Devices have permission to be marked with  on the label	Devices have to be marked with the "UL-Listing Mark" 
Devices as components approved for "factory wiring": devices for employment in control panels, when they are selected, mounted and wired according to the charging conditions by skilled worker.	Devices approved for "field wiring", a) devices for employment in control panels, when they are mounted and wired by skilled worker. b) devices for retail in USA
Valid UL-Standards: UL 508„Standard for Industrial Control Equipment“ (partly limited)	Valid UL-Standards: UL 508„Standard for Industrial Control Equipment“ (unlimited) UL 486"Standard for Wire Connectors and Soldering Lugs"

Are devices approved as "Listed Equipment"  the approval is also valid for using as "Recognized Component" .

Approvals

Country	USA, Canada		Switzerland	Europe	Register of Shipping			CENELEC CB-Certificates
	UL 		SEV 		Great Britain LRS	GUS MRS	Italy RINA	
Type								
Mini Contactors J7KNA and Accessories								
J7KNA-AR...(D)	o	-	-	o	-	-	-	o
J7KNA-09...(D)	o	-	-	o	-	-	-	o
J7KNA-12...(D)	o	-	-	o	-	-	-	-
J73KN-A..., J73KN-AM	o	-	-	o	-	-	-	o
Contactors Series J7KN								
J7KN(G)-10...(D)	o	-	-	o	-	-	-	o
J7KN(G)-14...(D)	o	-	-	o	-	-	-	o
J7KN(G)-18...(D)	o	-	-	o	-	-	-	o
J7KN(G)-22...(D)	o	-	-	o	-	-	-	o
J7KN(G)-24...(D)	o	-	-	o	-	-	-	o
J7KN(G)-32...(D)	o	-	-	o	-	-	-	o
J7KN(G)-40...(D)	o	-	-	o	-	-	-	o
J7KN-50...(D)	o	-	-	o	-	-	-	o
J7KN-62...(D)	o	-	-	o	-	-	-	o
J7KN-74...(D)	o	-	-	o	-	-	-	o
J7KN-85...(D)	o	-	-	o	-	-	-	o
J7KN-110...(D)	o	-	-	o	-	-	-	o
J7KN-151...	o	-	-	o	-	-	-	-
J7KN-176...	o	-	-	o	-	-	-	-
J7KN-200...	-	-	-	o	-	-	-	-
Accessories								
J73KN-B...	o	-	-	o	-	-	-	o
J73KN-C...	o	-	-	o	-	-	-	o
J74KN-B-PT...	o	-	-	o	-	-	-	-
J74KN-A-VG...	o	-	-	o	-	-	-	-
J74KN-B-VG	-	-	-	o	-	-	-	-
J74KN-C...	o	-	-	o	-	-	-	-
J74KN-D...	o	-	-	o	-	-	-	-
Thermal Overload Relays								
J7TKN-A...	o	-	-	o	-	-	-	o
J7TKN-B...	o	-	-	o	-	-	-	o
J7TKN-C...	o	-	-	o	-	-	-	o
J7TKN-D...	o	-	-	o	-	-	-	o
J7TKN-E...	o	-	-	o	-	-	-	o
J7TKN-F...	-	-	-	o	-	-	-	-

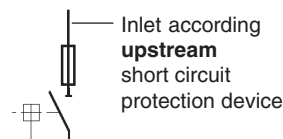
o In Standard version approved x In Test - Not provided for test until now

Permissible ratings of devices approved for North America

Circuit breakers of J7MN series are approved for USA and Canada. According to UL 508 and C22.2 No.14 they can also be used with a load feeder contactor. These Circuit breakers can be used as „Manual Motor Starter“ for „Group Fusing“ or for „Group Installation“ or as „Manual Motor Controller Suitable for Tap Conductor Protection in Group Installations“ or as „Self Protected Combination Motor Controller“ (Type E).

Circuit breakers J7MN as „Manual Motor Starter“

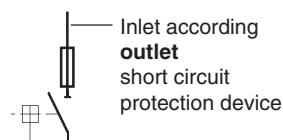
If used as „Manual Motor Starter“ the circuit breaker is always operated in combination with a short circuit device. For use with approbated fuses or circuit breakers according to UL489 or CSA22.2 No. 5 only. The size are selected according to National Electrical Code (UL), or Canadian Electrical Code (CSA).



Circuit breaker	J7MN12		J7MN25		J7MN50		J7MN100	
	NEMA Size 00 FLA max. 12 A, 600 V hp-rating max.		NEMA Size 1 FLA max. 25 A, 600 V hp-rating max.		NEMA Size 2 FLA max. 50 A, 600 V hp-rating max.		NEMA Size 3 FLA max. 100 A, 600 V hp-rating max.	
V	1-phas.	3-phas.	1-phas.	3-phas.	1-phas.	3-phas.	1-phas.	3-phas.
110/120	1/2	–	2	–	3	–	10	–
200	11/2	3	3	71/2	71/2	15	20	30
220/240	2	3	5	71/2	10	20	20	40
440/480	–	71/2	–	15	–	40	–	75
550/600	–	10	–	20	–	50	–	100

Circuit breakers J7MN as „Manual Motor Controller Suitable for Tap Conductor Protection in Group Installations“

For UL only, not for CSA. If used as „Manual Motor Controller Suitable for Tap Conductor Protection in Group Installations“ the circuit breaker is always operated in combination with a short circuit device. For use with approbated fuses or circuit breakers according to UL489 only. The size are selected according to National Electrical Code.



Circuit breaker	J7MN12		J7MN25		J7MN50		J7MN100	
	NEMA Size 00 FLA max. 12 A, 600 V hp-rating max.		NEMA Size 1 FLA max. 25 A, 600 V hp-rating max.		NEMA Size 2 FLA max. 50 A, 600 V hp-rating max.		NEMA Size 3 FLA max. 100 A, 600 V hp-rating max.	
V	1-phas.	3-phas.	1-phas.	3-phas.	1-phas.	3-phas.	1-phas.	3-phas.
110/120	1/3	–	2	–	3	–	10	–
200	3/4	2	3	71/2	71/2	15	20	30
220/240	1	2	3	71/2	10	20	20	40
440/480	–	5	–	15	–	40	–	75
550/600	–	–	–	10	–	50	–	75

Circuit breakers J7MN as „Combination Motor Controller Type E“

As of UL 16. 07. 2001, UL508 demands a line-side 1 air and 2 creepage distance for „Combination Motor Controller Type E“ Therefore circuitbreakers J7MN-25 and J7MN-100 are approved to UL 508 in combination with the terminal blocks listed below. The basic unit of circuit-breakers J7MN-25 conforms with the required air/creepage distances. According to CSA these terminal blocks can be omitted when the device is used as „Combination Motor Controller Type E“.

Circuit breaker	J7MN12		J7MN25 + J74MN-TB25		J7MN50		J7MN100 + J74MN-TB100	
	NEMA Size 00 FLA max. 12 A, 600 V hp-rating max.		NEMA Size 1 FLA max. 25 A, 600 V hp-rating max.		NEMA Size 2 FLA max. 50 A, 600 V hp-rating max.		NEMA Size 3 FLA max. 100 A, 600 V hp-rating max.	
V			1-phas.	3-phas.	1-phas.	3-phas.	1-phas.	3-phas.
110/120	–		2	–	3	–	10	–
200	–		3	71/2	71/2	15	20	30
220/240	–		3	71/2	10	20	20	40
440/480	–		–	15	–	40	–	75
550/600	–		–	10	–	50	–	75

Ratings of auxiliary switches and alarm switches	Lateral auxiliary switch with 1NO + 1 NC J73MN11S	Transversal auxiliary switch with 1NO + 1NC J73MN11F
Max. rated voltage to NEMA AC V	600	240
uninterrupted current A	10	2,5
Breaking capacity AC	A600	C300
DC	Q300	R300

Permissible ratings of devices approved for North America

Ratings Icu complies with „short circuit breaking capacity“		Manual Motor Starter						Manual Motor Controller Suitable for Tap Conductor Protection in Group Installations			Combination Motor Controller Type E					
Circuit breaker Type	Rated current IN A	up to AC 240 V		up to AC 480 V		up to AC 600 V		up to AC 240 V	up to AC 480 V	up to AC 240 V	up to AC 240 V		up to AC 480 V		up to AC 600 V	
		UL kA	CSA kA	UL kA	CSA kA	UL kA	CSA kA	UL kA	UL kA	UL kA	UL kA	CSA kA	UL kA	CSA kA	UL kA	CSA kA
J7MN-12	0,11... 3,2	65	50	65	50	30	10	65	65	-	-	-	-	-	-	-
	4	65	50	65	50	30	10	65	65	-	-	-	-	-	-	-
	5	65	50	65	50	30	10	65	65	-	-	-	-	-	-	-
	6,3	65	50	65	50	30	10	65	65	-	-	-	-	-	-	-
	8	65	50	65	50	30	10	65	65	-	-	-	-	-	-	-
	10	50	50	10	-	-	-	-	-	-	-	-	-	-	-	-
	12	50	50	10	-	-	-	-	-	-	-	-	-	-	-	-
J7MN-25 (+J74MN-TB25)	0,11 ... 3,2	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	4	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	5	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	6,3	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	8	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	10	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	12,5	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	16	65	50	65	50	30	30	65	65	-	65	50	65	30	-	-
	20	65	50	65	50	30	30	65	65	-	65	50	65	30	-	-
	22	65	50	65	50	30	30	65	65	-	65	50	65	30	-	-
25	65	50	65	50	30	30	-	-	-	-	-	-	-	-	-	
J7MN-50	25	65	50	65	50	25	25	65	65	25	65	50	65	50	25	25
	32	65	50	65	50	25	25	65	65	25	65	50	65	50	25	25
	40	65	50	65	50	25	25	65	65	25	65	50	65	50	25	25
	45	65	50	65	50	25	25	65	65	25	65	50	65	50	25	25
	50	65	50	65	50	25	25	65	65	25	65	50	65	50	25	25
J7MN-100 (+J74MN-TB100)	50	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	63	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	75	65	50	65	50	30	30	65	65	30	65	50	65	30	50	30
	90	65	50	65	50	30	30	65	65	-	65	50	65	30	-	-
	100(99)	65	50	65	50	30	30	65	65	-	65	50	65	30	-	-

hp-rating = Power rating in in horse power (maximum motor rating)
 FLA = Full Load Amps / Motor full load current
 Icu complies with „short circuit breaking capacity“ to UL

Approvals

Country	USA	Canada	USA	Canada	Europe
	MANUAL MOTOR CONTROLLER		COMBINATION MOTOR CONTROLLER		
Type	UL	UL	UL	UL	CE
J7MN-12	o	o	-	-	o
J7MN-25	o	o	o ^{*1}	o ^{*1}	o
J7MN-50	o	o	o	o	o
J7MN-100	o	o	o ^{*2}	o ^{*2}	o
J73MN-11F	o	o	-	-	o
J73MN-N	o	o	-	-	o
J73MN-S	o	o	-	-	o
J73MN-T-11S	o	o	-	-	o
J73MN-L	o	-	-	-	o
J74MN-TB25	o	o	-	-	o
J74MN-TB100	o	o	-	-	o

*1 in use with J74MN-TB25
 *2 un use with J74MN-TB100
 o In standard version approved
 - Not provided for test till now



UL and N-UL-Guide- and File-No.

These data are important for UL-inspecting

Devices	Guide-No.		File-No.
	Canada	USA	
Circuit Breakers J7MN as Manual Motor Controller	NLRV7	NLRV	E129916
Circuit Breakers J7MN as Combination Motor Controller	NKJH7	NKJH	E197641
J74MN busbar system	NLRV7	NLRV	E129916
J74MN accessories	NKCR7	NKCR	E66273

 and -Guide- and File-No.

These data are important for UL-inspecting

Devices	Guide-No.			
				
	Kanada	USA	Kanada	USA
Contactors	NLDX7	NLDX	NLDX8	NLDX2
Accessories	NKCR7	NKCR	NKCR8	NKCR2
Thermal Overload Relays	NKCR7	NKCR	-	-
Circuit Breakers J7MN as Manual Motor Controller	NLRV7	NLRV	-	-
Circuit Breakers J7MN as Combination Motor Controller	NKJH7	NKJH	-	-
J7MN Bus Bar Assemblies	NLRV7	NLRV	-	-
J7MN Accessories	NKCR7	NKCR	-	-

■ Technical information

Degree of protection acc. to EN60947

Protection ratings are prefixed by the internationally agreed letters IP followed by two digits.

1st digit: Pertains to solid objects

2nd digit: Pertains to water.

1 st digit	Short description	Definition
1	Protected against solid objects greater than 50 mm	Excludes solid objects exceeding 50 mm in diameter and protects against contact with live and moving parts by a large body surface such as a hand (but not against deliberate access).
2L	Protected against solid objects greater than 12,5 mm and against contact by standard test finger	Excludes solid objects exceeding 12,5 mm in diameter and protects against contact with live and moving parts by a standard test finger or similar objects not exceeding 80 mm in length.
3	Protected against solid objects greater than 2,5 mm	Excludes solid objects exceeding 2,5 mm in diameter or thickness.
4	Protected against solid objects greater than 1 mm	Excludes solid objects exceeding 1 mm in diameter or thickness.
5	Dust protected	Prevents ingress of dust in quantities and locations that would interfere with the intended operation of the equipment.
6	Dust tight	Prevents ingress of dust.

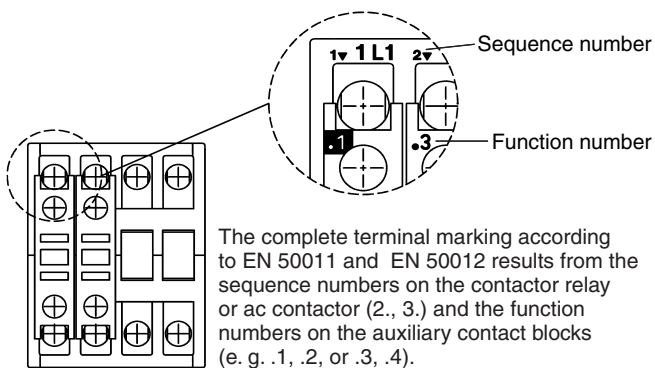
2 nd digit	Short description	Definition
1	Protected against-dripping water	Dripping water (vertically falling drops) shall have no harmful effect.
2	Protected against dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at any angle up to 15° from its normal position.
3	Protected against spraying water	Water falling as a spray at an angle up to 60° from the vertical shall have no harmful effect.
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effect.
5	Protected against water jets	Water protected by a nozzle against the enclosure from any direction shall have no harmful effect.
6	Protected against heavy seas	Water from heavy seas or water projected in powerful jets shall not enter the enclosure in harmful quantities.
7	Protected against the effects of immersion	Ingress of water in a harmful quantity shall not be possible when the enclosure is immersed in water under standard conditions of pressure and time.
8	Protected against submersion	No ingress of water.

Terminal markings acc. to EN50011

Auxiliary contacts of AC contactors and contacts of contactor relays and thermal overload relays are particularly marked. The terminal markings of normally-open contacts are printed as positive figures, they of normally-closed contacts as negative figures.

This gives a clear indication of the function of the contacts.

The figure below illustrates the determination of terminal markings for contactors with auxiliary contact blocks.



Resistance to climatic conditions acc. to IEC 68

Open-type devices are climate-resistant in the constant climate according to IEC 68-2-3 (this is a climate with an ambient temperature of 40°C and an atmospheric humidity of 90 to 95%).

Enclosed devices are climate-resistant in an alternating climate according to IEC 68-2-30 (this is a moist alternating climate with a 24-hour cycle between climates with an ambient temperature of 25°C, and an atmospheric humidity of 95 to 100% and an ambient temperature of 40°C, and an atmospheric humidity of 90 to 96% in the presence of condensation during rises in temperature).

Data are valid up to an altitude of 2000m above sea level.

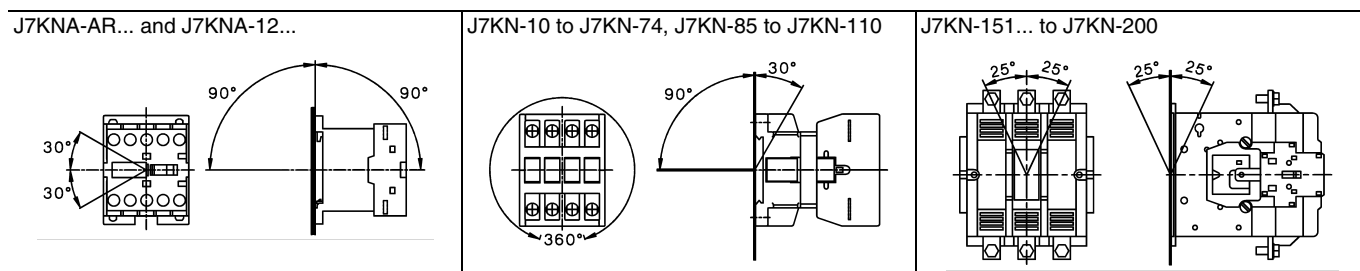
Short circuit protection

Back up fuses should be used to protect contactors and starters against short circuits. For starters the device with the smaller admissible fuse at the main and at the control circuit (contactor or thermal overload) determines the fuse size.

After a short circuit devices have to be checked for correct operation.

Disconnect power before proceeding with any work on the equipment!

Mounting positions of contactors



Terminal screws

Devices	Kind of connection	
	Screw with washer	Screw with clamp box
Mini Contactors		
All conductors		
J7KN-AR...; J7KNA-09...; J7KNA-12...	M3,5	-
Contactors		
Main conductor		
J7KN-10... to J7KN-22...	M3,5	-
J7KN-24... to J7KN-40...	-	M5
J7KN-50... to J7KN-74...	-	M6
J7KN-85..., J7KN-110...	-	M8
Auxiliary conductor		
J7KN-10... to J7KN-22...	M3,5	-
J7KN-85... to J7KN-110	M3,5	-

Devices	Kind of connection	
	Screw with washer	Screw with clamp box
Type		
Coil conductor		
J7KN-10... to J7KN-110...	M3,5	-
Accessories		
J73KNA(M)...	M3,5	-
J73KN-B, J73KN-C	M3,5	-
Thermal Overload Relays		
Main conductor		
J7TKN-A	M4	-
J7TKN-B	M3,5	-
J7TKN-C	M5	-
J7TKN-D	-	M6
Auxiliary conductor		
All devices	M3,5	-

Terminal screws in relation to screwdriver sizes and tightening torques

Terminal screws	Size	Poqidriv	Screw driver	Tightening torque	
				Nm	lb. inch
Screw with Poqidriv and slot	M3	Pz 1	Size 1	0,6 - 1,2	5 - 11
	M3,5	Pz 2	Size 2, 3	0,8 - 1,4	7 - 12
	M4	Pz 2	Size 3, 4	1,2 - 1,8	11 - 16
	M5	Pz 2	Size 3, 4, 5	2,5 - 3	22 - 26
	M6	Pz 3	Size 4, 5	3,5 - 4,5	31 - 40
Screw or nut with hexagonal-head	M8	-	-	6 - 10	53 - 88

General technical information

■ Current carrying capacities of PVC insulated 600/1000 Volt cables with copper or aluminium conductors.

In accordance with the 16th edition of the "Wiring Regulations for Electrical Installations".

Basic assumptions: Ambient temperature of 30°C.

Circuit of protected by a OMRON circuit-breaker to IEC 947-2, or a fuse to BS 88 or BS 1361.

Figures must be adjusted by the correction factors for ambient temperature and/or cable grouping as detailed in the IEE regs.

Conductor size mm ²	In conduit or trunking (enclosed)				Clipped to surface or cable tray, bunched, embedded in plaster (unenclosed)				Fixed to vertical surface of wall or open cable trench with 20 mm separation between cables and wall			
	Single-phase		Three-phase		Single-phase		Three-phase		Single-phase		Three-phase	
	Cu [A]	Al [A]	Cu [A]	Al [A]	Cu [A]	Al [A]	Cu [A]	Al [A]	Cu [A]	Al [A]	Cu [A]	Al [A]
Single core, PVC insulated cable non-armoured, copper or aluminium conductors.												
1.0	13.5	-	12.0	-	15.5	-	14.0	-	-	-	-	-
1.5	17.5	-	15.5	-	20.0	-	18.0	-	-	-	-	-
2.5	24.0	-	21.0	-	27.0	-	25.0	-	-	-	-	-
4.0	32.0	-	28.0	-	37.0	-	33.0	-	-	-	-	-
6.0	41.0	-	36.0	-	47.0	-	43.0	-	-	-	-	-
10.0	57.0	-	50.0	-	65.0	-	59.0	-	-	-	-	-
16.0	76.0	-	68.0	-	87.0	-	79.0	-	-	-	-	-
25.0	101.0	-	89.0	-	114.0	-	104.0	-	126.0	-	112.0	-
35.0	125.0	-	110.0	-	141.0	-	129.0	-	156.0	-	141.0	-
50.0	151.0	118.0	134.0	104.0	182.0	134.0	167.0	123.0	191.0	144.0	172.0	132.0
70.0	192.0	150.0	171.0	133.0	234.0	172.0	214.0	156.0	246.0	185.0	223.0	169.0
95.0	232.0	181.0	207.0	161.0	284.0	210.0	261.0	194.0	300.0	225.0	273.0	206.0
120.0	296.0	210.0	239.0	186.0	330.0	245.0	303.0	226.0	349.0	261.0	318.0	240.0
150.0	300.0	234.0	262.0	204.0	381.0	283.0	349.0	261.0	404.0	301.0	369.0	277.0
185.0	341.0	266.0	296.0	230.0	436.0	324.0	400.0	299.0	463.0	344.0	424.0	317.0
240.0	400.0	312.0	346.0	269.0	515.0	384.0	472.0	354.0	549.0	407.0	504.0	375.0
300.0	458.0	358.0	394.0	306.0	594.0	444.0	545.0	410.0	635.0	469.0	584.0	435.0
400.0	546.0	-	467.0	-	694.0	-	634.0	-	732.0	-	679.0	-
500.0	626.0	-	533.0	-	792.0	-	723.0	-	835.0	-	778.0	-
630.0	720.0	-	611.0	-	904.0	-	826.0	-	953.0	-	892.0	-
Twin and multi-core PVC insulated cable, non-armoured, copper or aluminium conductors.												
1.0	11.0	-	11.5	-	15.0	-	13.5	-	17.0	-	14.5	-
1.5	14.0	-	15.0	-	19.5	-	17.5	-	22.0	-	18.5	-
2.5	18.5	-	20.0	-	27.0	-	24.0	-	30.0	-	25.0	-
4.0	25.0	-	27.0	-	36.0	-	32.0	-	40.0	-	34.0	-
6.0	32.0	-	34.0	-	46.0	-	41.0	-	51.0	-	43.0	-
10.0	43.0	-	46.0	-	63.0	-	57.0	-	70.0	-	60.0	-
16.0	57.0	54.0	62.0	48.0	85.0	66.0	76.0	59.0	94.0	73.0	80.0	61.0
25.0	75.0	71.0	80.0	62.0	112.0	83.0	96.0	73.0	119.0	89.0	101.0	78.0
35.0	92.0	86.0	99.0	77.0	138.0	103.0	119.0	90.0	148.0	111.0	126.0	96.0
50.0	110.0	104.0	118.0	92.0	168.0	125.0	144.0	110.0	180.0	135.0	153.0	117.0
70.0	139.0	131.0	149.0	116.0	213.0	160.0	184.0	140.0	232.0	173.0	196.0	150.0
95.0	167.0	157.0	179.0	139.0	258.0	195.0	261.0	170.0	282.0	210.0	238.0	183.0
120.0	192.0	-	206.0	160.0	299.0	245.0	259.0	197.0	328.0	-	276.0	212.0
150.0	219.0	-	225.0	184.0	344.0	283.0	299.0	227.0	379.0	-	319.0	245.0
185.0	248.0	-	255.0	210.0	392.0	324.0	341.0	259.0	434.0	-	364.0	280.0
240.0	291.0	-	297.0	248.0	461.0	384.0	403.0	305.0	514.0	-	430.0	330.0
300.0	334.0	-	339.0	258.0	530.0	444.0	464.0	351.0	593.0	-	497.0	381.0
400.0	-	-	402.0	-	634.0	-	557.0	-	715.0	-	597.0	-

■ Overall diameter of cables (Copper)

The dimensions are based on BS specification or the average values as given by the manufacturers.
The overall diameters given are for cables of 600/1000 V grade.

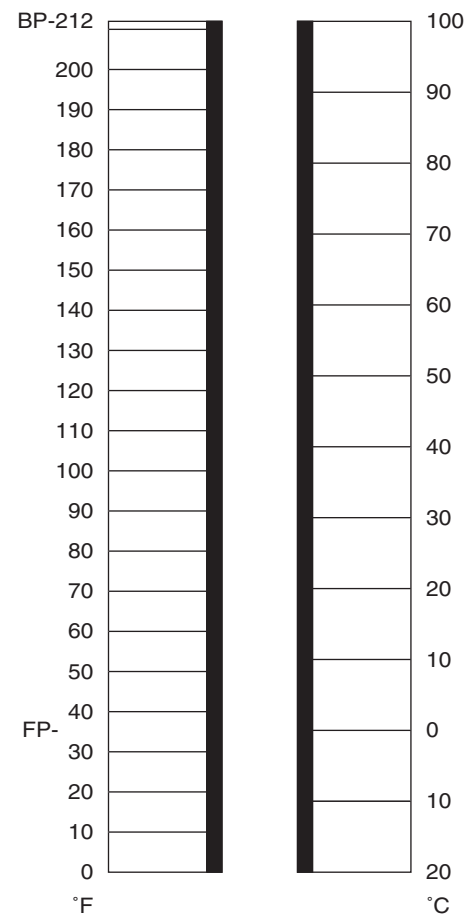
Number and nominal area of cables (mm ²)	Approx. overall diameter in mm		Number and nominal area of cables (mm ²)	Approx. overall diameter in mm	
	PVC/SWA	PVC		PVC/SWA	PVC
1 x 1.0	-	4.5	2 x 1.0	-	-
1 x 1.5	-	4.9	2 x 1.5	11.7	7.2
1 x 2.5	-	5.8	2 x 2.5	13.1	8.6
1 x 4.0	-	6.8	2 x 4.0	15.1	10.7
1 x 6.0	-	7.4	2 x 6.0	16.5	12.0
1 x 10.0	-	8.8	2 x 10.0	20.1	14.9
1 x 16.0	-	10.5	2 x 16.0	21.9	17.2
1 x 25.0	-	12.5	2 x 25.0	23.0	18.4
1 x 35.0	-	13.5	2 x 35.0	24.9	20.1
1 x 50.0	19.1	15.1	2 x 50.0	27.8	22.8
1 x 70.0	21.1	16.9	2 x 70.0	30.4	25.5
1 x 95.0	23.4	19.4	2 x 95.0	35.5	29.3
1 x 120.0	26.3	21.0	2 x 120.0	38.0	31.8
1 x 150.0	28.3	23.2	2 x 150.0	41.3	35.1
1 x 185.0	30.8	25.8	2 x 185.0	46.4	39.1
1 x 240.0	34.1	29.0	2 x 240.0	51.2	43.9
1 x 300.0	37.0	32.1	2 x 300.0	56.4	48.7
1 x 400.0	42.0	35.8	2 x 400.0	61.9	54.2
1 x 500.0	45.6	39.6	-	-	-
1 x 630.0	49.7	43.8	-	-	-

Number and nominal area of cables (mm ²)	Approx. overall diameter in mm		Number and nominal area of cables (mm ²)	Approx. overall diameter in mm	
	PVC/SWA	PVC		PVC/SWA	PVC
3 x 1.0	-	-	4 x 1.0	-	-
3 x 1.5	12.3	7.6	4 x 1.5	13.0	8.3
3 x 2.5	13.6	9.1	4 x 2.5	14.5	10.0
3 x 4.0	15.8	11.5	4 x 4.0	17.8	12.6
3 x 6.0	18.0	12.8	4 x 6.0	19.2	14.2
3 x 10.0	21.2	15.8	4 x 10.0	22.8	17.7
3 x 16.0	23.1	19.7	4 x 16.0	26.3	20.6
3 x 25.0	25.0	20.4	4 x 25.0	27.8	22.9
3 x 35.0	27.3	22.4	4 x 35.0	30.5	25.4
3 x 50.0	30.5	25.5	4 x 50.0	35.4	29.2
3 x 70.0	35.0	28.7	4 x 70.0	39.2	33.0
3 x 95.0	39.3	33.3	4 x 95.0	44.3	38.3
3 x 120.0	42.2	36.3	4 x 120.0	49.3	41.8
3 x 150.0	47.5	40.0	4 x 150.0	53.6	46.3
3 x 185.0	51.9	44.6	4 x 185.0	59.0	61.3
3 x 240.0	57.8	50.1	4 x 240.0	65.7	58.0
3 x 300.0	63.2	55.6	4 x 300.0	72.0	64.6
3 x 400.0	69.6	62.2	4 x 400.0	81.3	72.0

■ Conversion table

To convert	Multiply by
Inches to millimeters (mm)	25.4
Millimeters to inches (In.)	0.03937
Feet to meters (m)	0.3048
meters to feet (ft)	3.2808
Yards to meters (m)	0.9144
meters to yards (yd)	1.0936
Miles to kilometers (km)	1.6093
Kilometers to miles (mil.)	0.6214
Square inches to square millimeters (mm ²)	645.16
Square millimeters to square inches (inch ²)	0.00155
Square yards to square meters (m ²)	0.8361
Square meters to square yards (yd ²)	1.196
Cubic inches to cubic centimeters (cm ³)	16.387
Cubic centimeters to cubic inches (inch ³)	0.06102
Pounds to kilogrammes (kg)	0.4536
Kilogrammes to pounds (lb)	2.2046
Tons (2,240 lb) to kilogrammes (kg)	1,016.05
Kilogrammes to tons (240 lb)	0.0009842
Ounces (avoirdpois) to grammes (g)	28.3495
Grammes to ounces	0.0353
Gallons to litres (l)	4.561
Litres to gallons	0.220
Force N (newtons) to lbft 1 N = 1 kg (mass) accelerated at 1 metre/sec.	0.225
1 Nm = 1 J (joule) to calorie	0.239
Horse-power to kilowatts (kW)	0.7458
Kilowatts to horse-power (h.p.) 1 W (watt) = 1J/s	1.3408
Atmospheres to lb per square inch (lb/inch ²) 1 bar = 1 kg/cm ² = 735.6 mm Hg = 14.2 lb/inch ²	14.68

Conversion table for: Centigrade/Fahrenheit



Conversion table for mm²/AWG cable sizes

mm ²	AWG
0.75	18
1.0	17
1.5	16
2.5	13
4.0	12
6.0	10
10.0	8

■ Rated currents of 3-phase motors (approx. figures for squirrel-cage motors)

Minimum fuse size for protection of 3-phase motors

The maximum size is determined by the requirements of the switchgear or overload relay.

The rated motor currents are for standard 1500 r.p.m. 3-phase enclosed ventilated and totally enclosed fan-cooled motors.

D.O.L. starting: Maximum starting current 6 x rated motor current. Maximum starting time 5 s.

Y/D starting: Maximum starting current 2 x rated motor current. Maximum starting time 15 s.

Set overload relay in the phase lead to 0.58 x rated motor current.

Rated fuse currents for Y/D starting are also valid for 3-phase motors with slip-ring motors.

For higher rated currents, starting currents and/or longer starting times, larger fuses are required.

Table is valid for "slow" and/or "gL" fuses (DIN VDE 0636).

For NH fuses with aM characteristics, fuses = rated current is selected.

Motor rating			230 V			400 V			415 V		
			Rated motor current	Fuse starting D.O.L.	Y/Δ	Rated motor current	Fuse starting D.O.L.	Y/Δ	Rated motor current	Fuse starting D.O.L.	Y/Δ
kW	cos φ	η%	A	A	A	A	A	A	A	A, BS	A, BS
0.06	0.7	58	0.37	2.0	-	0.21	2.0	-	0.21	2.0	2
0.09	0.7	60	0.54	2.0	-	0.31	2.0	-	0.30	2.0	2
0.12	0.7	60	0.72	4.0	2	0.41	2.0	-	0.40	2.0	2
0.18	0.7	62	1.04	4.0	2	0.6	2.0	-	0.58	2.0	2
0.25	0.7	62	1.4	4.0	2	0.8	4.0	2	0.8	4.0	2
0.37	0.72	66	2.0	6.0	4	1.1	4.0	2	1.1	4.0	2
0.55	0.75	69	2.7	10.0	4	1.5	4.0	2	1.5	6.0	4
0.75	0.79	74	3.2	10.0	4	1.9	6.0	4	1.8	6.0	4
1.1	0.81	74	4.6	10.0	6	2.6	6.0	4	2.6	10.0	6
1.5	0.81	74	6.3	16.0	10	3.6	6.0	4	3.5	16.0	10
2.2	0.81	78	8.7	20.0	10	5.0	10.0	6	4.8	16.0	10
3.0	0.82	80	11.5	25.0	16	6.6	16.0	10	6.4	20.0	16
4.0	0.82	83	14.8	32.0	16	8.5	20.0	10	8.2	20.0	16
5.5	0.82	86	19.6	32.0	25	11.3	25.0	16	10.9	25.0	20
7.5	0.82	87	26.4	50.0	32	15.2	32.0	16	14.6	35.0	25
11.0	0.84	87	38.0	80.0	40	21.7	40.0	25	20.9	50.0	32
15.0	0.84	88	51.0	100.0	63	29.3	63.0	32	28.2	80.0	40
18.5	0.84	88	63.0	125.0	80	36.0	63.0	40	35.0	80.0	50
22.0	0.84	92	71.0	125.0	80	41.0	80.0	50	40.0	80.0	50
30.0	0.85	92	96.0	200.0	100	55.0	100.0	63	53.0	100.0	80
37.0	0.86	92	117.0	200.0	125	68.0	125.0	80	65.0	125.0	80
45.0	0.86	93	141.0	250.0	160	81.0	160.0	100	78.0	125.0	80
55.0	0.86	93	173.0	250.0	200	99.0	200.0	125	96.0	160.0	100
75.0	0.86	94	233.0	315.0	250	134.0	200.0	160	129.0	250.0	160
90.0	0.86	94	279.0	400.0	315	161.0	250.0	200	155.0	250.0	160
110.0	0.86	94	342.0	500.0	400	196.0	315.0	200	189.0	315.0	200
132.0	0.87	95	401.0	630.0	500	231.0	400.0	250	222.0	355.0	250
160.0	0.87	95	486.0	630.0	630	279.0	400.0	315	269.0	355.0	315
200.0	0.87	95	607.0	800.0	630	349.0	500.0	400	337.0	450.0	355
250.0	0.87	95	-	-	-	437.0	630.0	500	421.0	500.0	450
315.0	0.87	96	-	-	-	544.0	800.0	630	525.0	630.0	560
400.0	0.88	96	-	-	-	683.0	1000.0	800	-	-	-
450.0	0.88	96	-	-	-	769.0	1000.0	800	-	-	-
500.0	0.88	97	-	-	-	-	-	-	-	-	-
560.0	0.88	97	-	-	-	-	-	-	-	-	-
630.0	0.88	97	-	-	-	-	-	-	-	-	-

Minimum fuse size for protection of 3-phase motors

The maximum size is determined by the requirements of the switchgear or overload relay.

The rated motor currents are for standard 1500 r.p.m. 3-phase enclosed ventilated and totally enclosed fan-cooled motors.

D.O.L. starting: Maximum starting current 6 x rated motor current. Maximum starting time 5 s.

Y/D starting: Maximum starting current 2 x rated motor current. Maximum starting time 15 s.

Set overload relay in the phase lead to 0.58 x rated motor current.

Rated fuse currents for Y/D starting are also valid for 3-phase motors with slip-ring motors.

For higher rated currents, starting currents and/or longer starting times, larger fuses are required.

Table is valid for "slow" and/or "gL" fuses (DIN VDE 0636).

For NH fuses with aM characteristics, fuses = rated current is selected.

Motor rating			500 V			600 V		
			Rated motor current	Fuse starting D.O.L.	Y/Δ	Rated motor current	Fuse starting D.O.L.	Y/Δ
kW	cos φ	η%	A	A	A	A	A	A
0.06	0.7	58	0.17	2.0	-	0.12	2.0	-
0.09	0.7	60	0.25	2.0	-	0.18	2.0	-
0.12	0.7	60	0.33	2.0	-	0.24	2.0	-
0.18	0.7	62	0.48	2.0	-	0.35	2.0	-
0.25	0.7	62	0.70	2.0	-	0.50	2.0	-
0.37	0.72	66	0.90	2.0	2	0.70	2.0	-
0.55	0.75	69	1.20	4.0	2	0.90	4.0	2
0.75	0.79	74	1.50	4.0	2	1.10	4.0	2
1.1	0.81	74	2.1	6.0	4	1.5	4.0	2
1.5	0.81	74	2.9	6.0	4	2.1	6.0	4
2.2	0.81	78	4.0	10.0	4	2.9	10.0	4
3.0	0.82	80	5.3	16.0	6	3.8	10.0	4
4.0	0.82	83	6.8	16.0	10	4.9	16.0	6
5.5	0.82	86	9.0	20.0	16	6.5	16.0	10
7.5	0.82	87	12.1	25.0	16	8.8	20.0	10
11.0	0.84	87	17.4	32.0	20	12.6	25.0	16
15.0	0.84	88	23.4	50.0	25	17.0	32.0	20
18.5	0.84	88	28.9	50.0	32	20.9	32.0	25
22.0	0.84	92	33.0	63.0	32	23.8	50.0	25
30.0	0.85	92	44.0	80.0	50	32.0	63.0	32
37.0	0.86	92	54.0	100.0	63	39.0	80.0	50
45.0	0.86	93	65.0	125.0	80	47.0	80.0	63
55.0	0.86	93	79.0	160.0	80	58.0	100.0	63
75.0	0.86	94	107.0	200.0	125	78.0	160.0	100
90.0	0.86	94	129.0	200.0	160	93.0	160.0	100
110.0	0.86	94	157.0	250.0	160	114.0	200.0	125
132.0	0.87	95	184.0	250.0	200	134.0	250.0	160
160.0	0.87	95	224.0	315.0	250	162.0	250.0	200
200.0	0.87	95	279.0	400.0	315	202.0	315.0	250
250.0	0.87	95	349.0	500.0	400	253.0	400.0	315
315.0	0.87	96	436.0	630.0	500	316.0	500.0	400
400.0	0.88	96	547.0	800.0	630	396.0	630.0	400
450.0	0.88	96	615.0	800.0	630	446.0	630.0	630
500.0	0.88	97	-	-	-	491.0	630.0	630
560.0	0.88	97	-	-	-	550.0	800.0	630
630.0	0.88	97	-	-	-	618.0	800.0	630

ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.