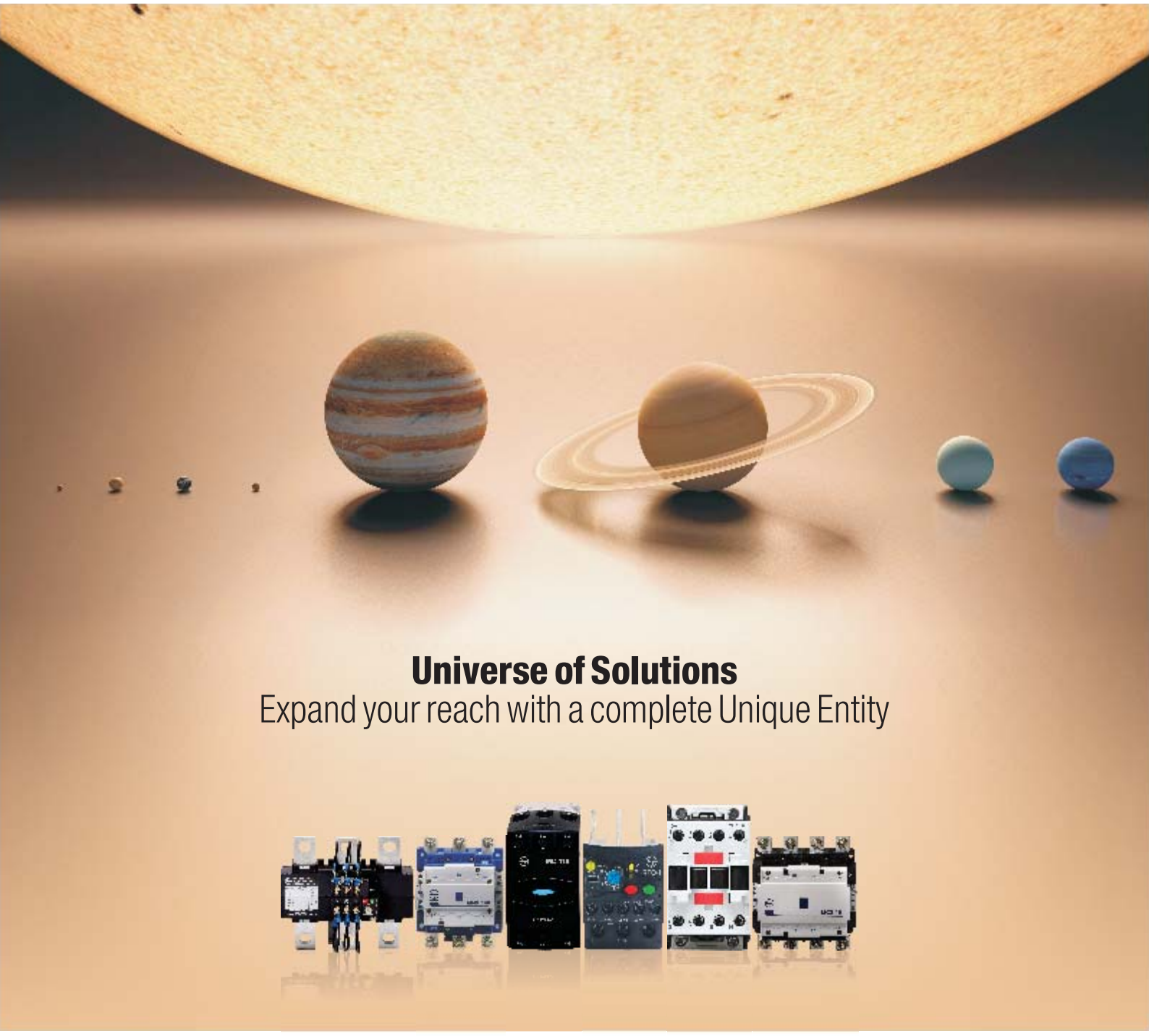
LARSEN & TOUBRO

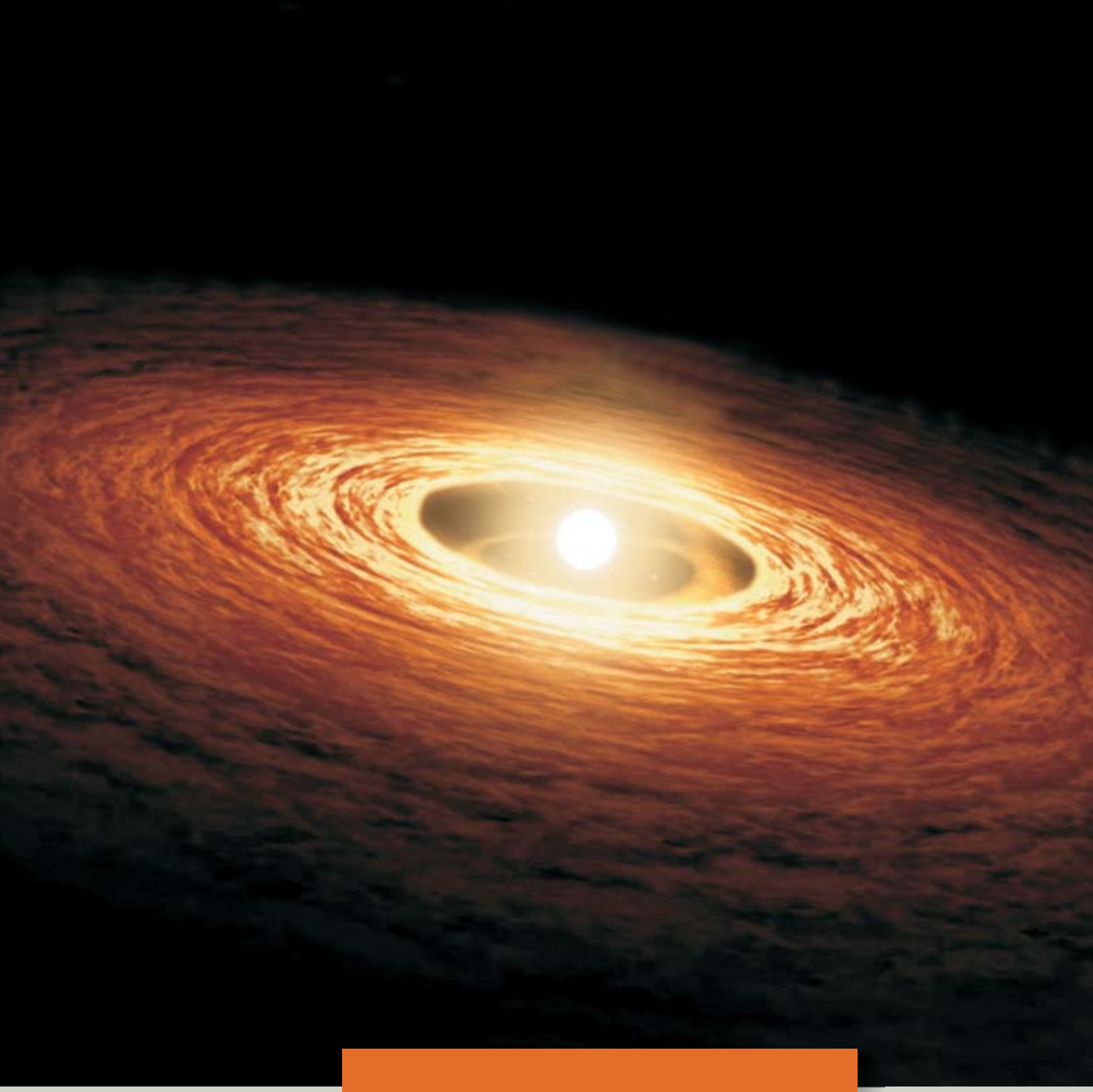


Universe of Solutions

Expand your reach with a complete Unique Entity

L&T SWITCHGEAR

SAFE & SURE

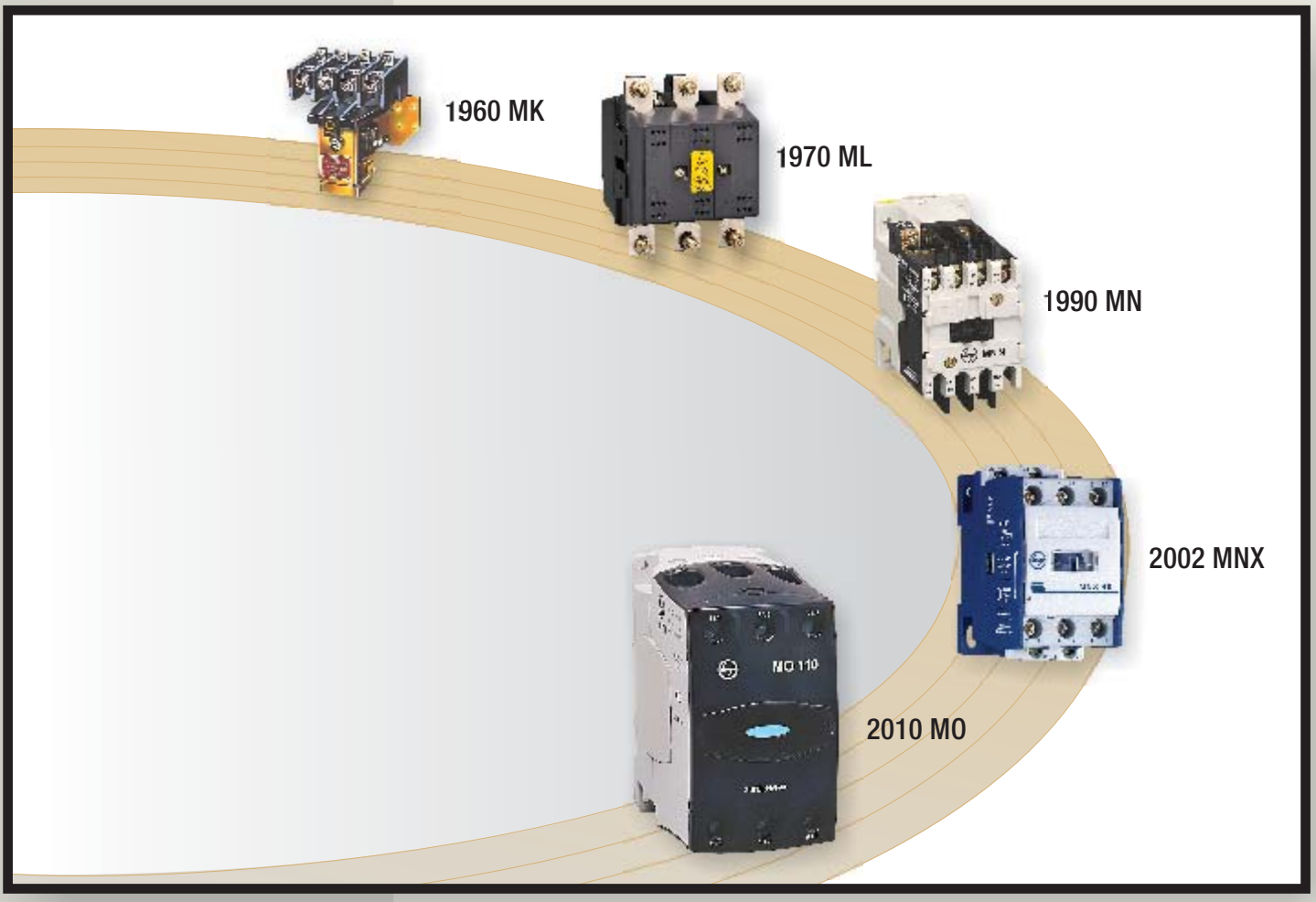


A PEEK INTO THE PAST

GLORIOUS HISTORY REPLETE WITH MILESTONES

It all began way back in the 1960's when Larsen & Toubro embarked on a momentous voyage and started its controlgear business. Right from the launch of MK series more than 50 years ago, L&T has been at the forefront of controlgear product development. Over the years, this excellent range has grown in width of its offerings, size, etc.

Hence, it comes as no surprise today that L&T has won the confidence and trust of millions of its customers across the globe.



PILLARS OF SUPPORT

PROVIDING MUCH-NEEDED SUPPORT

Our extensive range of contactors is further augmented by our range of thermal overload relays, giving reliable protection across diverse applications.

MN relays are available from 0.2 to 570A in trip class 10A and 30. Relays can be directly mounted on contactors for space-saving or through separate mounting kits, depending on the requirement.

MO contactors along with RTO relays, MNX contactors along with RTX relays and MX contactors along with MX-RO relays are perfect examples of these compact motor feeders.

MULTI DIMENSIONAL COMPLETE SYSTEMS

ADDING VALUE, ASSURING RESULTS

Our wide range of accessories has been specifically designed and developed to suit diverse application requirements. From add-on blocks to surge suppressors and mechanical interlock kits to protection shrouds, you name it, we have it.

With a wide range of accessories complementing our switchgear products, our controlgear range is the most comprehensive to meet all our customer needs.

UP AND RUNNING, ALWAYS

LESS DOWNTIME, MORE PRODUCTIVITY

If downtime is not brought under control, it can spell doom for any industry. This makes reducing down time one of the most important needs of the industry. Equally significant is ease of maintenance.

L&T offers a wide range of spares for its contactors, right from the lowest rating. The contactors are extremely easy to inspect and this, coupled with easily replaceable coil and contacts, ensures reduction in downtime and maintenance time. In other words, one can always be assured of high levels of productivity and efficiency.

RANGE IN ONE PLACE

ONE-STOP SOLUTION FOR EVERY APPLICATION

Industry requirements are constantly evolving and our clients' demands are ever-increasing. A scenario which may seem as a challenge to many is seen by us as an opportunity to learn and grow. An opportunity to excel in our commitments and exceed customer expectations.

Due to our through understanding and in-depth knowledge of customer requirements, we make sure that our extensive range of contactors caters to every single customer need. Our contactors are well suited for varied applications such as motor control, capacitor duty switching, single phase applications, supply changeover and many more. In short, we are a one-stop solution for every application.

The comprehensive range of controlgear products from L&T Switchgear is your key to meet every demand and suit every requirement across diverse applications.

Whether it is motor control, capacitor switching, supply changeover or any other single phase or three phase application, you can always be assured of finding a perfect solution in our extensive range of contactors.

Thermal overload relays with their sensitive mechanism ensure that your system is protected against overloads. Motor Protection circuit breakers combine both overload and short circuit protection
in a single compact solution.

To complement these products, we also have a wide range of accessories and spares to ensure that support is always at hand.

In other words, our controlgear range is a one-stop solution for every application.

Standards & Approvals

Controlgear range comply with the following standards

- **IEC 60947-1, EN 60947-1, IS/IEC 60947-1**
  Low-voltage switchgear and controlgear, Part 1: General Rules

- **IEC 60947-4, EN 60947-4, IS/IEC 60947-4**
  Low-voltage switchgear and controlgear, Part 4: Contractors & Motor starters

Third party certificates (ERDA / CPRI) available for Controlgear Product

NABL

NABL accreditation is a formal recognition of the technical competence of testing, calibration or medical laboratory for a specific task following ISO/IEC 17025:2005 Standard. Accredited laboratories have the responsibility of satisfying the criteria of laboratory accreditation at all times, which are verified during Surveillance and Reassessment visits by NABL. Further the accredited laboratories should prove their technical competence by satisfactory participation in recognized Proficiency Testing Programmes.

L&T's Switchgear Testing Lab is NABL accredited subject to continued satisfactory compliance to above standard & additional requirements of NABL.

The Controlgear Product are tested in L&T's NABL accredited Switchgear Testing Lab.

CE Marking

A CE marking is a European marking of conformity that indicates a product complies with the essential requirements of the applicable European laws or directives with respect to safety, health and environment and consumer protection. Generally, this conformity to the applicable directives is done through self-declaration and is required on products in the countries of the European Economic Area (EEA) to facilitate trade among the member countries. The manufacturer or their authorized representative established in the EEA is responsible for affixing the CE marking to their product. The CE marking provides a means for a manufacturer to demonstrate that a product complies with a common set of laws required by all countries in the EEA to allow free movement of trade within the EEA countries.

L&T's Controlgear range conform to the Low voltage directive 73/23/EEC as amended by directive 93/68/EEC, provided it is used in the application for which it is made and is installed and maintained in accordance with professional practices with relevant installation standards and operating instructions.

RoHS Compliance

As a green initiatives, Larsen & Toubro understands the requirements of the RoHS directive. The directive restricts the use of hazardous substances in electrical and electronic equipment and bans electrical equipment containing more than permitted levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBS) and polybrominated diphenyl ether (PBDE) flame retardants.

Application Notes

Our comprehensive library of Application notes will help you optimize your selection of Controlgear products. These include short technical notes giving a brief description of a specific development, technique or procedure and it will guide for specific switchgear selection for different applications. The main criteria for publication will be the novelty of concepts involved, the validity of the technique and its potential for such applications.

Utilization categories

Contactors are most commonly used in applications concerning control of electric motors. They are used to start, stop, reverse, jog and plug the motors depending upon the application requirement. Contactors along with thermal overload relays also provide protection to the motor against overloads.

The most basic data required for contactor selection is the motor HP rating and it's rated current. However this data is alone not sufficient. The type of load, duty cycle of the load, switching frequency are some of the factors that influence contactor selection. The switching capability of contactors is majorly dependent on the type of application, and hence international standards (IEC 60947-4-1) specify utilization categories which cover a broad range of applications. These utilization categories and the data associated with them are used by manufacturers to establish contactor ratings.

The utilization categories as per IEC 60947-4-1 are as follow:

Kind of current	Utilization Categories	Typical applications
AC	AC - 1	Non-inductive or slightly inductive loads, resistance furnaces
	AC - 2	Slip-ring motors : starting, switching off
	AC - 3	Squirrel-cage motors : starting, switching off motors during running 1
	AC - 4	Squirrel-cage motors : starting, plugging, inching
	AC - 5a	Switching of electric discharge lamp controls
	AC - 5b	Switching of incandescent lamps
	AC - 6a	Switching of transformers
	AC - 6b	Switching of capacitor banks
	AC - 7a	Slightly inductive loads in household appliances and similar applications
	AC - 7b	Motor loads for household applications
	AC - 8a	Hermetic refrigerant compressor motor to control with manual resetting of overload release
	AC - 8b	Hermetic refrigerant compressor motor to control with automatic resetting of overload release
	AC - 15	Control of a.c electromagnetic loads
DC	DC - 1	Non-inductive or slightly inductive loads, resistance furnace
	DC - 3	Shunt-motors : Starting, Plugging, Inching
		Dynamic braking of dc motors
	DC - 5	Series-motors : Starting, Plugging, Inching
		Dynamic braking of dc motors
	DC - 6	Switching of incandescent lamps
	DC 13	Control for DC electromagnetic loads

1) AC-3 category may be used for occasional inching (jogging) or plugging for limited time periods such as machine set-up: during limited time periods, the number of such operations should not exceed five per minute or more than 10 in a ten minute period.
2) 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.

The utilization categories most commonly encountered in contactor applications are AC-3 & AC-4

Applications under utilization category AC-3 (Normal Switching) are:
Compressors, Pumps, Fans, Conveyors, Mixers, Agitators, Air conditioners, Elevators etc

Applications under utilization category AC-4 (Plugging, inching) are:
Printing presses, Wire drawing machines, Centrifuges etc

The making and breaking capacities of contactors are dependent on the utilization categories and the standard specifies that the contactors or starters shall be capable of making and breaking currents without failure under the conditions stated.

The conditions are as given below,

Table (a):

Normal Operation						
Utilization categories	**Making Conditions**			**Breaking Conditions**		
	I/I_e	U/U_e	cosØ	I/I_e	U/U_e	cosØ
AC - 1	1	1	0.8	1	1	0.95
AC - 2	2.5	1	0.65	2.5	1	0.65
AC - 3	6	1	1)	1	0.17	1)
AC - 4	6	1	1)	6	1	1)

1) For Ie < 17A cos Ø = 0.65, For Ie>17A cos Ø = 0.35

Table (b):

Occasional Operation (50 Operating cycles)						
Utilization categories	**Making Conditions**			**Breaking Conditions**		
	I_c/I_e	U_r/U_e	cosØ	I/I_e	U/U_e	cosØ
AC - 1	1.5	1.05	0.8	1.5	1.05	0.8
AC - 2	4	1.05	0.65	4	1.05	0.65
AC - 3	10	1.05	1)	8	1.05	1)
AC - 4	12	1.05	1)	10	1.05	1)

1) For 17A < Ie < 100A cos Ø = 0.45, For Ie > 100A cos Ø = 0.35

Where;

I_e = Rated Operational Current
U_e = Rated Operational Voltage
U_r = Recovery Voltage
I_c = making and breaking current

The starting current of a squirrel cage induction motor is 6 times while that of slip ring induction motor is 2.5 times the rated current. Starting current in slip ring induction motor is less because of the higher rotor resistance in the rotor circuit, which can be effectively removed in steps as the motor attains its rated speed.

Selection Criteria:

From the above table (a) it can be seen that, for AC-3 utilization category during normal operation the contactor must be capable of making 6 times the rated current. The current that contactor must break, however remains the rated current. This is because the AC-3 utilization category specifies that the motor is switched off after it starts running.

In the case of AC-4 utilization category, the current, the contactor must be capable of making as well as breaking remains 6 times the rated current. This is because AC-4 utilization category involves plugging and inching operations, in which the motor is switched on and off frequently.

Hence it can be concluded that AC-4 utilization category is more severe than AC-3 and the switching capability of contactors (Operating cycles/Hr) for AC-4 is lower than that of AC-3.

Table (b) specifies the values of currents the contactor must be capable of making or breaking under abnormal conditions which occur occasionally. Here also it can be concluded that AC-4 utilization category is the most severe among all the other utilization categories.

Also it can be seen that making and breaking capacities for AC-4 category is more than that of AC-3, clearly highlighting that AC-4 is severe than AC-3.

Selection Example:
Contactor must be selected such that the making and breaking capacities during both normal as well as abnormal conditions must be within contactor making and breaking capacity.

Consider a 10 HP squirrel cage Induction motor with Direct On-Line (DOL) starting.
Rated Current of the motor In = 15A

Motor Operation in AC-3 Utilization category
Normal Operation
Making current of the contactor =6In = 90A
Breaking current of the contactor = In = 15A

Abnormal operation
Making current of the contactor = 10In = 150A
Breaking current of the contactor = 8In = 120A

Motor Operation in AC-4 Utilization category
Normal Operation
Making current of the contactor =6In = 90A
Breaking current of the contactor = 6In = 90A

Abnormal operation
Making current of the contactor = 12In = 180A
Breaking current of the contactor = 10In = 150A

Hence, in both cases, we can select MO18 which has Rated Current of 18A, Making Capacity of 450A and Breaking Capacity of 350A which is higher than the abnormal making and breaking currents calculated above.

Motors are the backbone of the industry. Their use is also increasing in commercial establishments. Hence, protection of motor is extremely important so as to keep these processes functioning safely and continuously.

The main purpose of motor protection system is to prevent excessive temperature built up in the windings because of over-current and short-circuit current. Following are the reasons for over-current.

- Overloading.
- Single phasing.
- Over-voltage.

IS 13947 (Part 4/Sec 1): 1993 / IEC Pub 60947-4-1 (2004) require that the thermal overload relay and SCPD are co-ordinated to ensure that they operate satisfactorily under all load and fault conditions. Following aspects need to be considered to achieve proper co-ordination.

- Discrimination between thermal overload relay & SCPD.
- Adequacy of short circuit protection.

What is co-ordination?

Co-ordination means matching the characteristics of SCPD and down stream equipment to ensure that the let-through energy and peak cut-off current do not rise above the levels that the circuit can withstand.

Improper co-ordination can lead to

- High electro-dynamic force (magnetic force $\propto$ Ipeak ^{2}).
- High thermal stress leads to excessive heat (I^2t let-through).
- Nuisance tripping/operation of SCPD under small overloads, leading to reduced life of SCPD.
- Nuisance tripping of SCPD during motor starting.
- Nuisance tripping of SCPD during transient conditions like open transition star delta starter starting.

As per the standard two types of co-ordination are permissible, Type “1” and “2”.

Type “1” co-ordination requires that under short-circuit conditions, the contactor or the starter shall cause no danger to persons or installation. The motor feeder may not be suitable for further service without repair and replacement of parts (Not remaining suitable is NOT a requirement and hence you may find separating in a different sentence could avoid possibility of misconception)

Type “2” co-ordination requires that under short-circuit conditions, the contactor or the starter shall cause no danger to persons or installation and shall be suitable for further use. However contact welding is recognized. Also the time-current characteristics of the over load protection device should not change. This in other words means safety, low down time and continued protection.

Recommended combination needs to be proven through short-circuit tests at

- Prospective current “r”
- Conditional short-circuit current Iq.

Test at Prospective current “r” is done to verify the performance under fault conditions practically possible at the motor feeder end. These faults are normally associated with the motor and the associated feeder. Prospective current “r” is specified according to the rated operational current (Ie, AC-3) of the feeder. If the motor feeder is not specified according to utilization category AC-3, the prospective current “r” shall correspond to the highest rated operational current for any utilization category claimed by the manufacturer. The values are mentioned below.

The values are mentioned below.

Rated operational current Ie (AC-3)* A	Prospective current "r" kA
0 Ie <= 16	1
16 < Ie <= 63	3
63 < Ie <= 125	5
125 < Ie <= 315	10
315 < Ie <= 630	18
630 < Ie <= 1000	30
1000 < Ie <= 1600	42
1600 < Ie	Subjected to agreement between manufacturer and user.

Test at Conditional short-circuit current Iq is carried out to verify the performance under system level faults. Iq is declared by the manufacturer. This is the maximum fault current that the feeder can withstand. Generally the declared value of Iq is 50 kA.

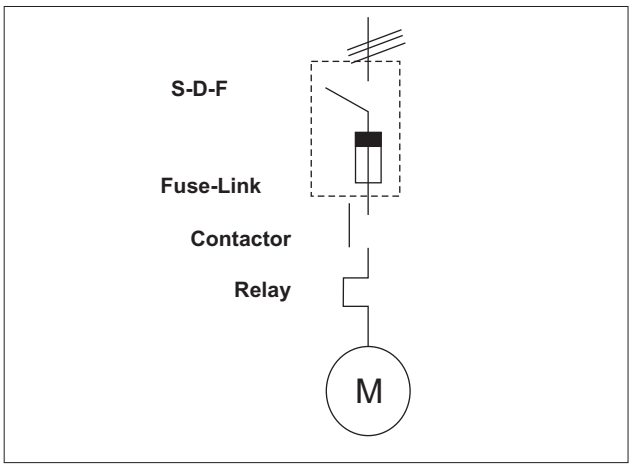
Trends in motor feeder protection

- Fuse protection with S-D-F
- Fuseless protection with MCCB and MPCB

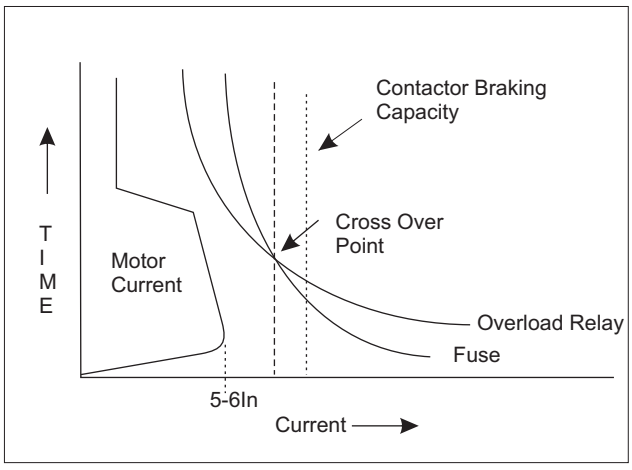
S-D-F, which incorporates H.R.C fuses, is the most efficient and popular in the industry. S-D-F, like conventional fuse-switch units, is capable of switching and protecting electrical circuits. In addition these are also suitable for isolating down stream equipment. MCCB was primarily used for protection of distribution circuits. However, with the development of current limiting MCCBs, it has become possible to employ MCCBs in motor feeders also. With the availability of various accessories, MCCB as SCPD offers several advantages.

MPCB can be used in two ways. It can be used directly for switching of a motor. This is very cost effective. However downside is limited electrical life of MPCB compared to that of a contactor. Moreover, a separate undervoltage protection is required. Alternately, MPCB can be used along with a contactor. Since, MPCB combines thermal as well as short circuit protection, it will trip and interrupt even small overloads (which otherwise could be interrupted by a contactor).

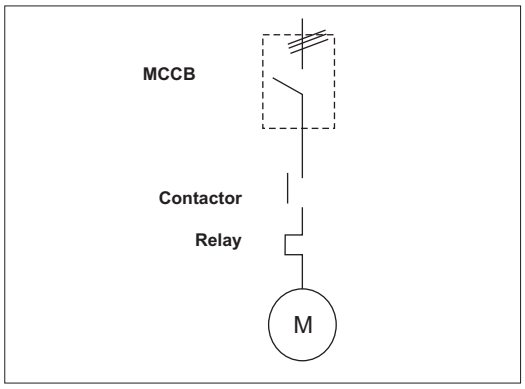
Typical DOL Motor Feeder with S-D-F



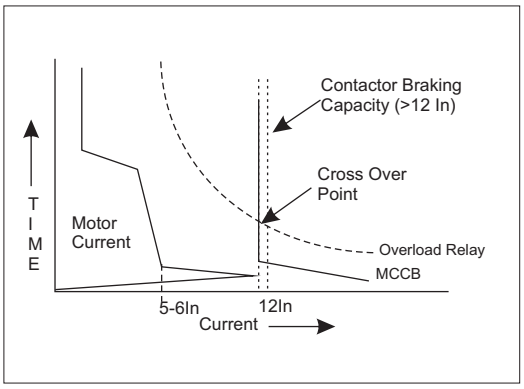
Co-Ordination with S-D-F



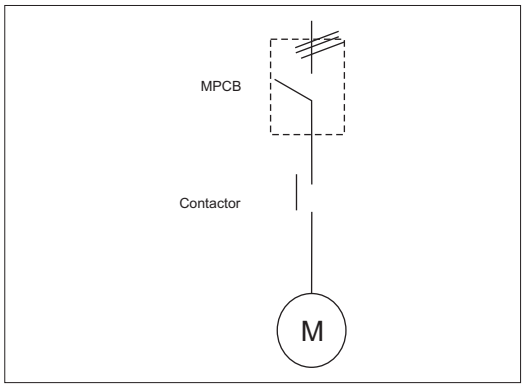
Typical DOL Motor Feeder with MCCB



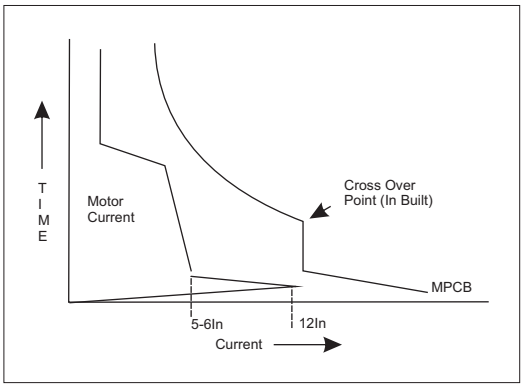
Co-ordination with MCCB



Typical DOL Motor Feeder with MPCB



Co-ordination with MPCB



Open and Close Transition Star-Delta Starting

For Star-Delta motor feeders, the motor winding is connected in star. When it reaches a certain speed the motor winding connection is changed to delta. In case of Open transition from star to delta, there is some time difference between opening of the star contactor and closing of the delta contactor. During this period there is no voltage across the motor terminal and the motor will momentarily act as a generator. When the delta contactor closes, full line voltage appears across the motor terminal. If the motor emf and the line voltage add up, the transient current peaks may reach up to 18In. Also the motor will experience a jerk, which in some cases may be critical.

In case of open transition star-delta starting (most common practice), it's an established fact that the transient current peaks during change-over from star to delta are in the order of 18 times the line current (In). As the maximum magnetic threshold of a MPCB is 14In and as it is a current peak sensing device, such conditions will definitely lead to nuisance tripping of MPCBs during change-over from star to delta mode. Both the above facts i.e. 18 times transient peak and nuisance tripping of MPCB have been verified through inhouse tests as well.

Hence, to avoid nuisance tripping, it is technically correct to increase the MPCB rating for star/delta starting so that the ratio of instantaneous release setting to the motor full load current is at least 18. However, this will lead to loss in thermal overload protection offered by the MPCB (as the MPCB rating will be higher than the full load current of the motor). This aspect can be addressed by providing an additional thermal overload relay in the phase circuit.

In case of close transition, the change over from star to delta will take place through three resistors. These resistors do not allow full line voltage to appear across the motor terminal and also there will be no break in the supply to the motor. Hence, there will be no jerk to the motor and transient current peaks will also get eliminated.

Summarising

Effective motor protection should protect motor and the associated feeder against any overcurrent including short circuit current. More and more users demand Type '2' coordination because it helps to ensure a safe working environment. In view of down times and maintenance costs, though Type '2' co-ordination has higher initial costs, in the long term will prove economical. Manufacturer having all the products in its product portfolio is better place to recommend the combinations for proper Type '2' co-ordination.

Standard Coil Voltage Ratings used in India

240V

Coils with rated voltage of 240V are the most widely used coils in Industrial and commercial applications. 240V single phase-neutral supply can be easily derived from a 415V Three Phase Four Wire system by connecting across one phase and neutral point (415/sqrt(3)=240). Since this distribution system is prevalent across many industrial applications, 240V coils find their application in majority of contactor applications. Common applications are industrial motor feeder systems. Also, in most of the industrial installations voltage values are quite stable and variations are limited. Hence in such systems with very less voltage fluctuations, it is viable to go for 240V coil with a standard coil band of 80% to 110% of rated coil voltage.

220V

220V coils are generally preferred in applications where the available supply is slightly less than the rated voltage of 240V. In such applications it is advisable to go for a 220V coil because one gets a lower value of pick up voltage as compared to 240V. For example for a 240V coil the coil band would be 156 – 288V. If one goes for a 220V coil then the available coil band is 143 – 264V. This takes care of the slight fluctuation in voltage which is below the band specified for 240V or a consistent low voltage.

415V

415V coils are used when there is a possibility of neutral floating condition affecting contactor operation. Neutral floating arises when the neutral is not properly grounded or ground connection is completely broken. Conventional distribution systems are three phase four wire systems in which individual single phase systems are derived from a three phase supply. In such cases the neutral is grounded and ideally must be at zero potential. In a perfectly balanced three phase four wire systems, loss of neutral conductor will not cause any abnormal voltage variation on connected single phase loads. However this condition is extremely rare and there is always some current flowing through the neutral owing to imbalances in the single phase loads. In such a scenario a loss of neutral will lead to abnormal voltage variations across the connected single phase loads. The extent of voltage variation will depend on the extent of unbalance in the single phase loads. However the imbalance in voltages will not affect the line voltages and they will continue to be at 415V.

In such a scenario if one used 240V coils then they may get damaged due to over voltage condition arising out of neutral floating. This problem can be efficiently eliminated by going for 415V coils as neutral floating condition does not affect the line voltages. Hence the issue of coil burning due to neutral floating is completely eliminated. Improper neutral grounding can lead to voltage rise and hence going for 415V coils is advisable.

Hence for all changeover application involving four Pole contactors (MCX Range) it is recommended to go for 415V coils. But, it should be noted that the allowable control cable length due to cable capacitance is lowest at 415V. (Refer application note: Guidelines on control cable lengths dated 12/07/2012)

360 or 380V

These coil voltages are mainly used in agricultural applications. In agriculture applications even though the rated secondary of transformer is 415V, because of simultaneous running of loads leading to sustained voltage drop and absence of voltage stablilizers, many of the users get voltages in the range of 360-380V. Since this voltage levels are much lower than 415V special coils of 360 or 380 volts have to be designed specifically for agricultural applications. These coils are restricted to applications where it is known that reduced voltage is available. These coils don't find their applications in industrial applications where voltage supply is as per rated and stable. The choice of 360V and 380V coils can be based on how low the supply voltage can dip to in that particular installation. It is also to be noted that in such installation Phase to neutral voltage connection is not preferred for coil voltages, due to the possible problem of neutral floating.

440V

These coil voltages are mainly used in Industrial applications, and there are chances of failure of coils due to sustained high voltages These coils are restricted to applications where it is known that higher voltage is available. These coils don't find their applications in industrial applications where voltage supply is rated and stable.

110V

110V coils are generally used in applications where one wants to prevent any unauthorized start of the contactor. For example in many applications, operating personnel tend to override the contactor drop command given by a Distributed control system (DCS). This is mainly done by using easily available 240V single phase supply to on the contactor. However if one uses 110V coils, it acts as an efficient deterrent against overriding DCS commands as 240V supply to an 110V coil will damage the coil beyond repair. This acts as an efficient safety feature in the system. It also efficiently isolates the coil supply from the main supply through a control transformer. 110V 60Hz supply is also used mainly in western countries as 110V is much safer to operating personnel as compared to 240V. Also it should be noted that the allowable control cable length due to cable capacitance is highest at 110V. (Refer application note: Guidelines on control cable lengths dated 12/07/2012)

24V DC

24V DC coils are mainly used in automation applications and in contactors which are used along with backup supplies. In many process industries having the entire control through PLC one finds applications of 24V DC coil contactors as 24V DC is predominantly required for PLC. Some of the contactors have low coil consumption coils and can be directly actuated by the PLC without the use of an interface relay. PLC output, generally being 24VDC, DC coil voltage is required. 24V DC Coils are also largely used in battery backed up systems and UPS applications. For example, in power plant a lot of critical equipment is kept on backup supply where actuation is done through a DC coil contactor, 24VDC being the most widely used.

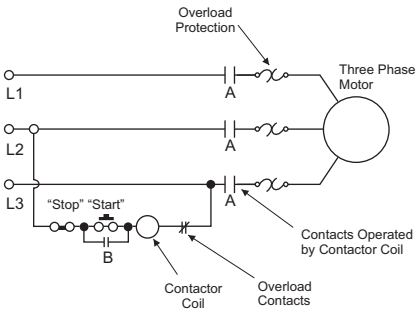
Coil Voltage	Application	Caution
240V AC	Most commonly used coil voltage	Limitation where pickup at low voltage is required
220V AC	Used where voltage fluctuation on lower side. Can pick up at lower voltage	Overvoltage withstand will be limited as band shifts to lower side
415V AC	Ideal for DG applications, there is a chance of neutral floating	Allowable control cable length reduces
360 or 380V AC	To be used in agricultural applications, where undervoltage is prevalent	Overvoltage withstand will be limited as band shifts to lower side
440V AC	Used where voltage fluctuation on higher side. Better withstand at sustained high voltage	Pick up at lower side gets limited as band shifts to higher side
110V AC	Provides separation between control voltage and common available single phase supply.	Separate control transformer is needed which makes it expensive
24V DC	Used in PLC applications or Automation systems, Eliminates need for interposing relay	Expensive due to high cost of DC Coils and limitations of NC contacts

Importance of using Surge Suppressor

Cause of voltage surges in the system

Surge Suppressors are mainly used to suppress the voltage spikes or surges that occur whenever any inductive load is de-energized.

A general schematic of a contactor and load is shown below. The contactor is operated by an electromagnetic coil which is energized to close the contacts and de-energized to open them.

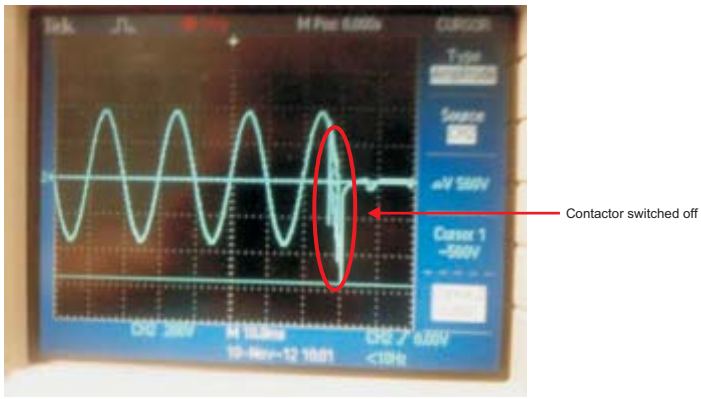


When the coil is de-energized its electromagnetic field collapses and being an inductive load it opposes this sudden change by producing an Electromotive Force (EMF) given by,

$$E = L \frac{di}{dt}$$

This is because the absolute change in current is very high and in a short duration of time. This coupled with high inductance of the coil produces a voltage spike in the system. This voltage spike is of the order 8 to 10 times of the rated coil voltage i.e. for a coil of rated voltage 240Vac the voltage surge can reach a value of around 2kV.

A typical surge characteristic is shown below,



Effects of voltage surges on the system

This voltage spike generated in the system has the potential to propagate to other components connected to the same supply system. If the surge is not suppressed on time it will damage any sensitive electronic components connected to the system

.

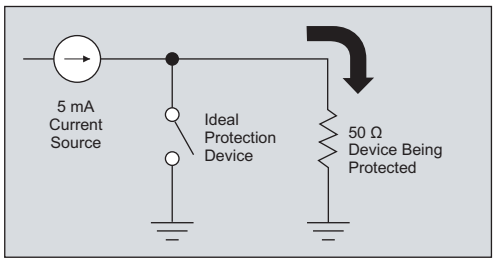
Also if any counters or logic circuits are present in the system then the voltage spike will cause them to change state momentarily, giving erroneous outputs. It may also damage the ICs beyond repair.

Hence it is very much imperative that the voltage spike is effectively dampened by absorbing the energy associated with it. This is where a surge suppressor comes into the picture.

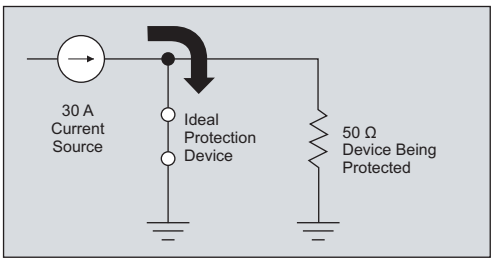
Mitigating Voltage Surges

As we have seen above it is very necessary to clamp down the voltage spike as it produces damaging effects for electronic components in the system.

A surge suppressor is a device which is connected in parallel with the coil. During normal operation the suppressor does not conduct as the supply voltage is much below its breakdown voltage. When a switching surge is generated the device starts conducting providing a parallel path to the excess current. This prevents the surge from propagating in the system and at the same time the spike is effectively suppressed. The device than automatically resets when the overvoltage goes away. This can be clearly understood by the schematic given below,



In the normal mode, the device being protected doesn't experience voltage or current surge events so the ideal protection device remains open.



If there is a voltage or current surge, the ideal protection device becomes a perfect short-circuit path to ground to protect the load.

Just as de-energization of contactor coil produces a voltage spike, external voltage surges in the system can also be damaging to the coil. In case of electronic coils like those in MNX 550-660 & MCX 45/46/47, external surges in the system may also damage the sensitive electronic components. In such cases a surge suppressor also protects the coil from external voltage surges

.

Now let us see the different types of surge suppressors

Types of Surge Suppressors

RC Surge Suppressor

RC surge suppressor is a resistor-capacitor in series combination which is in turn connected in parallel with the coil. The capacitor absorbs the energy associated with voltage spike and the resistor controls the charging of the capacitor. The values of resistor and capacitor are adjusted so as to provide efficient surge suppression.

MNX RC Surge Suppressor

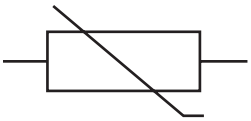
Advantages

- Can be used with AC as well as DC circuit.
- Low cost
- Simple construction

MNX surge suppressors used with MNX contactor coils are RC surge suppressors

Metal Oxide Varistor (MOV)

A Metal Oxide Varistor (MOV) as the name suggests it is a voltage dependent resistor. The result is that an MOV has a high resistance at low voltage and a low resistance at high voltage. The varistor is connected in parallel with the coil and only conducts when the voltage across it is beyond the clamping voltage. Thus when a surge occurs the varistor offers a low resistance path and efficiently discharges the surge. However the follow through current resulting due to a voltage strike gradually degrades the varistor and hence MOVs degrade from repeated exposure to surges.



MOV Symbol

Metal Oxide Varistors

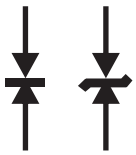
Advantages
- No resonance.
- Usage in AC and DC circuit
- Superior price to performance ratio
- Capacity to conduct large surges

MOV surge suppressors are in-built in Electronic coils of MNX 550/650 and MCX 45/46/47.

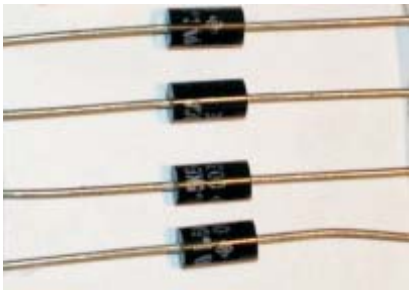
Transient voltage suppression diode (TVS)

The operating principle of a TVS diode is similar to that of a MOV. The device operates by providing a parallel path to the excess current when the voltage goes beyond its avalanche potential i.e. when a voltage surge occurs. At all other voltages below its clamping voltage the diode acts as an open circuit. TVS diodes are available in both unidirectional and bidirectional versions.

The response time of a TVS diode is much faster than a MOV and hence it provides an efficient suppression against fast and damaging voltage transients. Also unlike MOV a TVS diode is not degraded by surges within its rating. However TVS has a relatively lower energy absorbing capability as compared to a MOV. Hence TVS diodes are generally preferred for circuits with smaller current spikes.



TVS Bidirectional diode symbol



TVS Diodes

Advantages

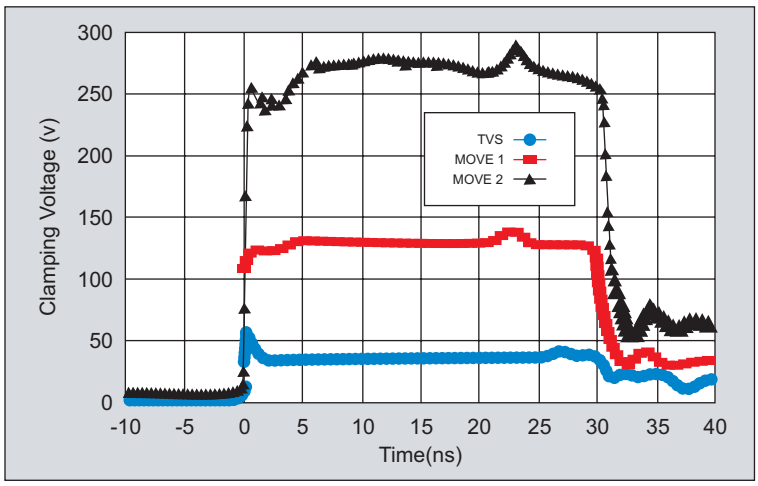
- Optical Muffling
- Faster response time
- No device degradation after prolonged use
- No change in breakdown potential

MX Mini (DC) contactors have in built diode surge suppressors.

MO contactors would soon be included with diode surge suppressors.

MDX DC contactors have diode surge suppressors. MDX 9-38 have inbuilt diode suppressor.

Following is the comparison between TVS diode and two MOVs of different specifications



TVS Diodes have a significantly lower clamping voltage than the MOVs

As mentioned above MOV gets degraded due to repeated exposure to surges. This degradation greatly impacts the leakage current, with varistor becoming more resistive after each over voltage while TVS diode shows no such degradation

Device degradation also causes a shift in the breakdown voltage VBR. MOVs show a reduction in VBR after each surge event while no such shift is observed in TVS diode.

Contactor selection for 60 Hz control supply applications

Contactor coils are designed for 50 Hz supply frequency as Indian power system typically operates at 50 Hz. However we do get requirement for 60Hz coils from the international market. In some situations where a dedicated 60 Hz coil is not available, the requirement can be sufficed by using a 50Hz coil at an appropriate voltage. The same is explained in detail below,

AC electromagnetic system in a contactor is a constant flux system. The electromagnetic force produced is directly proportional to the flux which in turn is a function of supply voltage, supply frequency and coil number of turns.

A contactor coil designed for 50 Hz or 60 Hz application, for the same supply voltage, must produce the same amount of force. Hence, to achieve this, the basic difference between a dedicated 50Hz and 60 Hz coil for same voltage is the number of turns. A 240V 60 Hz coil will have lower no of turns as compared to a 240V 50 Hz coil.

Since a 50 Hz coil will have different number of turns than a 60 Hz coil, in order to use the same 50 Hz coil for 60 Hz application, the parameter that must be maintained constant in order to produce the same force is V/f

Let us further understand this with the help of an example,

Consider a requirement of a 240V 60 Hz coil. This requirement can be catered by a standard coil of 50 Hz such that v/f ratio remains constant. Therefore,

$$\frac{V1}{f1} = \frac{V2}{f2}$$

$$\frac{V_{60hz}}{60} = \frac{V_{50Hz}}{50}$$

$$\frac{240}{60} = \frac{V_{50Hz}}{50}$$

Hence V_{50Hz} = (240 x 50)/60 = 200V
The nearest standard coil rating available is 220V 50 Hz. Applying the same principle of constant V/f ratio, the new voltage of 220V 50 Hz coil at 60 Hz is 264V

If coil operating band is considered to be 80% to 110% of rated coil voltage, the operating limits of the coil at 60 Hz will be considered at 264 V which turn out to be 211.2V to 290.4V

Hence a 220V 50 Hz coil can be used for a 240V 60 Hz application with a voltage band of 211.2 to 290.4V

The below table shows the new operating limits of the 50 Hz coil when used for 60 Hz applications

Range	Std 50 Hz coil (voltage)	Coil Pick up band at 60 Hz	
		Lower limit	Upper limit
MNX 9-32	110	86	158
	220	172	317
	240	187	346
MNX 40-650	110	106	145
	220	211	290
	240	230	317

Contactor selection for 60 Hz control supply applications

The following table gives the recommended 50 Hz coils to be used in 60 Hz applications for specified operating band,

Range	Requirement	Recommended	Coil Pick up Band
MNX 9-32	110V 60 Hz	110V 50 Hz	86 - 158V
	220V 60 Hz	220V 50 Hz	172 - 317V
	240V 60 Hz	220V 50 Hz	172 - 317V
MNX 40-650	240V 60 Hz	220V 50 Hz	211 - 290V

Hence when selecting a 50 Hz coil for 60 Hz application, one must ensure that the rated voltage is well within the operating limits at 60 Hz and the permissible variation on the lower side must be communicated to the customer.

Note: MO contactors are suitable for 50 / 60 Hz. refer date sheet for pickup band

		MO 9 - 45	**MO 50 - 300**
Pickup (50 Hz)	(%Uc)	65 - 110	75 - 110
	24V	16 - 27	18 - 27
	42V	27 - 46	32 - 46
	48V	31 - 52	36 - 52
	110V	72 - 121	83 - 121
	220V	143 - 242	165 - 242
	240V	156 - 264	180 - 264
	320V	20 - 352	240 - 352
	360V	234 - 396	270 - 396
	380V	247 - 418	285 - 418
	415V	270 - 456	312 - 456
	525V	341 - 577	394 - 577
		MO 9 - 300	
Pickup (60 Hz)	(%Uc)	85 - 110	
	24V	20 - 26	
	42V	36 - 46	
	48V	40 - 52	
	110V	94 - 121	
	220V	187 - 242	
	240V	204 - 264	
	320V	272 - 352	
	360V	306 - 396	
	380V	323 - 418	
	415V	353 - 465	
	525V	446 - 577	

Selection of Contactors for AC-4 (Crane Duty) Applications

Application Brief

Crane duty application is an example of AC-4 utilization category where the contactor is subjected to severe Inching operations. This is the case when the motors are used in DOL configuration without Variable frequency drives for speed and torque control. As such, Crane duty application is one of the most severe applications greatly straining the contactor.

In the earlier days Slip ring motors dominated crane duty applications. However nowadays we find both squirrel cage as well as slip ring induction motors being used for crane applications. With advent of Variable frequency drives providing efficient Speed and torque control, the application becomes less severe for the contactors. This is because all the switching needs are taken care by the VFD and the contactor can be selected as per AC-1 utilization category. However VFD is a costly proposition and in price driven markets like India, many still prefer to use contactors in conventional configuration for their crane duty applications.

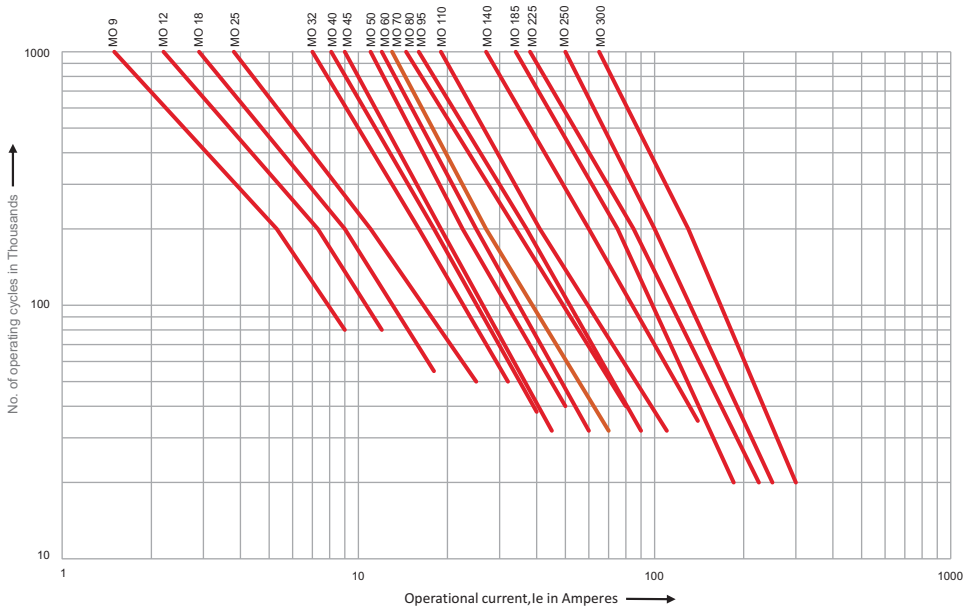
This application notes explains how one should go about selecting the contactors when VFD is not into the picture. In such a scenario the contactor is expected to undergo severe inching operations and hence life of the contactor becomes paramount selection criteria.

Selection of contactors based AC-4 Current Rating and Electrical Life Curves

As emphasized above, the life of the contactor is an important parameter and one must be clear about the life one expects from the contactors when used for crane duty applications. Most of the crane duty manufacturers would expect a certain fixed amount of life and this would then guide their contactor selection.

Power contactors usually have an AC-4 rating mentioned in the product catalogue. However the electrical life given in Life curves is also an important criterion which influences contactor selection.

For example,
Consider MO32 Power Contactor. The rated AC-4 current of MO32 is 32A.



The Electrical life of MO 32 at 32A AC-4 is 50000. When a 32A contactor is used for 32A AC-4 application, one gets an operation life of 50000 operating cycles. If the contactor does approximately 500 switching cycles per week then the contactor will last for a period of 50000/500 = 100 weeks i.e. roughly 2 Years.

Here the user must be aware of the approximate switching frequency that the contactors will be subjected too in a given day and then based on the life he desires he can back calculate to arrive at contactor rating.
For example,
User Specifications are given below,

Switching Operations per day: 300
Rated Motor current: 30A
Desired Contactor Life: 3 Years
Electrical Life = 300 x 365 x 3 = 328500 = 0.3 Million

Referring the electrical life curves, the contactor that gives a life of 0.35 million at 30A AC-4 current is MO **95. Hence for this requirement MO 95 is the correct contactor selection.**

If one directly selects the contactor as per rated current without considering the electrical life then the electrical life at 30 AAC-4 will be approximately 57000. Hence the contactor will last only for (57000/300) 190 days which is much lower than desired life.

Always consider the rated current and desired Electrical life and based on that arrive at the contactor rating through Electrical life curves.

Selection of contactors for 200000 Operating cycles at rated AC-4 current

Most of the times users are not aware of the exact operating cycles the contactor may be subjected too and hence they can refer a standard benchmark of 200000 operating cycles. This rating is given as a ready reckoner in catalogue and the user is assured of 200000 AC-4 operating cycles if the selection is as per this rating.

Below is the selection table of contactors for 200000 operating cycles

Contactor	Rated current (A) for 200000 operating cycles at AC-4 415V 50Hz
MO 9	4.5
MO 12	6.5
MO 18	8
MO 25	12
MO 32	16
MO 40	18
MO 45	19
MO 50	23
MO 60	25
MO 70	28

Contactor	Rated current (A) for 200000 operating cycles at AC-4 415V 50Hz
MO 80	35
MO 95	37
MO 110	42
MNX 140	66
MNX 185	90
MNX 225	100
MNX 400	150
MNX 550	150

For example, if one wants 200000 operating cycles for the rated current of 9A AC-4 then contactor selected should be MO 25.

This method of contactor selection is much simpler and must be employed when one expects a fixed electrical life of 200000 operating cycles which is more than sufficient for crane duty applications. If one desires a higher life than 200000 then one can derate the contactors by selecting one or two ratings higher or lower if lower life is acceptable and then verify the selection through Electrical life curves.

Selection of Contactors for AC-4 (Crane Duty) Applications

Annexure:
Selection Chart for Slip Ring Induction Motors for Crane Duty Applications

	Stator duty - 415V 50Hz (10 min cycle duration)			Rotor duty: Delta Connected (10 Min Cycle duration)			Max rotor voltage		
Duty Factor	**20%**	**40%**	**60%**	**20%**	**40%**	**60%**	**Starting**	**Plugging**	**Speed Control**
MO 9	12A	10.5A	9.5A	40A	35A	30A	1100V	415V	550V
MO12	17A	15A	13A	51A	42A	39A	1100V	415V	550V
MO 18	23A	19.5A	17.5A	63A	54A	47A	1100V	415V	550V
MO 25	32A	27A	23A	93A	80A	70A	1100V	415V	550V
MO 32	45A	39A	34A	102A	87A	76A	1100V	415V	550V
MO 40	50A	42A	37A	115A	95A	86A	1100V	415V	550V
MO 45	50A	42A	37A	115A	95A	86A	1100V	415V	550V
MO 50	63A	54A	48A	140A	120A	110A	1100V	415V	550V
MO 60	85A	73A	65A	180A	155A	140A	1100V	415V	550V
MO 70	110A	95A	85A	215A	185A	163A	1100V	415V	550V
MO 80	110A	95A	85A	215A	185A	163A	1100V	415V	550V
MO 95	165A	135A	120A	260A	230A	200A	2200V	415V	690V
MO 110	185A	150A	135A	300A	260A	230A	2200V	415V	690V
MO 140	210A	210A	175A	315A	315A	262A	2000V	415V	600V
MO 185	288A	288A	228A	416A	416A	343A	2000V	415V	600V
MO 225	331A	331A	281A	505A	505A	417A	2000V	415V	600V
MO 250	332A	332A	282A	506A	506A	423A	2000V	415V	600V
MO 300	407A	407A	340A	610A	610A	510A	2000V	415V	600V

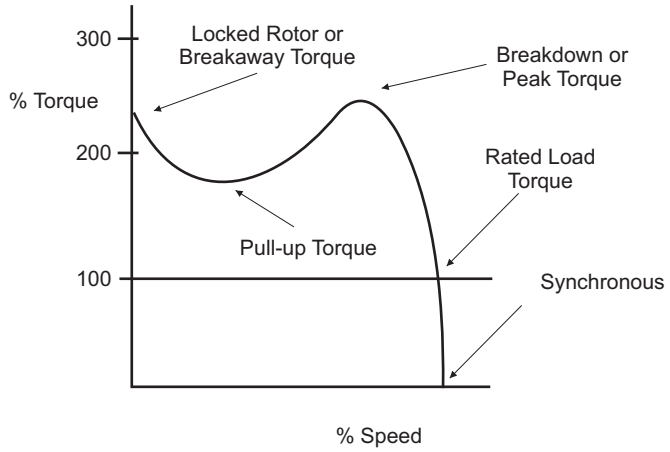
This note explains contactor selection for motors with long starting time. The note has been divided into three parts for easy understanding of the concepts involved. They are as follows,

1. Understanding Motor Inrush Current
2. Long Starting Time Applications
3. Contactor selection for motors with long starting time

Understanding Motor Inrush Current (Stator current)

A motor generally drives a load through some transmission system. During start, the motor draws a high starting current or inrush current.

This current is about 6-8 times the motor rated current and can cause a significant voltage drop. This voltage fluctuation affects other devices connected to the same supply. Hence several other strategies are employed for starting motors to reduce its starting current; the most commonly employed being the Star–Delta starting.
The starting value of the current is independent of the load attached; however it must be sufficient to overcome the inertia of the motor load system. However, inertia of the load impacts the starting time of the motor as explained in the next part. As the motor accelerates and nears its rated speed, the current gradually reduces and settles down to a value equal to motor rated current or less depending on the actual load connected. The typical torque-speed characteristics of an induction motor are as given below,



Speed/torque curve for a NEMA design B motor

Long Starting Time Applications

The total time from rest till the motor draws its rated current is called the starting time. The starting time of the motor is a function of the load inertia, load speed and the starting torque developed by the motor. A high inertia load requires an extended time to reach full speed and hence the motor also draws high starting current for a long time. The motor starting time is specified by the manufacturer in the motor data sheet. Since motor starting time is also a function of applied voltage it differs for different starting methods. For example starting time of the motor with Direct-Online starting would be different than with Star-Delta starting.

The starting line current in Star Delta configuration is one third of the starting current of the same motor in DOL configuration. However applied voltage and therefore starting torque also reduces, leading to higher starting time.

Contactor Selection for Motors with long starting time

The applications are generally those in which the motor starting time is around 40 to120 secs.

Typical applications involving motors with a high starting time are,

- Induced Draft Fans (ID Fans)
- Forced Draft Fans (FD Fans)

ID and FD fans have a high inertia and hence motors required to drive them will have a long starting time. As a result the motor will draw high inrush current for an extended period of time.

The high inrush current drawn by the motor at start is carried by the contactors that are used for switching. Since, this current flows for an extended period of time, the contactor needs to be selected judiciously. Guidelines for selection of contactor rating is as follows

Contactor Selection for motors with long starting time

Contactors are selected based on their overload current withstand capability. Overload withstand capability is defined in IEC 60947-4-1 as given below,

Rated Operational Current Ie(AC3)	Test Current	Duration of Test
≤ 630 A	8 x Ie max/AC-3	10 sec
> 630 A	6 x Ie max/AC-3*	10 sec

It means that a contactor with rated operational current equal to or less than 630A can withstand 8 times its rated Ac3 operational current for a period of 10 seconds. This rating is also called as the 10 sec rating of the contactors.

For Example:
Let Rated operational current (AC3 Utilization category) of contactor = 400A.
Then the maximum current it can carry for a period of 10 sec = 8 x I_e = 3200A

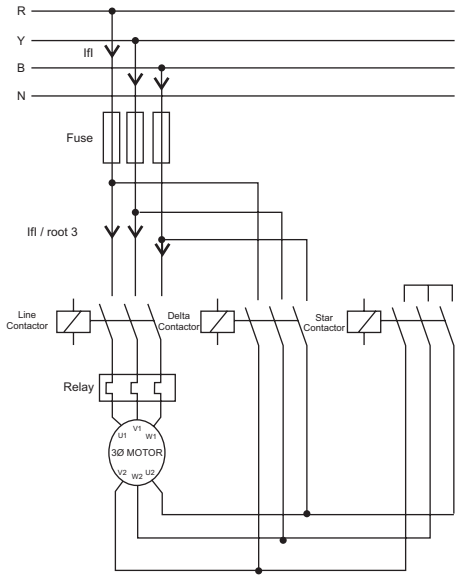
Now let us look at an example, how to arrive at minimum AC3 Ratings of the Star, Main and Delta contactors

Motor specifications
Motor kW Rating: 160 kW
Motor Full Load Line Current: 304A
Motor Starting time in Star-Delta: 85 sec

Solution:
Delta contactor can be directly selected as per type 2 chart specified by the contactor manufacturer. This is because delta contactor is connected only when the motor has reached near its rated speed and motor current has reduced to its full load value

For selection of Star contactor and Main contactor, the withstand current must be taken into consideration

A general schematic of Star-Delta starter is shown below,



Starting current in a normal delta motor with DOL starting is around 6 - 8 times the motor full load current. However in Star-Delta starter motor starting current in star is reduced to 1/3 of this value. Typically starting current when using Star-Delta starting method is around 2.2 times motor full load current.

Starting current (I_s) = 2.2 x motor full load current = 2.2 x 304 = 669A
Starting time (T_s) = 85 sec
Therefore, $(I_s)^2 \times (T_s)$ = 669 x 669 x 85…… (A)

Now, Value (A) must be less than the contactor withstand capacity. i.e.

Based on IEC 60947-4-1,
Contactor Withstand Capacity = $(8\ I_e\ (AC3)^2 \times 10$…… (B)

It is required that, B > A

$$Ie\ (AC3) > \left(\sqrt{\frac{A}{10}} \div 8\right)$$

Solving the above equation: **Ie(AC3) ⩾243.8**

The contactor must be selected such that its rated AC-3 current Ie satisfies the above condition.
Therefore in this case MNX 265 can be selected for Star & Main Contactor.

The rating thus arrived at should be compared with the rating of the contactor as given in Type2 Chart, and the higher rating of the two shall be selected

For e.g. In this case, the start and Main contactor rating as given in fused Type 2 chart for 160 kW motor is MNX 140 for Star and Main is MNX 185. Comparing this with the rating arrived at earlier, which is MNX 265, the correct selection will be to use MNX 265

In case of a 160 kW motor with normal starting time (<10 sec) the selection of contactors according to type 2 charts is:

Star Contactor: MNX 140
Main and Delta Contactor: MNX 185

However for the same 160 kW motor with long starting time (85 sec in this case) the contactor selection is:

Star Contactor: MNX 265
Main Contactor: MNX 265
Delta Contactor: MNX 185

Contactor Selection for Motors with long starting time

Introduction

A contactor is an electromagnetic device consisting of a coil and magnet system along with fixed and moving contacts. When the coil is energized, it produces a magnetic field thereby attracting the moving magnet. This causes the fixed and moving contacts to connect and the contactor is said to be actuated. The energization of contactor coil is usually done through a control transformer.

This is mainly done because voltage requirements vary with control systems and with an intermediary control transformer the desired voltage can be obtained.

When a contactor coil is energized, it draws in a high inrush current momentarily. Apart from contactor coils, relays and solenoids are some other devices which draw inrush current when energized. The control transformer selected must be able to accommodate this momentary high inrush current for a satisfactory operation.

Selection of a control transformer

For a proper selection of control transformer, three parameters of the load circuit must be determined in addition to the minimum voltage required to operate the circuit. These are Hold on VA, Pick-Up VA, and Inrush load power factor.

Hold-On VA: Hold-On VA is the product of load voltage (V) multiplied by the current that is required to operate the circuit after initial start up or under normal operating conditions. It is calculated by adding the hold-on VA requirements of all the electrical devices of the circuit that will be energized at any given time. Hold-On VA is also sometimes referred as steady state VA.

Pick-Up VA: Pick-Up VA is the product of load voltage (V) multiplied by the current (A) that is required during start up. It is calculated by adding the pick-up VA requirements of all devices (contactors, timers, relays, solenoids, etc) which will be energized together. Energization of electromagnetic devices takes 20-50 milliseconds. During this inrush period, the electromagnetic devices draw 3 to 10 times the normal current.

Inrush Load power factor: Inrush load power factor is difficult to determine without a detailed vector analysis of all the load components. Generally such analysis is not feasible; hence a safe assumption would be 40% power factor. Until recently 20% power factor was commonly used for transformer calculations; however tests conducted on major brands of control devices indicate that 40% power factor is a same assumption.

It is recommended that a control transformer be sized at 40% power factor. Some electromagnetic devices typically operate at that level due to their inherently low power factor. Selecting a control transformer at 40% power factor will be more than the adequate size for all the various loads in the circuit.

Besides the above parameters there are two parameters of primary and secondary voltage. Primary voltage is the voltage available from electrical distribution system which is connected to the transformer supply terminals. Secondary voltage is the voltage required for load operation which is connected to the transformer load voltage terminals.

Steps for selection of control transformer

1) Determine the supply and load voltages as per requirement. The supply voltage is the voltage available to control transformer and load voltage is the operating voltage of all the devices connected to the transformer output.
2) Determine the hold-on and pick-up VA of each coil in the control circuit. This data is provided by the product manufacturer in the datasheet.
3) Calculate the hold-on VA by adding the VA requirements of all the equipment that will be energized together (timers, contactors, relays, solenoids, pilot lamps etc).
4) Calculate the Pick-Up VA of all the coils that will be energized together. Be sure to include the hold-on VA of components that don't have inrush (lamps, timers) as they present load to the transformer during maximum inrush.
5) Calculate the application Inrush VA by using the following industry accepted formula.
6) Based on the value of application Inrush VA obtained, use regulation chart for selecting the control transformer rating.

$$\text{Application Inrush VA} = \sqrt{(\text{Pick Up VA})^2 + (\text{Hold On VA})^2}$$

Using regulation chart to select the transformer rating

Continuous VA Transformer Name plate rating (A)	Inrush V A @ 40% Power Factor		
	85% Secondary Voltage	90% Secondary Voltage (B)	95% Secondary Voltage
25	160	130	95
50	270	210	160
75	435	365	255
100	635	520	370
150	1300	1010	700
200	1975	1500	1020
250	2680	2030	1340
350	3665	2820	1895
500	6300	5035	3305
750	10555	7920	5050
1000	15225	11160	6000

The above regulation chart gives the continuous rating of the control transformer and the corresponding inrush VA at different secondary voltage levels. This secondary voltage value depends on internal losses in the transformer.

After calculating the application inrush VA as discussed above, determine the secondary voltage level of the transformer. Column B indicates that during inrush, 90% of the rated voltage would be available at the transformer secondary, which is an acceptable drop in rated voltage. Once this is determined, read down the column until you arrive at a value which is more than the application inrush VA calculated. Corresponding to this value, the value in column A would be the nameplate rating of the control transformer.

As a final check, make sure that the transformer VA rating is equal to or greater than the total circuit Hold-On requirements.

Control Transformer sizing for contactor actuation

Let us further understand this with the help of an example,

Consider MNX 110 contactor,

Pick Up VA = 550 VA
Hold On VA = 36 VA
Application Inrush = $\sqrt{(550^2 + 36^2)}$ = 552 VA

Now from the above table we consider the secondary voltage delivered by the transformer as 90% of the nameplate secondary voltage under maximum inrush conditions at rated input voltage.

In column B, under 90% secondary voltage, we have to select a value more than 552 VA. The nearest value greater than 552 VA is 1010 VA. Corresponding to the value the control transformer nameplate rating is 150 VA in column A.

Hence rating of the control transformer for energizing MNX 110 is 150 VA

Let us now consider MO 110 contactor,

Pick-up VA = 240 VA
Hold-on VA = 25 VA
Application Inrush = $\sqrt{(240^2 + 25^2)}$ = 241.3 VA

Now from the above table we consider the secondary voltage delivered by the transformer as 90% of the nameplate secondary voltage under maximum inrush conditions at rated input voltage.

In column B, under 90% secondary voltage, we have to select a value more than 242 VA. The nearest value greater than 242 VA is 365 VA. Corresponding to this value the control transformer nameplate rating is 75 VA in column A.

Hence rating of the control transformer for energizing MO 110 is 75 VA

Summarizing for an 110A AC3 contactor the comparison is as below,

Contactor	MNX 110	MO 110
Pick-Up VA	550	240
Hold-On VA	36	25
Application Inrush	550	241.2
Size of Control Transformer	150 VA	75 VA

It can be seen that with MO contactors, there is a significant reduction in control transformer size. This will in turn result in cost savings for the user.

The above method assumes that all contactors are picked up at the same time.

There is also an alternative, more accurate way for sizing the control transformer. This method is more application specific and depends on the exact number of components that are actuated at a given point of time.

Let us consider a general example of a system having five Star-Delta motor feeders each of 50 HP motors. A typical Star-Delta feeder would consist of a Star contactor, Main contractor and a delta contactor. It would also have two auxiliary contactors, one for start interlocking and one for emergency stop.

We will now compute the pick-up VA requirements at different instants of time and would select the control transformer corresponding to the highest Pick-up VA requirement at any given time instant.

Case 1: Considering MNX contactors

For a 120 HP Star delta feeder as per Fuse based type 2 charts, selection would be,
Star Contactor: MNX 80
Main/Delta Contactor: MNX 95
Auxiliary contactor: MX0 (One for start interlocking and one for emergency stop)

Since there are 5 feeders total contactors are,
MNX 80: 5 Nos
MNX 95: 10 Nos
MX0: 10 Nos (2 in each feeder)

The Pick-up and Hold-on VA of individual contactors is as given below,

Contactor	Pick-Up VA	Hold-On VA
MNX 80	190	21
MNX 95	550	36
MX0	26	4.5

At t = 0 (At Panel Power On)
The emergency contactors in all five feeders will pick up.
Total Pick-up VA = 26 x 5 VA
= 130 VA

At t = 1 (When Start command is given)
The star contactor, main contactor and start interlocking auxiliary contactor will pick-up
Total Pick-up VA = (190 x 5) + (550 x 5) + (26 x 5)
= 3830 VA

At t = 2 (At Star to Delta Changeover)
The Star contactor will drop off and the main contactor will pick-up
Total Pick-up VA = 550 x 5
= 2750 VA

At t = 0 except star contactor all contactors will be picked up. Hence Hold on VA would be maximum at t=2 Total Hold-on VA = (36 x 10) + (4.5 x 10)
= 405 VA

Maximum Pick-up VA requirement = 3830 VA
Maximum Hold-on VA requirement = 405 VA

Assuming secondary voltage to be 90% of the rated value,

The control transformer rating to be selected is 500 VA

Had we assumed that all the contactors pick-up at the same time the control transformer selection would have been computed as below,

Pick-Up VA = 190 x 5 + 550 x 10 + 26 x 10
= 6710 VA

Hold-On VA = 21 x 5 + 36 x 10 + 4.5 x 10
= 510 VA

Hence the control transformer rating would be 750 VA, which is much more than the earlier calculated rating. So the earlier method which takes into account the application gives a more accurate control transformer sizing

Case 2: Considering MO contactors

For a 120 HP Star delta feeder as per type 2 charts, selection would be,
Star Contactor: MO 80
Main/Delta Contactor: MO 95
Auxiliary contactor: MX0 (One for start interlocking and one for emergency stop)

Since there are 5 feeders total contactors are,
MO 80: 5 Nos
MO 95: 10 Nos
MX0: 10 Nos (2 in each feeder)

The pick up and Hold-on VA of individual contactors is as given below,

Contactor	Pick-up VA	Hold-on VA
MO 32	240	25
MO 40	240	25
MX0	26	4.5

At t = 0 (At Panel Power On)
The emergency contactors in all five feeders will pick up.
Total Pick-up VA = 26 x 5 VA
= 130 VA

At t = 1 (When Start command is given)
The star contactor, main contactor, and start interlocking auxiliary contactor will pick up
Total Pick-up VA = (240 x 5) + (240 x 5) + (26 x 5)
= 2530 VA

At t = 2 (At Star to Delta Changeover)
The Star contactor will drop off and the main contactor will pick up
Total Pick-up VA = 240 x 5
= 1200 VA

At t = 2 except star contactor all contactors will be picked up. Hence Hold on VA would be maximum at t=2
Total Hold-on VA = (25 x 10) + (4.5 x 10)
= 295 VA

Maximum Pick-up VA requirement = 2530 VA
Maximum Hold-on VA requirement = 295 VA

Assuming secondary voltage to be 90% of the rated value,

The control transformer rating to be selected is 350 VA

Had we assumed that all the contactors pick up at the same time the control transformer selection would have been computed as below,

Pick-Up VA = 240 x 5 + 26 x 10
= 3860 VA

Hold-On VA = 25 x 15 + 4.5 x 10
= 420 VA

Hence the control transformer rating would be 500 VA, which is much more than the earlier calculated rating. So the earlier method which takes into account the application gives a more accurate control transformer sizing

The control transformer rating to be selected is 150 VA

Had we assumed that all the contactors pick-up at the same time the control transformer selection would have been computed as below,

Pick-up VA = 77 x 15 + 26 x 10
= 1415 VA

Hold-on VA = 9 x 15 + 4.5 x 10
= 180 VA

Hence the control transformer rating would be 200 VA, which is much more than the earlier calculated rating. So the earlier method which takes into account the application gives a more accurate control transformer sizing

From the above computation it is clear that control transformer size with MO contactors is much lower than that obtained by using MNX contactors. This greatly reduces the cost of the control transformer providing direct benefit to the user. Thus MO turns out to be an economical solution over MNX with regards to control transformer sizing for the end user.

Annexure

Below is the table for control transformer ratings for MNX & MO range of contactors (single contactor) at 90% secondary voltage

MNX Power Contactors

MNX Frame Wise	Pick-up VA (Single Coil)	Hold-on VA (Single Coil)	Application Inrush VA (Single Coil)	Transformer VA rating (For single Coil)
MNX 9-22	68	11	69	25
MNX 25-40	68	11	69	25
MNX 50-80	190	21	191	50
MNX 95-140	550	36	551	150
MNX 185-225	960	56	962	150
MNX 300-400	2100	95	2102	350
MNX 550-650	1000	25	1000	150

MO Power Contactors

MO Frame Wise	Pick-up VA (Single Coil)	Hold-on VA (Single Coil)	Application Inrush VA (Single Coil)	Transformer VA rating (For single Coil)
MO 9-45	77	9	77.5	25
MO 50-70	144	15	144.8	50
MO 80-110	240	25	241.3	75
MO 140-225	1000	50	1001.25	150
MO 250-300	1400	65	1401.5	200

Background:

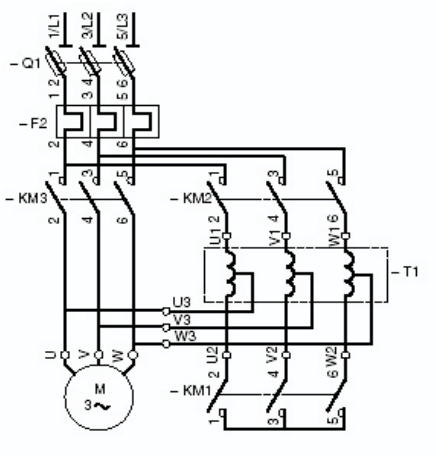
With the introduction of M-Line range of controlgear products and F-Line range of SDFs a need for a comprehensive selection chart for autotransformer motor feeder was felt necessary. Also, we have been receiving queries from various branches for an application guide on the same.

Brief Description:

An autotransformer starter reduces inrush current by using a transformer in the line just ahead of the motor to step down the voltage applied to the motor terminals. By reducing the voltage, the current drawn from the line is reduced during start-up.

Starting with reduced voltage decreases the full load current at the motor terminals in proportion to the voltage reduction while the full load torque is reduced by the square of the voltage reduction.

Recommended Wiring Diagram



Operation

In autotransformer starters, the motor is started at reduced voltage, which is supplied from an autotransformer. The starting sequence has three stages.

During the first stage, the autotransformer is star connected, and the line contactor is closed. This starts the motor with a reduced voltage, the value of which depends upon the ratio selected for the transformer. Autotransformers are normally provided with taps to allow the best ratio to be chosen during commissioning.

In the second stage, the star connection is opened, and the autotransformer acts as an inductor connected in series with the motor. This transition is normally timed to occur when the motor speed has stabilized at the end of the run-up period.

The third stage then follows almost immediately, and involves shunting the transformer completely, so that the motor is directly connected to the supply.

As shown in the wiring diagram

- Star connection of the autotransformer is made by KM1, then contactor KM2 closes and the motor starts under reduced voltage.
- The neutral point is opened by KM1; part of the autotransformer winding is switched into each phase for a short moment, constituting a stator starting inductance.
- KM3 switches the motor to full mains voltage and causes the autotransformer to be shunted out of circuit by Km2.

Contactor Switching Sequence

Contactor	Start	Transition (initial)	Transition (final)	ON
Km1(Star)	Close	Open	Open	Open
KM2(Step)	Close	Close	Close	Open
KM3(Main)	Open	Open	Open	Close

When the motor is directly switched to lines, the motor current is generally 6 times the full load current.

- $I_{start} = 6I_n = V/Z\ (3)^{1/3}$

I_{start} = Starting motor current
I_n = Full load current
V = Line voltage

In case of autotransformer if a tapping of transformation ratio K is used, then V_{ph} across motor is $KV/(3)^{1/3}$

Motor Current during start; $I = KV/Z\ (3)^{1/3}$
$= KI_{start}$
$= K*6I_n$

The current taken by the autotransformer is KI_2.
$= K^2*6I_n$
$= K^2 I_{start}$

Hence, though the motor current is reduced by only K times the direct switching current, the current taken by the line is reduced by K^2 times.

Similarly for starting torque,

- $T_1 \propto (V/3^{1/3})^2$

T1 = torque during direct starting.

With an autotransformer,

- $T_2 \propto (kV/3^{1/3})^2$

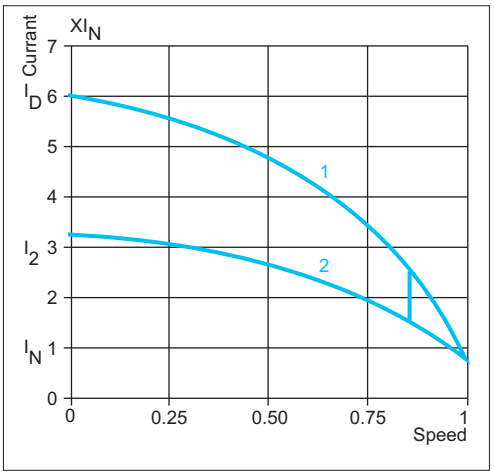
T1 = torque with autotransformer starting.

Hence, $T2 / T1 = K^2$

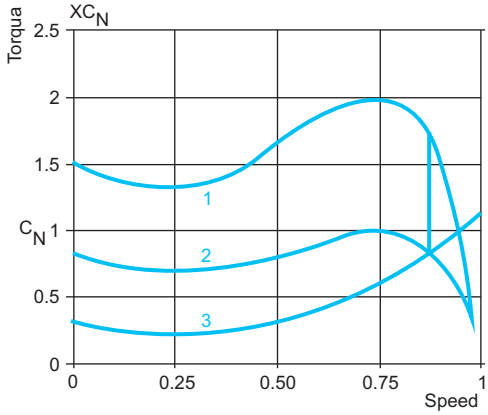
Starting torque with autotransformer = K^2 * Starting torque with direct on-line starting.

Thus it provides maximum starting torque with minimal line current. Due to transformer action, the line current will be 25 %, 42 % or 64 % of full voltage values for the 50 %, 65 % or 80 % taps respectively.

Operating Curves



1. Direct Switching Current
2. Current with Autotransformer



1. Direct Motor Torque
2. Torque with Autotransformer
3. Load Torque

The autotransformer motor starter selection chart is based on the closed transition which never disconnects the motor from the power source, and transient phenomena are eliminated. This is also known as **'Korndorfer'** method.

The transition from reduced voltage to full voltage on motor starters can be based on current or time. The over current relay monitors the motor current. When the motor current drops below the preset value, the relay signals the motor starter to switch to full voltage. Or when the setting time on the timer has expired, the autotransformer is bypassed.

Typically autotransformer has three taps, which provide 50%, 65% and 80% of full line voltage. The autotransformer starter can be used for any squirrel-cage motor. Typically autotransformer has three taps, which provide 50%, 65% and 80% of full line voltage. The autotransformer starter can be used for any squirrel-cage motor.

Conclusion:

This chart provides aready reckoner for selection of components for an autotransformer motor feeder.

Mtor Ratg: 3Ø, 415, 50 Hz				Contactor				Relay				
HP	kW	In (A)	MaIn (KM3)	Step (KM2)			Star (KM1)	Type	Range (A)	Fuse	Rating (A)	SDF
				50%	65%	80%						
7.5	5.5	11.2	MO 12	MO9	MO9	MO9	MO9	RTO-1	8.5-12.5	HF	32	FN 32 / FNX 32
10	7.5	14.8	MO 18	MO9	MO9	MO12	MO9	RTO-1	12.5-18.5	HF	32	FN 32 / FNX 32
12.5	9.3	19	MO 25	MO9	MO9	MO18	MO9	RTO-1	17-25.5	HF	50	FN 63 / FNX 63
15	11	22	MO 25	MO9	MO12	MO18	MO12	RTO-1	17-25.5	HF	63	FN 63 / FNX 63
17.5	13	24	MO 32	MO9	MO12	MO18	MO12	RTO-1	17-25.5	HF	63	FN 63 / FNX 63
20	15	29	MO 32	MO9	MO18	MO25	MO18	RTO-1	25-37	HF	63	FN 63 / FNX 63
25	18.6	35	MO 40	MO9	MO18	MO25	MO18	RTO-1	25-37	HN, 000*	80	FN 100 / FNX 100 *
30	22.5	40	MO 45	MO12	MO18	MO32	MO18	RTO-1	35-45	HN, 000*	80	FN 100 / FNX 100 *
35	26	47	MO50	MO12	MO25	MO32	MO25	RTO-2	40-57	HN, 000*	100	FN 100 / FNX 100 *
40	30	55	MO 70	MO18	MO25	MO40	MO25	RTO-2	40-57	HN, 000*	100	FN 100 / FNX 100 *
45	33.5	60	MO 70	MO18	MO32	MO40	MO32	RTO-2	50-75	HN, 000*	100	FN 100 / FNX 100 *
50	37	66	MO 80	MO18	MO32	MO45	MO32	RTO-2	50-75	HN, 00	125	FN 125 / FNX 125
60	45	80	MO 95	MO25	MO40	MO70	MO40	RTO-3	75-110	HN, 00	125	FN 125 / FNX 125
75	55	100	MO 110	MO32	MO45	MO70	MO45	RTO-3	75-110	HN, 00#	160	FN 160 / FNX 160#
90	67.5	120	MO 140	MO32	MO70	MO80	MO70	RTO-4	105-156	HN, 0	200	FN 200 / FNX 200
100	75	135	MO 140	MO40	MO70	MO95	MO70	RTO-4	105-156	HN, 0	200	FN 200 / FNX 200
110	80	139	MO 185	MO40	MO70	MO95	MO70	RTO-4	138-201	HN, 0	200	FN 200 / FNX 200
125	90	165	MO 185	MO45	MO95	MO110	MO95	RTO-4	138-201	HN, 1	250	FN 250 / FNX 250
150	110	200	MO 225	MO70	MO95	MO140	MO95	RTO-4	138-201	HN, 1	250	FN 250 / FNX 250
175	130	230	MO 250	MO70	MO110	MO185	MO110	RTO-4	201-291	HN, 1	315	FN 315 / FNX 315
197	147	260	MO 300	MO70	MO140	MO185	MO140	RTO-4	201-291	HN, 2	400	FN 400 / FNX 400
200	150	275	MO 300	MO70	MO140	MO185	MO140	RTO-4	201-291	HN, 2	400	FN 400 / FNX 400
215	160	280	MO 300	MO80	MO140	MO185	MO140	RTO-4	201-291	HN, 2	400	FN 400 / FNX 400
225	168	300	MO 300	MO80	MO140	MO225	MO140	RTO-4	255-375	HN, 2	400	FN 400 / FNX 400
245	180	320	MNX 400	MO95	MO140	MO225	MO140	RTO-4	255-375	HN, 2	400	FN 400 / FNX 400
270	200	340	MNX 400	MO95	MO185	MO225	MO185	RTO-4	255-375	HN, 3	500	FN 630 / FNX 630
300	225	385	MNX 550	MO110	MO185	MO250	MO185	MN12	340-570	HN, 3	500	FN 630 / FNX 630
335	250	425	MNX 550	MO110	MO185	MO300	MO185	MN12	340-570	HN, 3	500	FN 630 / FNX 630
400	300	500	MNX 550	MO140	MO225	MO300	MO225	MN12	340-570	HN, 3	630	FN 630 / FNX 630
430	315	535	MNX 550	MO140	MO300	MNX400	MO250	MN12	340-570	HN, 3	630	FN 630 / FNX 630

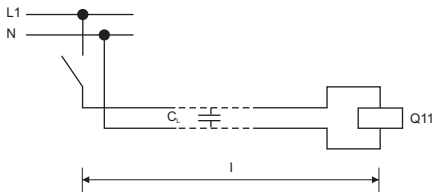
Length of control cables

Introduction

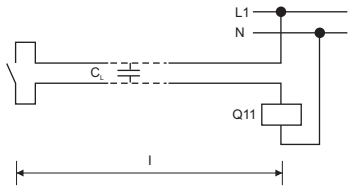
There is an inherent capacitance in cables. The cable capacitance indicates how much charge the cable can store within itself. If a voltage is being applied the insulation on the individual wires becomes charged by the voltage. This cable capacitance is defined in µF/km. With higher lengths of cable the ability to store charge also increases.

With advent of technology and focus on energy saving, contactors are also becoming energy efficient and compact. However there is one issue linked with low VA consumption of AC coil of contactors. When the control cable length is high, the cable capacitance is more and it may be sufficient to store energy for providing hold on VA to contactor coil. This may lead to delayed drop off of the contactor. This applies to contactors operating with AC control supply only.

The effect of cable capacitance depends on the design of the control circuit as shown below,



In this case, when the coil is de-energized the net cable capacitance is disconnected from the supply and discharges through the coil. Hence there may be a slight delay in contactor drop off due to CL



In this case, the net cable capacitance continues to remain connected to the supply even after the coil supply is switched off. This capacitance will feed the coil and if the energy stored in the capacitance is more than coil Hold-on VA, the coil will continue to remain energized and the contactor will fail to drop.

The problem of cable capacitances is mainly encountered in large scale installations such a crane systems in container terminals or where control is from field devices or automation system situated away from the control panels.

Maximum permissible control cable length for reliable contactor drop off can be defined as below:

$$L < 3.18 \left(\frac{m}{m+1}\right)\left(\frac{PH * 10^6}{C_C * U^2_C}\right) \text{ meter}$$

where,

- L - Length of control cable in meter
- m - ratio of minimum drop-off voltage to rated coil voltage
- P_H - Rated Hold-On power of the contactor in VA
- C_C - Cable capacitance per unit length in µF/km
- U_C - Rated control supply voltage in V

The following table gives a ready reckoner of maximum control cable length for MX contactor (AC) to ensure a clear drop off when control supply is cut off:

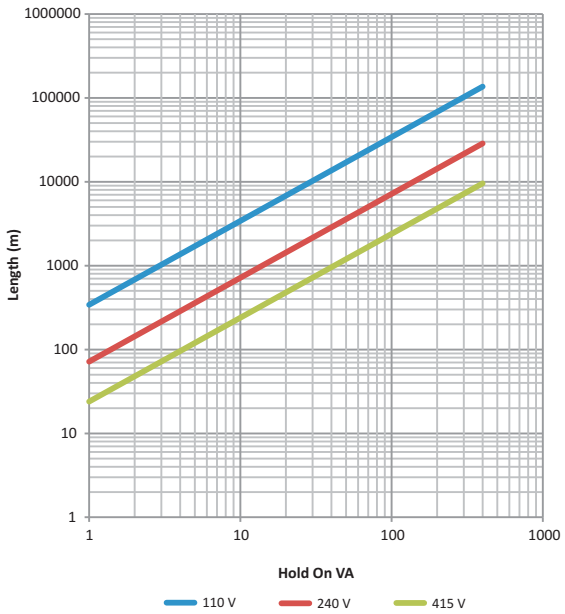
Family	Contactors	Hold-On Power PH (VA)	Min Drop-off Voltage/Rated voltage	L (m) <		
			U_d / U_c	110 V	240 V	415 V
MX mini	MX 0/6/9/12 AC	4.5	0.2	986.5	207.2	69.3
MNX	MNX 9 - 40	11	0.35	3751.0	788.0	263.5
	MNX 50 - 80	21	0.35	7161.0	1504.3	503.1
	MNX 95 - 140	36	0.35	12276.0	2578.8	862.5
	MNX 185 - 225	56	0.35	19096.1	4011.5	1341.6
	MNX 300 - 400	95	0.35	32395.1	6805.2	2276.0
	MNX 550 - 650	25	0.35	8525.0	1790.8	598.9
MO	MO 9 - 45	9	0.35	3069.0	644.7	215.6
	MO 50 - 70	15	0.35	5115.0	1074.5	359.4
	MO 80 - 110	25	0.35	8525.0	1790.8	598.9
	MO 140 - 225	50	0.35	17050.0	3581.7	1197.9
	MO 140 - 225 *	17	0.25	4472.0	939.4	314.2
	MO 250 - 300	65	0.35	22165.0	4656.2	1557.2
	MO 250 - 300 *	17	0.25	4472.0	939.4	314.2

* Electronic coil version

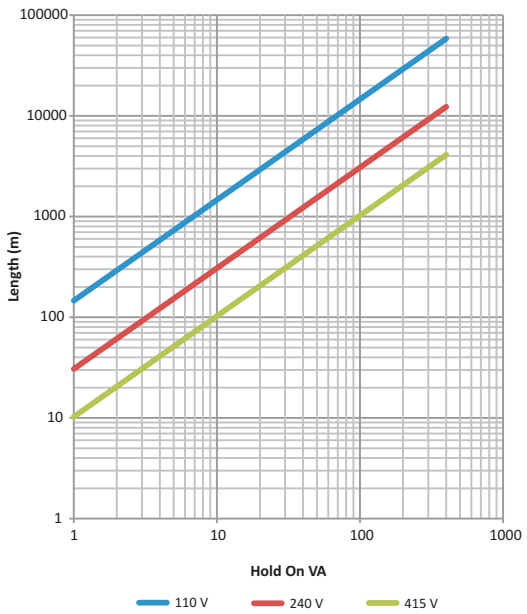
The following graphs give the trend of permissible control cable lengths with Hold-On VA at different voltage ranges. It must be noted that the trends are given at most common values of cable capacitances Cc.
Cc= 0.2 and Cc = 0.3 µf/km

Applicable for MNX / MO Contactors

Cc = 0.2 µf / km



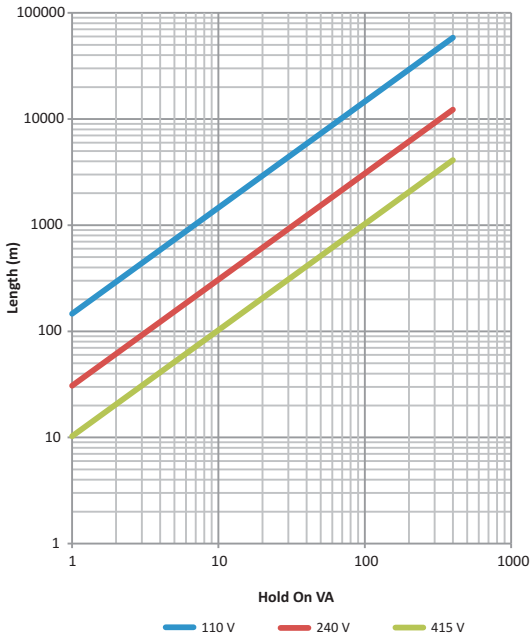
For Cc = 0.3 µf / km



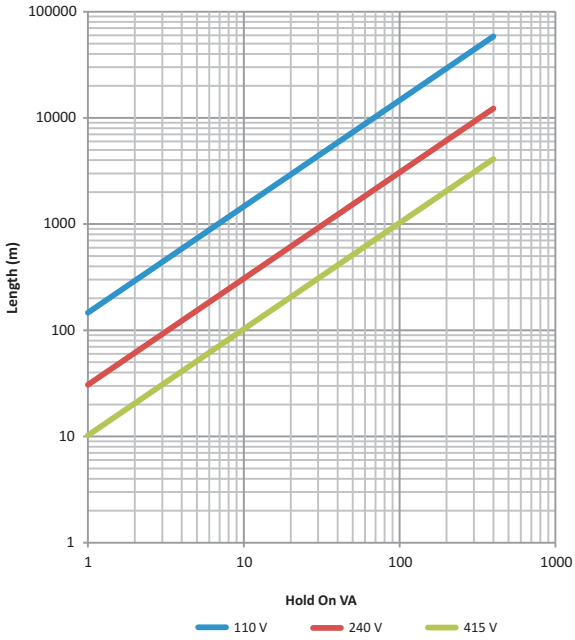
Length of control cables

Applicable for MX Mini & MX0 Control Contactors

For Cc = 0.2 µf / km



For Cc = 0.3 µf / km

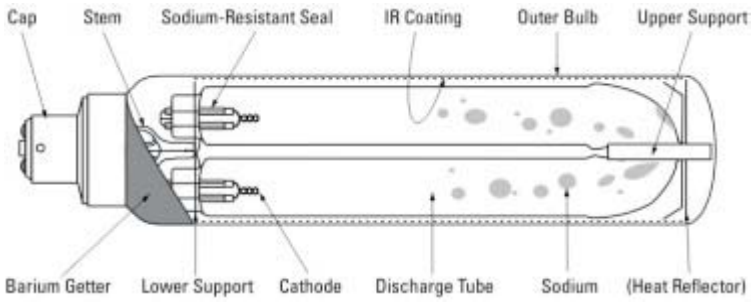


Today, street lighting commonly uses high intensity discharge lamps. The lamps generally used for street lighting and outdoor lighting are given below.

- Metal Halide lamps
- Sodium vapour lamps

Out of these, high pressure sodium vapour lamps are the most ubiquitous for street lighting because they are the most efficient light source. HPSV lamps are preferred because even though it has low colour rendering, it is not a major requirement in street lighting applications. The comparison is shown in the annex.

Brief description of HPSV lamp



Operation: -

- These lamps use an alloy of sodium and mercury (called sodium amalgam) in a discharge through xenon gas at high pressure inside the arc tube.
- There is an ignitor built into the ballast which sends a pulse of high voltage energy (3000V to 4500V) through the arc tube. This pulse starts an arc through the xenon gas.
- This ignitor operates within a second or two after switch on, and through the ballast induces aseries of very high voltage pulses to ignite the lamp. Once the lamp has started, the internal ignitor stops operating.
- Xenon gas is ionized and this facilitates striking of arc when voltage is applied across electrodes. The heat generated by the arc then vaporizes the mercury and sodium. The mercury vapor raises the gas pressure and the sodium vapour produces light when the pressure within the arc tube is sufficient.

Current profile

Inrush current during switch ON due to charging of circuit capacitors - With the capacitor introduced in the supply circuit for power factor compensation, it draws a charging current during switching ON. The value of inrush current during switch ON of lamps is generally between 20-60In for a period less than 5 ms.

Preheating current: - Before ignition in order to ionize the gas between the electrodes, the discharge lamp draws more current from the supply. This current (also known as starting current) generally ranges from 1.1 to 1.6 times the nominal current In for a period of 2-10 min.

For Lighting Circuit Switching

According to IEC 60947-4-1: AC-5a, 5b Utilization category

The operating conditions of lighting circuits have the following characteristics:

- Continuous duty: the switching device can remain closed for several days or even months
- A dispersion factor of 1: all luminaries in the same group are switched ON or OFF simultaneously
- A relatively high temperature around the device due to the enclosure, the presence of fuses, or an unventilated control panel location

Contactor Selection

Based on:

- A 220/240V single-phase circuit
- An ambient temperature of 55°C, taking into account the operating conditions
- An electrical life of more than 10 years

Considerations:

- The total current
- Transient phenomena which occur at switch-on
- The starting current and their duration
- The circulation of any harmonics which may be present

A) Selection chart for HPSV lamps 240V, 50 Hz with power factor compensation Utilization category AC-5a

HPSV Chart with Compensation

Lamp characteristics	**Rating (W)**		50	70	100	150	250	400	700	1000
	Total power (Including ballast power)		62.5	87.5	125	187.5	312.5	500	875	1250
Starting (preheating) current (A)			0.40	0.55	0.79	1.19	1.98	3.17	5.55	7.93
Running current (A)			0.28	0.40	0.57	0.85	1.42	2.26	3.96	5.66
Capacitance value required for compensation (µF)			6.8	10	15	22	33	68	100	150
Max no. of lamps per phase	**MO 9 (qty)**	9	32	23	16	11	6	4	2	2
	MO 12 (qty)	12	42	30	21	14	8	5	3	2
	MO 18 (qty)	18	63	45	32	21	13	8	5	3
	MO 25 (qty)	25	88	63	44	29	18	11	6	4
	MO 32 (qty)	32	113	81	56	38	23	14	8	6
	MO 40(qty)	40	141	101	71	47	28	18	10	7
	MO 45 (qty)	45	159	113	79	53	32	20	11	8
	MO 50 (qty)	50	176	126	88	59	35	22	13	9
	MO 60 (qty)	60	212	151	106	71	42	26	15	11
	MO 70 (qty)	70	247	176	123	82	49	31	18	12
	MO 80 (qty)	80	282	202	141	94	56	35	20	14
	MO 95 (qty)	95	335	239	168	112	67	42	24	17
	MO 110 (qty)	110	388	277	194	129	78	48	28	19
	MO 140 (qty)	140	494	353	247	165	99	62	35	25
	MO 185 (qty)	185	652	466	326	217	130	82	47	33
	MO 225 (qty)	225	794	567	397	265	159	99	57	40
	MO 250 (qty)	250	882	630	441	294	176	110	63	44
	MO 300 (qty)	300	1058	756	529	353	212	132	76	53

B) Selection chart for HPSV lamps 240V, 50 Hz without power factor compensation
Utilization category AC-5a

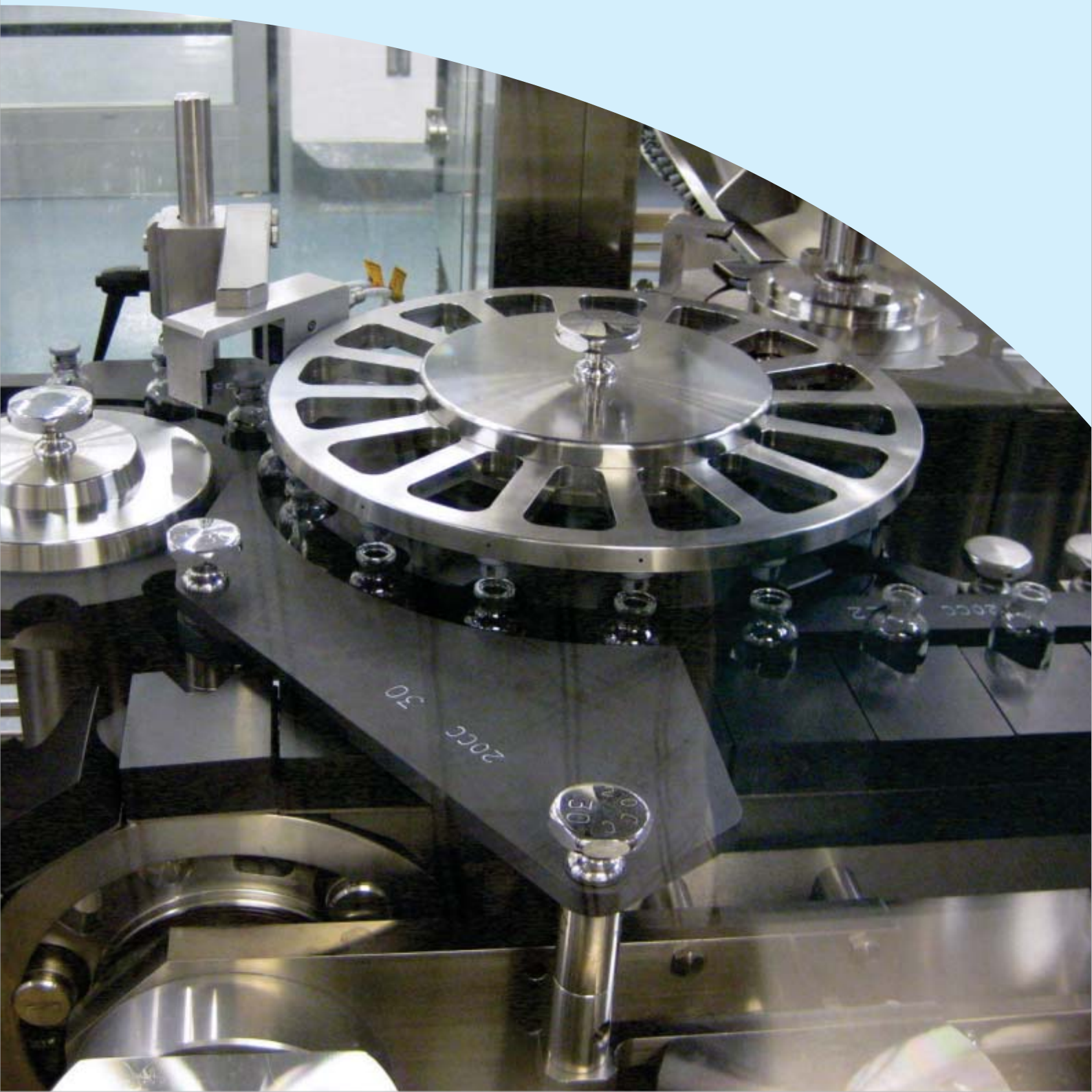
HPSV Chart without Compensation

Lamp characteristics	**Rating (W)**		50	70	100	150	250	400	700	1000
	Total power (Including ballast power)		62.5	87.5	125	187.5	312.5	500	875	1250
Starting (Preheating) current (A)			0.91	1.28	1.82	2.73	4.56	7.29	12.76	18.23
Running current (A)		AC3	0.65	0.91	1.30	1.95	3.26	5.21	9.11	13.02
Max no. of lamps per phase	**MO 9 (qty)**	9	14	10	7	5	3	2	1	1
	MO 12 (qty)	12	18	13	9	6	4	2	1	1
	MO 18 (qty)	18	28	20	14	9	6	3	2	1
	MO 25 (qty)	25	38	27	19	13	8	5	3	2
	MO 32 (qty)	32	49	35	25	16	10	6	4	2
	MO 40(qty)	40	61	44	31	20	12	8	4	3
	MO 45 (qty)	45	69	49	35	23	14	9	5	3
	MO 50 (qty)	50	77	55	38	26	15	10	5	4
	MO 60 (qty)	60	92	66	46	31	18	12	7	5
	MO 70 (qty)	70	107	77	54	36	21	13	8	5
	MO 80 (qty)	80	123	88	61	41	25	15	9	6
	MO 95 (qty)	95	146	104	73	49	29	18	10	7
	MO 110 (qty)	110	169	120	84	56	34	21	12	8
	MO 140 (qty)	140	215	153	107	72	43	27	15	11
	MO 185 (qty)	185	284	203	142	95	57	35	20	14
	MO 225 (qty)	225	345	246	173	115	69	43	25	17
	MO 250 (qty)	250	383	274	192	128	77	48	27	19
	MO 300 (qty)	300	460	329	230	153	92	58	33	23

MO 3 Pole Power Contactors

MO Contactors, with their unique styling and visual appeal provide a unique blend of aesthetics with reliable performance. The contactors, available from 9A to 300A AC-3 are suited for general purpose as well as special purpose machines. Their compact design ensures saving in panel space and being RoHS compliant they provide all the benefits of a clean and green contactor.

OPEN DOORS TO NEW DIMENSIONS IN SPACE ECONOMY



Overview

Cassette type bridge for easy contact replacement

Compact Mechanical Interlock

Safety shrouds for power terminals to ensure safe maintenance environment

Box clamp terminations for faster termination

Modular load feeder

1NO+1 NC Aux. contact inbuilt in 45 mm width for 9A / 12A / 18A

MO
CONTACTORS

Completely shrouded and safe

Compact thus saving panel space

Unique styling and visual appeal

Standardized accessories for entire range reducing inventory costs

Lug less termination for fast termination and significant reduction in wiring costs

Low VA consumption thus reducing control transformer size

Wide range of accessories to meet all applications

RoHS

In keeping with the mission to deliver the best, Larsen & Toubro understands the requirements of the RoHS directive. The directive restricts the use of hazardous substances in electrical and electronic equipment and bans electrical equipment containing more than permitted levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBS) and polybrominated diphenyl ether (PBDE) flame retardants.

Technical Details

- Range from 9A-300A AC-3
- Range 140A-300A available with conventional/universal AC/DC electronic coil version
- Built-In surge suppressor with the coil
- Low pick-up VA consumption
- Standardized accessories for 9A-110A & 140A-300A range
- DIN Rail mounting facility upto 110A
- Compact dimensions saving precious panel space
- Lug as well as Lugless termination
- RoHS compliant



		Units	MO 9	MO 12	MO 18
Catalogue no.			CS 94833	CS 94834	CS 94835
Conformance to standards					
Power Contacts					
No. of poles			3	3	3
Rated insulation voltage, U_i		V	1000	1000	1000
Rated impulse withstand voltage, U_{imp}		kV	8	8	8
Rated kW	240 V AC	kW	2.2	3.0	4.0
	415 - 500 V AC	kW	4.5	5.5	9.3
	690 V AC	kW	5.5	7.5	11.0
Rated making capacity	240 V AC	A	300	400	400
	415 - 500 V AC	A	300	400	400
	690 V AC	A	84	108	144
Rated breaking capacity	240 V AC	A	250	300	300
	415 - 500 V AC	A	250	300	300
	690 V AC	A	70	90	120
Rated operational current, I_e at 60°C Motor duty : 3Ø, 415 V, 50 Hz	Utilization category AC-1	A	30	32	32
	Utilization category AC-2	A	9	12	18
	Utilization category AC-3	A	9	12	18
	Utilization category AC-4	A	9	12	18
	Utilization category AC-4 (2,00,000 operations)	A	5.3	7.3	9
Rated Operational current, Ie at 60°C Motor duty : 3Ø, 690 V, 50 Hz	Utilization category AC-3	A	7	9	12
AC-8b rating at 415V, 50 Hz		A	11.5	15.5	23.5
Permissible short time ratings	1 Seconds	A	250	300	300
	10 Seconds	A	105	145	145
	30 Seconds	A	70	70	70
	1 Minute	A	60	80	80
	10 Minute	A	30	40	40
	15 Minute	A	25	30	30
Mechanical life, No. of operating cycles		millions	10	10	10
Max. frequency of operations: Operating cycles/hr	Mechanical	cy/hr	7200	7200	7200
	Utilization category AC-1	cy/hr	3000	3000	3000
	Utilization category AC-2	cy/hr	750	750	750
	Utilization category AC-3	cy/hr	750	750	750
	Utilization category AC-4	cy/hr	300	300	300
Vibration resistance conforming to IEC 60068-2-6					
Ambient temperature around the device	Service temperature	°C			
	Storage temperature	°C			
Altitude without deration		m			
Degree of Pollution					
Degree of protection					
Protective treatment as per IEC 60068 - 2 - 30					
Fuse protection against short circuit			HF 25	HF 32	HF 32
Watt loss per pole	Utilization category AC-1	W	1.6	2.5	2.5
	Utilization category AC-3	W	0.25	0.5	0.9






MO 25	MO 32	MO 40	MO 45	MO 50	MO 60
CS 94567	CS 94568	CS 94569	CS 94570	CS 94572	CS 94573
IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
3	3	3	3	3	3
1000	1000	1000	1000	1000	1000
8	8	8	8	8	8
5.5	7.5	11.0	15.0	15.0	18.6
11	17.3	22.5	25	30	33.5
12.5	18.5	22.0	22.0	30.0	30.0
550	550	550	550	1000	1000
550	550	550	550	1000	1000
180	252	300	300	420	420
550	550	550	550	900	900
550	550	550	550	900	900
150	210	250	250	350	350
45	50	5	50	100	100
25	32	40	45	50	60
25	32	40	45	50	60
25	32	40	45	50	60
16	16	18	19	23	25
15	22	25	25	35	35
32.5	41.5	52	58.5	65	78
400	600	600	600	1000	1000
240	400	400	400	650	650
120	225	225	225	370	370
110	150	150	150	35	250
50	70	70	70	120	120
45	65	65	65	110	110
10	10	10	10	10	10
7200	7200	7200	7200	3600	3600
3000	3000	3000	3000	3000	3000
750	750	750	750	750	750
750	750	750	750	750	750
300	300	300	150	300	300
5..... 300 Hz : 3g					
-20°C to + 60°C					
-40°C to +80°C					
3000					
3					
IP 20					
TH					
HF 63	HF 63	HN,000 80	HN,000 80	HN,00 100	HN,00 125
4	3.5	3.5	3.5	5.7	9.5
1.25	1.5	2.3	2.9	5	5.3

Technical Details

- Range from 9A-300A AC-3
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		Units	MO 9	MO 12	MO 18
Catalogue no.			CS 94833	CS 94834	CS 94835
Auxiliary Contacts					
No. of additional aux. contact possible			4	4	4
No. of built-in auxiliary contacts			1 NO + 1 NC	1 NO + 1 NC	1 NO + 1 NC
Conventional thermal current, I_{th} at 60°C		A	10	10	10
Endurance of auxiliary Contacts		millions	0.5	0.5	0.5
AC-15 rating at 415 V, 50 Hz	24-110 V	A	6	6	6
	220-240 V	A	4	4	4
	360-440 V	A	4	4	4
	525-600 V	A	1.2	1.2	1.2
DC-13 rating at 415 V	24 V	A	6	6	6
	110-125 V	A	1.1	1.1	1.1
	250 V	A	0.55	0.55	0.55
	480 V	A	0.31	0.31	0.31
	500 V	A	0.27	0.27	0.27
	600 V	A	0.2	0.2	0.2
Terminal capacity (Solid or multi strand conductors)		mm^2	2 x 2.5	2 x 2.5	2 x 2.5
Coil					
Voltage available U_C	50 / 60 Hz	V	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525
Pick-up	VA	VA	68	68	68
Hold-on	VA	VA	9	9	9
	Watts	W	3	3	3
Limits of operation	Pick-up (%Uc) 50Hz	%Uc	65 - 110	65 - 110	65 - 110
	Pick-up (%Uc) 60Hz	%Uc	85 - 110	85 - 110	85 - 110
	Drop-off (%Uc)	%Uc	35 - 55	35 - 55	35 - 55
Operating time	Closing time	ms	12 - 21	12 - 21	12 - 21
	Opening time	ms	6 - 16	6 - 16	6 - 16
Safe isolation between coil and auxiliary contacts		V	690	690	690
Overall dimensions **H x W x D**		mm^3	87 x 45 x 89	87 x 45 x 89	87 x 45 x 89
Mounting clearance (front)		mm	10	10	10
Weight		kg	0.38	0.38	0.38






MO 25	MO 32	MO 40	MO 45	MO 50	MO 60
CS 94567	CS 94568	CS 94569	CS 94570	CS 94572	CS 94573
8	8	8	8	8	8
-	-	-	-	-	-
10	10	10	10	10	10
0.5	0.5	0.5	0.5	0.5	0.5
6	6	6	6	6	6
4	4	4	4	4	4
4	4	4	4	4	4
1.2	1.2	1.2	1.2	1.2	1.2
6	6	6	6	6	6
1.1	1.1	1.1	1.1	1.1	1.1
0.55	0.55	0.55	0.55	0.55	0.55
0.31	0.31	0.31	0.31	0.31	0.31
0.27	0.27	0.27	0.27	0.27	0.27
0.2	0.2	0.2	0.2	0.2	0.2
2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525
77	77	77	77	144	144
9	9	9	9	15	15
3	3	3	3	6	6
65 - 110	65 - 110	65 - 110	65 - 110	75 - 110	75 - 110
85 - 110	85 - 110	85 - 110	85 - 110	85 - 110	85 - 110
35 - 55	35 - 55	35 - 55	35 - 55	35 - 55	35 - 55
12 - 21	12 - 21	12 - 21	12 - 21	11 - 20	11 - 20
6 - 16	6 - 16	6 - 16	6 - 16	6 - 13	6 - 13
690	690	690	690	690	690
87 x 45 x 93.5	87 x 45 x 93.5	87 x 45 x 93.5	87 x 45 x 93.5	123.5 x 55 x 122	123.5 x 55 x 122
10	10	10	10	10	10
0.44	0.44	0.44	0.44	1.1	1.1

Technical Details

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		Units	MO 9	MO 12	MO 18
Catalogue no.			CS 94833	CS 94834	CS 94835
Type of Terminal					
Main terminal capacity No.of cable x (Max.Range - Min. Range)	Cable with Ferrule type Lug	mm	1 x (1.5-4), 2 x (1-2.5)		
	Cable with Pin type Lug	mm	1 x (1.5-6)		
	Cable with Fork type Lug	mm	1 x (1.5-4), 2 x (1.5-4)		
	Cable with Ring type Lug	mm	-		
	Cable with Lug (spreader links)	(mm)^	2 x 16	2 x 16	2 x 16
	Busbar (with spreader)	(mm)^	12	12	12
	Busbar (without spreader)	mm	-	-	-
	Solid conductors	mm	2 x 10	2 x 10	2 x 10
	Multi strand conductors	mm	1 x (1.5-6), 2 x (1.5-4)		
Tightening Torque	Main Pole Terminal	Nm	M3.5 / 1.2	M3.5 / 1.2	M3.5 / 1.2
	Aux. Pole / Coil / Add on block Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
DC ratings with 3 poles in series and AC coil operation	DC 1 (24V)	A	20	25	25
	DC 1 (48V)	A	20	25	25
	DC 1 (110V)	A	20	25	25
	DC 1 (220V)	A	20	25	25
	DC 3 (24V)	A	20	25	25
	DC 3 (48V)	A	20	25	25
	DC 3 (110V)	A	20	25	25
	DC 3 (220V)	A	15	18	18
	DC 5 (24V)	A	20	25	25
	DC 5 (48V)	A	20	25	25
	DC 5 (110V)	A	12	18	20
	DC 5 (220V)	A	7.5	8	10
DC ratings with 2 poles in series and AC coil operation	DC 1 (24V)	A	20	25	25
	DC 1 (48V)	A	20	25	25
	DC 1 (110V)	A	20	20	20
	DC 1 (220V)	A	4	4	4
	DC 3 (24V)	A	20	25	25
	DC 3 (48V)	A	20	25	25
	DC 3 (110V)	A	20	20	25
	DC 3 (220V)	A	2	2	2
	DC 5 (24V)	A	20	25	25
	DC 5 (48V)	A	20	25	25
	DC 5 (110V)	A	12	20	25
	DC 5 (220V)	A	2	2	2
DC ratings with 1 pole in series and AC coil operation	DC 1 (24V)	A	20	25	25
	DC 1 (48V)	A	20	25	25
	DC 1 (110V)	A	4	4	4
	DC 1 (220V)	A	1	1	1
	DC 3 (24V)	A	20	25	25
	DC 3 (48V)	A	20	25	25
	DC 3 (110V)	A	2	2	2
	DC 3 (220V)	A	0.5	0.5	0.5
	DC 5 (24V)	A	20	25	25
	DC 5 (48V)	A	20	25	25
	DC 5 (110V)	A	2	2	2
	DC 5 (220V)	A	0.5	0.5	0.5

^ keeping (22mm-25mm) clearance






MO 25	MO 32	MO 40	MO 45	MO 50	MO 60
CS 94567	CS 94568	CS 94569		CS 94572	CS 94573
Philip and Slot Head Combination Screw				Box Clamp with Slot Head Screw	
1 x (4-10), 2 x (2.5-6)				1 x (10-35), 2 x (6-25)	
1 x (4-10), 2 x (2.5)				1 x (10-35), 2 x (6-25)	
1 x (4-10), 2 x (2.5-6)				-	
-				-	
2 x 16	2 x 16	2 x 16	2 x 16	2 x 50	2 x 50
12	12	12	12	18	18
-	-	-	-	-	-
2 x 10	2 x 10	2 x 10	2 x 10	-	-
1 x (4-10), 2 x (2.5-6)				1x (10-35), 2 x (6-35)	
M4 / 2.5	M4 / 2.5	M4 / 2.5	M4 / 2.5	M6 / 4	M6 / 4
M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	70
25	32	40	40	50	60
12	20	22	25	35	35
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	65
7	7	7	7	7	7
32	40	40	40	65	70
32	40	40	40	65	70
32	40	40	40	65	65
3	3	3	3	4	4
32	40	40	40	65	70
32	40	40	40	65	70
25	32	40	40	50	60
3	3	3	3	4	4
32	40	40	40	65	70
32	40	40	40	65	70
7	7	7	7	7	7
1	1	1	1	1	1.5
32	40	40	40	65	70
32	40	40	40	65	70
3	3	3	3	4	4
0.5	0.5	0.5	0.5	1	1.5
32	40	40	40	65	70
32	40	40	40	65	70
3	3	3	3	4	4
0.5	0.5	0.5	0.5	1	1.5

Technical Details

- Range from 9A-300A AC-3
- Range 140A-300A available with conventional/universal AC/DC electronic coil version
- Built-In surge suppressor with the coil
- Low pick-up VA consumption
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- DIN Rail mounting facility upto 110A
- Compact dimensions saving precious panel space
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- RoHS compliant

		Units	MO 70	MO 80	MO 95
Catalogue no.			CS 94574	CS 94576	CS 94577
Conformance to standards					
Power Contacts					
No. of poles			3	3	3
Rated insulation voltage, U_i		V	1000	1000	1000
Rated impulse withstand voltage, U_{imp}		kV	8	8	8
Rated kW	240 V AC	kW	18.6	22.0	25
	415 - 500 V AC	kW	37	40	45
	690 V AC	kW	40	45	45
Rated making capacity	240 V AC	A	1000	1500	1500
	415 - 500 V AC	A	1000	1500	1500
	690 V AC	A	540	600	600
Rated breaking capacity	240 V AC	A	900	1200	1200
	415 - 500 V AC	A	900	1200	1200
	690 V AC	A	450	500	500
Rated operational current, I_e at 60°C Motor duty : 3Ø, 415 V, 50 Hz	Utilization category AC-1	A	100	125	125
	Utilization category AC-2	A	70	80	95
	Utilization category AC-3	A	70	80	95
	Utilization category AC-4	A	70	80	95
	Utilization category AC-4 (2,00,000 operations)	A	27	34	37
Rated Operational current, I_e at 60°C Motor duty : 3Ø, 690 V, 50 Hz	Utilization category AC-3	A	45	50	50
AC-8b rating at 415V, 50 Hz		A	91	104	123.5
Permissible short time ratings	1 Seconds	A	1000	1320	1320
	10 Seconds	A	650	800	800
	30 Seconds	A	370	500	500
	1 Minute	A	250	400	400
	10 Minute	A	120	170	170
	15 Minute	A	110	160	160
Mechanical life, No. of operating cycles		millions	10	10	10
Max. frequency of operations: Operating cycles/hr	Mechanical	cy/hr	3600	3600	3600
	Utilization category AC-1	cy/hr	3000	3000	3000
	Utilization category AC-2	cy/hr	750	750	750
	Utilization category AC-3	cy/hr	750	750	750
	Utilization category AC-4	cy/hr	150	150	150
Vibration resistance conforming to IEC 60068-2-6					
Ambient temperature around the device	Service temperature	°C			
	Storage temperature	°C		-40°C to + 80°C	
Altitude without deration		m			
Degree of Pollution					
Degree of protection					
Protective treatment as per IEC 6006 - 2 - 30					
Fuse protection against short circuit			HN,00 160	HN,00 160	HN,0 200
Watt loss per pole	Utilization category AC-1	W	1.6	2.5	2.5
	Utilization category AC-3	W	0.25	0.5	0.9

* Universal AC/DC electronic coil version
# Pls refer ordering data for electronic coil version






MO 110	MO 140 #	MO 185 #	MO 225 #	MO 250 #	MO 300 #
CS 94578	CS 95000	CS 95001	CS 95002	CS 94441	CS 94440
IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
3	3	3	3	3	3
1000	1000	1000	1000	1000	1000
8	8	8	8	8	8
30	40	55	63	75	90
55	80	95	125	150	180
60	132	160	220	250	280
1500	1800	2400	3000	4000	4500
1500	1680	2700	2700	3600	4000
780	1680	2220	2700	3000	3600
1200	1600	1850	2500	3200	4000
1200	1400	2250	2250	3000	3600
650	1400	1850	2250	2500	3000
140	250	275	275	400	500
110	140	185	225	250	300
110	140	185	225	250	300
110	140	185	225	250	300
41	60	75	85	100	130
65	140	185	225	250	300
143	182	240.5	292.5	325	390
1320	2000	3000	3000	3500	3500
800	1800	2000	2000	2400	2400
500	1000	1400	1400	1500	1800
400	750	1100	1100	1100	1300
170	550	600	600	550	750
160	250	275	275	400	500
10	10	10	10	10	10
3600	3600/3600*	3600/3600*	3600/3600*	3600/2400*	3600/2400*
3000	3000	3000	3000	3000	3000
750	750	750	750	750	750
750	750	750	750	750	750
150	150	150	150	150	150
5..... 300 Hz: 3g					
-20°C to + 60°C					
-15°C to + 80°C					
3000					
3					
IP 20					
TH					
HN,0 200	HN,1 250	HN,1 315	HN,1 315	HN,2 400	2 NO+2 NC
4	3.5	3.5	3.5	5.7	5.3
1.25	1.5	2.3	2.9	5	9.5

Technical Details

- Range from 9A-300A AC-3
- Range 140A-300A available with conventional/universal AC/DC electronic coil version
- Built-In surge suppressor with the coil
- Low pick-up VA consumption
- Standardized accessories for 9A-110A & 140A-300A range
- DIN Rail mounting facility upto 110A
- Compact dimensions saving precious panel space
- Lug as well as Lugless termination
- RoHS compliant

		Units	MO 70	MO 80	MO 95
Catalogue no.			CS 94574	CS 94576	CS 94577
Auxiliary Contacts					
No. of additional aux. contact possible			8	8	8
No. of built-in auxiliary contacts					
Conventional thermal current, I_{th} at 55°C		A	10	10	10
Endurance of auxiliary Contacts		millions	0.5	0.5	0.5
AC-15 rating at 415 V, 50 Hz	24-110 V	A	6	6	6
	220-240 V	A	4	4	4
	360-440 V	A	4	4	4
	525-600 V	A	1.2	1.2	1.2
DC-13 rating at 415 V	24 V	A	6	6	6
	110-125 V	A	1.1	1.1	1.1
	250 V	A	0.55	0.55	0.55
	480 V	A	0.31	0.31	0.31
	500 V	A	0.27	0.27	0.27
	600 V	A	0.2	0.2	0.2
Terminal capacity (Solid or multi strand conductors)		mm^2	2 x 2.5	2 x 2.5	2 x 2.5
Coil					
Voltage available U_C	50 / 60 Hz	V	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525
Pick-up	VA	VA	144	240	240
Hold-on	VA	VA	15	25	25
	Watts	W	6	9	9
Limits of operation	Pick-up (%Uc) 50Hz	%Uc	75-110	75-110	75-110
	Pick-up (%Uc) 60Hz	%Uc	85-110	85-110	85-110
	Drop-off (%Uc)	%Uc	35-55	35-55	35-55
Electronic Coil					
Voltage available Uc	50 / 60 Hz	V	-	-	-
Pick-up	VA	VA	-	-	-
Hold-on	VA	VA	-	-	-
	Watts	W	-	-	-
Limits of operation	Pick-up (%Uc) 50Hz	%Uc	-	-	-
	Pick-up (%Uc) 60Hz	%Uc	-	-	-
	Drop-off (%Uc)	%Uc	-	-	-
Operating time	Closing time	ms	11 - 20	15 - 24	15 - 24
	Opening time	ms	6 - 13	6 - 23	6 - 23
Safe isolation between coil and auxiliary contacts		V	690	690	690
Overall dimensions **H x W x D**		mm^3	124 x 55 x 122	135 x 70 x 135	135 x 70 x 135
Mounting clearance (front)		mm	10	10	10
Weight		kg	1.1	1.6	1.6

Pls refer ordering data for electronic coil version






MO 110	MO 140 #	MO 185 #	MO 225 #	MO 250 #	MO 300 #
CS 94578	CS 95000	CS 95001	CS 95002	CS 94441	CS 94440
8	4	4	4	4	4
	2 NO+2 NC	HN,3 500	2 NO+2 NC	2 NO+2 NC	2 NO+2 NC
10	10	10	10	10	10
0.5	0.5	0.5	0.5	0.5	0.5
6	6	6	6	6	6
4	4	4	4	4	4
4	4	4	4	4	4
1.2	1.2	1.2	1.2	1.2	1.2
6	6	6	6	6	6
1.1	1.1	1.1	1.1	1.1	1.1
0.55	0.55	0.55	0.55	0.55	0.55
0.31	0.31	0.31	0.31	0.31	0.31
0.27	0.27	0.27	0.27	0.27	0.27
0.2	0.2	0.2	0.2	0.2	0.2
2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525	24, 42, 48, 110, 220, 240, 320, 360, 380, 415, 525
240	1000	1000	1000	1400	1400
25	50	50	50	65	65
9	18	18	18	23	23
75-110	75-110	75-110	75-110	75-110	75-110
85-110	85-110	85-110	85-110	85-110	85-110
35-55	35-55	35-55	35-55	35-55	35-55
-	110-240	110-240	110-240	110-240	110-240
-	300	300	300	350	350
-	17	17	17	17	17
-	6	6	6	6	6
-	75-110	75-110	75-110	75-110	75-110
-	75-110	75-110	75-110	75-110	75-110
-	25 - 50	25 - 50	25 - 50	25 - 50	25 - 50
15 - 24	15 - 40	15 - 40	15 - 40	15 - 40	15 - 40
6 - 23	7 - 20	7 - 20	7 - 20	7 - 20	7 - 20
690	690	690	690	690	690
135 x 70 x 135	197.5 x 120 x 170	197.5 x 120 x 170	197.5 x 120 x 170	225 x 145 x 190	225 x 145 x 190
10	10	10	10	10	10
1.6	4.24	4.6	4.6	6	6

Technical Details

- Range from 9A-300A AC-3
- Range 140A-300A available with conventional/universal AC/DC electronic coil version
- Built-In surge suppressor with the coil
- Low pick-up VA consumption
- Standardized accessories for 9A-110A & 140A-300A range
- DIN Rail mounting facility upto 110A
- Compact dimensions saving precious panel space
- Lug as well as Lugless termination
- RoHS compliant

		Units	MO 70	MO 80	MO 95	
Catalogue no.			CS 94574	CS 94576	CS 94577	
Type of Terminal			Box Clamp with Slot Head Screw			
Main terminal capacity No.of cable x (Max.Range - Min. Range)	Cable with Ferrule type Lug	mm	1 x (10-35), 2 x (6-25)		1 x (25-70), 2 x (16-35)	
	Cable with Pin type Lug	mm	1 x (10-35), 2 x (6-25)		1 x (25-70), 2 x (16-35)	
	Cable with Fork type Lug	mm	-		-	
	Cable with Ring type Lug	mm	-		-	
	Cable with Lug (spreader links)	(mm)^	2 x 50	2 x 95	2 x 95	
	Busbar (with spreader)	(mm)^	18	25	25	
	Busbar (without spreader)	mm	-	-	-	
	Solid conductors	mm	-	-	-	
	Multi strand conductors	mm	1 x (10-35), 2 x (6-35)		1 x (25-70), 2 x (16-70)	
Tightening Torque	Main Pole Terminal	Nm	M6 / 4	M8 / 5	M8 / 5	
	Aux. Pole / Coil / Add on block Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	
DC ratings with 3 poles in series and AC coil operation	DC 1 (24V)	A	80	100	100	
	DC 1 (48V)	A	80	100	100	
	DC 1 (110V)	A	80	100	100	
	DC 1 (220V)	A	80	100	100	
	DC 3 (24V)	A	80	100	100	
	DC 3 (48V)	A	80	100	100	
	DC 3 (110V)	A	80	100	100	
	DC 3 (220V)	A	80	100	100	
	DC 5 (24V)	A	80	100	100	
	DC 5 (48V)	A	80	100	100	
	DC 5 (110V)	A	70	80	95	
	DC 5 (220V)	A	35	63	70	
DC ratings with 2 poles in series and AC coil operation	DC 1 (24V)	A	80	100	100	
	DC 1 (48V)	A	80	100	100	
	DC 1 (110V)	A	65	100	100	
	DC 1 (220V)	A	7	12	12	
	DC 3 (24V)	A	80	100	100	
	DC 3 (48V)	A	80	100	100	
	DC 3 (110V)	A	65	100	100	
	DC 3 (220V)	A	4	5	5	
	DC 5 (24V)	A	80	100	100	
	DC 5 (48V)	A	80	100	100	
	DC 5 (10V)	A	65	80	95	
	DC 5 (220V)	A	4	5	5	
DC ratings with 1 pole in series and AC coil operation	DC 1 (24V)	A	80	100	100	
	DC 1 (48V)	A	80	100	100	
	DC 1 (110V)	A	7	12	12	
	DC 1 (220V)	A	1.5	2	2	
	DC 3 (24V)	A	80	100	100	
	DC 3 (48V)	A	80	100	100	
	DC 3 (110V)	A	4	5	5	
	DC 3 (220V)	A	1.5	1	1	
	DC 5 (24V)	A	80	100	100	
	DC 5 (48V)	A	80	100	100	
	DC 5 (110V)	A	4	5	5	
	DC 5 (220V)	A	1.5	1	1	

^ keeping (22mm-25mm) clearance # Pls refer ordering data for electronic coil version






MO 110	MO 140 #	MO 185 #	MO 225 #	MO 250 #	MO 300 #
CS 94578	CS 95000	CS 95001	CS 95002	CS 94441	CS 94440
Hexagon Head Screw					
		-		-	-
		-		-	-
		-		-	-
		2 x 16		-	-
2 x 95	2 x 185	2 x 185	2 x 185	2 x 240	2 x 240
25	28	28	28	40	40
-	25	25	25	32	32
-	-	-	-	-	-
		-		-	
M8 / 5	M10 / 20	M10 / 20	M10 / 20	M10 / 30	M10 / 30
M3.5 / 1.1	M3.5 / 1.2	M3.5 / 1.2	M3.5 / 1.2	M3.5 / 1.2	M3.5 / 1.2
120	140	185	225	250	300
120	140	185	225	250	300
120	140	185	225	260	300
120	140	185	225	260	300
120	140	185	225	250	300
120	140	185	225	250	300
120	140	185	225	260	300
120	140	185	225	260	300
120	140	185	225	250	300
120	140	185	225	250	300
110	120	160	200	220	265
80	100	140	185	200	250
120	140	185	225	250	300
120	140	185	225	250	300
120	140	185	225	250	300
120	140	185	200	250	280
120	140	185	225	250	300
120	140	185	225	250	300
120	140	160	180	250	300
120	140	140	160	220	280
120	140	185	225	250	300
120	140	185	225	250	300
110	140	160	180	250	300
80	125	140	160	220	280
120	140	185	225	250	300
120	140	185	225	250	300
12	12	185	225	250	300
10	10	-	-	-	-
120	140	185	225	250	300
120	140	185	225	250	300
10	10	-	-	250	-
3	3	-	-	-	-
120	140	185	225	250	300
120	140	185	225	250	300
10	10	-	-	250	-
3	3	-	-	-	-

Add-on auxiliary contact block, suitable for all MO contactors

MO Top Add-on Block

Mo Side Add-on Block

Description	Mounting Position	Contacts	Terminal Marking	Cat. Nos.
MO 9A-110A	Side Mounted First Left	1 NO + 1 NC	23 - 24, 31 - 32	CS94580OOOO
	Side Mounted First Right	1 NO + 1 NC	33 - 34, 41 - 42	CS94581OOOO*
	Side Mounted Second Left	1 NO + 1 NC	53 - 54, 61 - 62	CS94582OOOO
	Side Mounted Second Right	1 NO + 1 NC	73 - 74, 81 - 82	CS94583OOOO*
	Top Mounted Single Pole	1 NO	53 - 54	CS94585OOOO
	Top Mounted Single Pole	1 NC	51 - 52	CS94586OOOO
	Top Mounted Two Pole	2 NO	53 - 54, 63 - 64	CS94591OOOO
	Top Mounted Two Pole	1 NO + 1 NC	53 - 54, 61 - 62	CS94592OOOO
	Top Mounted Two Pole	2 NC	51 - 52, 61 - 62	CS94593OOOO
	Top Mounted Four Pole	4 NO	53 - 54, 63 - 64, 73 - 74, 83 - 84	CS94594OOOO
	Top Mounted Four Pole	3 NO + 1 NC	53 - 54, 61 - 62, 73 - 74, 83 - 84	CS94595OOOO
	Top Mounted Four Pole	2 NO + NC	53 - 54, 61 - 62, 71 - 72, 83 - 84	CS94596OOOO
	Top Mounted Four Pole	1 NO + 3 NC	53 - 54, 61 - 62, 71 - 72, 81 - 82	CS94597OOOO
	Top Mounted Four Pole	4 NC	51 - 52, 61 - 62, 71 - 72, 81 - 82	CS94598OOOO
MO 140A-300A	Side Mounted First Left	1 NO + 1 NC	13 - 14, 21 - 22	CS95033OOOO
	Side Mounted First Right	1 NO + 1 NC	33 - 34, 41 - 42	CS95034OOOO
	Side Mounted Second Left	1 NO + 1 NC	43 - 44, 51 - 52	CS95035OOOO
	Side Mounted Second Right	1 NO + 1 NC	63 - 64, 71 - 72	CS95036OOOO

* Right side add-on block can not be mounted on MO frame 0 (9 -18 A).

Mechanical Interlock Kit

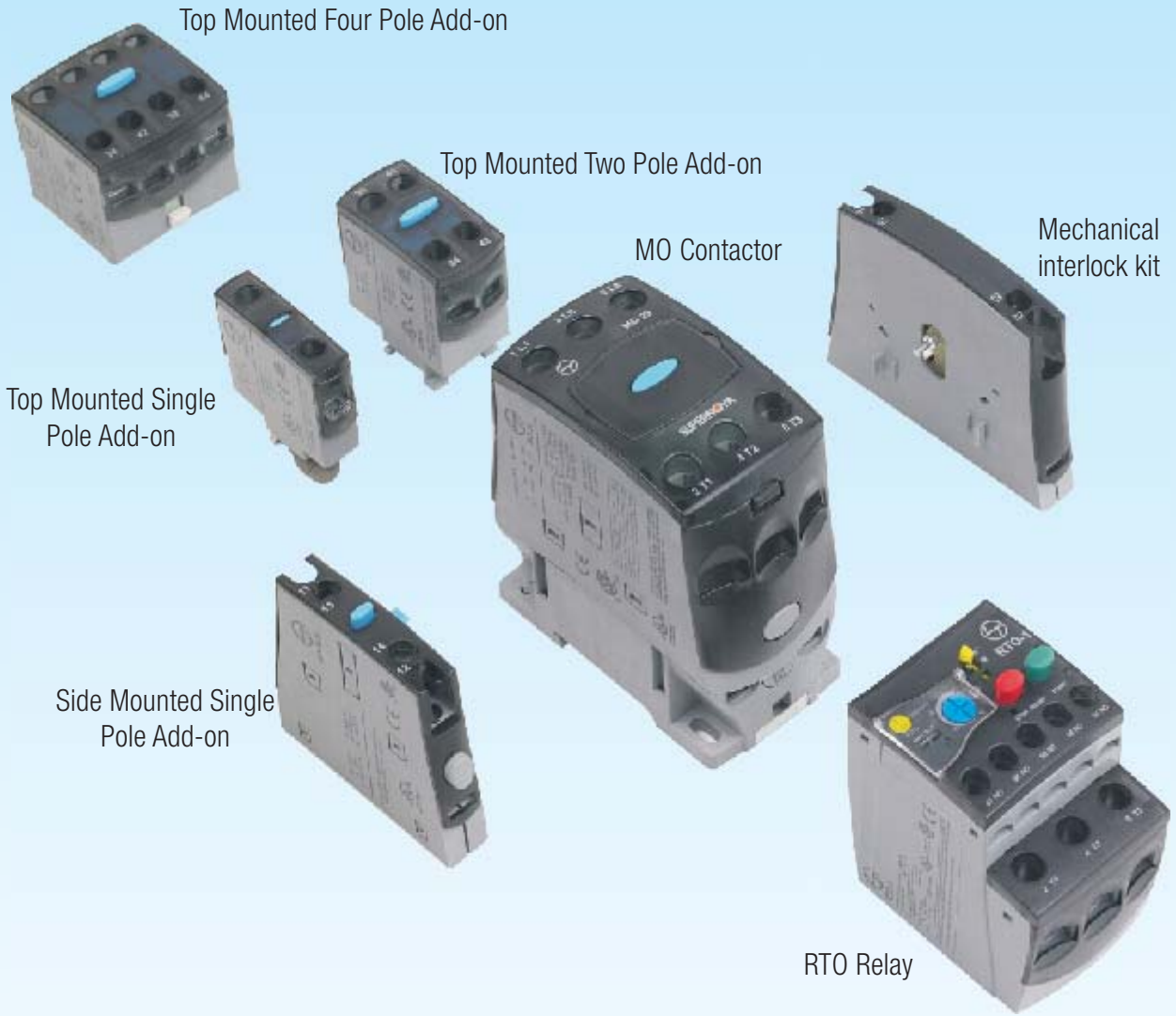
Description	Cat. No.
MO 9-110 Mechanical Interlock Kit	CS94584OOOO

Note: MO MIL Kit contains inbuilt 2 NC contacts.

MO Spreader Link Kit

Description	Cat. No.
MO 9 - 45	CS94274OOOO
MO 50 - 70	CS94093OOOO
MO 80 - 110	CS94094OOOO
MO 140 - 225	CS91057OOOO
MO 250 - 300	CS90940OOOO

Note: Spreader Link Kit consists of six terminals.


Top Mounted Four Pole Add-on
Top Mounted Two Pole Add-on
MO Contactor
Mechanical interlock kit
Top Mounted Single Pole Add-on
Side Mounted Single Pole Add-on
RTO Relay

Connecting Links

Reversing/star delta link

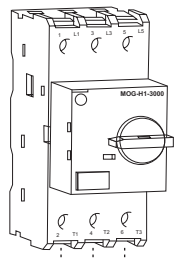
Paralleling link

Shorting link

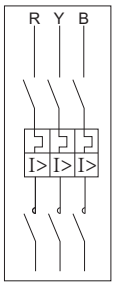
Contactor MPCB link

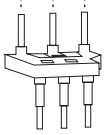
These are connecting links which connects MO Contactor and MPCB as a starter. These links eliminate complete power wiring of the starter. End user has to connect only the incomer cable at MPCB and load at load end of contactor. It is quick and easy to build a starter with direct connecting links. These links are available for DOL, Reverse DOL and Star Delta combination. These are available for MO contactor upto 45A and MPCB frame-1 (MOG S1/H1).

DOL Starter - Link

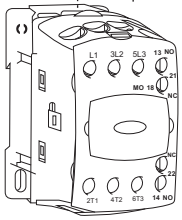


MPCB





DOL LINK

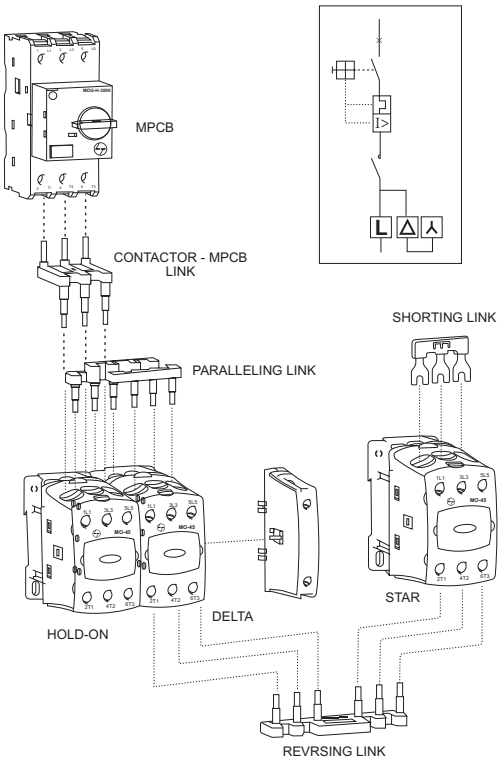


CONTACTOR

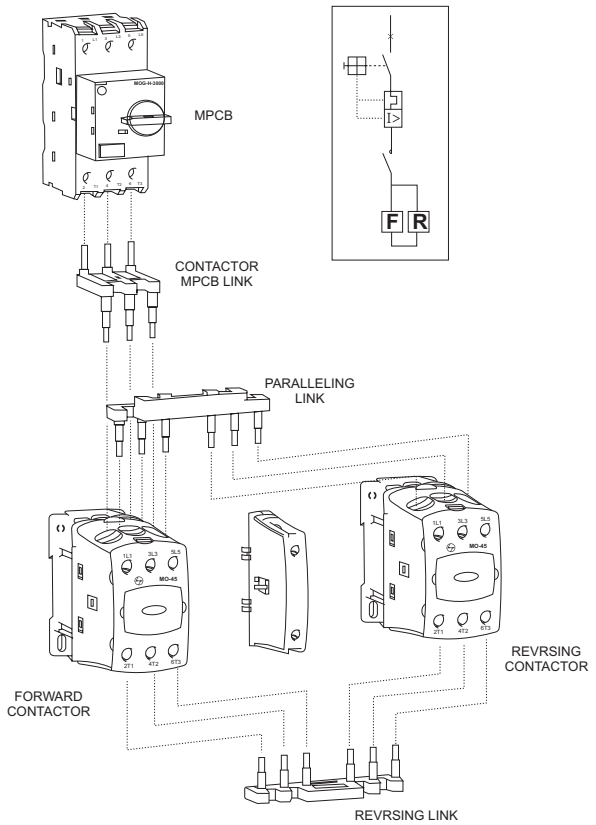
MPCB

Contactor

Star Delta Starter - Link



Reverse DOL Starter - Link



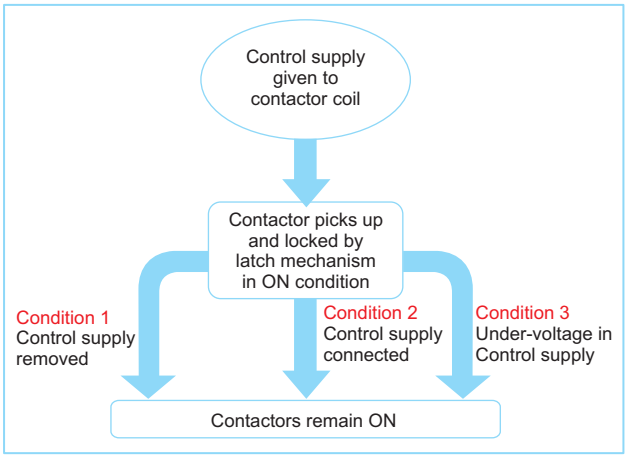
Mechanical Latch for MO Contactors

Mechanical Latch is an accessory available for MO contactors. It is mounted on top of contactor as shown:

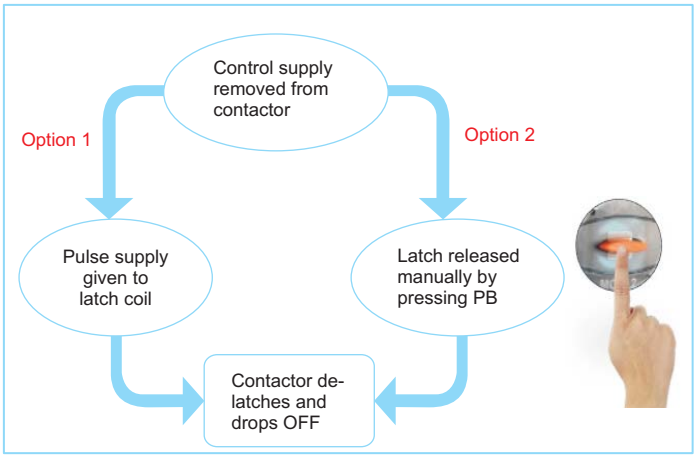
Operation

When contactor picks up, Latch locks the contactor mechanically in ON condition. Even if coil supply is removed conatctor will remain in ON condition. To turn OFF the contactor, Latch coil shall be given a pulse supply or push button on latch shall be pressed.

1 - Contactor
2 - Contactor coil terminals
3 - Latch
4 - Latch coil terminals
5 - Reset push button



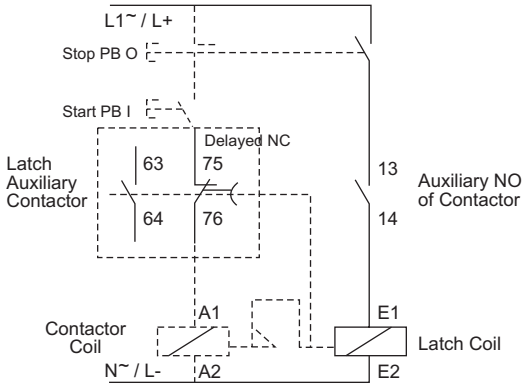
Operation to turn off the contactor



Operation at the time of contactor pick up

Recommended Wiring Diagram

Mechanical Latch has in-built 1NO+1NC contacts. NC contact (75-76) is a delayed contact. When the circuit is wired as per below schematic, supply to the coil of contactor gets removed automatically after pick up of contactor. This helps in saving energy consumption of control circuit



Note: Above wiring diagram is recommended when contactor coil voltage and latch coil voltage are same

Mechanical Latch

Suitable for	Description	Cat No.
MO 9- 70 A, MO 0 control	Mechanical Latch with 1NO + 1NC aux contact	CS90136*

*Coil Voltage: 240V AC Ordering suffix: BOOO; 110V AC Ordering suffix: AOOO; 24V AC Ordering suffix: GOOO

Connecting Links

Description	Link set contains	Cat. No.
Connecting Link Kit DOL (MO 9-18A)	MPCB to contactor link	CS90396OOOO
Connecting Link Kit for DOL (MO25-45A)	MPCB to contactor link	CS90391OOOO
Connecting Link Kit for DOL (MO25-45A)	MPCB to contactor link Paralleling link Reversing link	CS90548OOOO
Connecting Link Kit REV DOL (MO 9-18A)	MPCB to contactor link Paralleling link Reversing link	CS90546OOOO
Connecting Link Kit Star-Delta (MO9-18A)	MPCB to contactor link Paralleling link Reversing link Star shorting link	CS90549OOOO
Connecting Link Kit Star-Delta(MO25-45A)	MPCB to contactor link Paralleling link Reversing link Star shorting link	CS90547OOOO

MO Contactors

Type	AC1 Rating (A)	AC3 Rating (A)	Cat. Nos.*
MO 9 (1 NO + 1 NC)	30	9	CS94833
MO 12 (1 NO + 1 NC)	32	12	CS94834
MO 18 (1 NO + 1 NC)	32	18	CS94835
MO 25	45	25	CS94567
MO 32	50	32	CS94568
MO 40	50	40	CS94569
MO 45	50	45	CS94570
MO 50	100	50	CS94572
MO 60	100	60	CS94573
MO 70	100	70	CS94574
MO 80	125	80	CS94576
MO 95	125	95	CS94577
MO 110	140	110	CS94578
MO 140	250	140	CS95000
MO 185	275	185	CS95001
MO 225	275	225	CS95002
MO 250	400	250	CS94441
MO 300	500	300	CS94440
MO 140#	250	140	CS95042
MO 185#	275	185	CS95047
MO 225#	275	225	CS95052
MO 250#	400	250	CS94456
MO 300#	500	300	CS94464

MO Spares

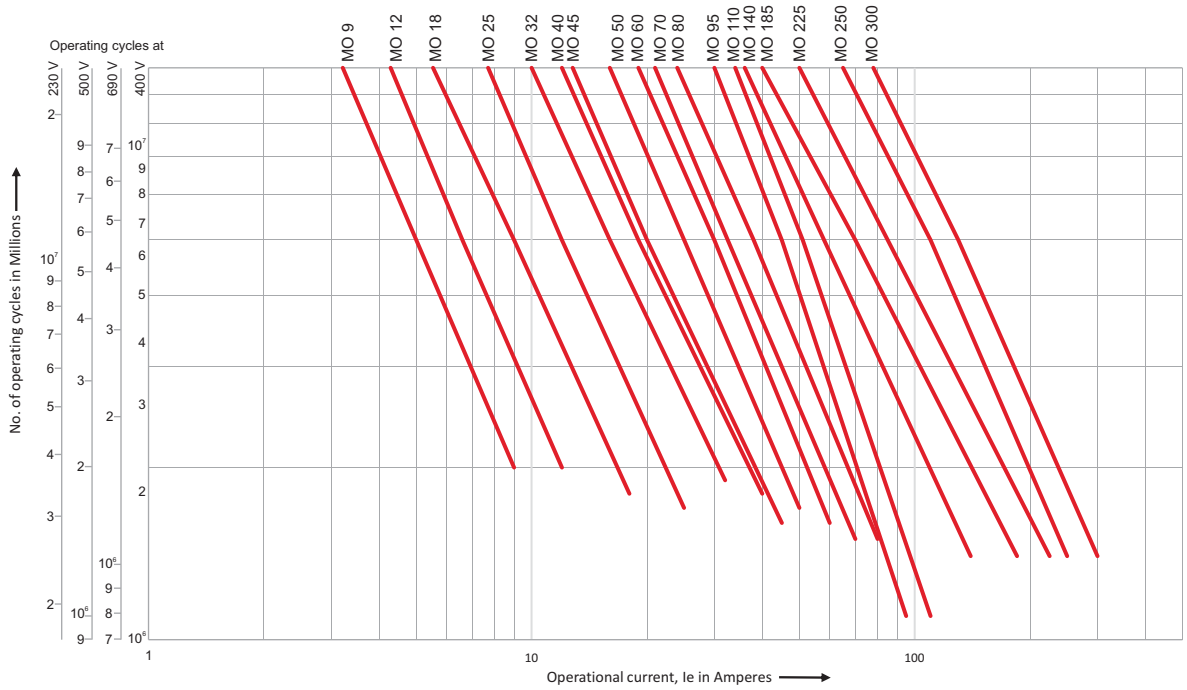
Type	Spare Contact Kit	Spare Coil *
MO 9 (1 NO + 1 NC)	CS94843OOOO	CS94841
MO 12 (1 NO + 1 NC)	CS94844OOOO	
MO 18 (1 NO + 1 NC)	CS94845OOOO	
MO 9	CS96380OOOO	CS96317
MO 12	CS96381OOOO	
MO 18	CS96382OOOO	
MO 25	CS96383OOOO	
MO 32	CS96384OOOO	
MO 40	CS96385OOOO	
MO 45	CS96386OOOO	
MO 50	CS96387OOOO	CS96318
MO 60	CS96388OOOO	
MO 70	CS96389OOOO	
MO 80	CS96390OOOO	CS96319
MO 95	CS96391OOOO	
MO 110	CS96392OOOO	
MO 140	CS90357OOOO	CS90356
MO 185	CS90358OOOO	
MO 225	CS90359OOOO	
MO 250	CS94444OOOO	CS94442
MO 300	CS94443OOOO	
MO 140#	CS90357OOOO	CS90855
MO 185#	CS90358OOOO	
MO 225#	CS90359OOOO	
MO 250#	CS94444OOOO	CS90738
MO 300#	CS94443OOOO	

* Add 4 digit suffix as per required coil voltage given below.
# Universal AC/DC electronic coil version
# Ordering Suffix per coil voltage band 110 - 240 V is BOOO

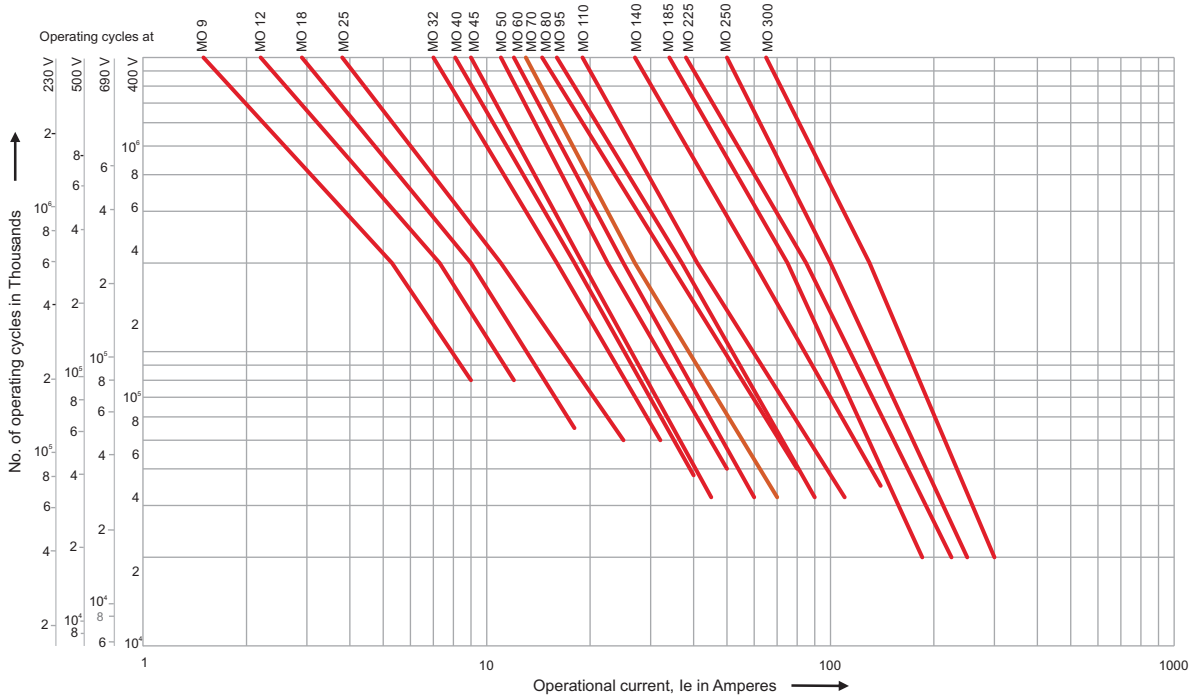
Ordering Suffix for Coil Voltages

Std Coil Voltage	24	42	48	110	220	240	320	360	380	415	525
Ordering Suffix - 50 / 60 Hz	GOOO	HOOO	JOOO	AOOO	KOOO	BOOO	ROOO	COOO	LOOO	DOOO	MOOO

Utilisation Category AC-3

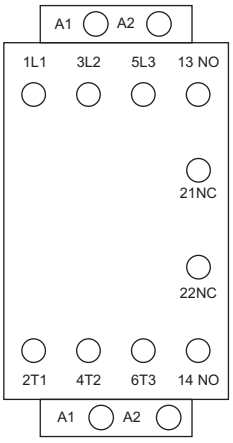


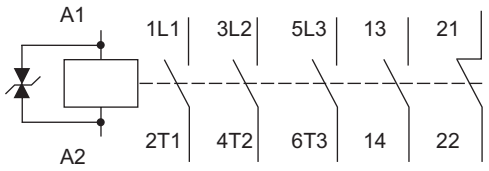
Utilisation Category AC-4



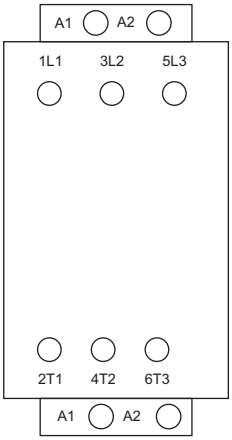
Terminal Designation

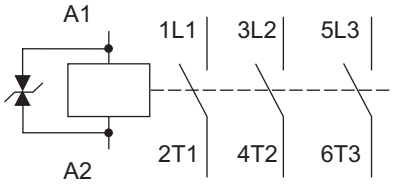
MO 9-18



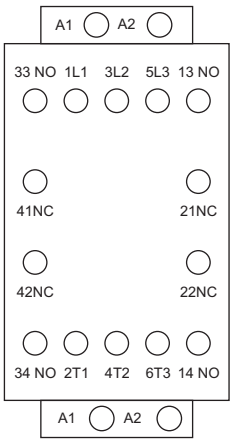


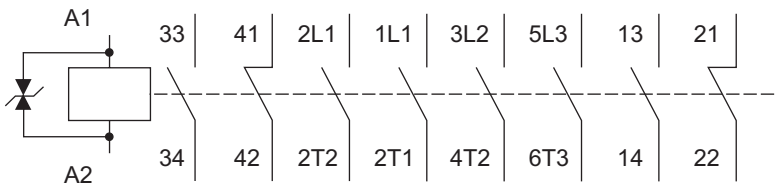
MO 25-100





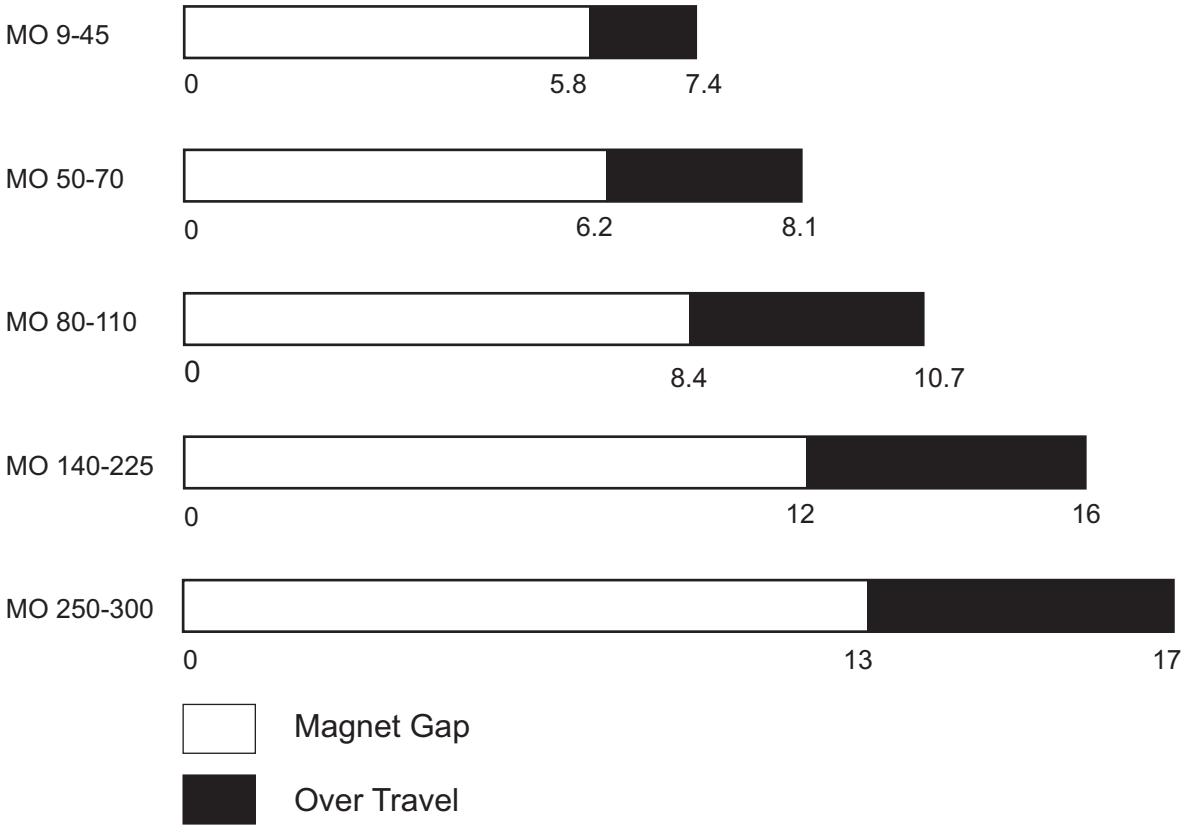
MO 140-300



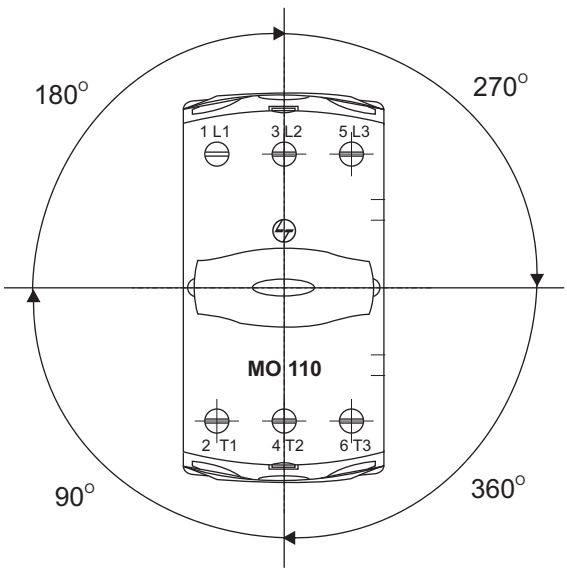


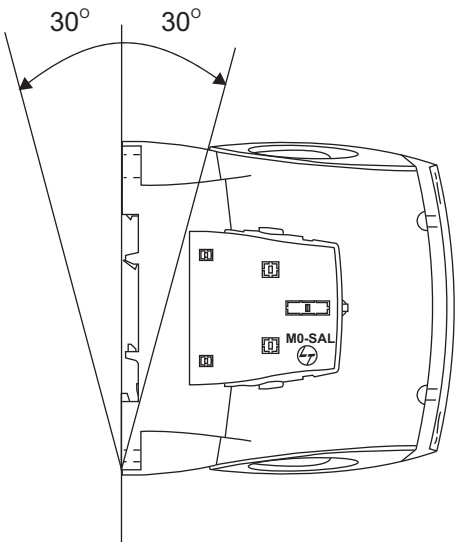
All dimensions in mm.

Contact Travel Diagram



Mounting Position

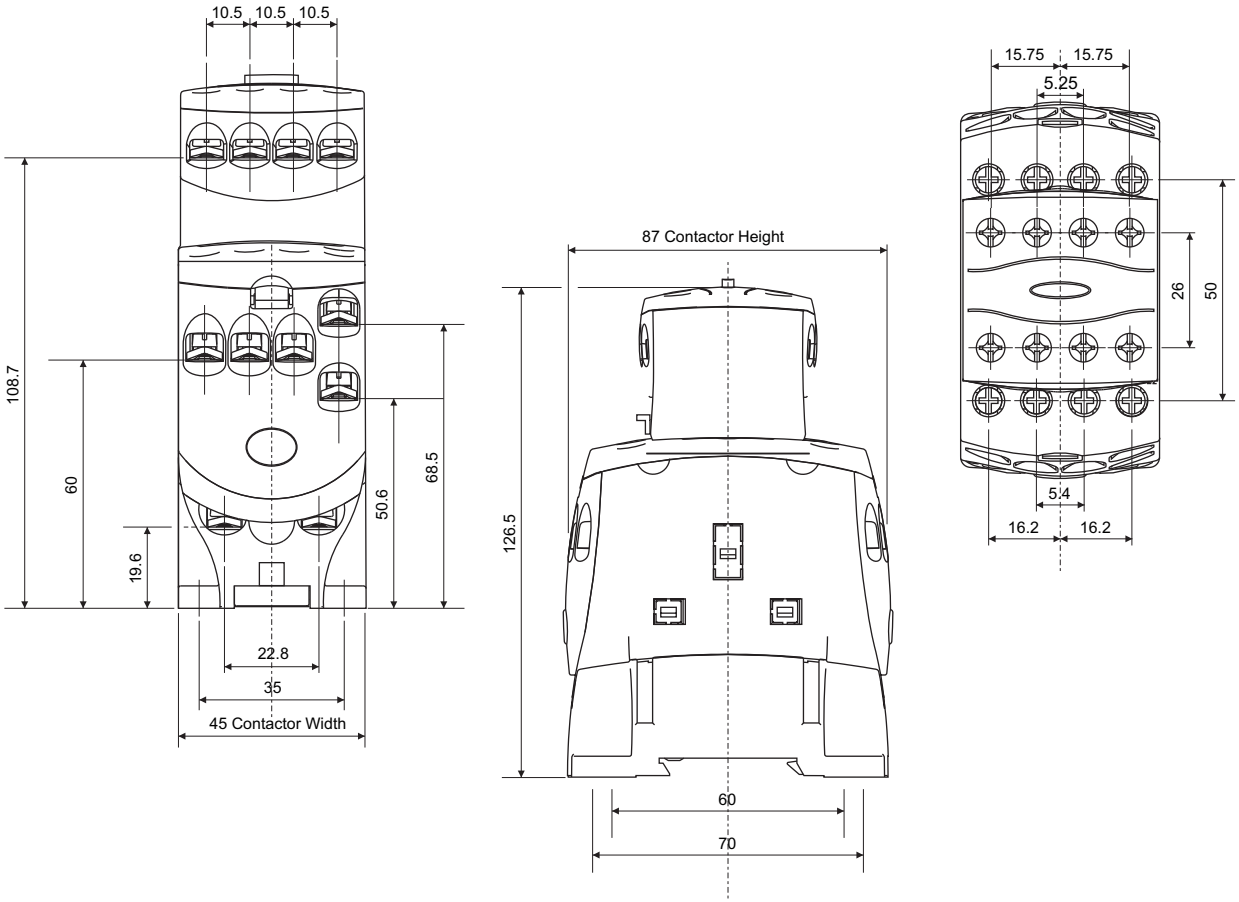




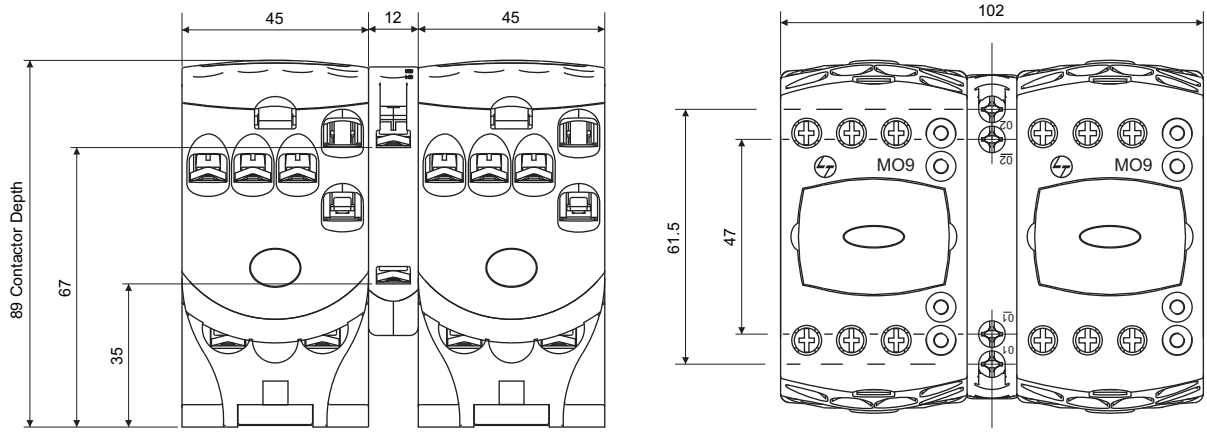
All dimensions in mm.

MO Frame 0: 9, 12, 18

Overall Dimensions with Auxiliary Contact Block



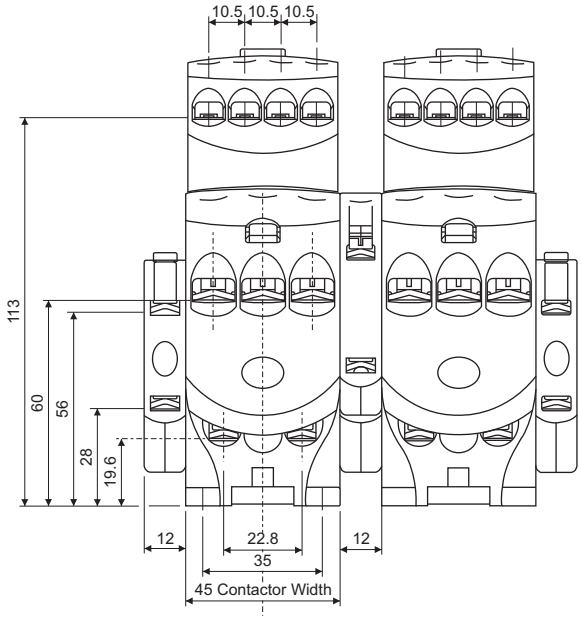
Overall Dimensions with Mechanical Interlock

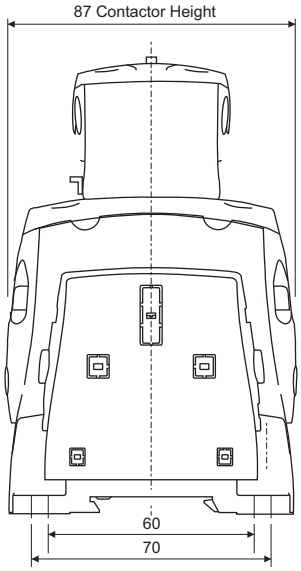


All dimensions in mm.

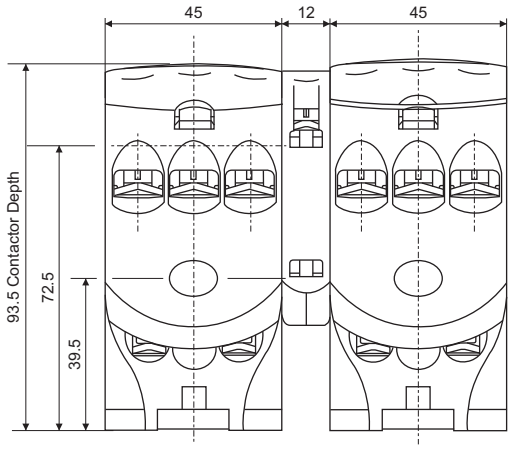
MO Frame I: 25, 32, 40, 45

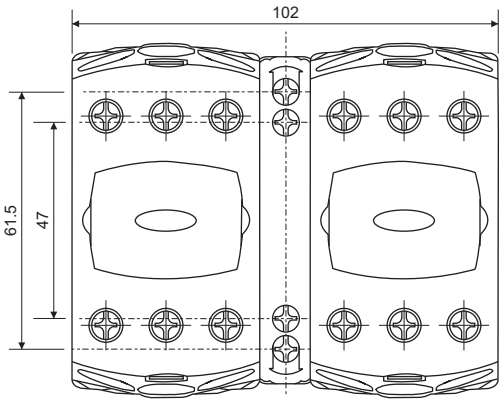
Overall Dimensions with Auxiliary Contact Block

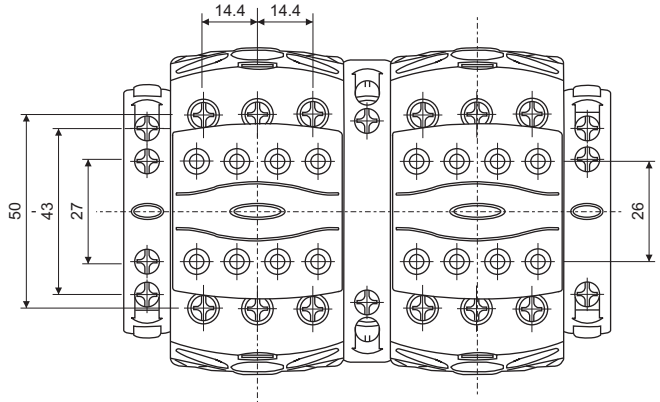




Overall Dimensions with Mechanical Interlock



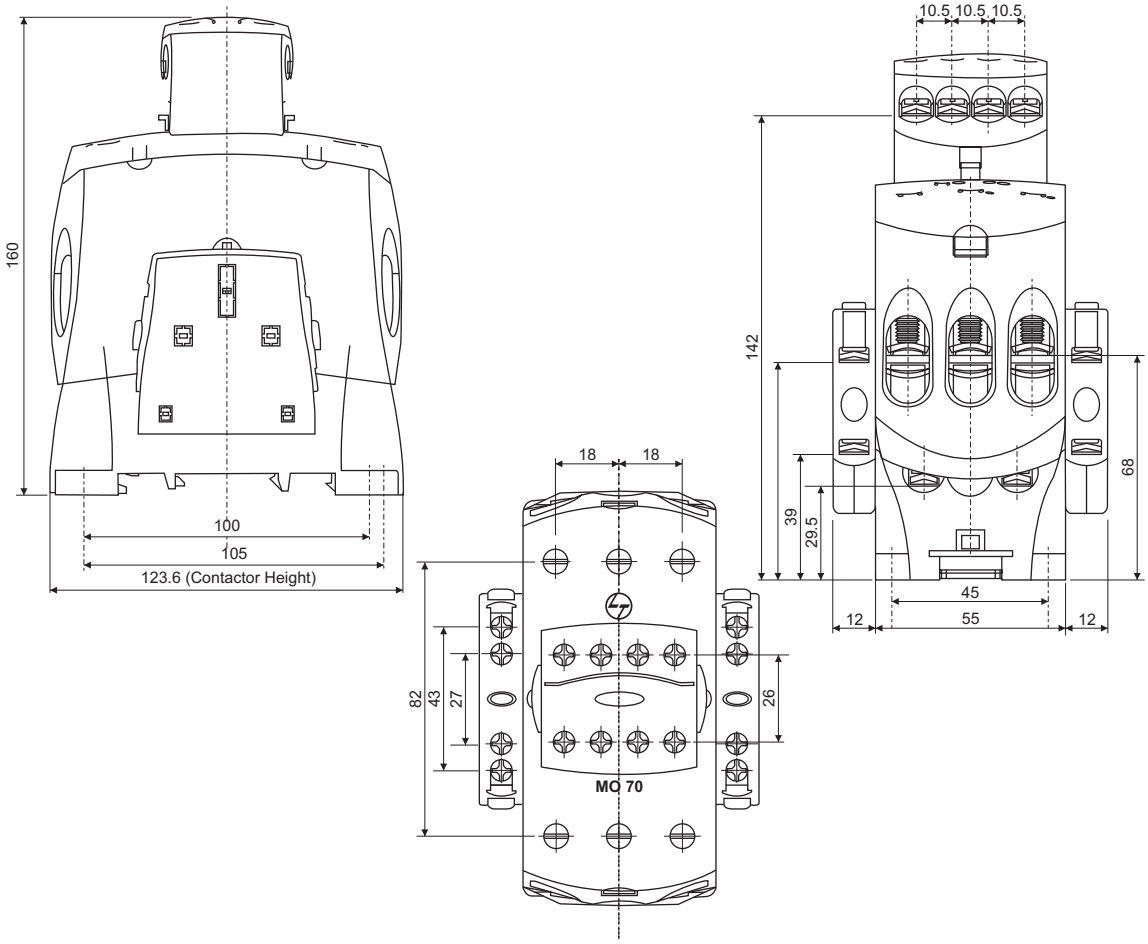




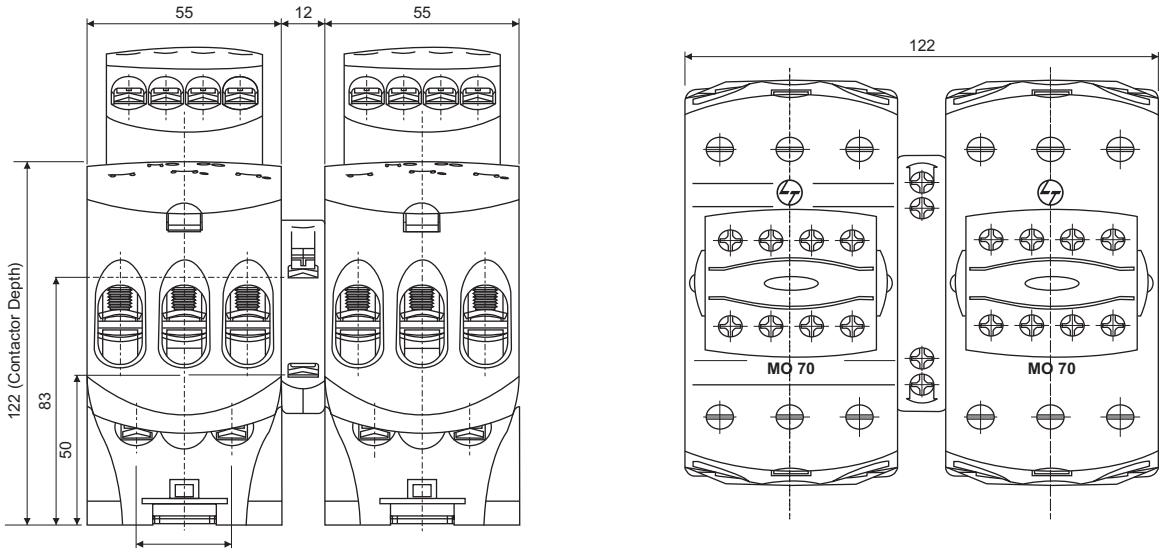
All dimensions in mm.

MO Frame II: 50, 60, 70

Overall Dimensions with Auxiliary Contact Block



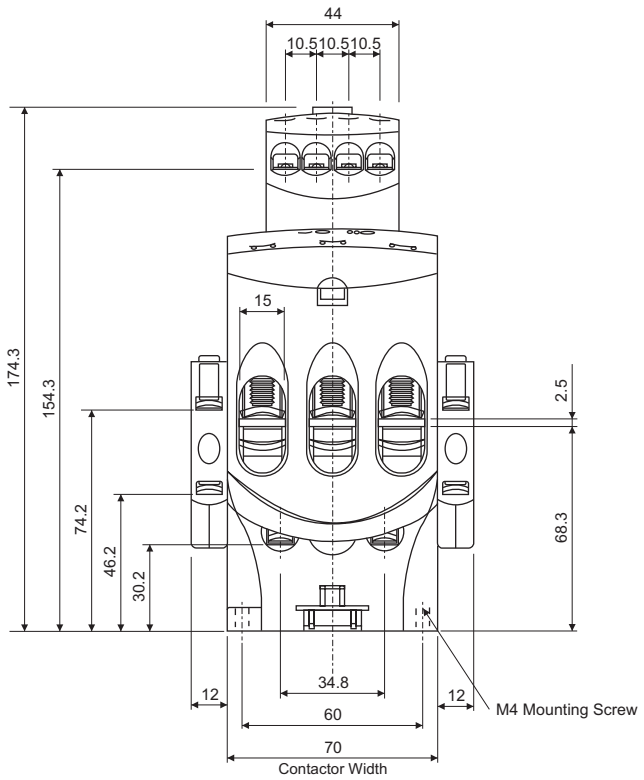
Overall Dimensions with Mechanical Interlock

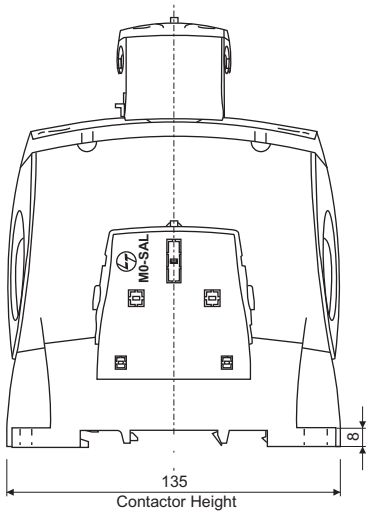


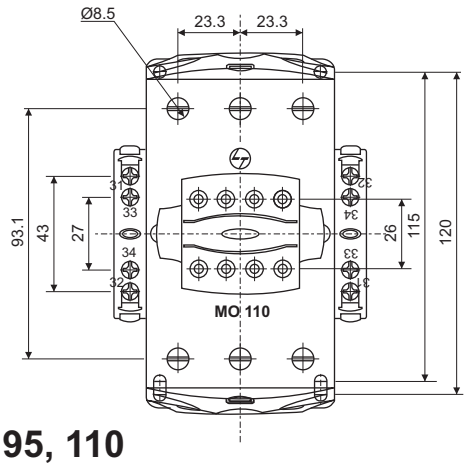
All dimensions in mm.

MO Frame III: 80, 95, 110

Overall Dimensions with Auxiliary Contact Block

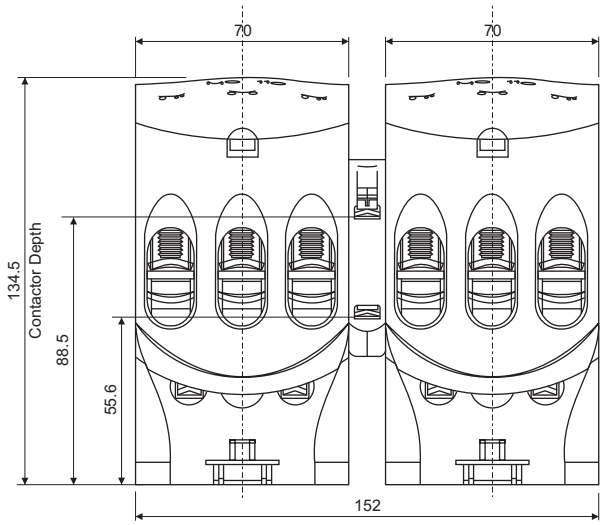


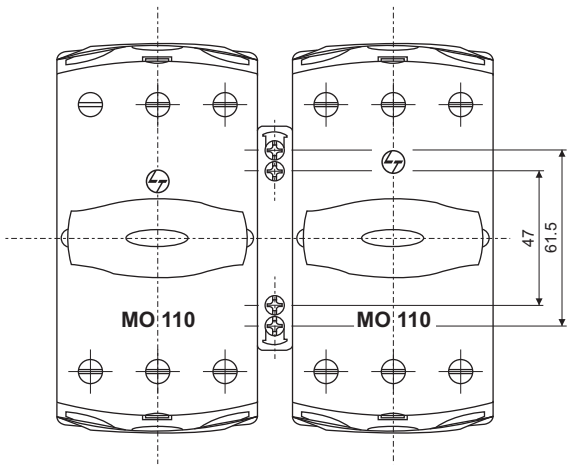




MO Frame III: 80, 95, 110

Overall Dimensions with Mechanical Interlock



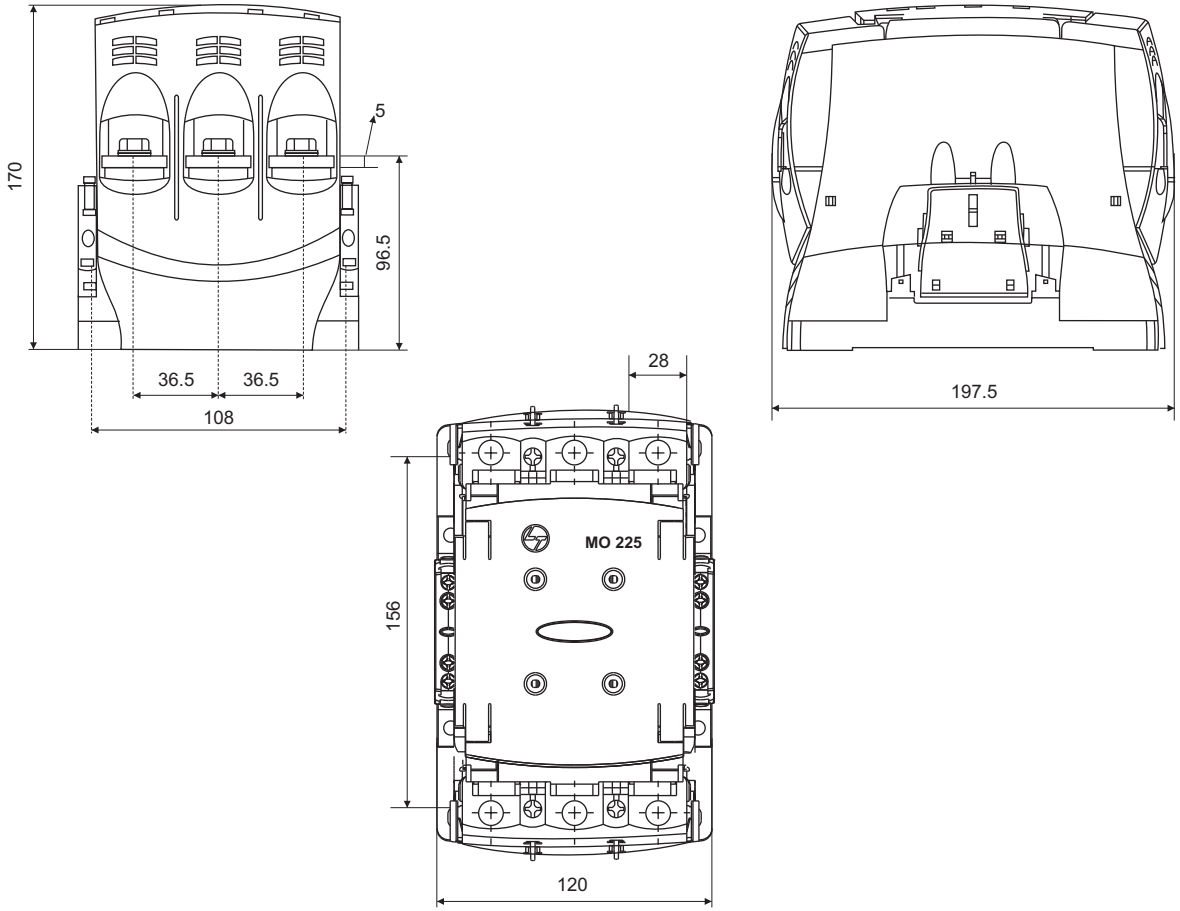


Note: Mechanical interlock kit can be fitted even with side auxiliary contacts in that case width will increase by 12 mm per auxiliary contact block.

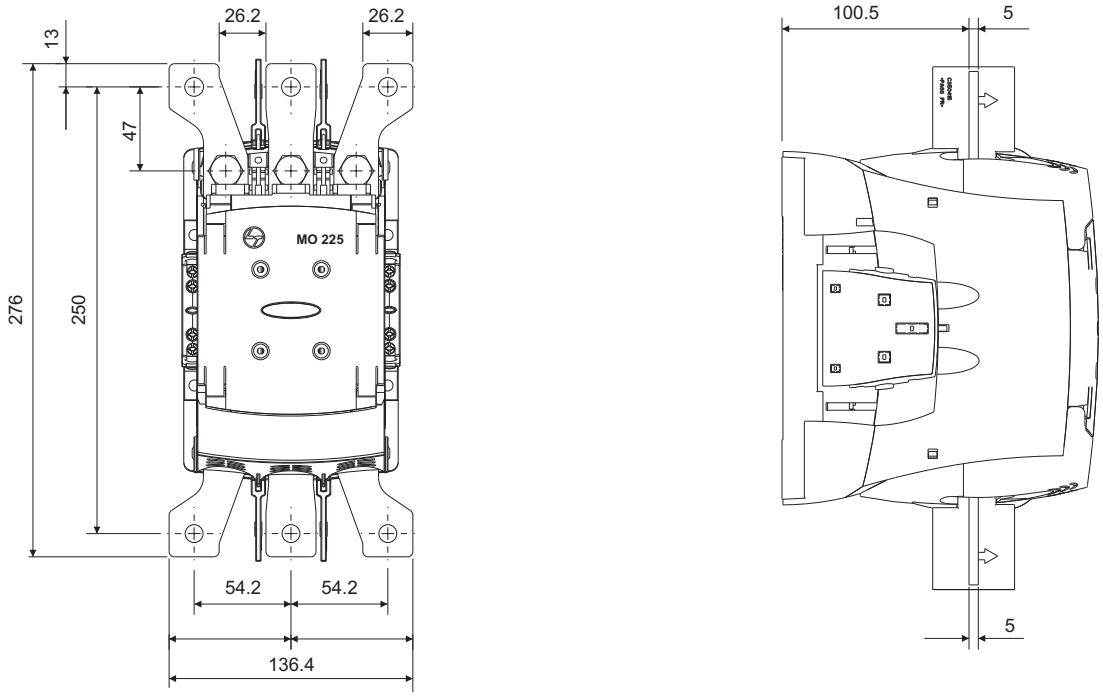
All dimensions in mm.

MO 140/185/225

Overall Dimensions



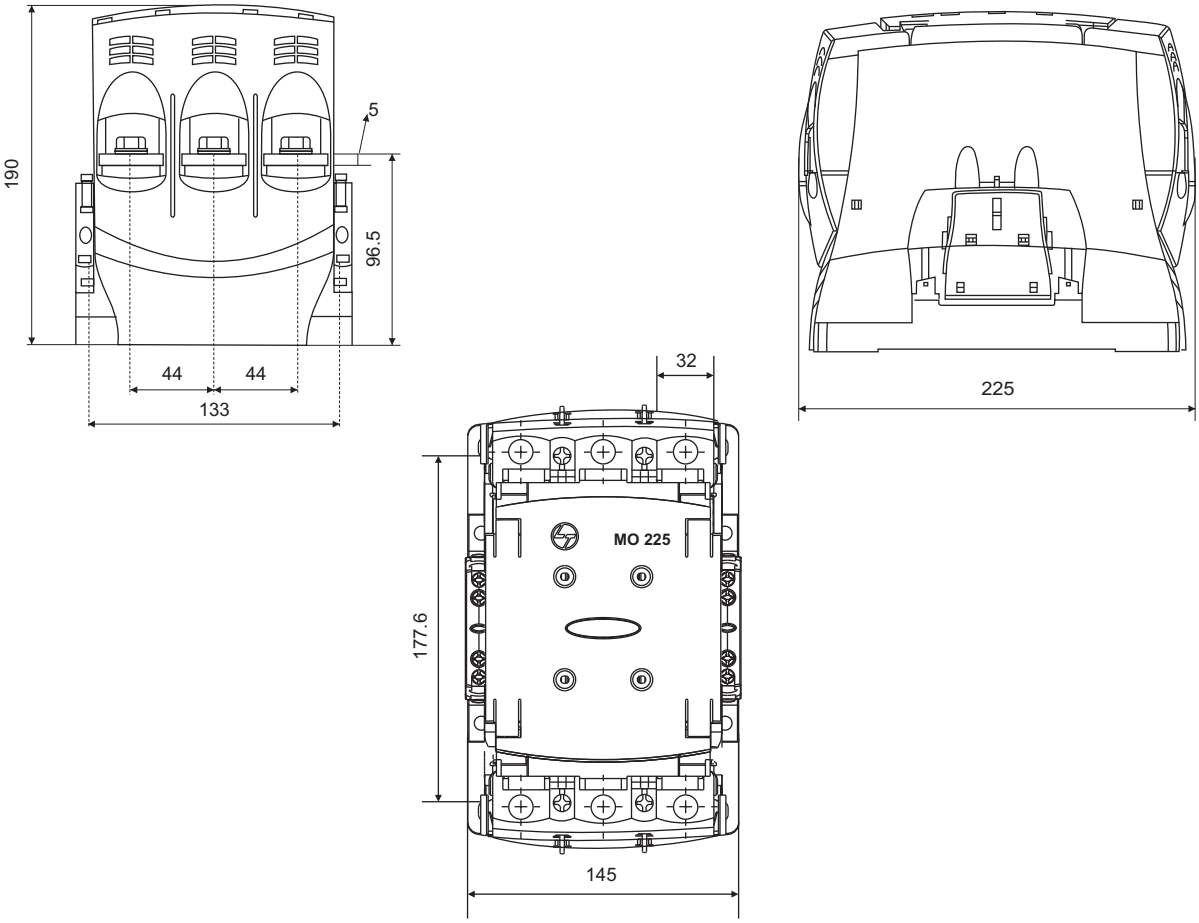
Overall Dimensions with Spreader Link



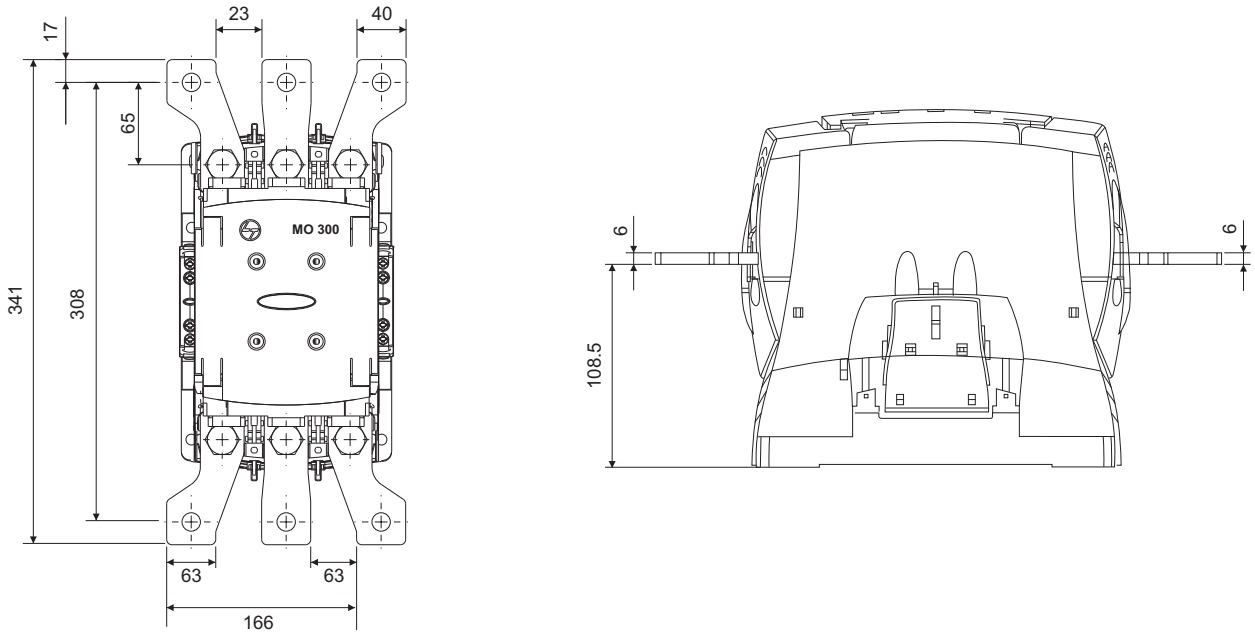
All dimensions in mm.

MO 250/300

Overall Dimensions



Overall Dimensions with Spreader Link



All dimensions in mm.

RTO Thermal Overload Relays

RTO Thermal Overload Relays complement MO range of contactors and can be directly mounted on them. The relays are ambient temperature compensated and are phase failure sensitive. The relays have a front access to START and STOP/RESET buttons and are provided with three contacts for Alarm, Trip and Start.

RTO

THERMAL OVERLOAD RELAYS

L&T introduces RTO range of Thermal Overload Relays to complement the MO range of contactors. RTO thermal overload relays are available in 26 ranges and 3 frame sizes. The range is available from 0.23A to 375A . RTO range of Thermal Overload Relays provide protections against overload and single phasing and are modular in design.

Features

- Visual status indication-tripped / non-tripped from front
- Phase failure sensitive
- Ambient temperature compensated
- Auto manual / Reset function
- Test function-simulates the tripping of the Relay from the front
- Front access to START and STOP / RESET buttons
- Three contacts: Alarm, Trip and Start
- Isolated alarm circuit (N.O.) contact
- Sealable in OFF condition
- Sealable transparent top cover
- Direct mounting on MO contactors

Accessories

- Separate mounting kit

Technical Details




Type	Units	RTO-1	RTO-2	RTO-3	RTO-4
Main Circuit					
Conformance to Standards		IS/IEC 60947-4-1			
Mounting		Direct / Separate			Direct
Direct Mounting on Contactors		MO 9 - 45	MO 50 - 70	MO 80 - 110	MO 140 - 300
Degree of Protection		IP20			
Rated Insulation Voltage U_i	V	1000			
Rated Impulse Withstand U_{imp}	kV	8			
Rated Operational Voltage	V	415			
Type of Operation		Direct Acting, Trip Free Mechanism			
Trip Class	A	class 10 A, Fixed			
Temp Compensation	°C	-20°C to +55°C			
Main Terminal Capacity (Cable)	mm^2	Solid - 2 x 2.5 to 10 Finely Stranded - 2 x 2.5 to 6	Solid - 2 x 6 to 35 Finely stranded - 2 x 6 - 25	Solid - 2 x 10 to 70 Finely stranded - 2 x 10 to 50	Solid - 2 X 2.5 to 150 Finely stranded - 2 X 2.5 to 150
Tightening Torque	Nm	2.5	4	5	30
Type of Screw		M4	M6	M8	M12
Auxiliary Circuit					
No. of Contacts		1NO - Alarm			
		1NO - Start			
		1NC - Trip			
Rated Insulation Voltage	V	1000			
Rated Impulse Withstand	kV	8			
AC-15 rating at 415 V, 50 Hz	A	2			
Thermal Current	A	6			
Terminal Capacity		2 x 2.5 sq. mm, Solid or finely stranded. Type of Screw - M3, Class 6.8 Tightening Torque - 1.5 Nm			

RTO Thermal Overload Relays

Type	Range (A)	Cat. Nos.
RTO-1	0.23 - 0.41	CS96355OOFO
	0.31 - 0.55	CS96355OOGO
	0.55 - 0.85	CS96355OOJO
	0.78 - 1.2	CS96355OOLO
	1.2 - 2.0	CS96355OONO
	1.9 - 2.8	CS96355OOPO
	2.4 - 3.6	CS96355OOQO
	3.5 - 5.2	CS96355OOSO
	4.6 - 6.7	CS96355OOTO
	6.7 - 9.7	CS96355OOVO
	8.5 - 12.5	CS96355OOAO
	12.5 - 18.5	CS96356OOCO
	17 - 25.5	CS96356OODO
	25 - 37	CS96356OOEO
	35 - 45	CS96356OOGO
RTO-2	5 -7.5	CS96366OOUO
	7-11	CS96366OOVO
	10.5 - 16	CS96366OOBO
	15 - 21	CS96366OOCO
	20 - 31	CS96366OOEO
	30 - 43	CS96366OOFO
	40 - 57	CS96366OOSO
	50 - 75	CS96367OOJO
RTO-3	23 - 30	CS90873OOEO
	29 - 38	CS96303OOQO
	37 - 49	CS96304OOGO
	47 - 62	CS96312OOTO
	60 - 78	CS96313OOJO
	75 - 110	CS96314OOKO
RTO-4	23.4 - 36	CS97096OOGO
	36 - 60	CS97096OOJO
	57 - 84	CS97096OOKO
	72 - 108	CS97096OOLO
	105 - 156	CS97096OOMO
	138 - 201	CS97096OONO
	201 - 291	CS97096OOQO
	255 - 375	CS97096OORO

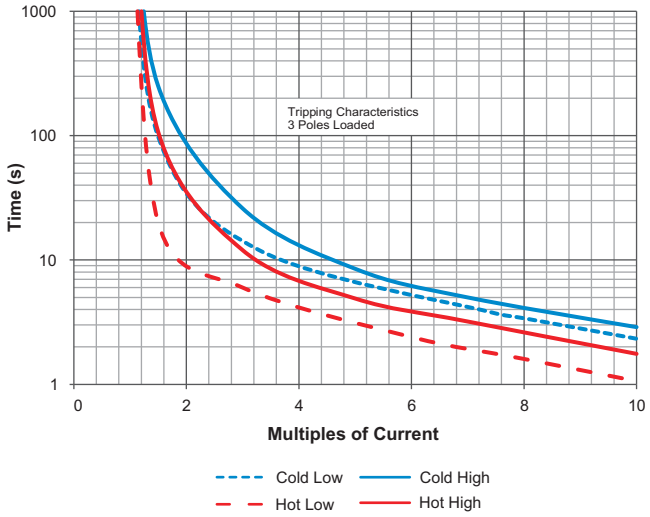
Accessories for RTO Relays

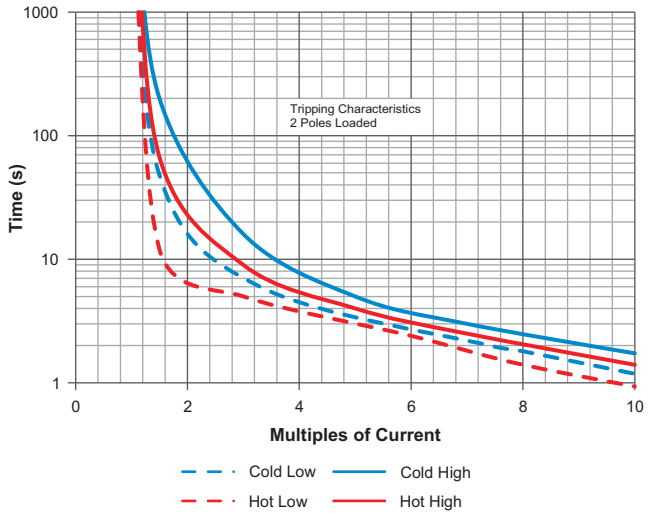
Separate Mounting Kit for RTO-1 Relay

Description	Cat. No.
RTO-1 Relay Separate Mounting Kit	CS96335OOOO
RTO-2 Relay Separate Mounting Kit	CS96306OOOO
RTO-3 Relay Separate Mounting Kit	CS96307OOOO

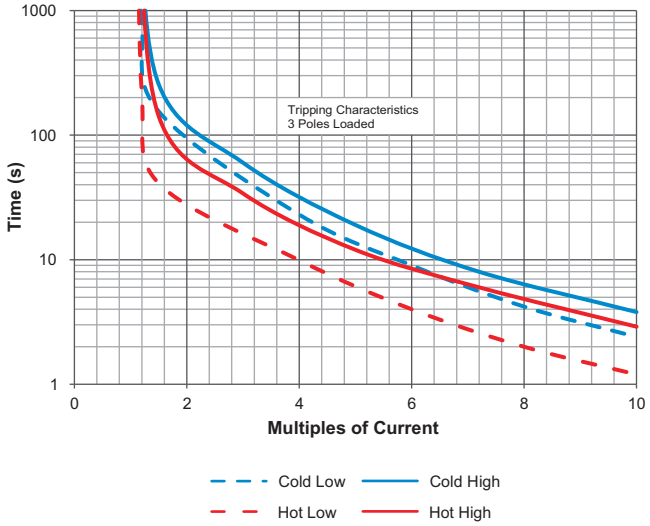
I-T Characteristics

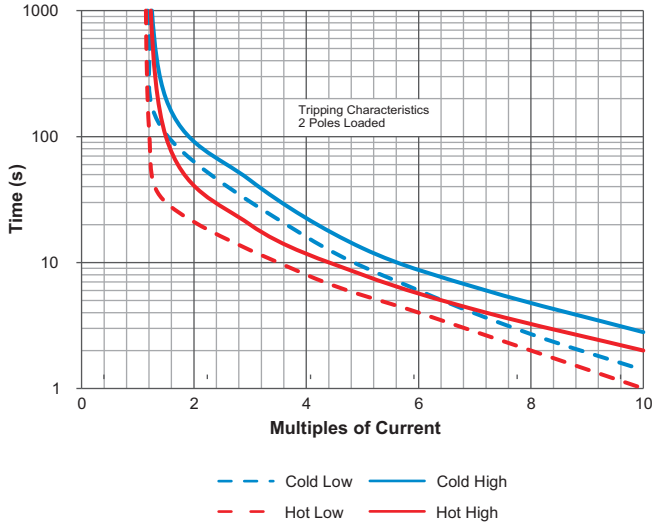
RTO1



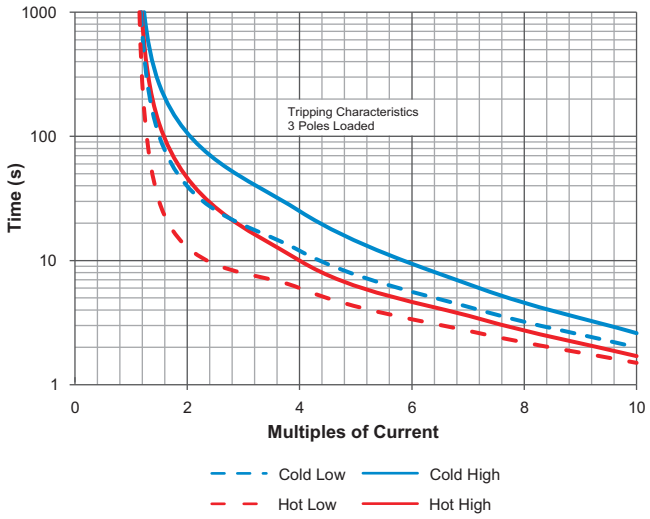


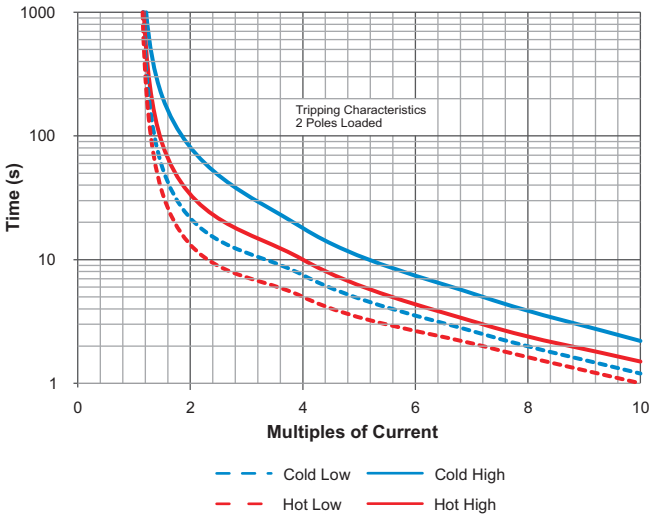
RTO2



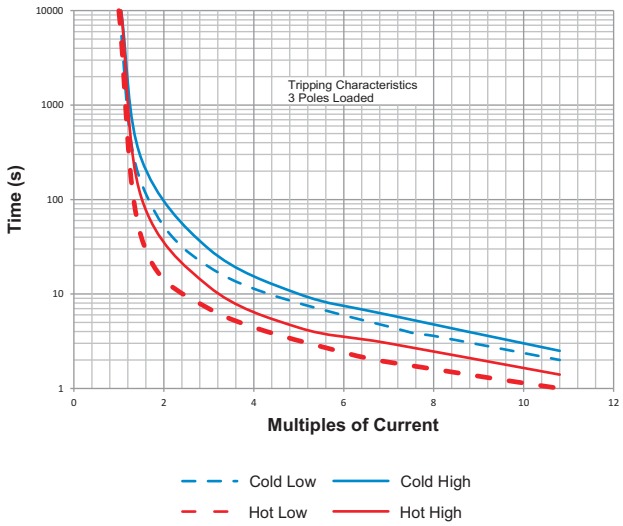


RTO3


Tripping Characteristics
3 Poles Loaded
Time (s)
1000
100
10
1
0
2
4
6
8
10
Multiples of Current
Cold Low
Cold High
Hot Low
Hot High

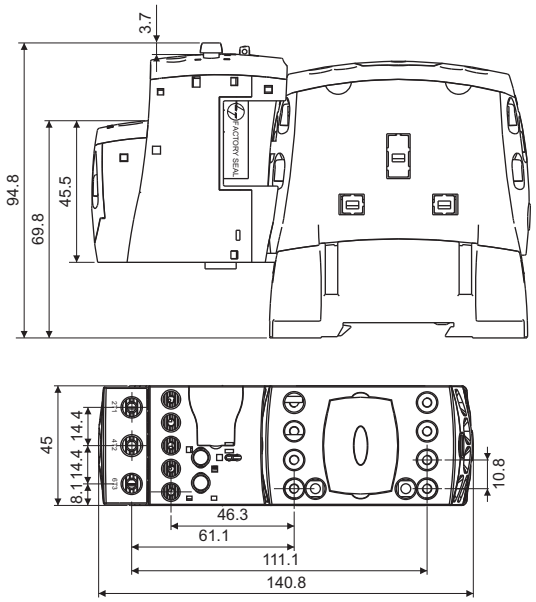

Tripping Characteristics
2 Poles Loaded
Time (s)
1000
100
10
1
0
2
4
6
8
10
Multiples of Current
Cold Low
Cold High
Hot Low
Hot High

RTO4

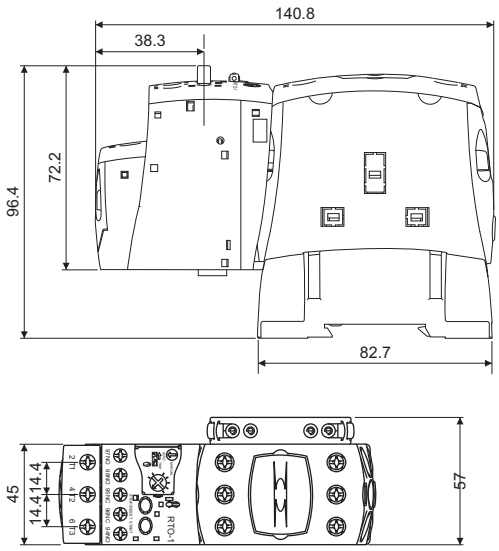

Tripping Characteristics
3 Poles Loaded
Time (s)
10000
1000
100
10
1
0
2
4
6
8
10
12
Multiples of Current
Cold Low
Cold High
Hot Low
Hot High

Overall Dimensions

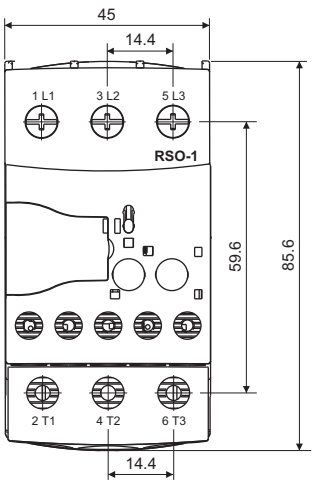
RTO-1 Relay On MO Frame 0 Contactor (9/12/18A)

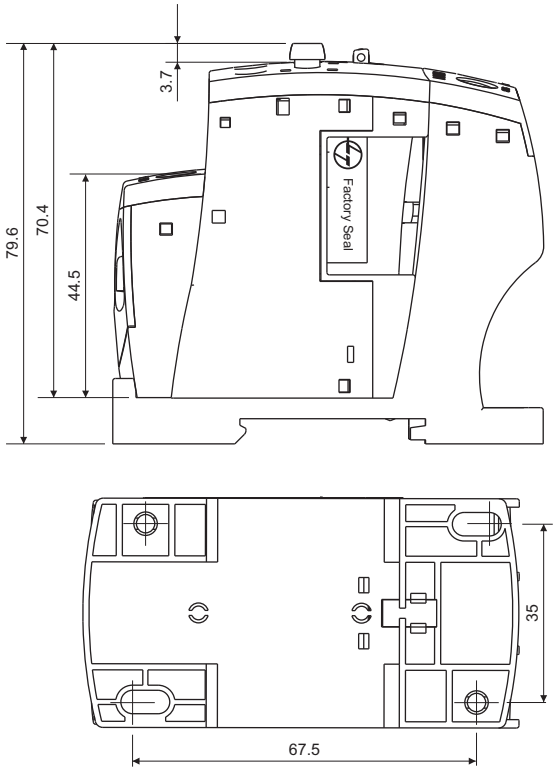


RTO-1 Relay On MO Frame 1 Contactor (25/32/40/45A)



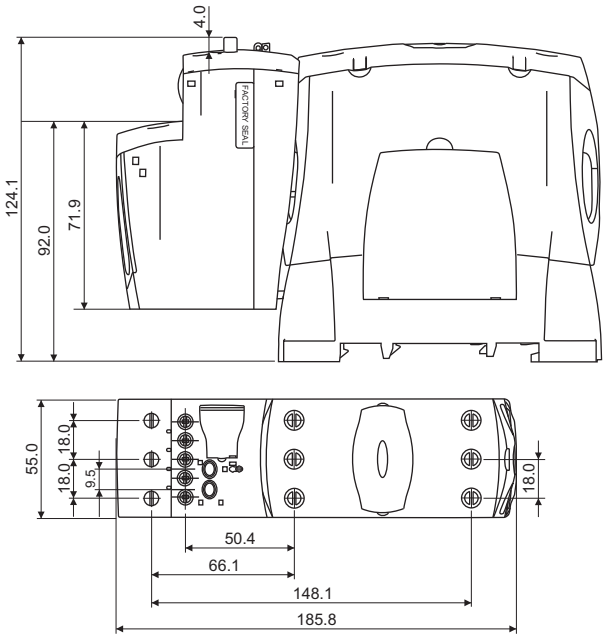
RTO-1 with Separate Mounting Kit RSO-1



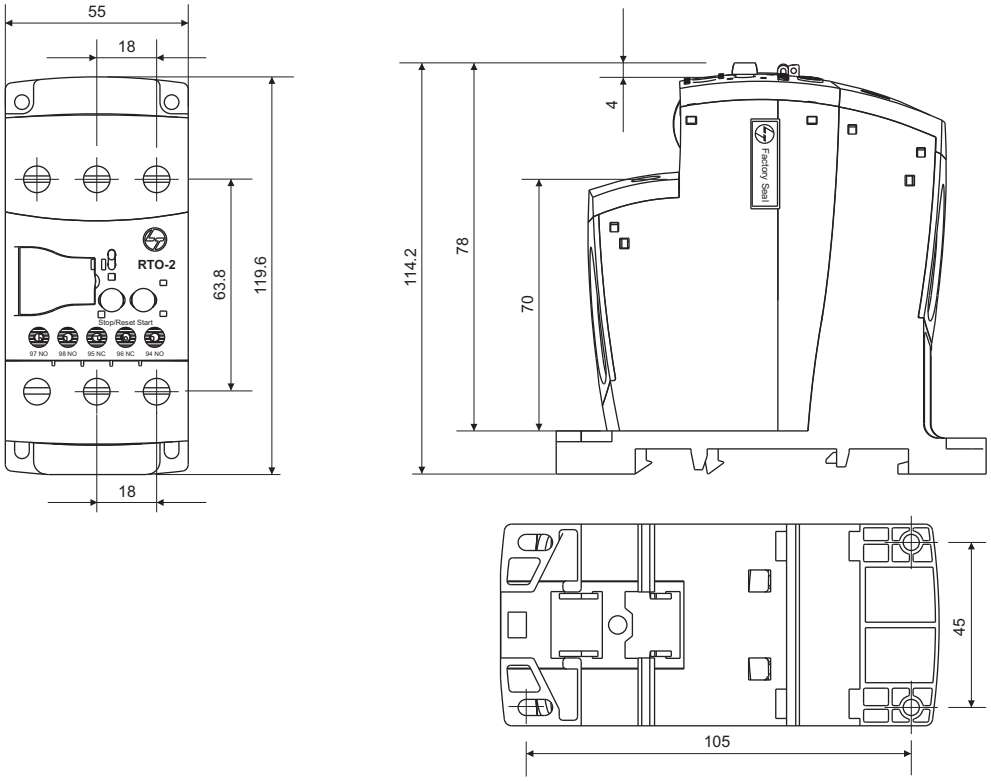


All dimensions in mm.

RTO-2 Relay On MO Frame 2 Contactor (50/60/70A)



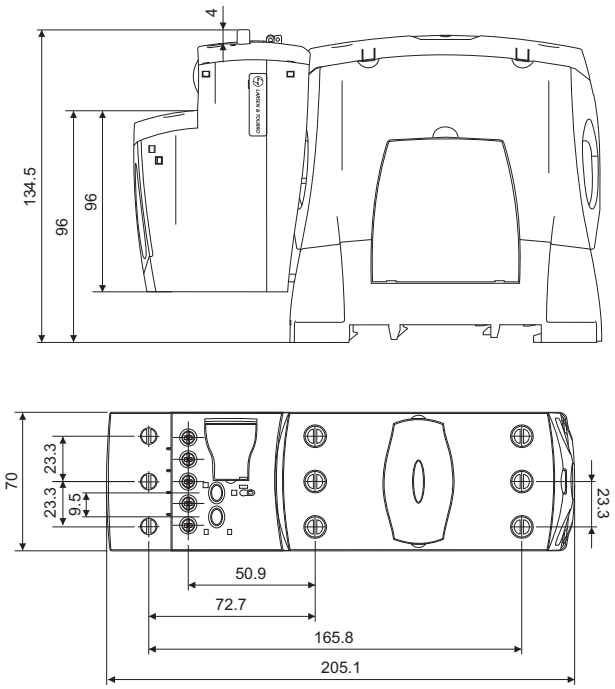
RTO-2 with Separate Mounting Kit RSO-2



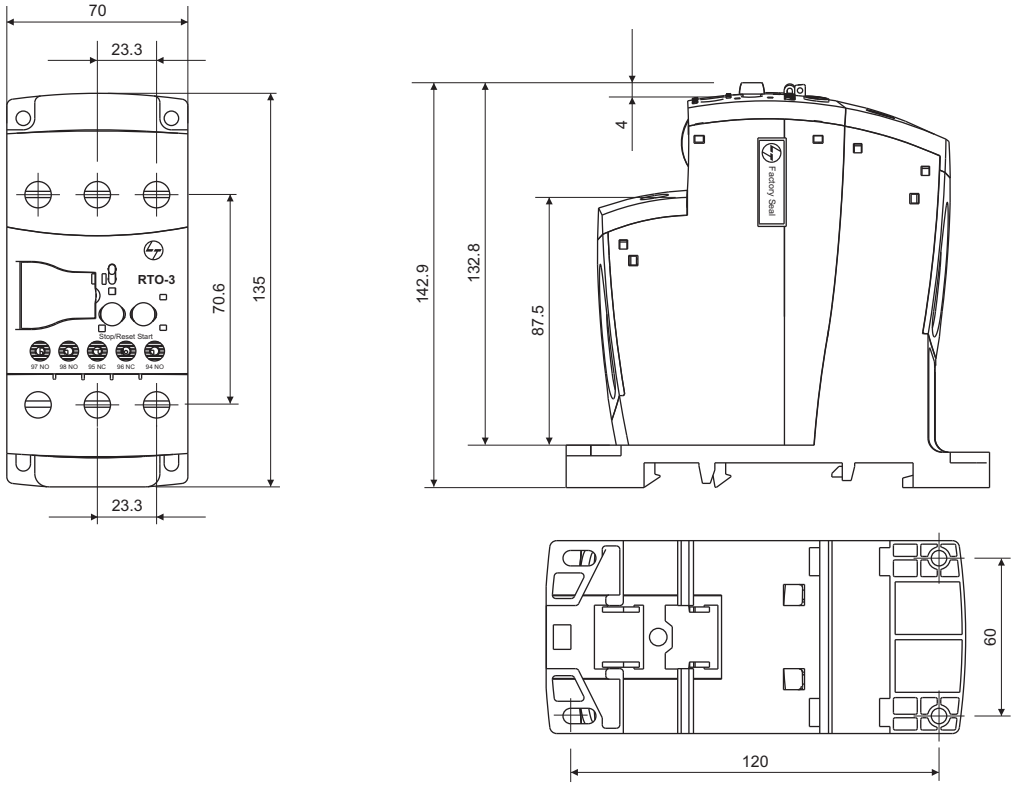
All dimensions in mm.

Overall Dimensions

RTO-3 Relay On MO Frame 3 Contactor (80/95/110A)

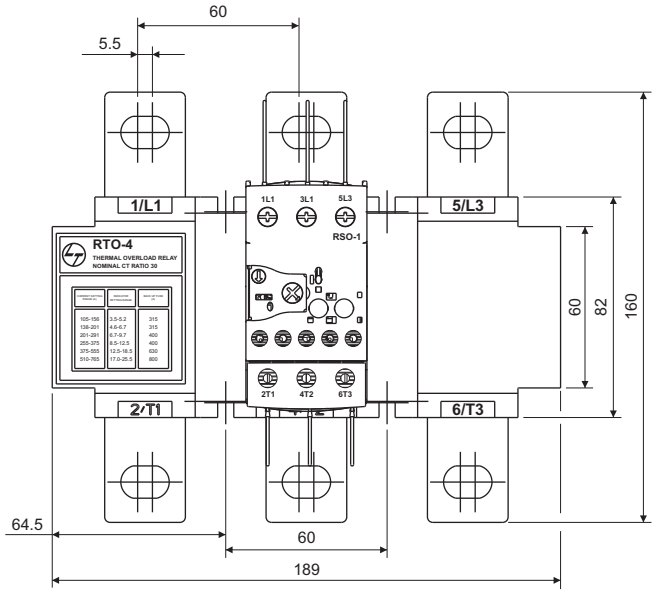


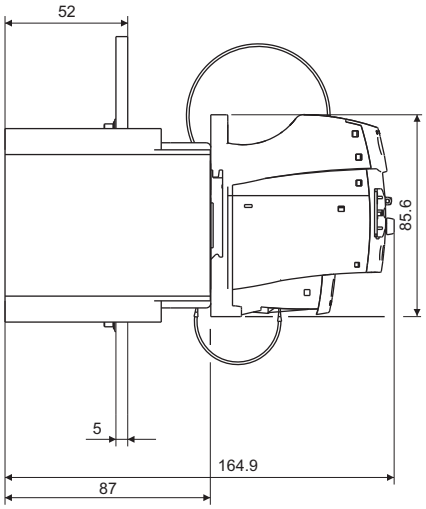
RTO-3 with Separate Mounting Kit RSO-3



All dimensions in mm.

RTO-4 Relay On
MO Frame 4/5 Contactor
(140/180/225/250/300A)





All dimensions in mm.

MVO Vacuum Contactor

MVO contactors encapsulating vacuum interrupters are suited for heavy duty applications like crane & hoist, mining etc. The contactors, available from 400A to 820A AC-3 in line with MO contactors having faster switching capabilities and higher reliability in dusty environment.

EMPOWERING THE FUTURE

Why Vacuum Contactor?

Vacuum as a medium has better di-electric strength, which makes electrical arc quenching easier than the same in air. Vacuum interrupters make the main contact system of a vacuum contactor. These encapsulated contacts prevent any arc from coming out of the interrupter and it also prevents entry of foreign particles inside the contacts. This makes the vacuum contactor a viable solution in harsh environmental conditions like mining and steel plants.

In vacuum contactor, the arc gets quenched at first zero crossing without a restrike. The duration of the arc is very short. This gives minimal wear and tear to the contacts and the electrical life of the contactor is much higher as compared to conventional air brake contactor.

Benefits of Vacuum contactor

- High electrical life
- Low maintenance
- Low down time
- Cost effective and compact
- Totally encapsulated structure for higher reliability in dusty and corrosive atmosphere
- RoHS compliant

Applications:

- Crawler cranes; forward reverse operation in mines
- Lifts hoists
- Blast furnace
- Cold rolling mill
- Resistive load switching in heaters, ventilation system, melting furnace

Note: Vacuum contactors are not recommended for

- Switching of DC current
- Switching of resistance in rotor circuit of Slip ring induction motors

Features

Contact life indicator on front facia for easy visibility

Potted Coil Drive
- Vibration & shock resistance
- Can withstand harsh environmental condition
- Protection from moisture In-built surge suppressor

- Available with universal AC/DC electronic coil version
- Contactor ON-OFF indicator on top
- Coil voltage indicator on top

- Termination capacity as per IEC 60947-1 Refer datasheet at below

Technical Details

Parameters		Units	MVO 400 CS90097	MVO 500 CS90098	MVO 630 CS90099	MVO 820 CS90077
Conformance to standard			IS/IEC 13947 -4-1 IEC 60947- 4-1 EN 60947-4-1			
Power Circuit						
No. of poles			3	3	3	3
Rated Operational Voltage U_e		V	690	690	690	690
Rated Insulation voltage U_i		V	1000	1000	1000	1000
Rated Impulse withstand voltage U_{imp}		kV	8	8	8	8
Service Temperature		°C	-25° to +55°C			
Storage Temperature		°C	-25° to +80°C			
Making capacity, 690 VAC		kA	5.1	5.1	7.6	7.6
Breaking capacity, 690 VAC		kA	4.3	4.3	7.2	7.2
Rated Operational Current Ie @690V	AC-1	A	630	630	820	1000
	AC-3	A	400	500	630	820
	AC-4	A	350	430	610	690
Mechanical life		millions	10	10	10	10
Electrical life @ 415 V	AC-3	millions	1.8	1.6	1.4	1.4
	AC-4	millions	0.7	0.6	0.4	0.34
Switching frequency.Operating cycles/Hr	Mechanical	cy/hr	800	800	800	800
	AC-3	cy/hr	750	750	500	500
	AC-4	cy/hr	150	150	150	150
Termination capacity, Cu bars (no. x sq.mm.)		mm^2	2 x 40 x 5	2 x 40 x 5	2 x 50 x 5	2 x 60 x 5
No of built in auxiliary contacts			2NO+2NC			
Coil Characteristics						
Voltages 50 Hz, AC		V	110 - 240			
Limits of operation	Pick up (% Uc)	% Uc	80% - 110% Uc			
	Drop off (% Uc)	% Uc	55% - 35% Uc			
Dimensions						
Overall Dimensions	H	mm	300	300	310	320
	W	mm	230	230	230	230
	D	mm	225	225	225	225
Accessories			Surge Supressor (in-built), Coil Drive (inbuilt), Erosion Indicator (in-built), Add-On blocks			

MVO Contactors

Type	AC1 Rating (A)	AC3 Rating (A)	Cat. Nos.
MVO 400	630	400	CS90097
MVO 500	630	500	CS90098
MVO 630	820	630	CS90099
MVO 820	1000	820	CS90077

Add-on auxiliary contact block, suitable for all MVO contactors

MVO 400A-820A	Side Mounted First Left	1 NO + 1 NC	13 - 14, 21 - 22	CS91208OOOO
	Side Mounted First Right	1 NO + 1 NC	33 - 34, 41 - 42	CS91209OOOO
	Side Mounted Second Left	1 NO + 1 NC	43 - 44, 51 - 52	CS95035OOOO
	Side Mounted Second Right	1 NO + 1 NC	63 - 64, 71 - 72	CS95036OOOO

MVO Spares

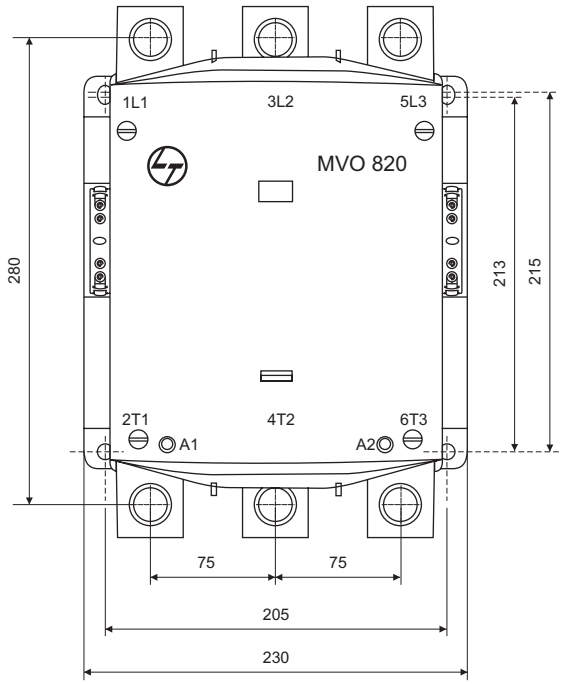
Type	Spare Coil
MVO	CS90174

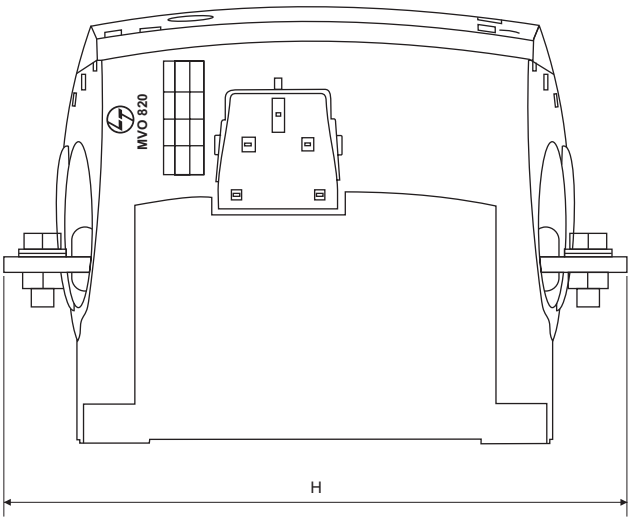
Ordering Suffix for Coil Voltages

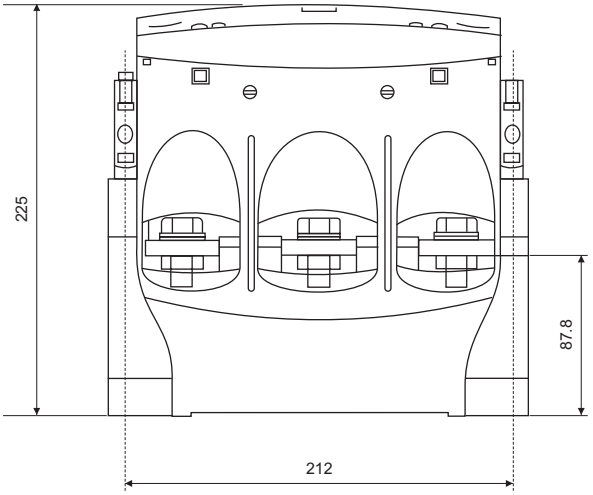
Std Coil Voltage	110-240	240-415
Ordering Suffix	AOOO	BOOO

MVO: 400, 500, 630, 820

Overall Dimensions with Auxiliary Contact Block







All dimensions in mm.

MNX 2 & 3 Pole Power Contactors

MNX power contactors are mainly used in motor feeder and control system applications. The range, available from 9A to 650A (AC-3) provides a reliable performance across diverse conditions like high ambient temperature, humidity etc. Standardized accessories and spares are available for the entire range.

REACH OUT TO RELIABILITY

Technical Details - 2&3 Pole Contactors

- Range from 9-650A AC3
- Coil on top design 95A and above
- Built-in 2 NO + 2 NC auxiliary contacts for 95A & above




		Units	MNX 9	MNX 12	MNX 18	MNX 22
Catalogue No.	2 Pole		CS 90232	CS 90234	CS 90236	CS 90238
	3 Pole		CS 94106 / 7*	CS 94108 / 9*	CS 94100 / 1*	CS 94980 / 81*
Conformance to standards						
Power Contacts						
Rated insulation voltage, U_i		V	690	690	690	690
Rated impulse withstand voltage, U_{imp}		kV	8	8	8	8
Rated kW	240 V AC	kW	2.2	3.0	4.0	5.5
	415 V AC	kW	4.0	5.5	9.3	11.0
	500 V AC	kW	5.5	7.5	9.3	11.0
Rated making capacity	240 V AC	A	450	450	450	450
	415 - 500 V AC	A	450	450	450	450
Rated breaking capacity	240 V AC	A	200	250	250	250
	415 - 500 V AC	A	200	250	250	250
Rated operational current, I_e at 55°C / 60°C Motor duty : 3Ø, 415 V, 50 Hz	Utilization category AC-1	A	25	30	30	32
	Utilization category AC-2	A	9	12	18	22
	Utilization category AC-3	A	9	12	18	22
	Utilization category AC-4	A	9	12	18	22
	Utilization category AC-4 (2,00,000 operations)	A	5.5	7.1	8	8.5
AC-8b rating at 415V, 50 Hz		A	11.5	15.5	23.5	28.5
Permissible short time ratings	1 Seconds		250	300	300	300
	10 Seconds	A	105	145	145	145
	30 Seconds		70	90	90	90
	1 Minute	A	60	80	80	80
	10 Minute		30	40	40	40
	15 Minute	A	25	30	30	30
Mechanical life, No. of operating cycles		millions	15	15	15	15
Max. frequency of operations: Operating cycles/hr	Mechanical	cy/hr	7200	7200	7200	7200
	Utilization category AC-1	cy/hr	3000	3000	3000	3000
	Utilization category AC-2	cy/hr	750	750	750	750
	Utilization category AC-3	cy/hr	750	750	750	750
	Utilization category AC-4	cy/hr	300	300	300	300
Vibration resistance conforming to IEC 60068-2-6						
Ambient temperature around the device	Service temperature	°C				
	Storage temperature	°C				-40°C to +80°C
Altitude without deration		m				
Degree of Pollution						
Degree of protection						
Protective treatment as per IEC 60068 - 2 - 30						
Watt loss per pole	Utilization category AC-1	W	1.5	2	2	2.2
	Utilization category AC-3	W	0.5	0.2	0.8	0.8
Type of Terminal			Philip and Slot Head Combination Screw			






	MNX 25	MNX 32	MNX 40	MNX 50	MNX 70	MNX 80
	CS 90240	CS 90241	CS 90242	CS 94061	CS 94062	CS 94063
	CS 94110	CS 94111	CS 94190	CS 97075	CS 97076	CS 97077
	IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
	690	690	690	690	690	690
	8	8	8	8	8	8
	5.5	7.5	11.0	15.0	18.6	22.0
	11.0	17.0	22.5	26.0	37.0	40.0
	15.0	18.6	22.5	30.0	45.0	55.0
	480	550	550	900	900	900
	480	550	550	900	900	900
	400	500	500	750	750	750
	400	500	500	750	750	750
	45	55	55	85	100	100
	25	32	32	50	70	80
	25	32	40	50	70	80
	25	32	40	50	63	70
	13.5	16	20	24	28.5	43
	32.5	41.5	52	651	91	104
	400	600	600	000	1000	1000
	240	400	400	650	650	650
	120	225	225	370	370	370
	110	150	150	250	250	250
	50	70	70	120	120	120
	45	65	65	110	110	110
	10	10	10	10	10	10
	7200	7200	3600	3600	3600	3600
	3000	3000	3000	3000	3000	3000
	750	750	750	750	750	750
	750	750	750	750	750	750
	300	300	300	300	300	300
		5..... 300 Hz : 3g				
		-20°C to +55°C				
				-15°C to +80°C		
		3000				
		3				
		IP 20				
		TH				
	3.7	5.1	5.1	9.7	12.9	12.9
	1.15	2.15	2.7	5	6.6	7
			Slot Head Screw			

Technical Details - 2&3 Pole Contactors

- Range from 9-650A AC3
- Coil on top design 95A and above
- Built-in 2 NO + 2 NC auxiliary contacts for 95A & above




		Units	MNX 9	MNX 12	MNX 18	MNX 22
Catalogue No.	2 Pole		CS 90232	CS 90234	CS 90236	CS 90238
	3 Pole		CS 94106 / 7*	CS 94108 / 9*	CS 94100 / 1*	CS 94980 / 81*
Conformance to standards						
Maximum Main terminal capacity	Cable with Lug	mm^2	6	6	6	6
	Cable with Lug (spreader links)	mm^2	-	-	-	-
	Solid conductors	mm^2	2 x 4	2 x 4	2 x 4	2 x 4
	Multi strand conductors	mm^2	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
Tightening Torque	Main Pole Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M4 / 1.3
	Aux. Pole / Coil / Add on block Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
Fuse protection against short circuit			HF 20	HF 32	HF 32	HF 40
Auxiliary Contacts						
No. of additional aux. contact possible			8	8	8	8
No. of built-in auxiliary contacts			1 NO or 1 NC	1 NO or 1 NC	1 NO or 1 NC	1 NO or 1 NC
Conventional thermal current, I_{th} at 55°C		A	10	10	10	10
Endurance of auxiliary Contacts		millions	0.5	0.5	0.5	0.5
AC-15 rating at 415 V, 50 Hz	24-110 V	A	6	6	6	6
	220-240 V	A	4	4	4	4
	360-440 V	A	4	4	4	4
	525-600 V	A	1.2	1.2	1.2	1.2
DC-13 rating at 415 V	24 V	A	6	6	6	6
	110-125 V	A	1.1	1.1	1.1	1.1
	250 V	A	0.55	0.55	0.55	0.55
	480 V	A	0.31	0.31	0.31	0.31
	500 V	A	0.27	0.27	0.27	0.27
	600 V	A	0.2	0.2	0.2	0.2
Terminal capacity (Solid or multi strand conductors)		mm^2	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
Coil						
Voltage available U_C	50 / 60 Hz	V	24, 42, 110, 220, 240, 415, 525	24, 42, 110, 220, 240, 415, 525	24, 42, 110, 220, 240, 415, 525	24, 42, 110, 220, 240, 415, 525
Pick-up	VA	VA	68	68	68	68
Hold-on	VA	VA	11	11	11	11
	Watts	W	4	4	4	4
Limits of operation	Pick-up (%Uc) 50Hz	%Uc	65 - 120	65 - 120	65 - 120	65 - 120
	Pick-up (%Uc) 60Hz	%Uc	85 - 110	85 - 110	85 - 110	85 - 110
	Drop-off (%Uc)	%Uc	35 - 50	35 - 50	35 - 50	35 - 50
Operating time	Closing time	ms	10 - 12	10 - 12	10 - 12	10 - 12
	Opening time	ms	7 - 18	7 - 18	7 - 18	7 - 18
Safe isolation between coil and auxiliary contacts		V	400	400	400	400
Overall dimensions **H x W x D**		mm^3	83 x 45 x 88	83 x 45 x 88	83 x 45 x 88	83 x 45 x 88
Mounting clearance (front)		mm	10	10	10	10
Weight		kg	0.36	0.36	0.36	0.36






	MNX 25	MNX 32	MNX 40	MNX 50	MNX 70	MNX 80
	CS 90240	CS 90241	CS 90242	CS 94061	CS 94062	CS 94063
	CS 94110	CS 94111	CS 94190	CS 97075	CS 97076	CS 97077
	IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
	10	10	10	1 x 35	1 x 35	1 x 35
	-	-	-	1 x 12.5 x 3	1 x 12.5 x 3	1 x 12.5 x 3
	2 x 6	2 x 6	2 x 6	-	-	-
	2 x 4	2 x 4	2 x 4	-	-	-
	M4 / 1.3	M4 / 1.3	M4 / 1.3	M5 / 2.4	M6 / 4.5	M6 / 4.5
	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
	HF 63	HN,000 63	HN,000 80	HN,000 80	HN,000 100	HN,000 125
	8	8	8	8	8	8
	#	#	#	#	#	#
	10	10	10	10	10	10
	0.5	0.5	0.5	0.5	0.5	0.5
	6	6	6	6	6	6
	4	4	4	4	4	4
	4	4	4	4	4	4
	1.2	1.2	1.2	1.2	1.2	1.2
	6	6	6	6	6	6
	1.1	1.1	1.1	1.1	1.1	1.1
	0.55	0.55	0.55	0.55	0.55	0.55
	0.31	0.31	0.31	0.31	0.31	0.31
	0.27	0.27	0.27	0.27	0.27	0.27
	0.2	0.2	0.2	0.2	0.2	0.2
	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
	24, 42, 110, 220, 240, 415, 525	24, 42, 110, 220, 240, 415, 525	24, 42, 110, 220, 240, 415, 525	24/29, 42/50, 110/132, 220/264, 240/288, 415/500, 525/630	24/29, 42/50, 110/132, 220/264, 240/288, 415/500, 525/630	24/29, 42/50, 110/132, 220/264, 240/288, 415/500, 525/630
	68	68	68	190	190	190
	11	11	11	21	21	21
	4	4	4	5.5	5.5	5.5
	65 - 120	65 - 120	80 - 110	80 - 110	80 - 110	80 - 110
	85 - 110	85 - 110	85 - 110	85 - 110	85 - 110	85 - 110
	35 - 50	35 - 50	35 - 65	35 - 65	35 - 65	35 - 65
	10 - 12	10 - 12	10 - 12	15 - 35	15 - 35	15 - 35
	7 - 18	7 - 18	7 - 18	10 - 25	10 - 25	10 - 25
	400	400	400	400	400	400
	83 x 45 x 88	83 x 45 x 88	83 x 45 x 88	109 x 89 x 120.5	109 x 89 x 120.5	109 x 89 x 120.5
	10	10	10	10	10	10
	0.4	0.4	0.4	1.1	1.1	1.1

Technical Details - 2&3 Pole Contactors

- Range from 9-650A AC3
- Coil on top design 95A and above
- Built-in 2 NO + 2 NC auxiliary contacts for 95A & above




		Units	MNX 9	MNX 12	MNX 18	MNX 22
Catalogue No.	2 Pole		CS 90232	CS 90234	CS 90236	CS 90238
	3 Pole		CS 94106 / 7*	CS 94108 / 9*	CS 94100 / 1*	CS 94980 / 81*
Conformance to standards						
DC ratings with 3 poles in series and AC coil operation	DC 1 (24V)	A	9	12	18	22
	DC 1 (48V)	A	9	12	18	22
	DC 1 (110V)	A	9	12	18	22
	DC 1 (220V)	A	9	12	18	22
	DC 3 (24V)	A	9	12	18	22
	DC 3 (48V)	A	9	12	18	22
	DC 3 (110V)	A	9	12	18	22
	DC 3 (220V)	A	9	12	18	22
	DC 5 (24V)	A	9	12	18	22
	DC 5 (48V)	A	9	12	18	22
	DC 5 (110V)	A	9	12	18	22
	DC 5 (220V)	A	6	7.5	9	12
DC ratings with 2 poles in series and AC coil operation	DC 1 (24V)	A	9	12	18	22
	DC 1 (48V)	A	9	12	18	22
	DC 1 (110V)	A	9	12	18	22
	DC 1 (220V)	A	4	4	4	4
	DC 3 (24V)	A	9	12	18	22
	DC 3 (48V)	A	9	12	18	22
	DC 3 (10V)	A	9	12	18	22
	DC 3 (220V)	A	2	2	2	2
	DC 5 (24V)	A	9	12	18	22
	DC 5 (48V)	A	9	12	18	22
	DC 5 (110V)	A	9	12	18	22
	DC 5 (220V)	A	2	2	2	2
DC ratings with 1 pole in series and AC coil operation	DC 1 (24V)	A	9	12	18	22
	DC 1 (48V)	A	9	12	18	22
	DC 1 (110V)	A	4	4	4	4
	DC 1 (220V)	A	1	1	1	1
	DC 3 (24V)	A	9	12	18	22
	DC 3 (48V)	A	9	12	18	22
	DC 3 (110V)	A	2	2	2	2
	DC 3 (220V)	A	0.5	0.5	0.5	0.5
	DC 5 (24V)	A	9	12	18	22
	DC 5 (48V)	A	9	12	18	22
	DC 5 (110V)	A	2	2	2	2
	DC 5 (220V)	A	0.5	0.5	0.5	0.5






	MNX 25	MNX 32	MNX 40	MNX 50	MNX 70	MNX 80
	CS 90240	CS 90241	CS 90242	CS 94061	CS 94062	CS 94063
	CS 94110	CS 94111	CS 94190	CS 97075	CS 97076	CS 97077
	IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	20	25	50	50	50	63
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	7	7	7	7	7	12
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	3	3	3	4	4	5
	25	32	40	50	63	80
	25	32	40	50	63	80
	25	32	40	50	63	80
	3	3	3	4	4	5
	25	32	40	50	63	80
	25	32	40	50	63	80
	7	7	7	7	7	12
	1	1	1	1	1.5	2
	25	32	40	50	63	80
	25	32	40	50	63	80
	3	3	3	4	4	5
	0.5	0.5	0.5	1	1.5	1
	25	20	40	50	63	80
	25	32	40	50	63	80
	3	3	3	4	4	5
	0.5	0.5	0.5	1	1.5	1

Technical Details - 2&3 Pole Contactors

- Range from 9-650A AC3
- Coil on top design 95A and above
- Built-in 2 NO + 2 NC auxiliary contacts for 95A & above




		Units	MNX 95	MNX 110	MNX 140	MNX 185
Catalogue No.	2 Pole		CS 94064	CS 94065	CS 94066	CS 94978
	3 Pole		CS 94136	CS 94137	CS 94138	CS 94139
Conformance to standards						
Power Contacts						
Rated insulation voltage, U_i		V	1000	1000	1000	1000
Rated impulse withstand voltage, U_{imp}		kV	8	8	8	8
Rated kW	240 V AC	kW	25.0	30.0	40.0	55.0
	415 V AC	kW	45.0	55.0	75.0	90.0
	500 V AC	kW	55.0	75.0	90.0	110.0
Rated making capacity	240 V AC	A	1680	1680	1800	2220
	415 - 500 V AC	A	1680	1680	1800	2220
Rated breaking capacity	240 V AC	A	1400	1400	1600	1850
	415 - 500 V AC	A	1400	1400	1600	1850
Rated operational current, I_e at 55°C / 60°C Motor duty : 3Ø, 415 V, 50 Hz	Utilization category AC-1	A	160	160	160	250
	Utilization category AC-2	A	95	110	140	185
	Utilization category AC-3	A	95	110	140	185
	Utilization category AC-4	A	95	110	140	160
	Utilization category AC-4 (2,00,000 operations)	A	53	58	66	90
AC-8b rating at 415V, 50 Hz		A	123.5	143	182	240.5
Permissible short time ratings	1 Seconds	A	1320	1320	1320	2000
	10 Seconds	A	800	800	800	1500
	30 Seconds	A	500	500	500	1000
	1 Minute	A	400	400	400	800
	10 Minute	A	170	170	170	350
	15 Minute	A	160	160	160	320
Mechanical life, No. of operating cycles		millions	10	10	10	10
Max. frequency of operations: Operating cycles/hr	Mechanical	cy/hr	3600	3600	3600	3600
	Utilization category AC-1	cy/hr	3000	3000	3000	3000
	Utilization category AC-2	cy/hr	750	750	750	750
	Utilization category AC-3	cy/hr	750	750	750	750
	Utilization category AC-4	cy/hr	300	300	300	250
Vibration resistance conforming to IEC 60068-2-6						
Ambient temperature around the device	Service temperature	°C				
	Storage temperature	°C				
Altitude without deration		m				
Degree of Pollution						
Degree of protection						
Protective treatment as per IEC 60068 - 2 - 30						
Watt loss per pole	Utilization category AC-1	W	13.5	13.5	17.6	16.6
	Utilization category AC-3	W	5	7	11.7	9.4
Type of Terminal						






MNX 225	MNX 250	MNX 300	MNX 400	MNX 550	MNX 650
CS94979	CS 90301	CS 94346	CS 94069	CS 90243	CS 90578
CS 94140	CS94141	CS90280	CS 94144	CS 94145	CS 96327
IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
1000	1000	1000	1000	1000	1000
8	8	8	8	8	8
63.0	63.0	90.0	110.0	160.0	180.0
110.0	132.0	160.0	200.0	315.0	355.0
132.0	142.0	180.0	250.0	365.0	-
2400	3000	4500	4500	5500	6500
2400	3000	4500	4500	5500	6500
2000	2500	4000	4000	4500	5200
2000	2500	4000	4000	4500	5200
300	300	400	425	650	800
225	250	300	400	550	650
225	250	300	400	550	650
200	200	235	275	300	400
100	120	140	150	150	-
292.5	325	390	520	715	845
2500	2500	3500	4600	7000	7000
1700	1700	2400	4400	6400	6400
1200	1200	1500	3100	4500	4500
1000	1000	1100	2500	3500	3500
450	450	550	900	1400	1400
400	400	500	840	1300	1300
10	10	10	10	10	10
3600	3600	3600	3600	1200	1200
3000	3000	3000	3000	750	750
750	750	750	750	750	750
750	750	750	750	750	750
150	150	150	150	150	150
	5...300Hz : 3g				
	-20°C to +55°C				
	-15°C to 80°C				
	3000				61.2
	3				48.6
	IP 20				
	TH				
19.4	20.8	17.6	40	52.7	
15	15	12.7	20.7	45	
	Slot Head Screw				

Technical Details - 2&3 Pole Contactors

- Range from 9-650A AC3
- Coil on top design 95A and above
- Built-in 2 NO + 2 NC auxiliary contacts for 95A & above




		Units	MNX 95	MNX 110	MNX 140	MNX 185
Catalogue No.	2 Pole		CS 94064	CS 94065	CS 94066	CS 94978
	3 Pole		CS 94136	CS 94137	CS 94138	CS 94139
Conformance to standards						
Maximum Main terminal capacity	Cable with Lug	mm^2	1 x 120	1 x 120	1 x 120	1 x 185
	2 Cable with Lug (spreader links)	mm^2	2 x 25 x 3	2 x 25 x 3	2 x 25 x 3	2 x 30 x 5
	2 Solid conductors	mm	-	-	-	-
	2 Multi strand conductors	mm	-	-	-	-
Tightening Torque	Main Pole Terminal	Nm	M8 / 11	M8 / 11	M8 / 11	M10 / 14
	Aux. Pole / Coil / Add on block Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
Fuse protection against short circuit			HN,0 200	HN,0 200	HN,1 250	HN,2 250
Auxiliary Contacts						
No. of additional aux. contact possible			4	4	4	4
No. of built-in auxiliary contacts			2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC
Conventional thermal current, I_{th} at 55°C		A	10	10	10	10
Endurance of auxiliary Contacts		millions	0.5	0.5	0.5	0.5
AC-15 rating at 415 V, 50 Hz	24-110 V	A	6	6	6	6
	220-240 V	A	4	4	4	4
	360-440 V	A	4	4	4	4
	525-600 V	A	1.2	1.2	1.2	1.2
DC-13 rating at 415 V	24 V	A	6	6	6	6
	110-125 V	A	1.1	1.1	1.1	1.1
	250 V	A	0.55	0.55	0.55	0.55
	480 V	A	0.31	0.31	0.31	0.31
	500 V	A	0.27	0.27	0.27	0.27
	600 V	A	0.2	0.2	0.2	0.2
Terminal capacity (Solid or multi strand conductors)		mm^2	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
Coil						
Voltage available U_C	50 / 60 Hz	V	24/29, 42/50, 110/132, 220/264, 240/288, 415/500, 525/630	24/29, 42/50, 110/132, 220/264, 240/288, 415/500, 525/630	24/29, 42/50, 110/132, 220/264, 240/288, 415/500, 525/630	110/132, 220/264, 240/288, 415/500, 525/630
Pick-up	VA	VA	550	550	550	960
Hold-on	VA	VA	36	36	36	56
	Watts	W	10	10	10	16
Limits of operation	Pick-up (%Uc) 50Hz	%Uc	80 - 110	80 - 110	80 - 110	80 - 110
	Pick-up (%Uc) 60Hz	%Uc	85 - 110	85 - 110	85 - 110	85 - 110
	Drop-off (%Uc)	%Uc	35 - 65	35 - 65	35 - 65	35 - 65
Operating time	Closing time	ms	20 - 40	20 - 40	20 - 40	20 - 45
	Opening time	ms	10 - 25	10 - 25	10 - 25	10 - 25
Safe isolation between coil and auxiliary contacts		V	690	690	690	690
Overall dimensions **H x W x D**		mm^3	175 x 137 x 152	175 x 137 x 152	175 x 137 x 152	208.2 x 147 x 181
Mounting clearance (front)		mm	10	10	10	10
Weight		kg	3	3	3	5.2





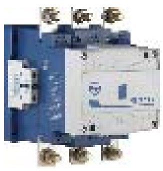
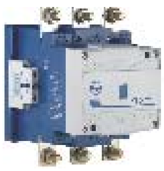

MNX 225	MNX 250	MNX 300	MNX 400	MNX 550	MNX 650
CS94979	CS 90301	CS 94346	CS 94069	CS 90243	CS 90578
CS 94140	CS94141	CS90280	CS 94144	CS 94145	CS 96327
IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
1 x 185	1 x 185	2 x 240 / 1 x 300	2 x 240 / 1 x 300	2 x 50 x 5	-
2 x 30 x 5	2 x 30 x 5	2 x 50 x 5	2 x 50 x 5	2 x 50 x 5	2 x 60 x 5
-	-	-	-	-	-
-	-	-	-	-	-
M10 / 14	M10 / 14	M12 / 27	M12 / 27	M12 / 27	M12 / 27
M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
HN,3 315	HN,3 315	HN,2 400	HN,3 500	HN,3 630	HN,3 800
4	4	4	4	4	4
2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC
10	10	10	10	10	10
0.5	0.5	0.5	0.5	0.5	0.5
6	6	6	6	6	6
4	4	4	4	4	4
4	4	4	4	4	4
1.2	1.2	1.2	1.2	1.2	1.2
6	6	6	6	6	6
1.1	1.1	1.1	1.1	1.1	1.1
0.55	0.55	0.55	0.55	0.55	0.55
0.31	0.31	0.31	0.31	0.31	0.31
0.27	0.27	0.27	0.27	0.27	0.27
0.2	0.2	0.2	0.2	0.2	0.2
2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
110/132, 220/264, 240/288, 415/500, 525/630	110/132, 220/264, 240/288, 415/500, 525/630	110/132, 220/264, 240/288, 415/500, 525/630	110/132, 220/264, 240/288, 415/500, 525/630	110, 220, 240, 415	110, 220, 240, 415
960	960	2100	2100	1000	1000
56	56	95	95	25	25
16	16	35	35	10	10
80 - 110	80 - 110	80 - 110	80 - 110	80 - 110	80 - 110
85 - 110	85 - 110	85 - 110	85 - 110	85 - 110	85 - 110
35 - 65	35 - 65	35 - 65	35 - 65	35 - 65	35 - 65
20 - 45	20 - 45	20 - 45	20 - 45	40 -70	40 -70
10 - 25	10 - 25	10 - 25	10 - 25	30 - 60	30 - 60
690	690	690	690	690	690
208.2 x 147 x 181	208.2 x 147 x 181	275 x 200 x 220	275 x 200 x 220	275 x 200 x 220	296 x 200 x 220
10 mm	10 mm	10 mm	10 mm	10 mm	10 mm
5.2	5.2	9.7	9.7	10.4	10.4

Technical Details - 2&3 Pole Contactors

- Range from 9-650A AC3
- Coil on top design 95A and above
- Built-in 2 NO + 2 NC auxiliary contacts for 95A & above




		Units	MNX 95	MNX 110	MNX 140	MNX 185
Catalogue No.	2 Pole		CS 94064	CS 94065	CS 94066	CS 94978
	3 Pole		CS 94136	CS 94137	CS 94138	CS 94139
Conformance to standards						
DC ratings with 3 poles in series and AC coil operation	DC 1 (24V)	A	95	110	140	185
	DC 1 (48V)	A	95	110	140	185
	DC 1 (110V)	A	95	110	140	185
	DC 1 (220V)	A	95	110	140	185
	DC 3 (24V)	A	95	110	140	185
	DC 3 (48V)	A	95	110	140	185
	DC 3 (110V)	A	95	110	140	185
	DC 3 (220V)	A	95	110	140	185
	DC 5 (24V)	A	95	110	140	185
	DC 5 (48V)	A	95	110	140	185
	DC 5 (110V)	A	95	110	140	185
	DC 5 (220V)	A	95	110	125	185
DC ratings with 2 poles in series and AC coil operation	DC 1 (24V)	A	95	110	140	185
	DC 1 (48V)	A	95	110	140	185
	DC 1 (110V)	A	95	110	140	185
	DC 1 (220V)	A	12	110	140	185
	DC 3 (24V)	A	95	110	140	185
	DC 3 (48V)	A	95	110	140	185
	DC 3 (110V)	A	95	110	140	160
	DC 3 (220V)	A	5	110	140	140
	DC 5 (24V)	A	95	110	140	185
	DC 5 (48V)	A	95	110	140	185
	DC 5 (110V)	A	95	110	140	160
	DC 5 (220V)	A	5	80	125	140
DC ratings with 1 pole in series and AC coil operation	DC 1 (24V)	A	95	110	140	185
	DC 1 (48V)	A	95	110	140	185
	DC 1 (110V)	A	12	12	12	185
	DC 1 (220V)	A	2	10	10	-
	DC 3 (24V)	A	95	110	140	185
	DC 3 (48V)	A	95	110	140	185
	DC 3 (110V)	A	5	10	10	-
	DC 3 (220V)	A	1	3	3	-
	DC 5 (24V)	A	95	110	140	185
	DC 5 (48V)	A	95	110	140	185
	DC 5 (110V)	A	5	10	10	-
	DC 5 (220V)	A	1	3	3	-



MNX 225	MNX 250	MNX 300	MNX 400	MNX 550	MNX 650
CS94979	CS 90301	CS 94346	CS 94069	CS 90243	CS 90578
CS 94140	CS94141	CS90280	CS 94144	CS 94145	CS 96327
IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
225	250	300	400	550	650
225	250	300	400	550	650
225	225	300	400	550	650
225	225	265	400	550	650
225	250	300	400	550	650
225	250	300	400	550	650
225	225	300	400	550	650
225	225	265	400	550	650
225	250	300	400	550	650
225	250	300	400	550	650
225	225	300	400	550	650
225	225	265	400	550	650
225	250	300	400	550	650
225	250	300	400	550	650
225	250	300	400	520	650
200	250	280	350	450	650
225	250	300	400	550	650
225	250	300	400	550	650
180	250	300	350	500	650
160	220	280	310	480	650
225	250	300	400	550	650
225	250	300	400	550	650
180	250	300	350	500	650
160	220	280	310	480	650
225	250	300	400	550	650
225	250	300	400	550	650
225	250	300	380	520	650
-	-	-	-	-	-
225	250	300	400	550	650
225	250	300	400	550	650
-	250	-	-	-	-
-	-	-	-	-	-
225	250	300	400	550	650
225	250	300	400	550	650
-	250	-	-	-	-
-	-	-	-	-	-

Accessories for MNX

Add-on Blocks

MNX / MCX
Top Add-on Block

MNX / MCX
Side Add-on Blocks

Mechanical Interlock Kits

MNX M1
(MNX 9-40)

MNX M7
(MNX 185-250)

MNX M8
(MNX 300-650)

Surge Suppressors

MNX S1

MNX S3

MNX S4

Spares for MNX

MNX Spare Kits

MNX Spare Coils

Accessories								
			MNX 9 - 40	MNX 50 - 80	MNX 95 - 140	MNX 185 - 250	MNX 300 - 400	MNX 550 - 650
	Mounting	Configuration	Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.
Add on Block$	Top	4 NO	CS94112	CS94112	-	-	-	-
		3 NO + 1 NC	CS94113	CS94113	-	-	-	-
		2 NO + 2 NC	CS94114	CS94114	-	-	-	-
		1 NO + 3 NC	CS94115	CS94115	-	-	-	-
		4 NC	CS94116	CS94116	-	-	-	-
		2 NO	CS94117	CS94117	-	-	-	-
		1 NO + 1 NC	CS94118	CS94118	-	-	-	-
		2 NC	CS94119	CS94119	-	-	-	-
		1 NO	CS94120	CS94120	-	-	-	-
		1 NC	CS94121	CS94121	-	-	-	-
	First Left	1 NO + 1 NC	CS94220	CS94201	CS94205	CS94205	CS94205	CS94205
	First Right	1 NO + 1 NC	CS94221	CS94202	CS94206	CS94206	CS94206	CS94206
	Second Left	1 NO + 1 NC	-	CS94203	CS94207	CS94207	CS94207	CS94207
	Second Right	1 NO + 1 NC	-	CS94204	CS94208	CS94208	CS94208	CS94208
Mechanical Interlock Kit$			CS94126	CS94197	CS94198	CS94199	CS94200	CS94200
Surge Suppressors*			CS94166	CS94163	CS94164	CS94164	CS94165	-

Spares		
Contactor	Spare Kits$	Spare Coil*
MNX 9	CS94123	CS94105
MNX 12	CS94124	
MNX 18	CS94125	
MNX 22	CS94269	
MNX 25	CS94127	
MNX 32	CS94128	
MNX 40	CS94147	
MNX 50	CS94150	CS94192
MNX 70	CS94151	
MNX 80	CS94152	
MNX 95	CS94153	CS94196
MNX 110	CS94154	
MNX 140	CS94155	
MNX 185	CS94156	CS94194
MNX 225	CS94157	
MNX 250	CS90310	
MNX 300	CS90283	CS94195
MNX 400	CS94161	
MNX 550	CS94162	CS94193
MNX 650	CS96336	

* Add 4 Digit Coil Suffix as per required voltage
$ Ordering suffix : OOOO

Ordering Suffix for Coil Voltages

Std Coil voltage	24	42	48	110	220	240	320	360	380	415	525
Ordering Suffix - 50/60 Hz	GOOO	HOOO	JOOO	AOOO	KOOO	BOOO	ROOO	COOO	LOOO	DOOO	MOOO

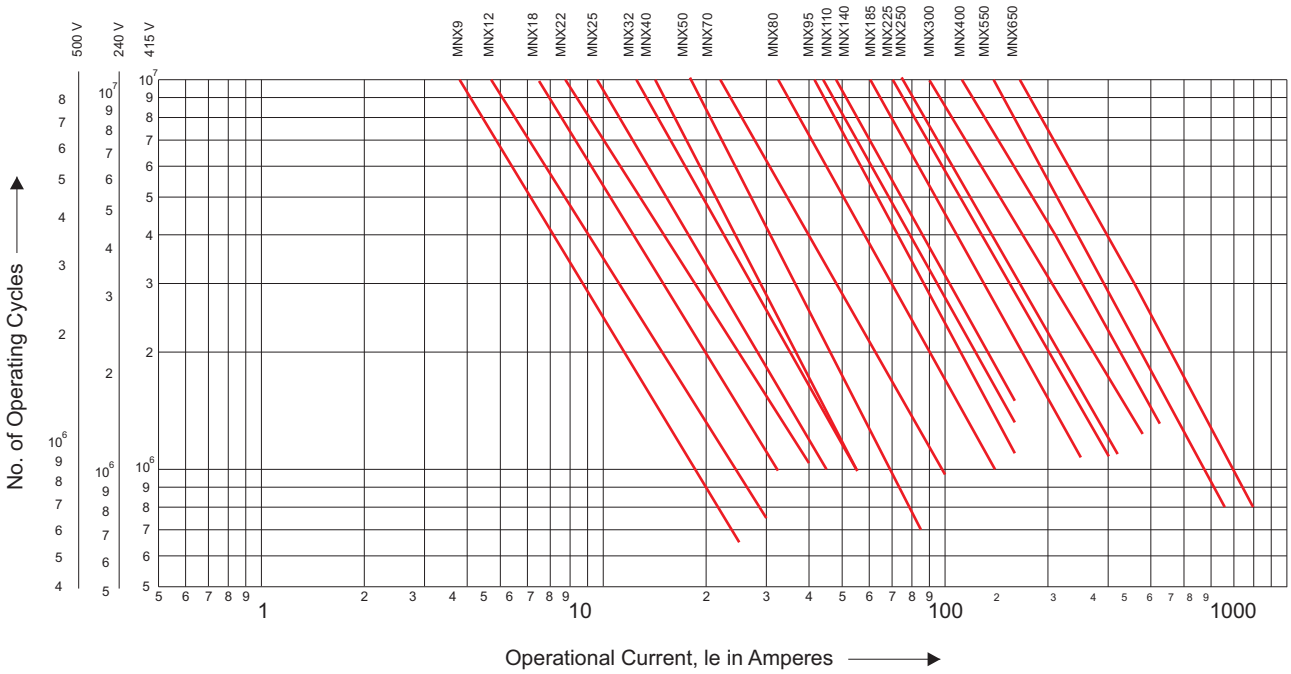
Terminal Marking of Addon Block

Mounting	Add-ON Block	Contact Combination	MNX 9 - 40	
			Cat. No.	Terminal Markings
Top	MNX-A1	4NO - 4 Pole	CS94112OOOO	53-54, 63-64, 73-74, 83-84
		3NO+1NC - 4 Pole	CS94113OOOO	53-54, 61-62, 73-74, 83-84
		2NO+2NC - 4 Pole	CS94114OOOO	53-54, 61-62, 71-72, 83-84
		1NO+3NC - 4 Pole	CS94115OOOO	53-54, 61-62, 71-72, 81-82
		4NC - 4 Pole	CS94116OOOO	51-52, 61-62, 71-72, 81-82
	MNX-A2	2 NO - 2 Pole	CS94117OOOO	53-54, 63-64
		1NO+1NC - 2 Pole	CS94118OOOO	53-54, 61-62
		2 NC - 2 Pole	CS94119OOOO	51-52, 61-62
		1 NO - 2 Pole	CS94120OOOO	53-54
		1 NC - 2 Pole	CS94121OOOO	61-62
Side	MNX-A12S/ MNX-A4/MNX-A6	1NO+1NC (1st Left)	CS94220OOOO	23-24, 31-32
		1NO+1NC (1st Right)	CS94221OOOO	33-34, 41-42
	MNX-A4/MNX-A6	1NO+1NC (2nd Left)	-	-
		1NO+1NC (2nd Right)	-	-

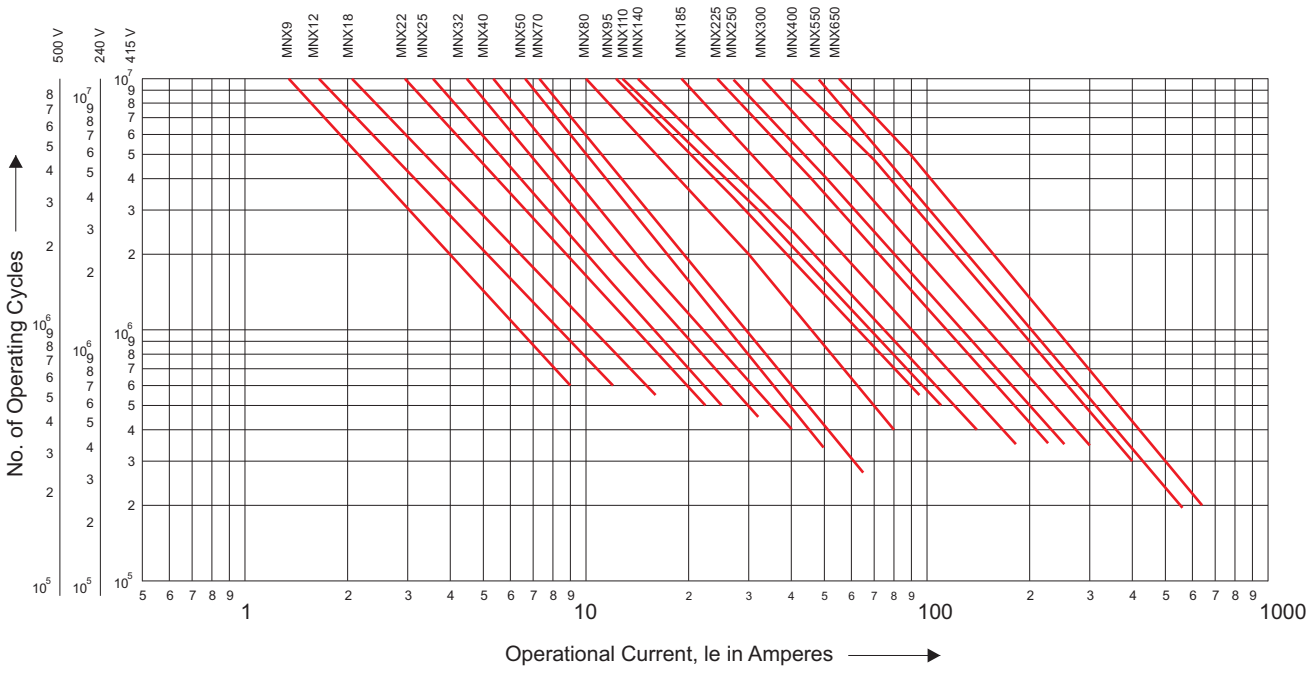
Mounting	Add-ON Block	Contact Combination	MNX 50 - 80	
			Cat. No.	Terminal Markings
Top	MNX-A1	4NO - 4 Pole	CS94112OOOO	53-54, 63-64, 73-74, 83-84
		3NO+1NC - 4 Pole	CS94113OOOO	53-54, 61-62, 73-74, 83-84
		2NO+2NC - 4 Pole	CS94114OOOO	53-54, 61-62, 71-72, 83-84
		1NO+3NC - 4 Pole	CS94115OOOO	53-54, 61-62, 71-72, 81-82
		4NC - 4 Pole	CS94116OOOO	51-52, 61-62, 71-72, 81-82
	MNX-A2	2 NO - 2 Pole	CS94117OOOO	53-54, 63-64
		1NO+1NC - 2 Pole	CS94118OOOO	53-54, 61-62
		2 NC - 2 Pole	CS94119OOOO	51-52, 61-62
		1 NO - 2 Pole	CS94120OOOO	53-54
		1 NC - 2 Pole	CS94121OOOO	61-62
Side	MNX-A12S/ MNX-A4/MNX-A6	1NO+1NC (1st Left)	CS94201OOOO	13-14, 21-22
		1NO+1NC (1st Right)	CS94202OOOO	43-44, 31-32
	MNX-A4/MNX-A6	1NO+1NC (2nd Left)	CS94203OOOO	53-54, 61-62
		1NO+1NC (2nd Right)	CS94204OOOO	83-84, 71-72

Mounting	Add-ON Block	Contact Combination	MNX 95 - 650	
			Cat. No.	Terminal Markings
Top	MNX-A1	4NO - 4 Pole	-	-
		3NO+1NC - 4 Pole	-	-
		2NO+2NC - 4 Pole	-	-
		1NO+3NC - 4 Pole	-	-
		4NC - 4 Pole	-	-
	MNX-A2	2 NO - 2 Pole	-	-
		1NO+1NC - 2 Pole	-	-
		2 NC - 2 Pole	-	-
		1 NO - 2 Pole	-	-
		1 NC - 2 Pole	-	-
Side	MNX-A12S/ MNX-A4/MNX-A6	1NO+1NC (1st Left)	CS94205OOOO	13-14, 21-22
		1NO+1NC (1st Right)	CS94206OOOO	43-44, 31-32
	MNX-A4/MNX-A6	1NO+1NC (2nd Left)	CS94207OOOO	53-54, 61-62
		1NO+1NC (2nd Right)	CS94208OOOO	83-84, 71-72

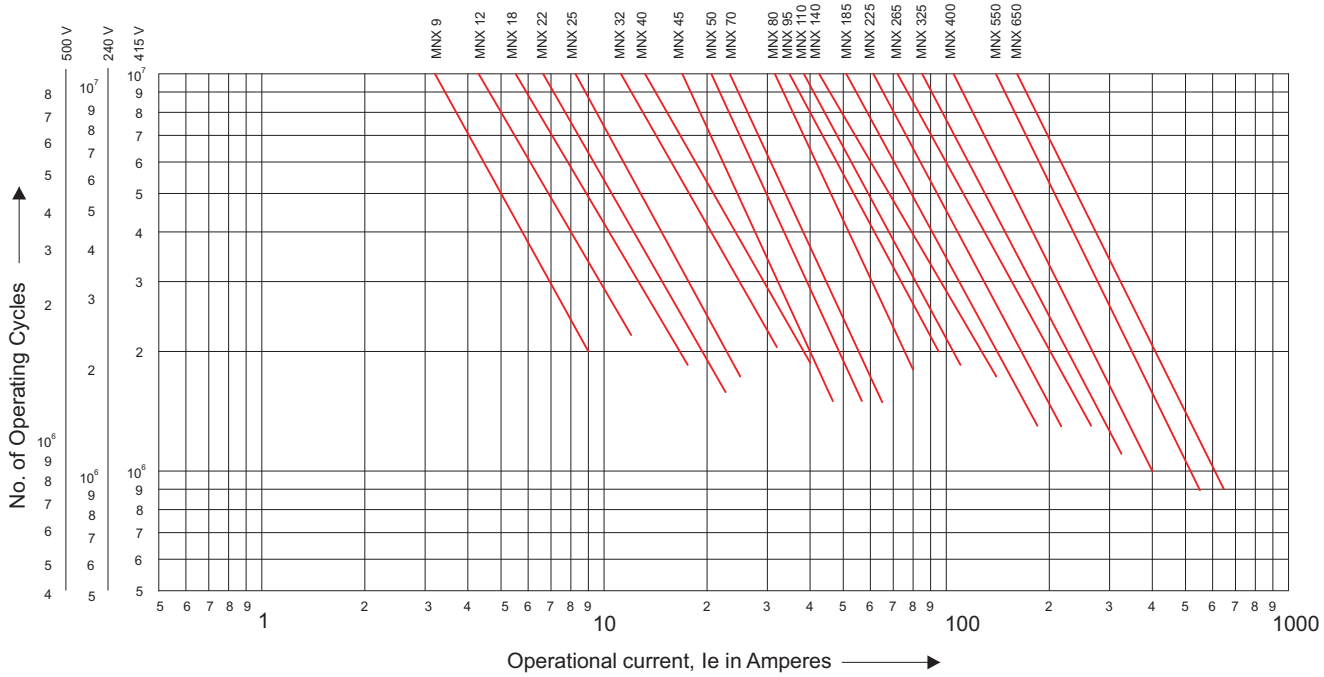
Utilisation Category AC-1



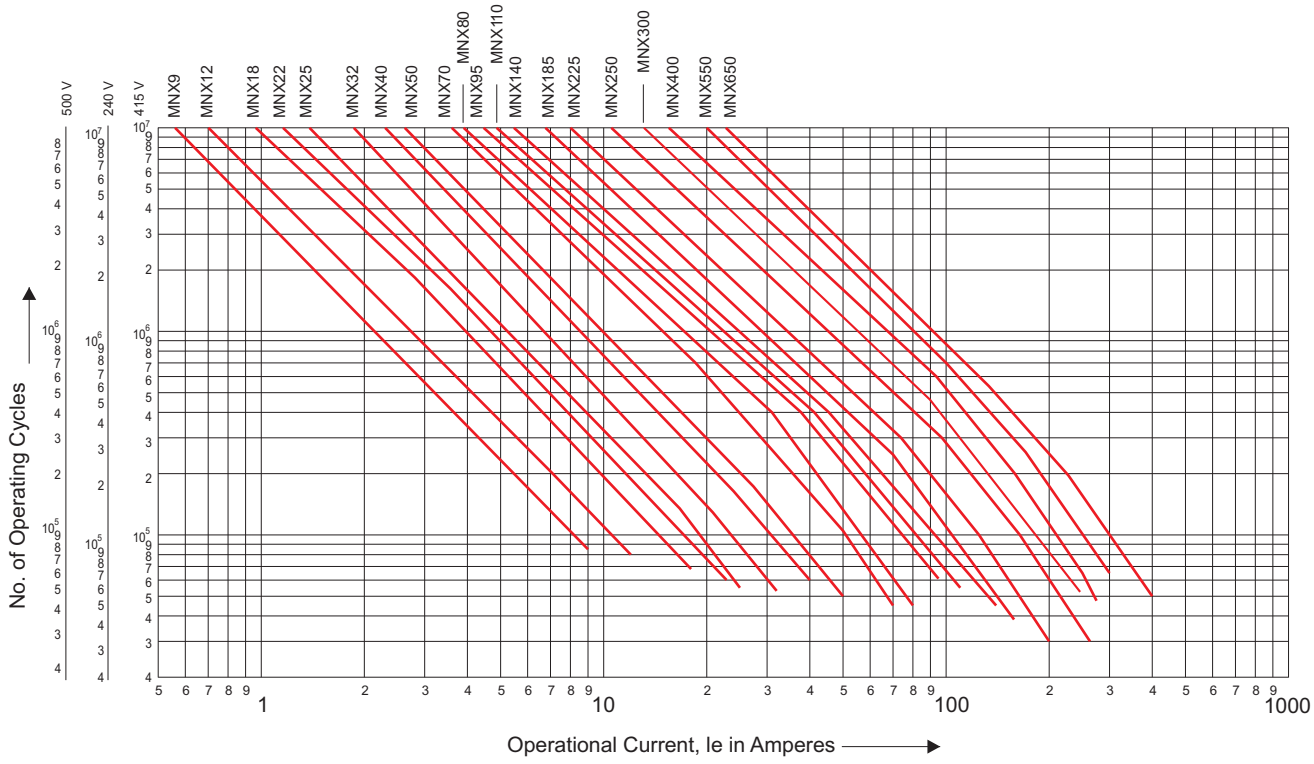
Utilisation Category AC-2



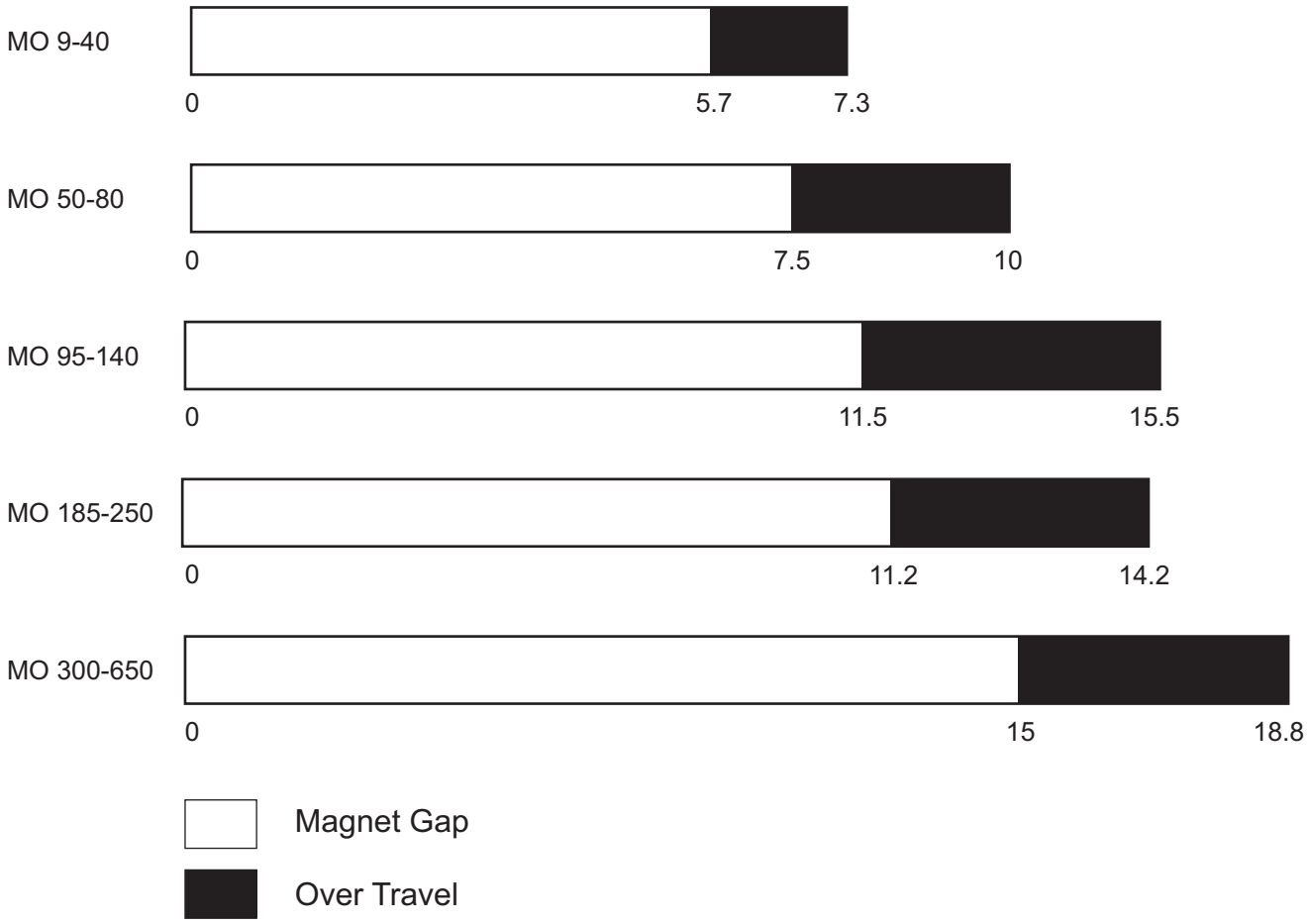
Utilisation Category AC-3



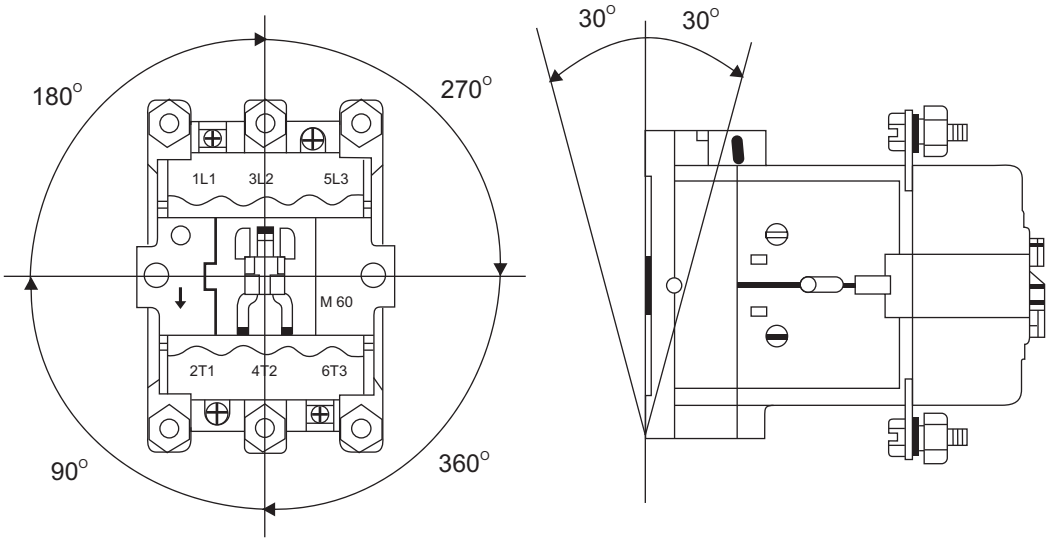
Utilisation Category AC-4



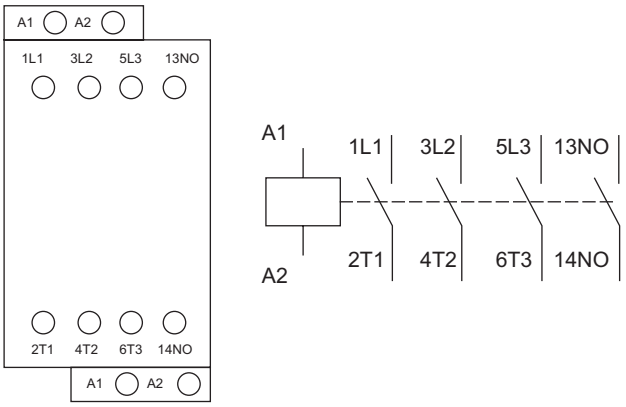
Contact Travel Diagram

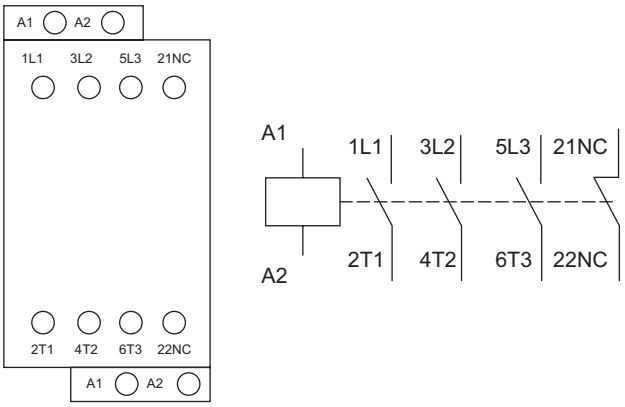


Mounting Position

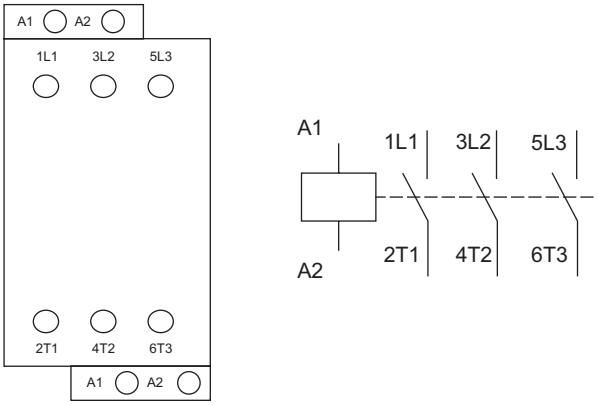


MNX Frame I : 9A - 22A

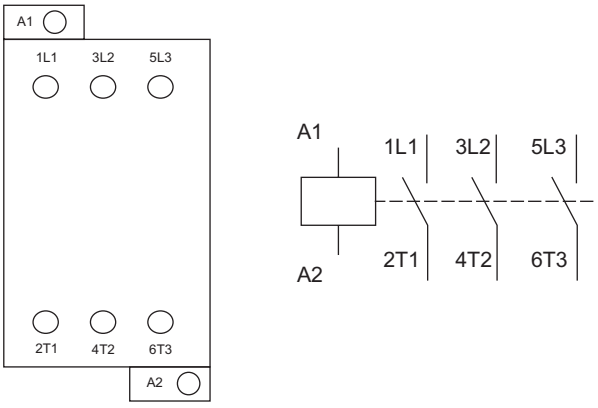




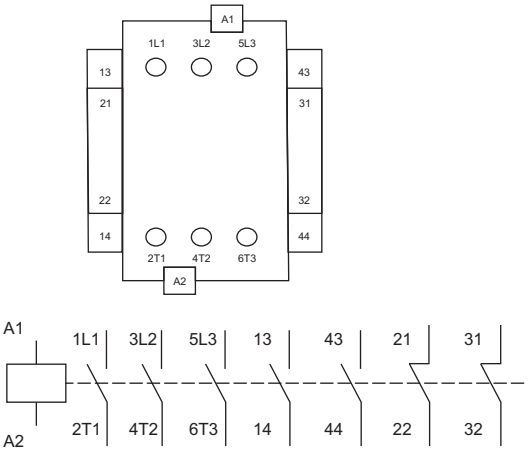
MNX Frame II : 25A - 40A



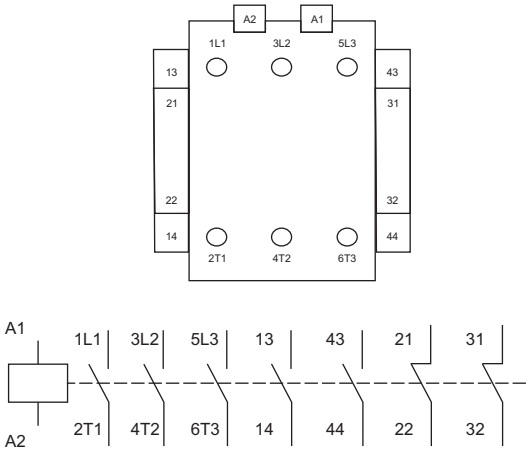
MNX Frame III : 50A - 80A



MNX Frame IV : 95A - 140A
MNX Frame V : 185A - 250A
MNX Frame VI : 300 - 400

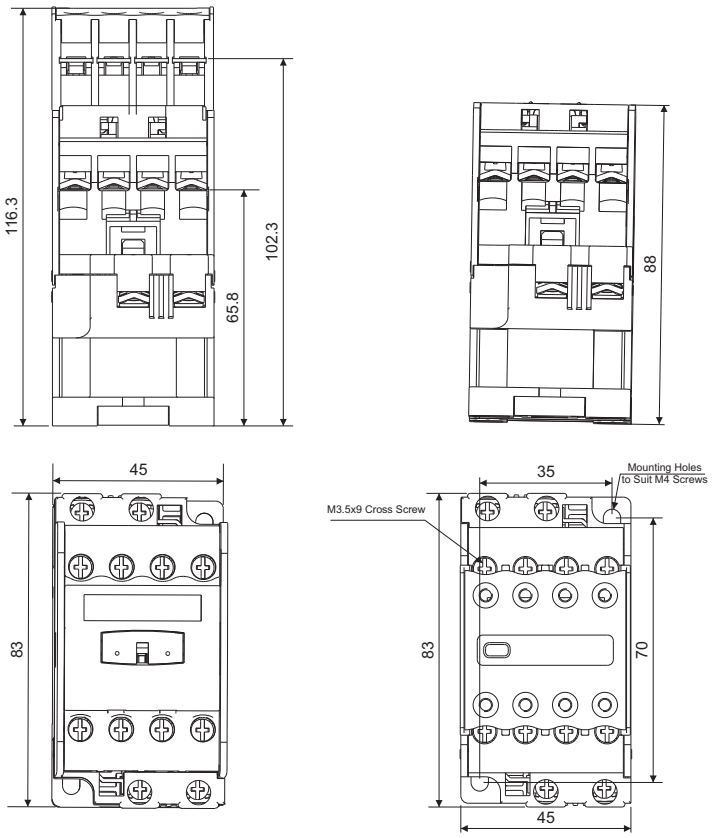


MNX Frame VI : 550A - 650A

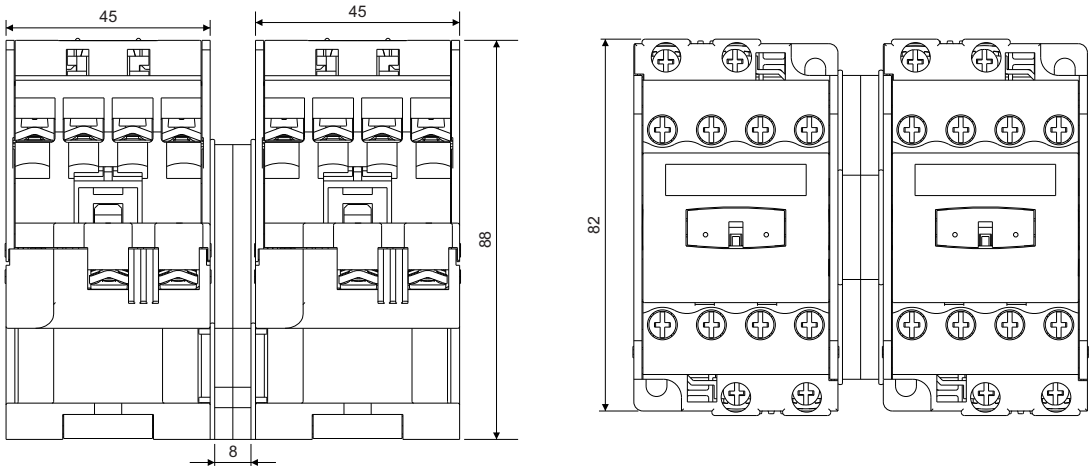


Overall Dimensions

MNX Frame I : 9A, 12A, 18A, 22A



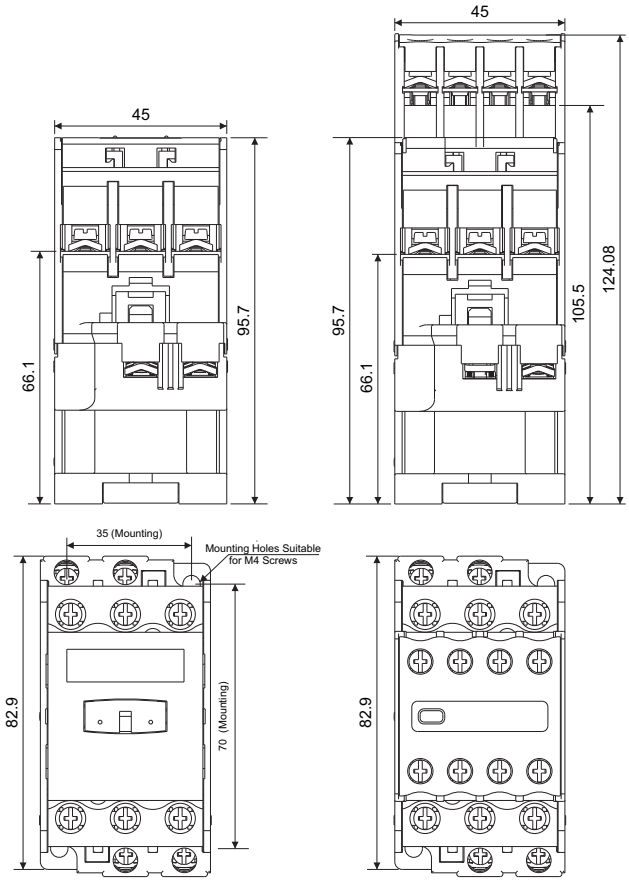
MNX Frame I : 9A, 12A, 18A, 22A (with MIL Kit)



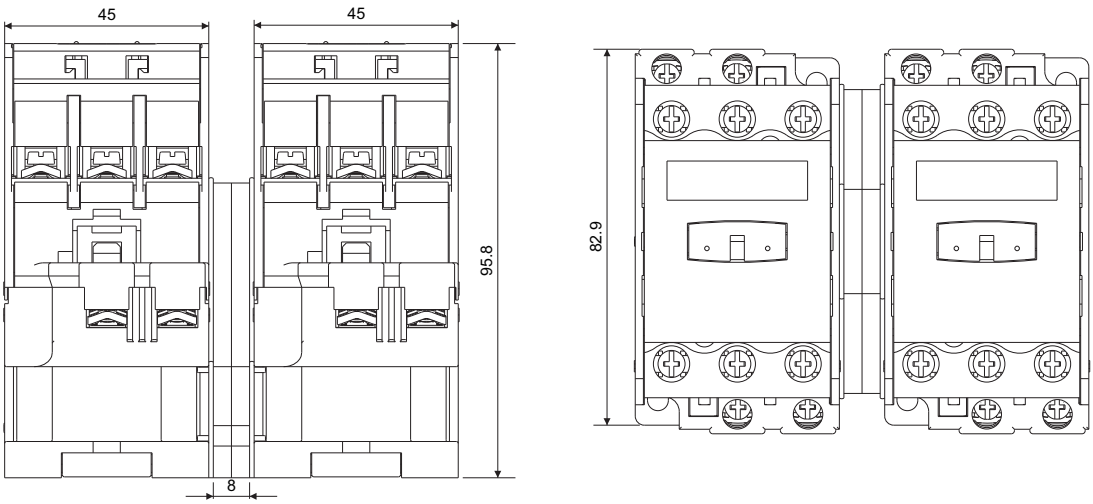
Note: Dimension for 2 Pole contactor is same as dimension for 3 Pole contactor.

All dimensions in mm.

MNX Frame II : 25A, 32A, 40A



MNX Frame II : 25A, 32A, 40A (with MIL Kit)

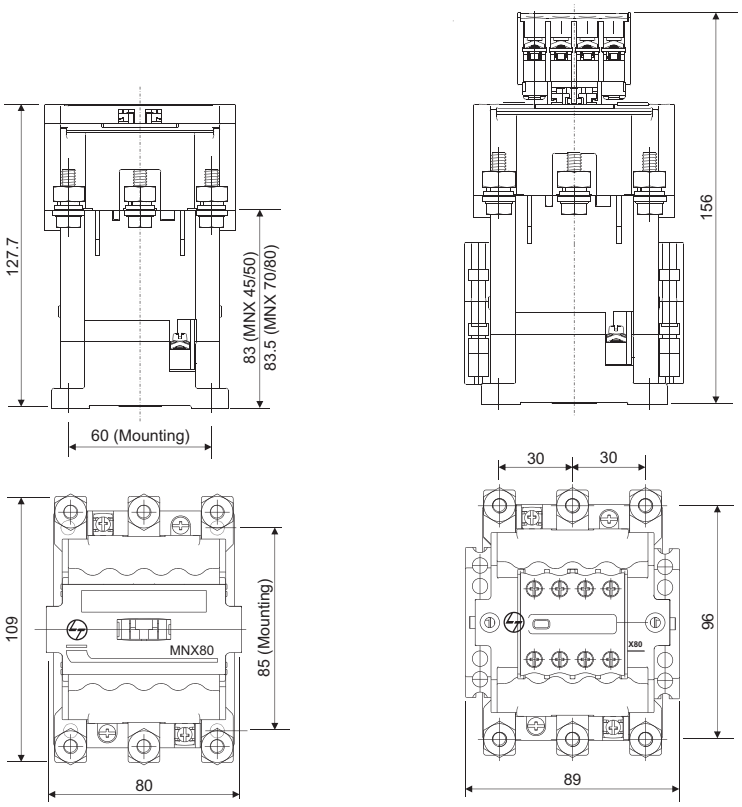


Note: Dimension for 2 Pole contactor is same as dimension for 3 Pole contactor.

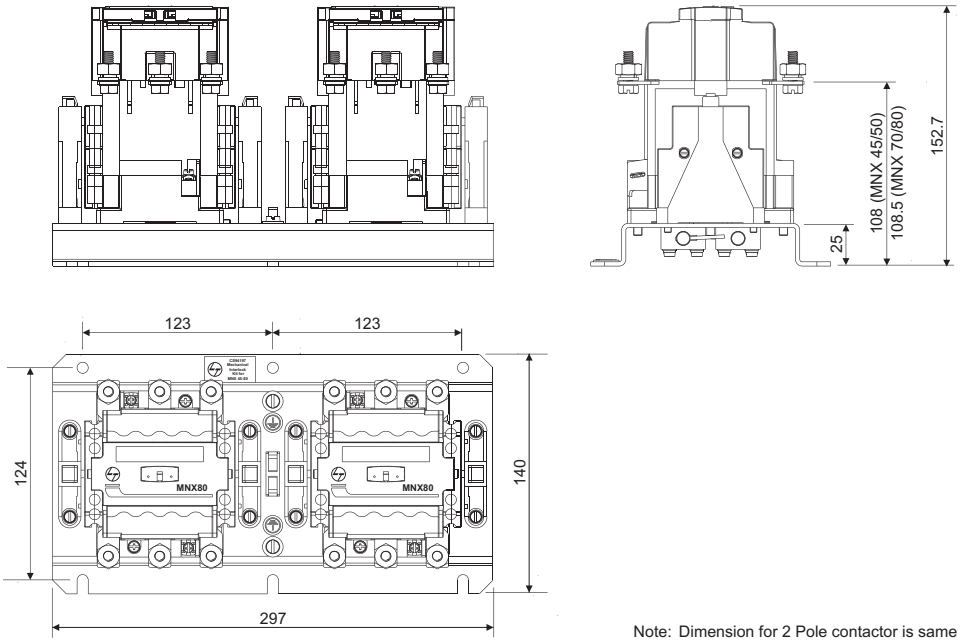
All dimensions in mm.

Overall Dimensions

MNX Frame III : 50A, 70A, 80A



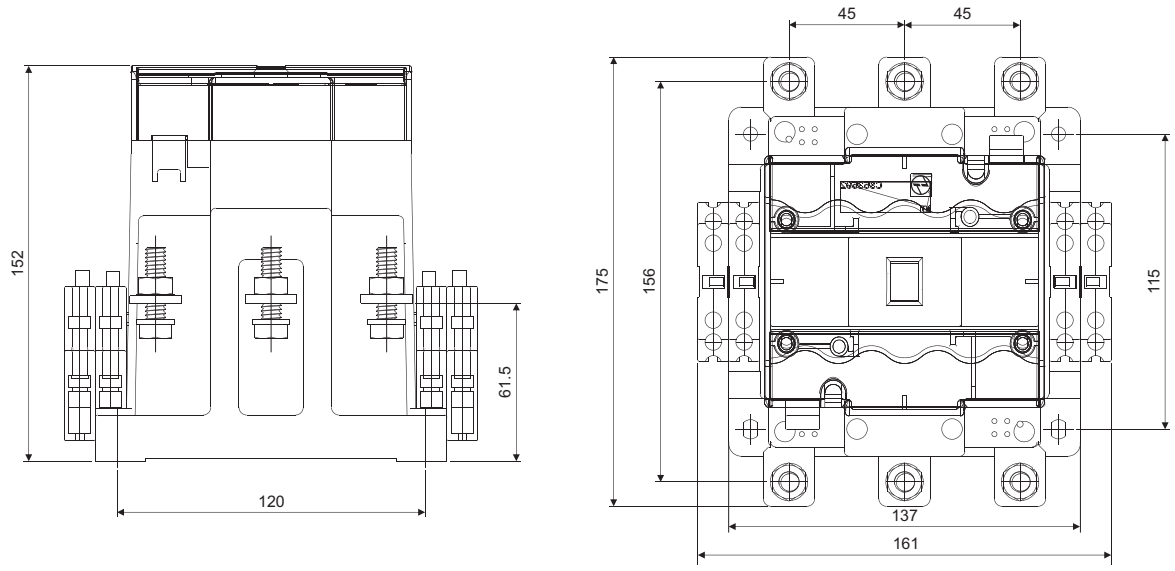
MNX Frame III : 50A, 70A, 80A (with MIL Kit)



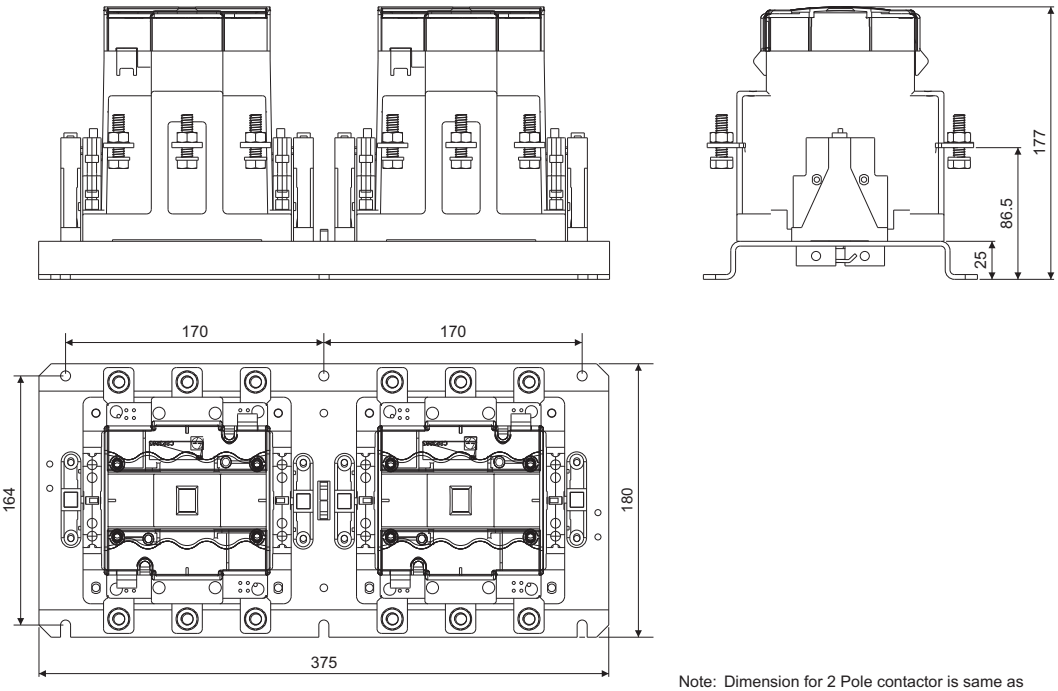
Note: Dimension for 2 Pole contactor is same as dimension for 3 Pole contactor.

All dimensions in mm.

MNX Frame IV : 95A, 110A, 140A



MNX Frame IV : 95A, 110A, 140A (with MIL Kit)

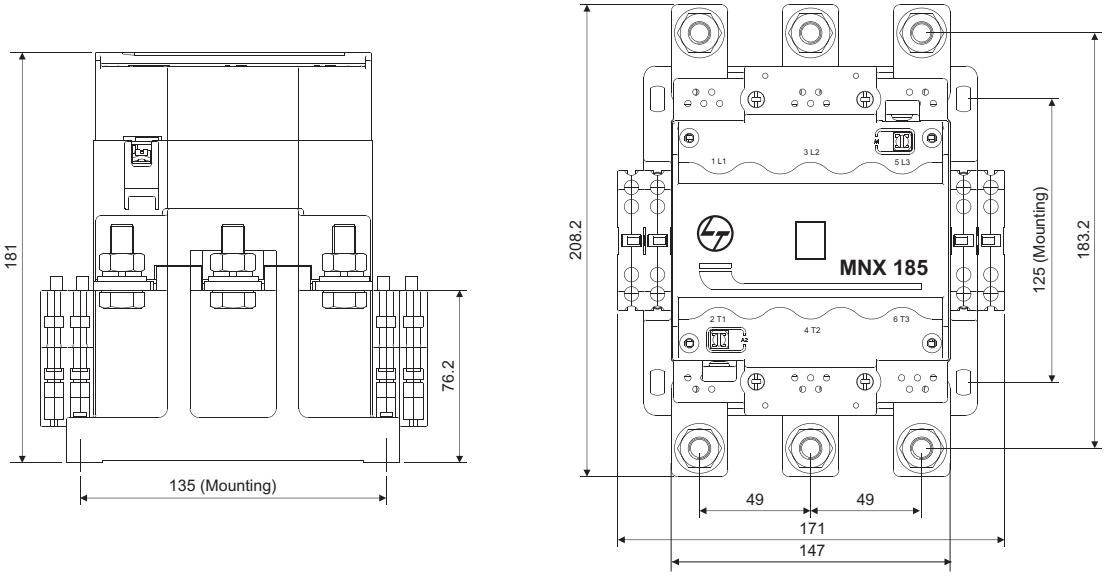


Note: Dimension for 2 Pole contactor is same as dimension for 3 Pole contactor.

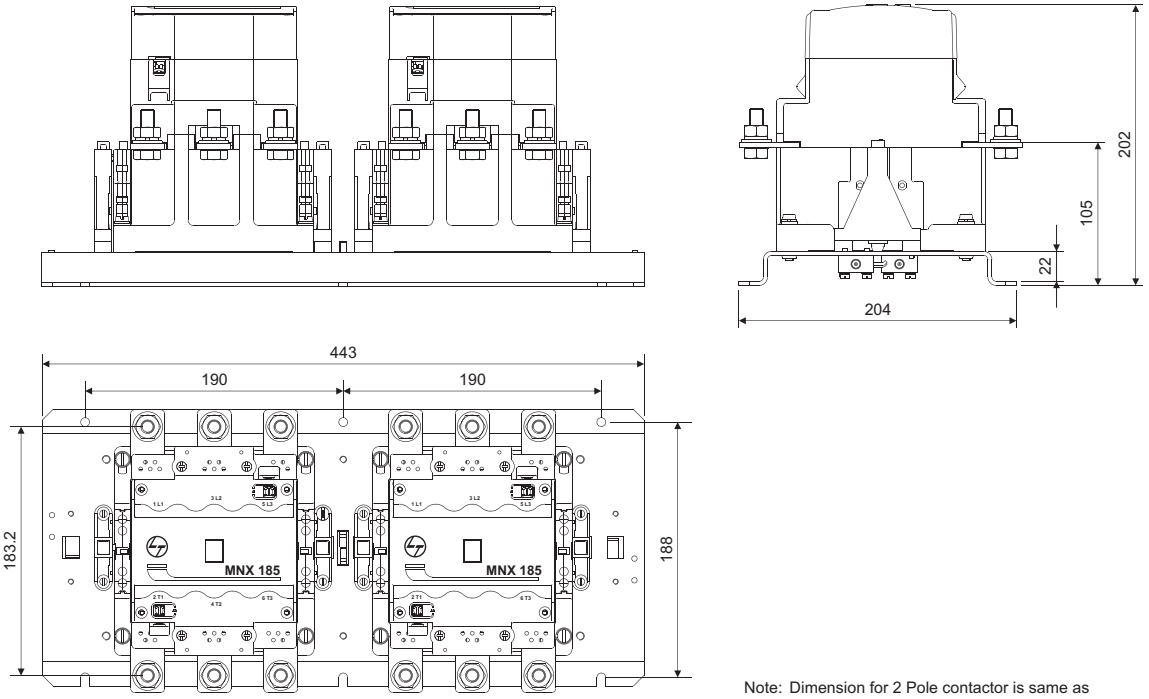
All dimensions in mm.

Overall Dimensions

MNX Frame V : 185A, 225A, 250A



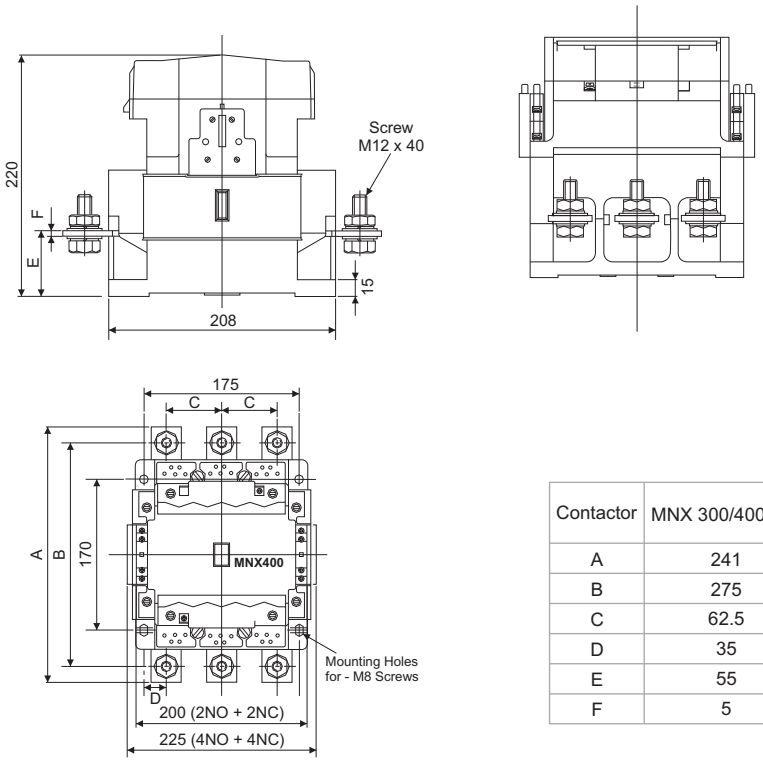
MNX Frame V : 185A, 225A, 250A (with MIL Kit)



Note: Dimension for 2 Pole contactor is same as dimension for 3 Pole contactor.

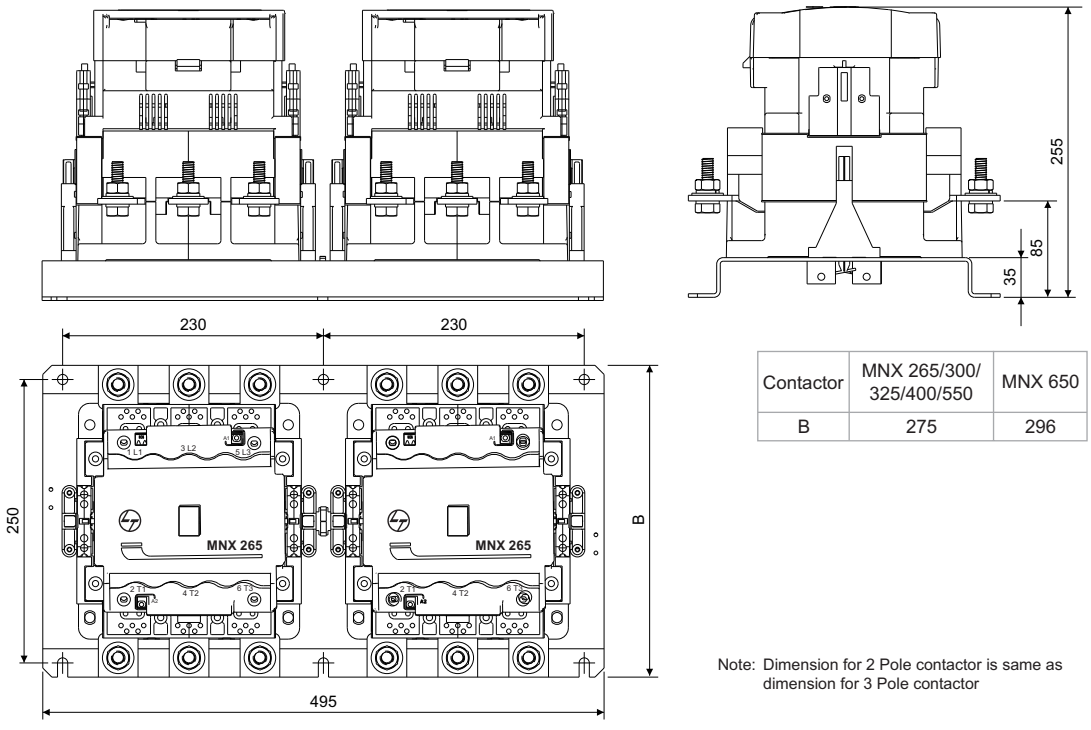
All dimensions in mm.

MNX Frame VI : 300A, 400A, 550A, 650A



Contactor	MNX 300/400/550	MNX 650
A	241	259
B	275	296
C	62.5	74
D	35	40
E	55	56
F	5	6

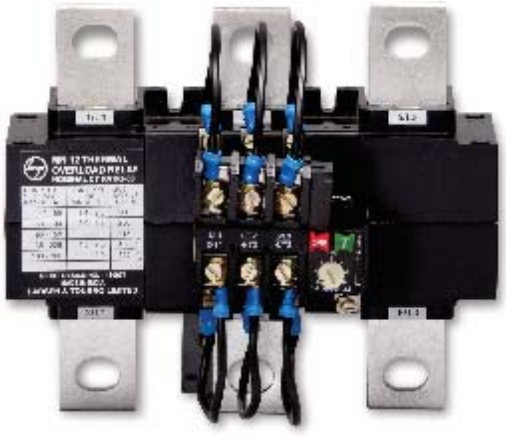
MNX Frame VI : 300A, 400A, 550A, 650A (with MIL Kit)



Contactor	MNX 265/300/ 325/400/550	MNX 650
B	275	296

Note: Dimension for 2 Pole contactor is same as dimension for 3 Pole contactor

All dimensions in mm.



MN Thermal Overload Relays

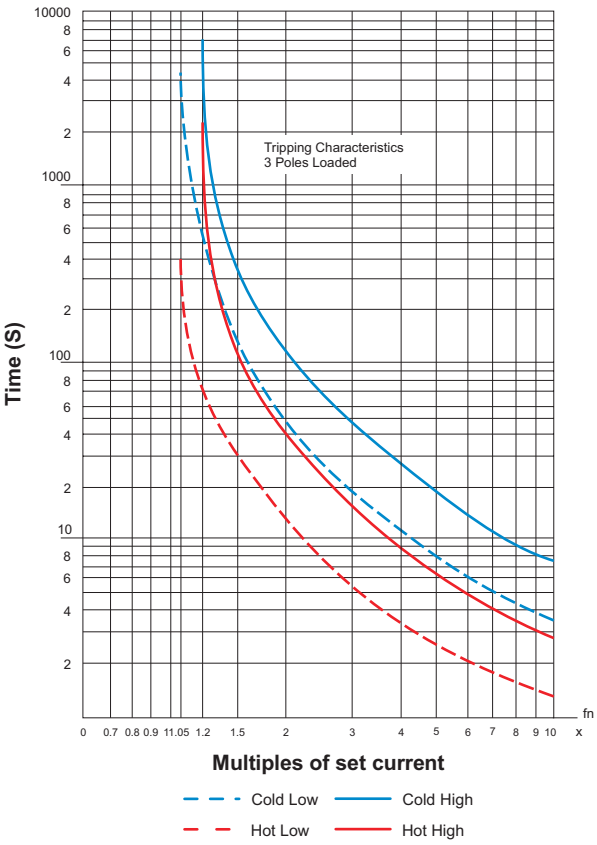
MN Thermal Overload Relays, available from 0.2A to 570A complement the MNX range of power contactors. The relays are ambient temperature compensated, and the unique double slide mechanism provides reliable protection against single phasing. MN 12L relays with trip class 30 are specially designed for long starting time applications.

- Available in 3 frame sizes from 0.2-570A
- Direct mounting on MNX contactors
- Trip class 10A (30 available in MN 12L)
- Ambient temperature compensated
- Built-in single phasing protection

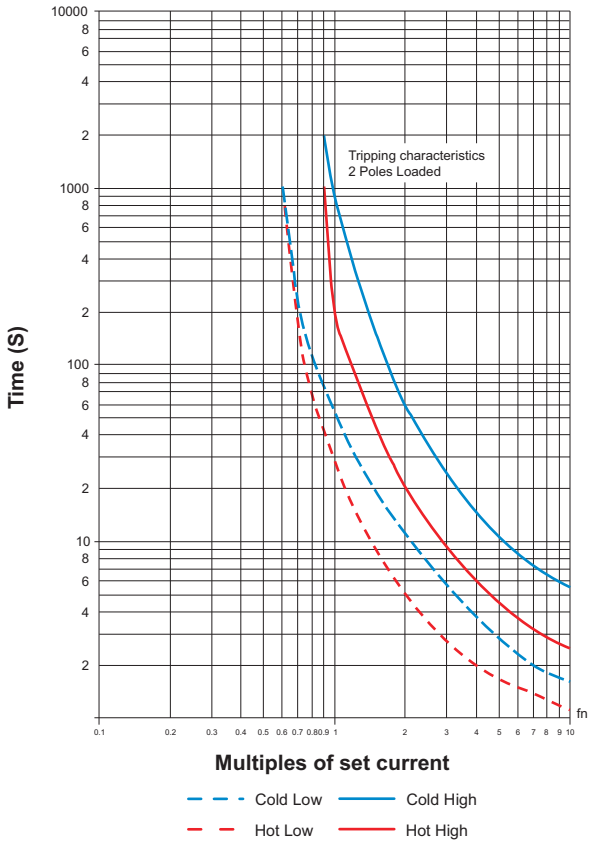



		Units	MN 2	MN 5	MN 12	MN 12L
Conformance to standards			IS/IEC 60947-4-1 & IEC 60947-4-1			
Mounting			Direct	Direct	-	-
			Separate	Separate	Separate	Separate
Suitable for contactors			MNX 9, 12, 18 22, 25, 32, 40	MNX 45, 50, 70, 80	MNX 95, 110, 140, 185, 225, 265 325, 400, 550, 650	
Rated insulation voltage	U_i	V	690	690	690	690
Rated impulse voltage	U_{imp}	kV	6	6	6	6
Service temperature		°C	-5°C to +55°C			
Start / OFF / Reset			1 Start & OFF / Reset			
Built-in contacts			2 NO + 1 NC	2 NO + 1 NC	2 NO + 1 NC	2 NO + 1 NC
Rated operational current for AC-15 utilization category at 50 Hz	24 V	A	6	6	6	6
	110 V	A	5	5	5	5
	220 V	A	3	3	3	3
	380 / 415 V	A	2	2	2	2
	500 V	A	2	2	2	2
Trip class		A	10	10	10	30
Max. frequency of operations		Cy / hr	30	30	30	30
Main terminal capacity	Lug	mm^2	10	50	240	240
Aux. terminal capacity	Wires	mm^2	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5

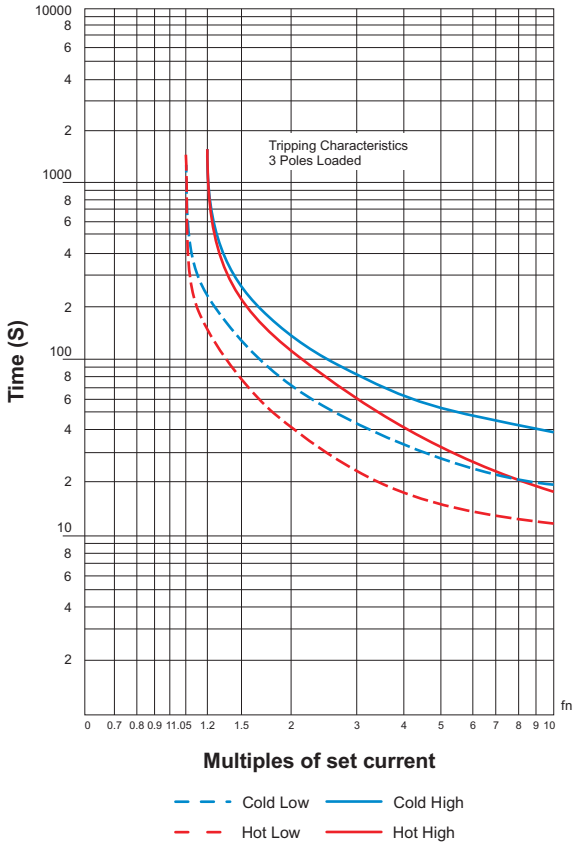
MN 2 / MN 5 / MN 12 Relay



MN 2 / MN 5 / MN 12 Relay



MN 12L Relay



MN Relays

Relay Mounting Kit

Kit for Mounting MN5 Relay

DIN Rail Mounting Kit MN2 Relay

Description	Cat. No.	Std. Pkg. (Nos.)
Push button unit for MK 1 / ML Relays	SS90004OOOO	1
Push button extension unit for MN 2 Relays	SS94968OOOO	100
Kit for Mounting MN 2 Relay on ML 1.5 contactor	SS94701OOOO	50
Kit for Mounting MN 2 Relay separately (Direct Mounting Type)	SS94700OOOO	50
Kit for Mounting MN 5 Relay on MNX 95 / 110 / 140 contactor	SS94638OOOO	20
Kit for Mounting MN 5 Relay on ML 2 / ML 3 contactor	SS94151OOOO	20
Kit for Mounting MN 5 Relay on ML 4 / ML 6 contactor	SS94152OOOO	20
DIN Rail Mounting Kit Relay on MN 2 Relay	SS91887OOOO	50

Relay Reset Cord For MN Relays

400 mm

650 mm

900 mm

1200 mm

Description	Cat. No.	Std. Pkg. (Nos.)
MN Relay reset cord - 400 mm	SB94207OOOO	1
MN Relay reset cord - 650 mm	SB94208OOOO	1
MN Relay reset cord - 900 mm	SB94209OOOO	1
MN Relay reset cord - 1200 mm	SB94210OOOO	1

Ordering Information

Type	Range (A)	Cat. No.
MN 2	0.2 - 0.33	SS94141OOEO
	0.3 - 0.5	SS94141OOGO
	0.45 - 0.75	SS94141OOJO
	0.6 - 1	SS94141OOKO
	0.9 - 1.5	SS94141OOMO
	1.4 - 2.3	SS94141OOPO
	2 - 3.3	SS94141OOQO
	3 - 5	SS94141OOSO
	4.5 - 7.5	SS94141OOUO
	6 - 10	SS94142OOVO
	9 - 15	SS94142OOBO
	14 - 23	SS94144OODO
	20 - 33	SS94145OOEO
	24 - 40	SS94145OOFO

Type	Range (A)	Cat. No.
MN 5	9 - 15	SS94135OOBO
	14 - 23	SS94135OODO
	20 - 33	SS94136OOEO
	30 - 50	SS94136OOGO
	36 - 60	SS94136OOTO
	45 - 75	SS94137OOJO
	66 - 110	SS94137OOKO

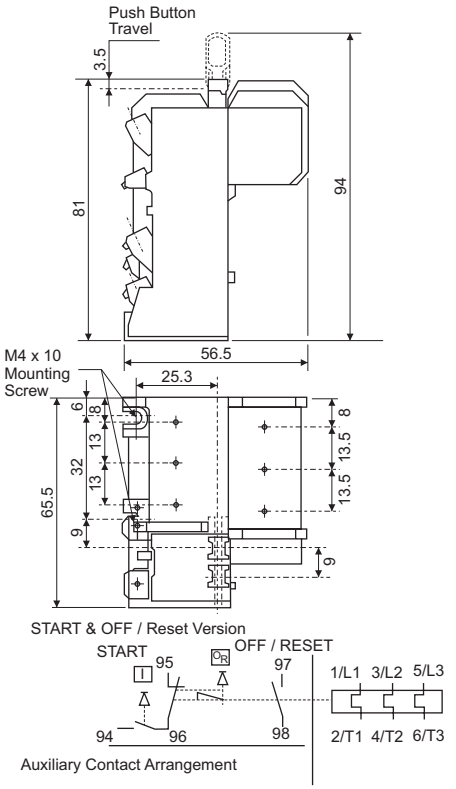
Type	Range (A)	Cat. No.
MN 12	28 - 46.5	SB94211OOGO
	42 - 69	SS94138OOHO
	60 - 100	SS94138OOKO
	90 - 150	SS94138OOMO
	135 - 225	SS94138OOPO
	180 - 300	SS94139OOQO
	270 - 450	SS94139OORO

Type	Range (A)	Cat. No.
MN 12L*	42 - 69	SS94127OOHO
	60 - 100	SS94127OOKO
	90 - 150	SS94127OOMO
	135 - 225	SS94127OOPO
	180 - 300	SS94127OOQO
	340 - 570	SS94127OOSO

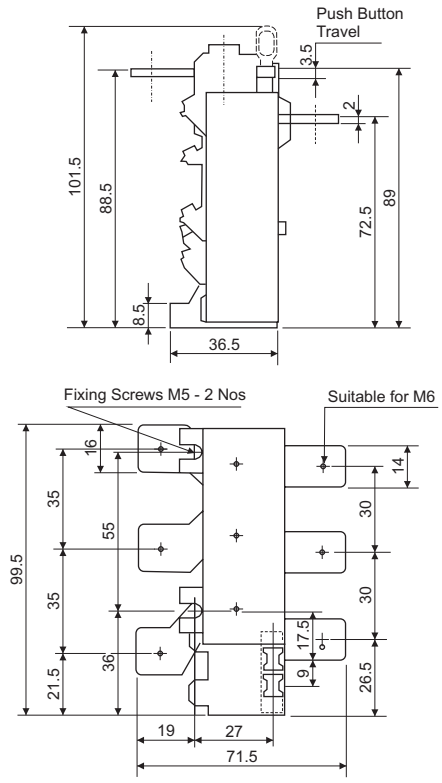
*For motors with long starting time

Thermal Overload Relay - Type MN

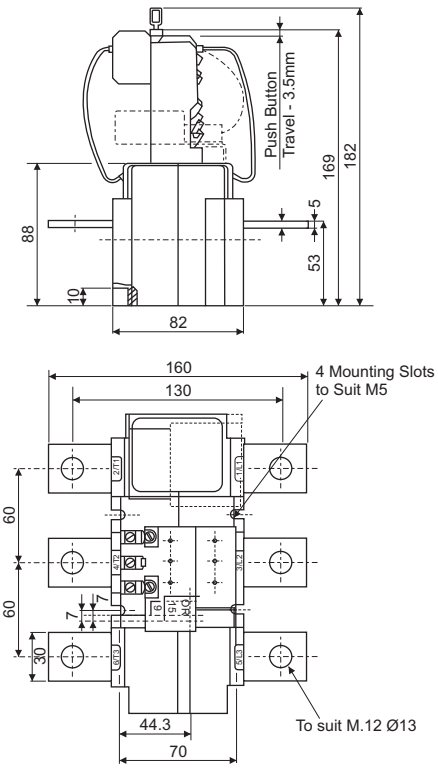
MN 2 (Separate Mounting)



MN 5 (Separate Mounting)



MN 12 / 12L (Relay)



All dimensions in mm.

MDX DC Coil 3 Pole Power Contactors

MDX Power Contactors cater to all those applications where DC control supply is used. The range is available from 9A-110A AC-3 and the major applications are battery chargers, traction systems, UPS systems etc. Many critical installations like power generation equipment, crane terminals, hospital equipment also incorporate DC Coil contactors.

EFFICIENT SWITCHING NOW WITH DC CONTROL

Technical Details



Type Designation		Units	MDX 9	MDX 12	MDX 18
Catalogue no.			CS96564	CS96565	CS96566
Conformance to standards					
Power contacts					
No. of poles			3	3	3
Rated insulation voltage U_i		V	690	690	690
Rated impulse withstand voltage U_{imp}		kV	6	6	6
Operational current Motor duty: 3Φ, 415 V, 50 Hz	Conventional free air Thermal current I_{th} (40°C)	A	25	28	32
	Utilization category AC-3 (55°C)	A / kW	9 / 4.5	12 / 6.2	18 / 9
Rated kW	240V AC		2.2	3.2	4
	415V AC		4.5	6.2	9
	690V AC		7.5	10	10
Rated making capacity		A	90	120	180
Rated breaking capacity (≤440 V)		A	72	96	144
Operation current I_e for AC-4 Utilization category at 415 V, 3Φ, 50 Hz for 200000 operating cycles		A	4.9	7.9	8.5
Permissible short time ratings	10s	A	110	110	130
Mechanical life		million	20	20	20
Electrical life at 415V, AC-3 Utilization category		million	2	2	1.6
Max. frequency of operations		cy/hr	3600	3600	3600
Ambient Temperature around the device	Service temperature	°C			
	Storage Temperature				
Degree of Protection	From front				
Fuse protection against short circuit, gG			25	32	32
Maximum altitude without deration		m			
Auxliary contacts					
No. of in built auxiliary contacts			1 NO	1 NO	1 NO
Conventional thermal current I_{th} at 55°C		A	10	10	10
Terminal capacity	Flexible w/o lug	mm^2	1 - 6	1 - 6	1 - 6
	Flexible c/w lug	mm^2	6	6	6
Coil characteristics					
Coil voltage available		VDC			
Average hold on coil consumption		Watts	5.4	5.4	5.4
Limits of operation	Pick-up	% U_c	70 - 125	70 - 125	70 - 125
	Drop-off	% U_c	10 - 40	10 - 40	10 - 40
Pick-up		VA	75	75	75
Hold-on		VA	9	9	9
Overall dimensions	Height	mm	81	81	81
	Width	mm	45	45	45
	Depth	mm	98.5	98.5	98.5
	Weight	Kg	0.47	0.47	0.47

Add on Block can be ordered separately.








MDX 25	MDX 32	MDX 38	MDX 50	MDX 65	MDX 80	MDX 95	MDX 110
CS96567	CS96552	CS96553	CS96554	CS96555	CS96556	CS96557	CS96558
IS/IEC 60947-4-1 & IEC 60947-4-1							
3	3	3	3	3	3	3	3
690	690	690	1000	1000	1000	1000	1000
6	6	6	8	8	8	8	8
32	56	56	90	110	125	125	125
25 / 13.4	32 / 17	38 / 18.5	50 / 27.2	65 / 36	80 / 46	95 / 55	110 / 66
7	8.8	11	15	18.5	22	27.6	33
13.4	17	18.5	30	37	45	55	66
18	22	22	37	45	75	74	80
250	320	380	800	1090	1200	1200	1200
200	256	304	800	1090	1200	1200	1200
10	13.5	15.5	28	31	38	43	43
160	320	320	390	390	480	760	880
20	20	20	15	15	15	15	15
1.2	1.6	1.4	1.5	1.4	1.3	1.2	0.8
3600	3600	3600	3600	3600	3600	3600	3600
	(-50°C to +70°C)						
	(-60°C to +80°C)						
	IP20						
50	63	63	100	125	160	160	160
	3000						
1 NO	#	#	#	#	#	#	#
10	10	10	10	10	10	10	10
1 - 6	2.5	2.5	2.5	2.5	2.5	2.5	2.5
6	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	24 / 48 / 110 / 220						
5.4	5.4	5.4	15	15	15	15	15
70 - 125	70 - 125	70 - 125	80 - 110	80 - 110	80 - 110	80 - 110	80 - 110
10 - 40	10 - 40	10 - 40	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25
75	75	75	210	210	210	220	220
9	9	9	15	15	15	18	18
81	90	90	124	124	124	124	124
45	45	45	75	75	75	75	75
98.5	107.5	107.5	150.5	150.5	150.5	150.5	150.5
0.47	0.54	0.54	1.69	1.69	1.73	1.73	1.73



Type Designation		Units	MDX 9	MDX 12	MDX 18
Catalogue no.			CS96564	CS96565	CS96566
Conformance to standards					
Terminal capacity	Flexible w/o lug	m	1 - 6	1 - 6	1 - 6
	Flexible c/w lug	mm^2	1 - 4	1 - 4	1 - 4
Terminal Torque (Nm)	Main pole terminal		1.5...1.8		
	Aux. Pole / Coil / Add on block Terminal				
Type of Terminal					Clamp-Screw
DC ratings with 3 poles in series and AC coil operation	DC 1(24 V)	A	20	22	22
	DC 1(48 V)	A	20	22	22
	DC 1(110 V)	A	15	16	16
	DC 1(220 V)	A	10	11	11
	DC 3-5 (24 V)	A	15	18	18
	DC 3-5 (48 V)	A	15	18	18
	DC 3-5 (110 V)	A	15	18	18
	DC 3-5 (220 V)	A	15	18	18
DC ratings (A) with 2 poles in series and AC coil operation	DC 1(24 V)	A	18	20	20
	DC 1(48 V)	A	18	20	20
	DC 1(110 V)	A	12	13	13
	DC 1(220 V)	A	8	8	8
	DC 3-5 (24 V)	A	13	15	15
	DC 3-5 (48 V)	A	11	13	13
	DC 3-5 (110 V)	A	13	15	15
	DC 3-5 (220 V)	A	11	13	13
DC ratings (A) with 1 pole in series and AC coil operation	DC 1(24 V)	A	15	17	17
	DC 1(48 V)	A	13	15	15
	DC 1(110 V)	A	6	6	6
	DC 1(220 V)	A	4	4	4
	DC 3-5 (24 V)	A	10	12	12
	DC 3-5 (48 V)	A	9	11	11
	DC 3-5 (110 V)	A	10	12	12
	DC 3-5 (220 V)	A	9	11	11








MDX 25	MDX 32	MDX 38	MDX 50	MDX 65	MDX 80	MDX 95	MDX 110
CS96567	CS96552	CS96553	CS96554	CS96555	CS96556	CS96557	CS96558
IS/IEC 60947-4-1 & IEC 60947-4-1							
1 - 6	2. 5 - 16	2.5 - 16	4 - 50	4 - 50	6 - 50	6 - 50	6 - 50
1 - 4	1 - 10	1 - 10	4 - 50	4 - 50	6 - 50	6 - 50	6 - 50
	2.5...3		4...5				
0.8...1							
		Double Lug-Clamp			Lug-Clamp		
23	32	36	60	70	100	100	100
23	32	34	60	70	100	100	100
18	27	34	55	60	85	85	85
12	16	26	45	50	55	55	55
22	30	32	50	55	80	80	80
22	28	28	50	50	70	75	75
22	30	32	40	55	80	80	80
22	28	28	50	50	70	75	75
23	32	36	60	70	100	100	100
23	32	34	60	70	100	100	100
16	25	32	50	60	80	80	80
8	14	20	36	36	40	40	40
18	25	28	35	45	60	60	60
18	22	25	35	40	50	55	55
18	25	28	32	45	60	60	60
18	22	25	35	40	50	55	55
20	30	35	45	50	70	70	70
18	26	30	40	50	60	60	60
6	8	8	8	8	8	8	8
4	5	5	6	6	6	6	6
15	20	24	30	35	40	40	40
13	17	20	25	25	30	30	30
15	20	24	27	35	40	40	40
13	17	20	25	25	30	30	30

DC Contactors

Product Type	I_{th}	I_e (AC-3) at ≤ 440V	Motor Rating at 50 Hz				Terminal Type	In Built Auxiliary Contacts	Cat. No.*
	≤ 40°C	≤ 55°C	230 V	415 V	440 V	690 V			
	(A)	(A)	(kW)	(kW)	(kW)	(kW)		NO/NC	
MDX 9	25	9	2.2	4.5	4.8	7.5	Clamp-screw	1 NO	CS96564
MDX 12	28	12	3.2	6.2	6.2	10	Clamp-screw	1 NO	CS96565
MDX 18	32	18	4	9	9	10	Clamp-screw	1 NO	CS96566
MDX 25	32	25	7	13.4	13.4	11	Clamp-screw	1 NO	CS96567
MDX 32	56	32	8.3	17	17	22	Clamp-screw	-	CS96552
MDX 38	56	38	11	18.5	18.5	22	Clamp-screw	-	CS96553
MDX 50	90	50	14.3	27.2	27.2	43.5	Clamp-screw	-	CS96554
MDX 65	110	65	18.5	36	36	59.7	Lug-clamp	-	CS96555
MDX 80	125	80	23	46	46	74	Lug-clamp	-	CS96556
MDX 95	125	95	27.6	55	55	74	Lug-clamp	-	CS96557
MDX 110	125	110	33	66	70	80	Lug-clamp	-	CS96558

* Please add coil suffix as per required coil voltage.

Accessories

Add on Block

Surge Suppressor

Add on Blocks				
For Contactor	Mounting	I_{th} (A)	Contact Combinations	Cat. No.
MDX 9 - 110	Top	10	1 NO + 1 NC	CS96568OOOO
MDX 9 - 110	Top	10	2 NO + 2 NC	CS96569OOOO
MDX 9 - 110	Side	10	1 NO + 1 NC	ST94985OOOO
MDX 9 - 110	Top	10	1 NO / 1 NC reversible	CS96586OOOO

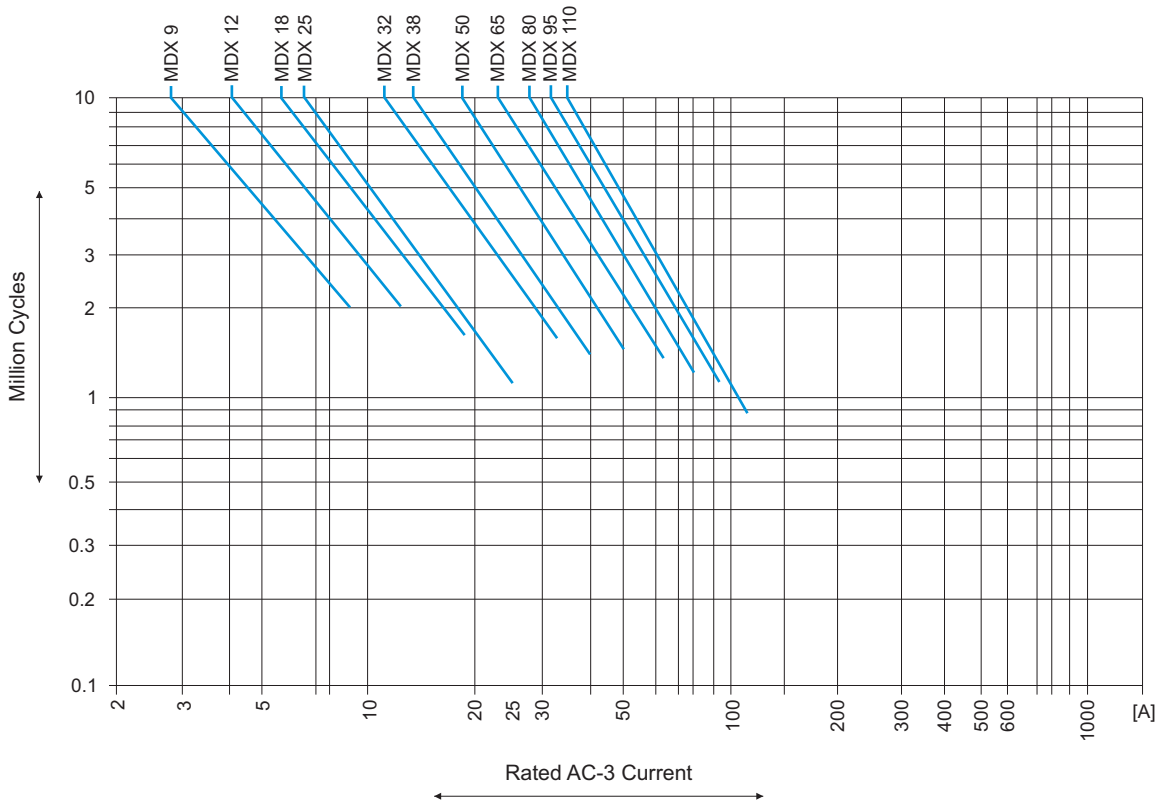
Surge Suppressors	
For Contactor	Cat. No.
MDX 50 - 110	CS96571OOOO

Note: Inbuilt surge suppressor for MDX 9 - 38

Mechanical Interlock kit	
For contactor	Cat. No.
MDX 9 - 38	CS96572OOOO
MDX 50 - 110	CS96573OOOO

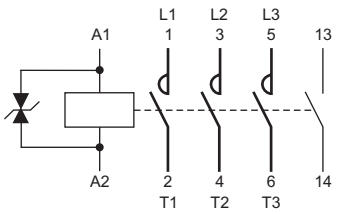
Ordering Suffix for Coil Voltages

Coil Voltage V DC	24	48	110	220
Suffix	4OOO	5OOO	1OOO	2OOO

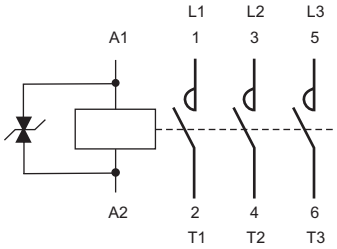

MDX 9
MDX 12
MDX 18
MDX 25
MDX 32
MDX 38
MDX 50
MDX 65
MDX 80
MDX 95
MDX 110
Million Cycles
10
5
3
2
1
0.5
0.3
0.2
0.1
2
3
5
10
20
25
30
50
100
200
300
400
500
600
1000
[A]
Rated AC-3 Current

Terminal Designation

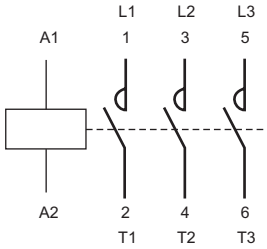
MDX 9 - 25 (with 1 NO)



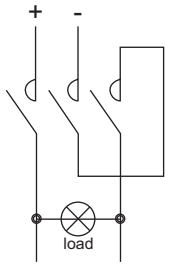
MDX 32 - 38



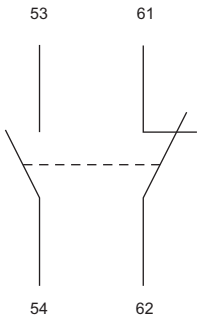
MDX 50 - 110



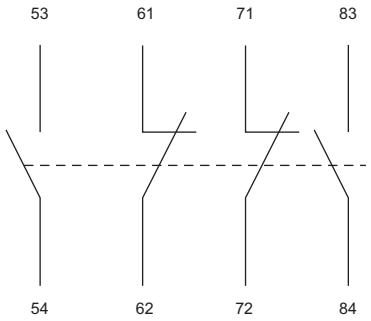
3 Pole in series



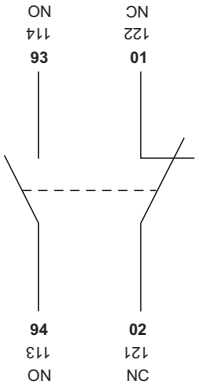
MDX 11E Top add on



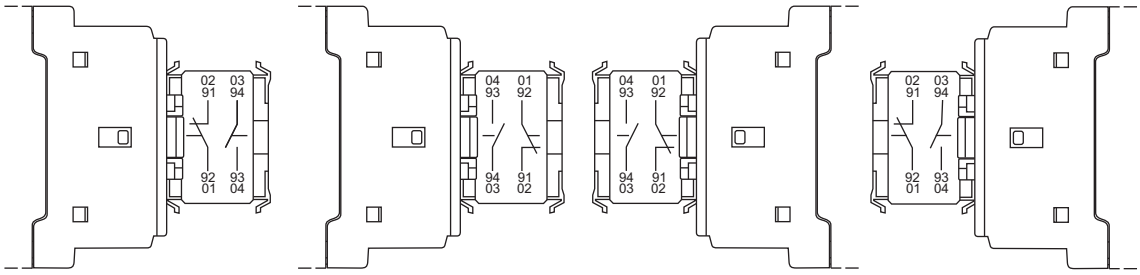
MDX 22E Top add on



MDX 11E Side add on

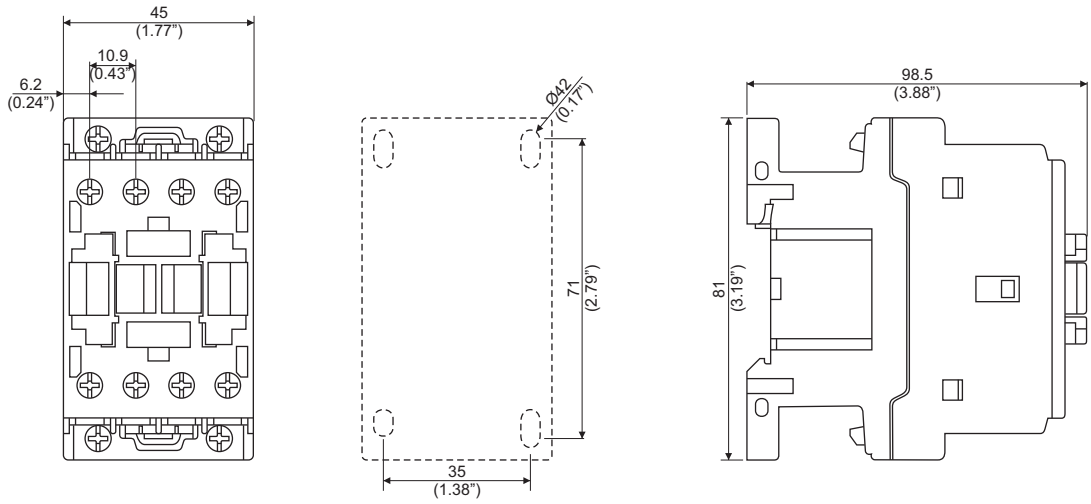


MDX Top add On 1 NO / 1 NC reversible (MDX 9 - 110)

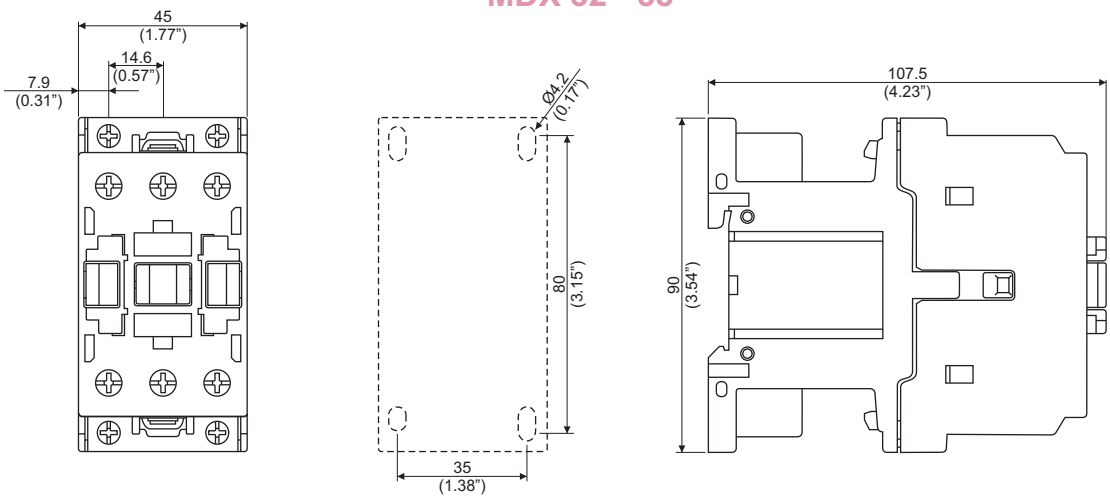


All dimensions in mm.

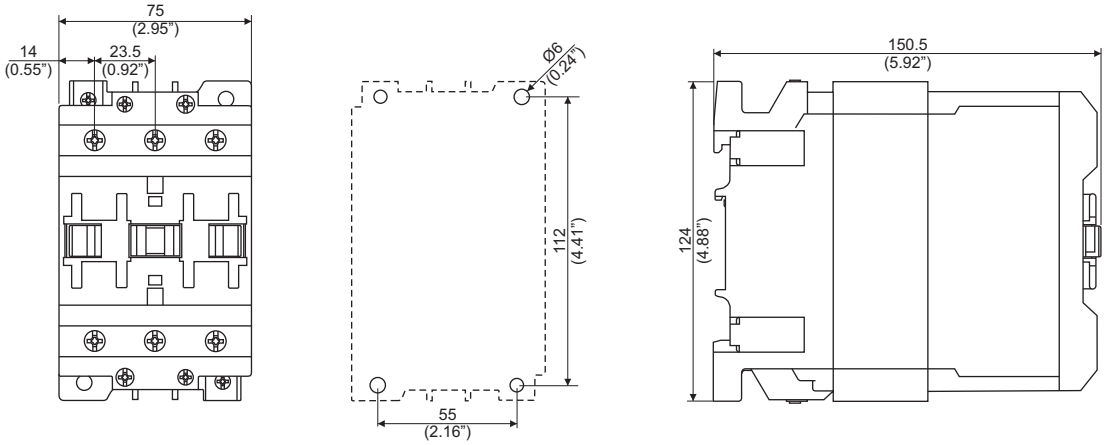
MDX 9 - 25



MDX 32 - 38



MDX 50 - 110



All dimensions in mm.

ML 3 Pole Power Contactors

ML Power Contactors are suitable for applications involving harsh environments. They are used in motor feeder applications in steel industries, material handling plants etc. The series includes a wide range from 25A to 300A (AC-3) and are complemented by ML Thermal Overload Relays.

TAP THE TOUGH SOLUTION

Technical Details

- Conforms to IS/IEC 60947-4-1, IEC 60947-4-1
- Range from 25A - 300A AC-3
- Rugged and designed for harsh operating conditions

Type		Units	ML 1.5	ML 2
Cat. no.			SS91851	SS90701
Conformance Standards				
No. of poles			3	3
Thermal rating / Utilization category AC-1 : 3 Ø, 415V, 50 Hz		A	25	40
Insulation voltage, U_i		V	500	500
Motor duty 3Ø, 415V, 50 Hz	Utilization Category AC-2	A	25	32
	Utilization Category AC-3	kW/A	11 / 25	15 / 32
	Utilization Category AC-4	kW/A	9 / 21	15 / 32
Operational Current Ie (AC-4 Utilization Category) For contact life of 300000 Operating cycles		A	13.5	17
I) Stator duty - 415V, 50Hz Duty factor (10 min. cycle duration)	20%	A	37	48
	40%	A	37	48
	60%	A	30	40
II) Rotor duty - Delta connected Duty factor (10 min. cycle duration)	20%	A	56	72
	40%	A	56	72
	60%	A	44	60
III) Max. Rotor Voltage (10 min. cycle duration)	Starting	V	830	830
	Plugging	V	415	415
	Speed control	V	500	500
Making Capacity at 457V, Cos Ø - 0.35, 50 Hz		A	252	400
Breaking Capacity at 457V, Cos Ø - 0.35, 50 Hz		A	210	320
DC rating (with 3 poles in series) and AC coil operation	DC 1 - 110V	A	25	32
	DC 1 - 220V	A	25	32
	DC 3 - 110V	A	25	32
	DC 3 - 220V	A	10	32
	DC 5 - 110V	A	25	32
	DC 5 - 220V	A	7.5	32
Mechanical life : No of operating cycles		mm	15 x 10^6	10 x 10^6
Max. Frequency of operation : Operating	Mechanical	cy/hr	3000	2000
	Utilization Category AC-1	cy/hr	3000	750
	Utilization Category AC-2	cy/hr	750	750
	Utilization Category AC-3	cy/hr	750	750
	Utilization Category AC-4	cy/hr	250	250
Service temperature		°C	-20°C to + 55°C	-20°C to + 55°C
Main terminal capacity	Wires	mm	2 x 10	2 x 25
	Lugs	mm	16	50
Auxiliary Contacts				
No. of built in auxiliary contacts			2 NO + 2 NC	2 NO + 2 NC
Operating Sequence				
Thermal Rating at 415V, 50 Hz			16	16
Aux. Terminal Capacity : Wires		mm^2	2 x 2.5	2 x 2.5
AC-15 Rating at 415V, 50Hz		A	4	4
Making Capacity at 415V, Cos Ø - 0.35, 50 Hz		A	80	80
Breaking Capacity at 415V, Cos Ø - 0.35 Ø, 50 Hz		A	70	70
Coil				
Voltages Available for 50Hz operation, Uc		V	24, 42, 110, 220, 240, 360, 380, 415, 440, 525	42, 110 60, 380
Pick-up	VA	VA	60	120
	Cos Ø		0.8	0.4
Hold-on	VA	VA	15	20
	Watts	W	5	8.5
Limits of operation	Pick-up (% Uc)	%Uc	75 - 110	75 - 110
	Drop-off (% Uc)	%Uc	65 - 15	65 - 15
Typical closing delay		ms	5 - 35	10 - 35
Typical opening delay		ms	5 - 20	5 - 25
Weight (unpacked)		kg	0.5	0.95



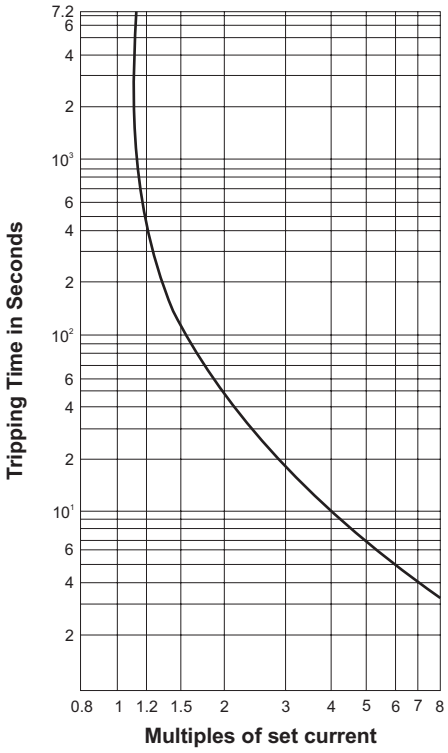

ML 3	ML 4	ML 6	ML 12
SS90721	SS90910	SS90921	SS91010
IS/IEC 60947-4-1, IEC 60947-4-1			
3	3	3	3
45	100	125	400
500	660	660	660
40	70	110	300
22 / 40	37 / 70	55 / 110	165 / 300
22 / 40	37 / 70	45 / 85	140 / 250
22	35	46	112
60	95	165	375
60	95	165	375
50	78	135	310
90	157	270	560
90	157	270	560
75	118	206	465
830	830	830	830
415	415	415	415
500	500	500	500
480	840	1200	3000
400	700	1000	2500
40	63	85	300
40	63	85	300
40	63	85	300
40	63	63	300
40	63	85	300
40	63	63	300
10×10^6	10×10^6	10×10^6	10×10^6
2000	1200	1200	1200
750	1000	750	750
750	500	500	500
750	750	750	500
250	250	250	250
-20°C to + 55°C	-20°C to + 55°C	-20°C to + 55°C	-20°C to + 55°C
2 x 25	-	-	-
50	50	95	240
2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC
Break Before Make			
16	16	16	16
2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
4	4	4	4 A
80	80	80	80
70	70	70	70
220, 240 415, 440, 525	110, 220 240, 415, 525		110, 220, 240 380, 415, 525
120	450	450	1450
0.4	0.3	0.3	0.25
20	50	50	85
8.5	17	17	27
75 - 110	75 - 110	75 - 110	75 - 110
65 - 15	65 - 15	65 - 15	65 - 15
10 - 35	10 - 35	10 - 35	15 - 45
5 - 25	10 - 40	10 - 40	5 - 25
0.95	2.9	3	9.2

ML Thermal Overload Relay

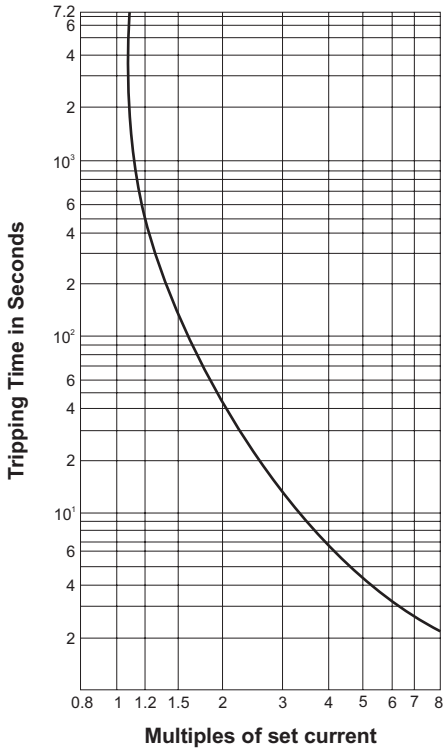
Type		Units	ML 1.5	ML 2/3
Cat. no.			SS91858	SS91859
Conformance Standards			**IS/IEC 60947-4-1, IEC 60947-4-1**	
Rated insulation voltage (U_i)		V	500	500
Rated impluse strength (U_{imp})		V	6	6
Service temperature		°C	-5°C to + 55°C	-5°C to + 55°C
Rated thermal current I_{th} at 415V, 50 Hz		A	6	6
Rated operational current for AC-15 utilization category at 50 Hz	24V	A	6	6
	110V	A	5	5
	220V	A	3	3
	380 / 415V	A	2	2
	500V	A	2	2
Built in contacts			1 Start	1 Start
			1 Off / Reset	1 Off / Reset
			1 Alarm (NO)	1 Alarm (NO)
Tripping class		A	10	10
Max. Frequency of operation	Op. cycles / hr	cy / hr	30	30
Main Terminal capacity	Lug	mm^2	16	50
Aux. Terminal capacity	Wires	mm^2	2 x 2.5	2 x 2.5

3 Pole Balanced Loading Condition

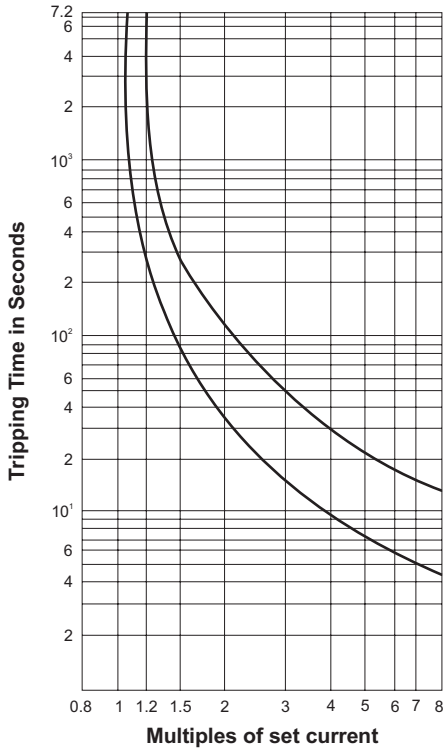
ML 1 (upto 6-10 Amps)



ML 1 (upto 10-16 Amps)



ML 2 / 3



ML Relays

Type	Range (A)	Cat. No.
ML 0 ML 1 ML 1.5	0.15 - 0.25	SS91858OODO
	0.25 - 0.4	SS91858OOFO
	0.4 - 0.65	SS91858OOHO
	0.6 - 1	SS91858OOKO
	1 - 1.6	SS91858OOMO
	1.5 - 2.5	SS91858OOPO
	2.5 - 4	SS91858OORO
	4 - 6.5	SS91858OOTO
	6 - 10	SS91858OOVO
	10 - 16	SS91858OOBO
ML 2 ML 3	9 - 14	SS91859OOAO
	13 - 21	SS91859OOCO
	20 - 32	SS91859OOEO
	28 - 42	SS91859OOFO

Accessories & Spares



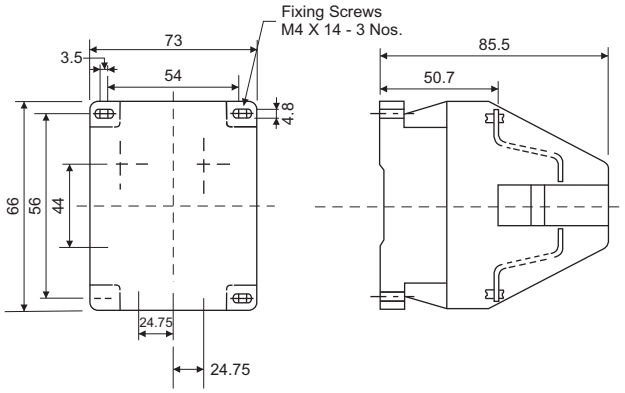

Contactor Type	Aux. Add on Block	Spare Coil*	Spare Kit	Housing & Bridge Kit
ML 1.5	Not available	SS90873	SS95305	ST28734
ML 2	Not available	SS90545	SS95307	ST23866
ML 3			SS95309	
ML 4	SS91494	SS91258	SS95311	ST28735
ML 6			SS95313	
ML10	SS91474	SS91011	SS95315	-
ML 12			SS95317	-

* Add 4 digit suffix as per required coil voltage given below.

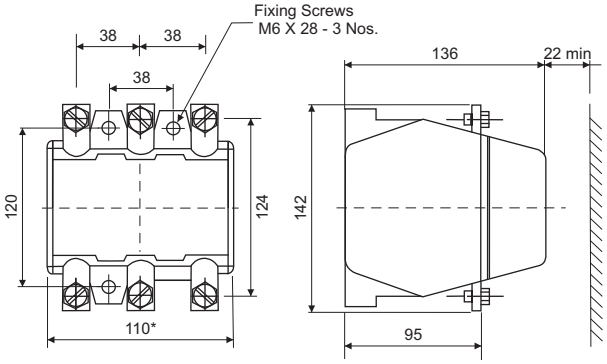
Ordering Suffix for Coil Voltages

Std Coil voltage at 50Hz	24	42	48	110	220	240	360	380	415	440	525
Ordering Suffix	GOOO	JOOO	HOOO	AOOO	KOOO	BOOO	COOO	LOOO	DOOO	POOO	MOOO

ML 1.5 Contactor (Without shroud)

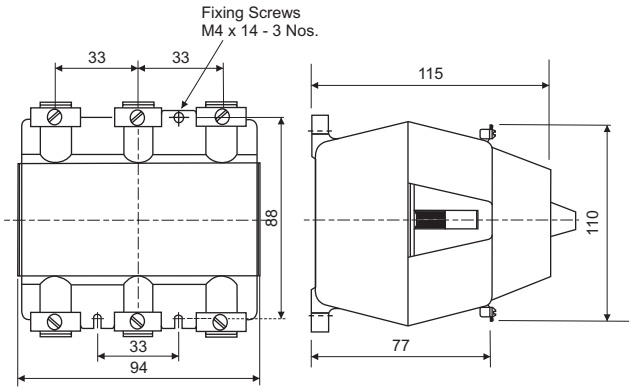


ML 4 Contactor

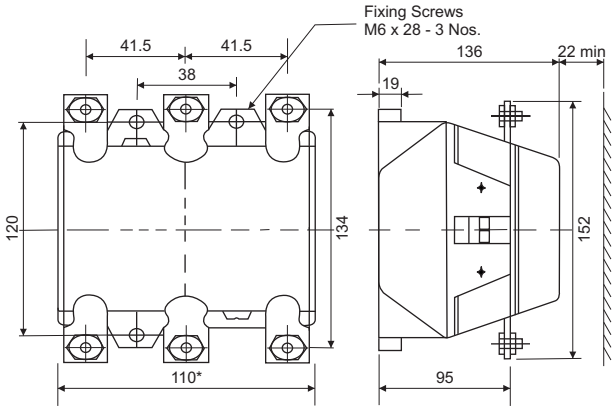


*Provide 12 mm extra for each Add-on block

ML 2 / 3 Contactor

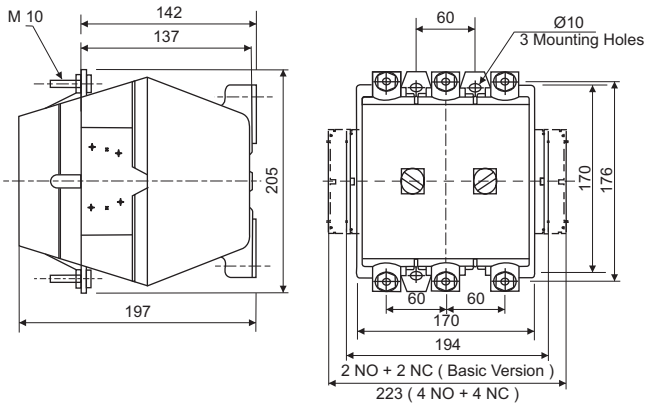


ML 6 Contactor



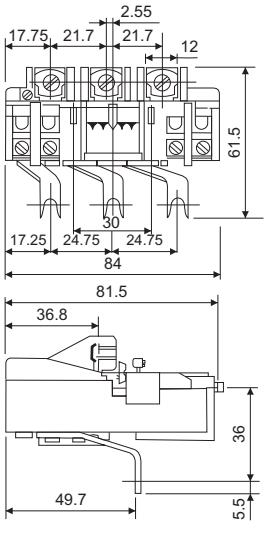
*Provide 12 mm extra for each Add-on block

ML 12 Contactor



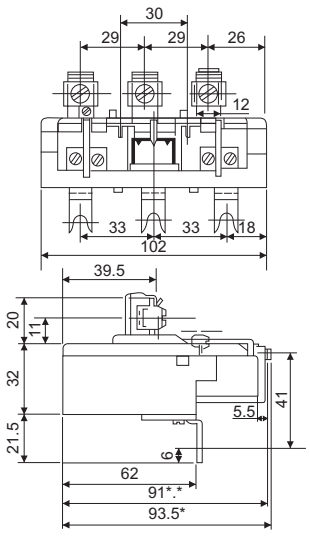
Thermal Overload Relay

ML 0/1/1.5



Terminal Screws M4

ML 2/3



Terminal Screws M4

All dimensions in mm.

MX Mini Contactors & Thermal Overload Relay

MX Mini Contactors are designed for panels where panel space is a constraint. The contactors have a compact design and exhibit reliable performance even in smaller space. The range is suitable for both industrial and commercial applications for motor loads up to 5.5 kW and electromagnetic loads up to 4A.

MAKE WAY FOR BIGGER BENEFITS IN SMALLER FOOTPRINTS

Technical Details - MX Power Contactors

- Range from 6A - 12A AC3
- Control contactors available in all NO/NC combinations (4 Pole)
- Top mounting accessories
- Available with AC or DC control
- Built-in surge suppressor with DC control
- Direct mounting thermal overload relay type RX
- RoHS Compliant

Type Designation for AC / DC Control		Units	MX 6 AC / DC	MX 9 AC / DC	MX 12 AC / DC
Catalogue no. for AC control			CS94012 / 3	CS94014 / 5	CS94016 / 7
Catalogue no. for DC control			CS94021 / 2	CS94023 / 4	CS94025 / 6
Conformance to standards			IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1		
Rated insulation voltage, U_i		V	690		
Service temperature		°C	-5°C to +55°C		
Degree of protection			IP20		
Tightening torque		Nm	0.8		
Power Contacts					
No. of main poles			3		
Conventional thermal current, I_{th}		A	20		
Rated current at 415 V, 50 Hz	Utilization category AC-1	A	20		
	Utilization category AC-3	A / kW	6 / 3	9 / 4	12 / 5.5
Making capacity at 415 V, 50 Hz		A	10 I_e (AC - 3)		
Breaking capacity at 415 V, 50 Hz		A	8 I_e (AC - 3)		
Short-circuit protection	gG fuse at 415 V, 50 Hz	A	20		
Electrical durability (AC-3)		million	1	0.8	0.6
Frequency of operation at U_c	Utilization category AC-1	cy / hr	3000		
	Utilization category AC-3	cy / hr	750		
Main terminal capacity	Solid conductors	mm^2	2 x 2.5		
	Multi-stranded conductors	mm^2	2 x 2.5		
Auxiliary Contacts					
No. of built-in auxiliary contact			1 NO or 1 NC		
Conventional thermal current, I_{th}		A	10		
Rated current at 415 V, 50 Hz	Utilization category AC-15	A	4		
Short-circuit protection	gG fuse at 415 V, 50 Hz	A	10		
Electrical durability (AC-15) at 415 V, 50 Hz		million	1.5		
Minimum non-overlapping distance		mm	0.5		
Maximum frequency of operation at U_c (AC-15)		cy / hr	1000		
Auxiliary terminal capacity	Solid conductors	mm^2	2 x 2.5		
	Multi-stranded conductors	mm^2	2 x 2.5		
Maximum Permissible control cable length for drop-off*	415 V	m	69.30		
	240 V	m	207.21		
	110 V	m	986.37		

CS94012 / 14 / 16 / 21 / 23 / 25 are 3 Main + 1NO auxiliary contact combination
CS94013 / 15 / 17 / 22 / 24 / 26 are 3 Main + 1NC auxiliary contact combination
*Cable capacitance assumed to be 0.2 microfarad/km

Technical Data

Type Designation for AC / DC Control		Units	MX 0 AC / DC				
Catalogue no. for AC control			CS94018	CS94019	CS94020	CS94041	CS94042
Catalogue no. for DC control			CS94027	CS94028	CS94029	CS94043	CS94044
Contact combination			40E	31E	22E	13E	04E
Conformance to standards			IS/IEC 60947-5-1, IEC 60947-5-1, EN 60947-5-1				
Rated insulation voltage, U_i		V	690				
Service temperature		°C	-5°C to +55°C				
Degree of protection			IP20				
Tightening torque		Nm	0.8				
Contacts							
No. of poles			4				
Contact details			4NO	3NO+1NC	2NO+2NC	1NO+3NC	4NC
Conventional thermal current, I_{th}		A	10				
Rated current at 415 V, 50 Hz	Utilisation category AC-15	A	4				
Short-circuit protection	gG fuse at 415 V, 50 Hz	A	10				
Electrical durability (AC-15) at 415 V, 50 Hz		million	1.5				
Minimum non-overlapping distance		mm	0.5				
Maximum frequency of operation at U_c for AC-15		cy / hr	1000				
Terminal capacity	Solid conductors	mm^2	2 x 2.5				
	Multi-stranded conductors	mm^2	2 x 2.5				
Control Circuit for Power Contactor & Contactor Relay							
Coil voltage			AC		DC		
Standard coil voltage U_c, at 50 Hz		V	24, 110, 240, 415		24, 110, 220		
Average consumption at U_c, 50 Hz	Pick-up	VA	26		2.8		
	Hold-on	VA	4.5		2.8		
		W	1.2		2.8		
Limits of operation	Pick-up	% U_c	80 - 110		80 - 110		
	Drop-off	% U_c	20 - 65		10 - 65		
Operating time at U_c, 50 Hz	Between coil energisation and: - Opening of NC contacts	ms	5 - 20		5 - 25		
	- Closing of NO contacts	ms	10 - 25		10 - 30		
	Between coil de-energisation and: - Opening of NO contacts	ms	10 - 25		10 - 30		
	- Closing of NC contacts	ms	15 - 30		15 - 35		
Mechanical durability		million	10		10		
Maximum frequency of operation at U_c		cy / hr	9000		9000		
Maximum Permissible control cable length for drop-off*	415 V	m	69.30				
	240 V	m	207.21				
	110 V	m	986.37				

Note :
1) 5NC and above combinations not recommended for DC control
2) 1NO + 3NC, 4NC add on block combinations are not recommended for DC control
For example, 4NO + 4NC combination can be achieved with 2NO + 2NC auxiliary contactor and 2NO + 2NC add on block and not with 4NO standalone contactor plus 4NC add on block
3) *Cable capacitance assumed to be 0.2 microfarad/km

Auxiliary Contact Blocks

Type Designation		Units	MX-A1							
Catalogue no.			CS94030	CS94031	CS94032	CS94033	CS94034	CS94035	CS94036	CS94037
Contact combination			20E	11E	02E	40E	31E	22E	13E	04E
Conformance to standards			IS/IEC 60947-5-1, IEC 60947-5-1, EN 60947-5-1							
Rated insulation voltage, U_i		V	690							
Service temperature		°C	-5°C to +55°C							
Degree of protection			IP20							
Tightening torque		Nm	0.8							
Contacts										
No. of poles			2			4				
Contact details			2NO	1NO+1NC	2NC	4NO	3NO+1NC	2NO+2NC	1NO+3NC	4NC
Conventional thermal current, I_{th}		A	10							
Rated current at 415 V, 50 Hz Utilization category AC-15		A	3							
Short-circuit protection gG fuse at 415 V, 50 Hz		A	10							
Electrical durability(AC-15) at 415 V, 50 Hz		million	1							
Minimum overlapping distance		mm	0.5							
Maximum frequency of operation at U_c for (AC-15)		cy / hr	1000							
Terminal capacity	Solid conductors	mm²	2 x 2.5							
	Multi-stranded conductors	mm²	2 x 2.5							

Mechanical Interlock

Type Designation	MX-M1
Catalogue no.	CS94038OOOO

Surge Suppressor

Type Designation	MX-S1		
Catalogue no.	CS94039		
Suitable Coil Voltage at 50 Hz	24 - 48 V	110 - 240 V	360 - 415 V
Ordering Suffix	JOOO	BOOO	DOOO

Ordering Suffix for Coil Voltages

Std Coil Voltage at 50 Hz	24	42	48	110	220	240	360	380	415	440	525
Ordering Suffix - 50 Hz	GOOO	HOOO	JOOO	AOOO	KOOO	BOOO	COOO	LOOO	DOOO	POOO	MOOO
Ordering Suffix - 60 Hz	-	-	-	YOOO	VOOO	-	-	-	SOOO	-	-

Coil Voltage V DC	24	48	110	220
Suffix	4OOO	5OOO	1OOO	2OOO

Technical Data

Type Designation		Units	RX	
Catalogue no.			ST94074	
Conformance to standards			**IS/IEC 60947-4-1 & IEC 60947-4-1**	
Current range			Range (A)	Ordering Suffix
		A	0.23-0.41	OOFO
		A	0.45-0.78	OOJO
		A	0.78-1.2	OOLO
		A	1.2-1.9	OONO
		A	1.8-2.8	OOPO
		A	2.6-3.6	OOQO
		A	3.6-5.2	OOSO
		A	4.8-7	OOTO
		A	6.4-9.7	OOVO
		A	8.2-12.1	OOAO
Rated insulation voltage, U_i		V	690	
Rated impulse voltage, U_{imp}		kV	6	
Service temperature		^{0}C	-5^{0}C to +55^{0}C	
Contacts				
Rated operational current for AC-15 utilisation category at 50 Hz for	24 V	A	6	
	110 V	A	5	
	220 V	A	3	
	380 / 415 V	A	2	
	500 V	A	2	
Tripping class		A	10	
Maximum frequency of operation		cy / hr	30	
Main terminal capacity (Lug)			10	
Auxiliary terminal capacity (Wires)		mm^2	2 x 2.5	
Mounting		mm^2	Direct	
OFF / Reset			1 OFF and Reset	
Built-in contacts			1NO and 1NC	

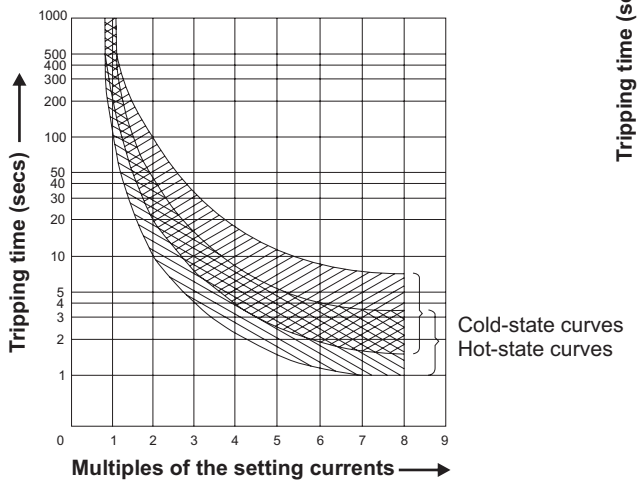
Technical Data

Relay Selection Chart

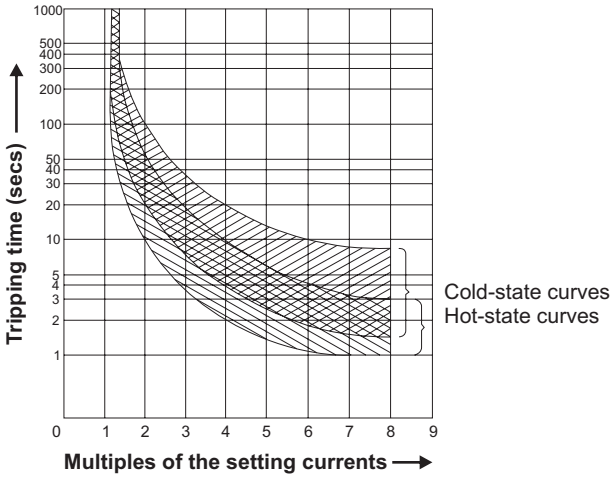
Range (A)	Back-up fuse (HF) (A)	Contactor
0.23 - 0.41	2	MX 6
0.45 - 0.78	2	MX 6
0.78 - 1.2	2	MX 6
1.2 - 1.9	2	MX 6
1.8 - 2.8	4	MX 6
2.6 - 3.6	4	MX 6
3.6 - 5.2	6	MX 6
4.8 - 7	8	MX 9
6.4 - 9.7	10	MX 12
8.2 - 12.1	16	MX 12

Protection Characteristics

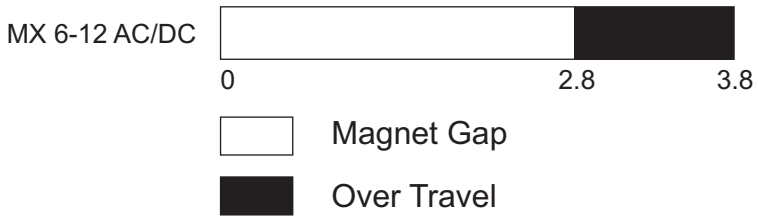
Single-phase



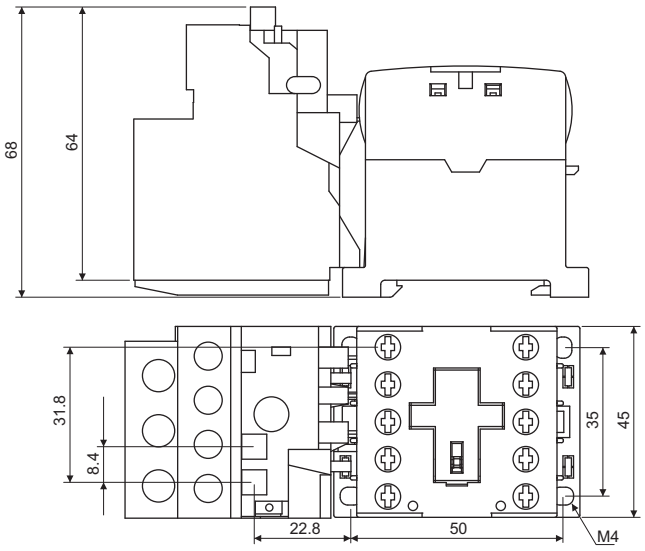
Three-phase



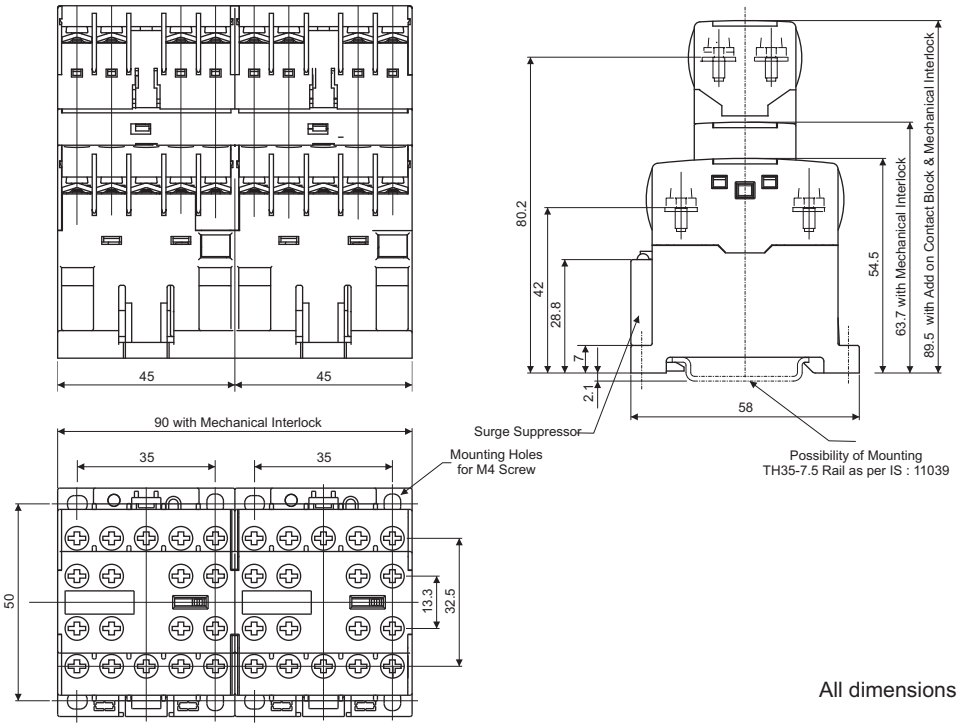
Contact Travel Diagram



Dimension with Relay



Dimension with MIL Kit



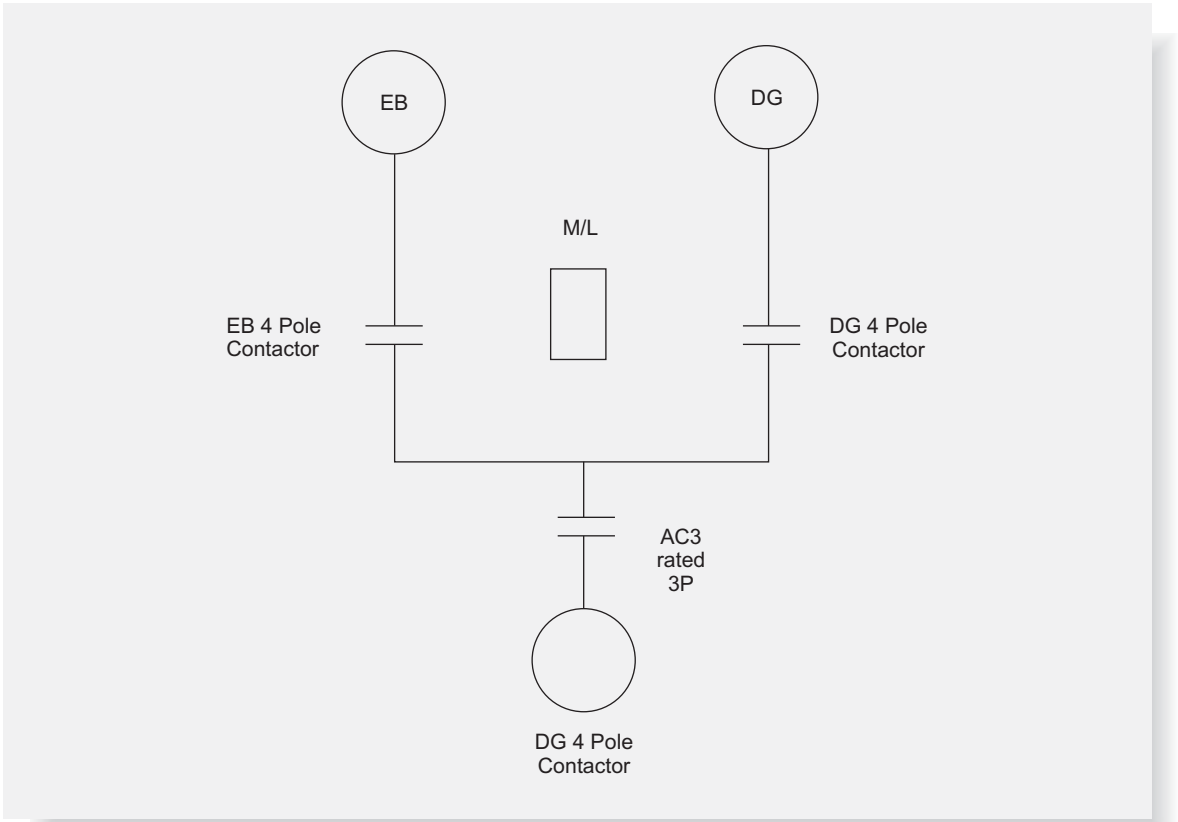
All dimensions in mm.

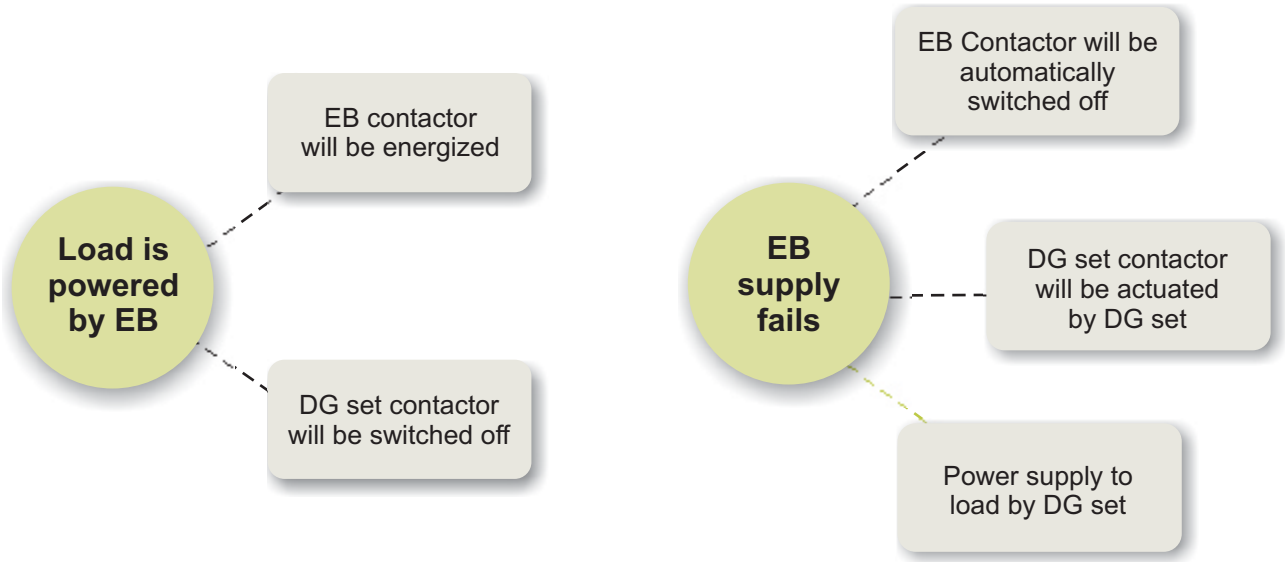
MCX 4 Pole Power Contactors

MCX range of 4 pole contactors is available from 16A to 800A AC-1. The contactors are widely used in conjunction with auto source transfer controller for transfer of power from mains to backup supply.

THE PATHWAY TO SMOOTHER CHANGEOVERS

4 Pole Contactors in DG Set





* Both the contactors are electrically & mechanically interlocked
* Auxiliary NC contact will be used for actuation and NO for indication

4 pole contactors used for DG set changeover applications are generally located upstream

Even if motor loads are connected down stream, the upstream 4 pole contactor will not be making the starting current of the motor

This starting current will have to be made by the downstream AC3 rated 3 pole contactor which will actually switch on he motor

Hence, 4 Pole contactors must always be selected as per their AC1 rating

- Range from 16-800A AC1
- Wide operating band upto 100A AC1
- Compact mechanical interlock arrangement upto 80A




Type		Unit	MCX 01	MCX 02	MCX 03	MCX 04
Catalogue no.			CS97009	CS97010	CS97011	CS97012
Conformance to standards						
Preferred DG ratings		kVA	7.5	15	20	25
Power contacts						
No. of poles			4	4	4	4
Number of built-in auxiliary contacts			-	-	-	-
Rated insulation voltage, U_i		V	690	690	690	690
Rated operational voltage, U_e		V	415	415	415	415
Rated impulse withstand voltage, U_{imp}		kV	8	8	8	8
Conventional thermal current, I_{th} / AC1 at 55°C / 60°C		**A**	**16**	**25**	**32**	**40**
Permissible short time ratings	1 Second	**A**	250	250	320	400
	10 Seconds	**A**	105	105	134	168
	15 Seconds	**A**	70	70	90	112
	1 Minute	**A**	60	60	77	96
	10 Minutes	**A**	30	30	38	48
	15 Minutes	**A**	25	25	32	40
Vibration resistance conforming to IEC 60068-2-6						
Ambient temperature around the device	Service temperature	°C				
	Storage temperature	°C				
Altitude without deration		m				
Degree of Pollution						
Degree of protection						
Protective treatment						
Watt loss per pole		W	1	1.1	2	3.1
Type of Terminal			Philip and Slot Head Combination Screw			
Maximum Main terminal capacity	Cable with Lug	mm^2	1 x 6	1 x 6	1 x 6	1 x 6
	Busbar (with spreader)	mm^2	-	-	-	-
	Solid conductor	mm^2	2 x 4	2 x 4	2 x 4	2 x 4
	Multistrand conductors	mm^2	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
Tightening Torque	Main Pole Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1
	Aux. Pole / Coil / Add on block Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1





MCX 11	MCX 12	MCX 13	MCX 22	MCX 23
CS97013	CS97014	CS97015	CS97017	CS97018
IS/IEC 60947-4-1 & IEC 60947-4-1				
30	40	50	62.5	82.5
4	4	4	4	4
-	-	-	-	-
690	690	690	690	690
415	415	415	415	415
8	8	8	8	8
50	**63**	**80**	**100**	**130**
400	504	640	1000	1300
240	302	384	650	845
120	151	192	370	481
110	139	176	250	325
50	63	80	120	156
45	57	72	110	143
5..... 300 Hz : 3g				
-20°C to 60°C				
-40°C to 80°C			-15°C to 80°C	
3000				
3				
IP 20				
TH				
4.8	6.6	7	7.3	7.8
Slot Head Screw				
1 x 16	1 x 16	1 x 16	1 x 35	1 x 35
-	-	-	1 x (12.5 x 3)	1 x (12.5 x 3)
2 x 10	2 x 10	2 x 10	-	-
2 x 6	2 x 6	2 x 6	-	-
M5 / 2.4	M5 / 2.4	M5 / 2.4	M6 / 4.5	M6 / 4.5
M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1

Technical Details

- Range from 16-800A AC1
- Wide operating band upto 100A AC1
- Compact mechanical interlock arrangement upto 80A




Type		Unit	MCX 01	MCX 02	MCX 03	MCX 04
Catalogue no.			CS97009	CS97010	CS97011	CS97012
Conformance to standards						
Auxiliary Contacts						
Endurance of auxiliary Contacts		million	0.5	0.5	0.5	0.5
AC-15 rating at 415 V, 50 Hz	24-110 V	A	6	6	6	6
	220-440 V	A	4	4	4	4
	360-440 V	A	4	4	4	4
	525-600 V	A	1.2	1.2	1.2	1.2
DC-13 rating at 415 V	24 V	A	6	6	6	6
	110-125 V	A	1.1	1.1	1.1	1.1
	250 V	A	0.55	0.55	0.55	0.55
	480 V	A	0.31	0.31	0.31	0.31
	500 V	A	0.27	0.27	0.27	0.27
	600 V	A	0.2	0.2	0.2	0.2
Auxiliary terminal capacity	Solid or multistrand conductors	mm^2	-	-	-	-
Operating time	Closing time	ms	10 - 12	10 - 12	10 - 12	10 - 12
	Opening time	ms	7 - 18	7 - 18	7 - 18	7 - 18
Coil						
Voltage available for 50 Hz operation, U_c		V	110, 220, 240, 415	110, 220, 240, 415	110, 220, 240, 415	110, 220, 240, 415
Pick-up	VA	VA	68	68	68	68
Hold-on	VA	VA	11	11	11	11
	Watts	W	4	4	4	4
Limits of operation	Pick-up	$\%U_c$	55 - 120	55 - 120	55 - 120	55 - 120
	Drop-off	$\%U_c$	30 - 50	30 - 50	30 - 50	30 - 50
Safe isolation between coil and auxiliary contacts		V	400	400	400	400
Overall dimensions H x W x D		mm^3	83 x 45 x 83.7	83 x 45 x 83.7	83 x 45 x 83.7	83 x 45 x 83.7
Mountingl dimensions H x W		mm^2	(60 - 65 - 70) x 35	(60 - 65 - 70) x 35	(60 - 65 - 70) x 35	(60 - 65 - 70) x 35
Mounting clearance (front)		mm	10	10	10	10
Weight		kg	0.35	0.35	0.35	0.35





MCX 11	MCX 12	MCX 13	MCX 22	MCX 23
CS97013	CS97014	CS97015	CS97017	CS97018
IS/IEC 60947-4-1 & IEC 60947-4-1				
0.5	0.5	0.5	0.5	0.5
6	6	6	6	6
4	4	4	4	4
4	4	4	4	4
1.2	1.2	1.2	1.2	1.2
6	6	6	6	6
1.1	1.1	1.1	1.1	1.1
0.55	0.55	0.55	0.55	0.55
0.31	0.31	0.31	0.31	0.31
0.27	0.27	0.27	0.27	0.27
0.2	0.2	0.2	0.2	0.2
-	-	-	-	-
10 - 12	10 - 12	10 - 12	15 - 35	15 - 35
7 - 18	7 - 18	7 - 18	10 - 25	10 - 25
110, 220, 240, 415	110, 220, 240, 415	110, 220, 240, 415	240, 415	240, 415
180	180	180	190	190
22	22	22	22	22
5	5	5	5.5	5.5
50 - 120	50 - 120	50 - 120	65 - 120	65 - 120
25 - 45	25 - 45	25 - 45	40 - 60	40 - 60
400	400	400	400	400
80 x 83.5 x 91.8	80 x 83.5 x 91.8	80 x 83.5 x 91.8	109 x 103 x 120.5	109 x 103 x 120.5
(55 - 58) x 70	(55 - 58) x 70	(55 - 58) x 70	80 x 85	80 x 85
10	10	10	10	10
0.8	0.8	0.8	1.3	1.3

Technical Details

- Range from 16-800A AC1
- Wide operating band upto 100A AC1
- Compact mechanical interlock arrangement upto 80A

Type		Unit	MCX 32	MCX 33	MCX 34
Catalogue no.			CS97020	CS97021	CS97022
Conformance to standards					
Preferred DG ratings		kVA	100	125	160
Power contacts					
No. of poles			4	4	4
Number of built-in auxiliary contacts			2 NO + 2 NC	2 NO + 2 NC	2NO+2NC
Rated insulation voltage, U_i		V	1000	1000	1000
Rated operational voltage, U_e		V	415	415	415
Rated impulse withstand voltage, U_{imp}		kV	8	8	8
Conventional thermal current, I_{th}/Utilisation category AC1 at 55°C		**A**	**160**	**200**	**255**
Permissible short time ratings	1 Second	**A**	1320	1320	1683
	10 Seconds	**A**	880	1120	1428
	15 Seconds	**A**	500	500	638
	1 Minute	**A**	400	400	510
	10 Minutes	**A**	170	170	217
	15 Minutes	**A**	160	160	204
Vibration resistance conforming to IEC 60068-2-6					
Ambient temperature around the device	Service temperature	°C			
	Storage temperature	°C			
Altitude without deration		m			
Degree of Pollution					
Degree of protection					
Protective treatment					
Watt loss per pole		W	17	22	25
Type of Terminal					
Maximum Main terminal capacity	Cable with Lug	mm^2	1 x 120	1 x 120	1x120
	Busbar (with spreader)	mm^2	2 x (25 x 3)	2 x (25 x 3)	2x(25 x3)
	Solid conductor	mm^2	-	-	-
	Multistrand conductors	mm^2	-	-	-
Tightening Torque	Main Pole Terminal	Nm	M8 / 11	M8 / 11	M10 / 14
	Aux. Pole / Coil / Add on block Terminal	Nm	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1

MCX41	MCX 42	MCX 43	MCX 44	MCX 45	MCX 46	MCX 47
CS97023	CS97024	CS97025	CS97026	CS97027	CS97028	CS94291
IS/IEC 60947-4-1 & IEC 60947-4-1						
200	225	250	320	380	437.5	500
4	4	4	4	4	4	4
2NO+2NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC	2 NO + 2 NC
1000	1000	1000	1000	1000	1000	1000
415	415	415	415	415	415	415
8	8	8	8	8	8	8
325	**360**	**400**	**500**	**600**	**700**	**800**
2500	2500	3500	4375	5250	6125	7000
1800	1800	2400	3000	3600	4200	6400
1200	1200	1500	1875	2250	2625	4500
1000	1000	1100	1375	1650	1925	3500
450	450	550	688	825	963	1400
400	400	500	625	750	875	1300
	5..... 300 Hz : 3g					
	-20°C to +60°C					
	-15°C to 80°C					
	3000					
	3					
	IP 20					
	TH					
25	25	30	38	48	60	66
	Hexagon Head Screw					
2x240	2 x 240	2 x 240	2 x 240	2 x 240	2 x 240	2 x 240
2x(50 x5)	2 x (50 x 5)	2 x (50 x 5)	2 x (50 x 5)	2 x (50 x 5)	2 x (50 x 5)	2 x (50 x 5)
-	-	-	-	-	-	-
-	-	-	-	-	-	-
M12 / 27	M12 / 27	M12 / 27	M12 / 27	M12 / 27	M12 / 27	M12 / 27
M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1	M3.5 / 1.1

Technical Details

- Range from 16-800A AC1
- Wide operating band upto 100A AC1
- Compact mechanical interlock arrangement upto 80A

Type		Unit	MCX 32	MCX 33	MCX 34
Catalogue no.			CS97020	CS97021	CS97022
Conformance to standards					
Auxiliary Contacts					
Endurance of auxiliary Contacts		million	0.5	0.5	0.5
AC-15 rating at 415 V, 50 Hz	24-110 V	A	6	6	6
	220-440 V	A	4	4	4
	360-440 V	A	4	4	4
	525-600 V	A	1.2	1.2	1.2
DC-13 rating at 415 V	24 V	A	6	6	6
	110-125 V	A	1.1	1.1	1.1
	250 V	A	0.55	0.55	0.55
	480 V	A	0.31	0.31	0.31
	500 V	A	0.27	0.27	0.27
	600 V	A	0.2	0.2	0.2
Auxiliary terminal capacity	Solid or multistrand conductors	mm^2	-	-	-
Operating time	Closing time	ms	20 - 40	20 - 40	20 - 40
	Opening time	ms	10 - 25	10 - 25	10 - 25
Coil					
Voltage available for 50 Hz operation, U_c		V	110, 240, 415	110, 240, 415	110, 240, 415
Pick-up	VA	VA	550	550	550
Hold-on	VA	VA	36	36	36
	Watts	W	10	10	10
Limits of operation	Pick-up (%U_c)	%U_c	80 - 110	80 - 110	80 - 110
	Drop-off (%U_c)	%U_c	35 - 65	35 - 65	35 - 65
Safe isolation between coil and auxiliary contacts		V	690	690	690
Overall dimensions H x W x D		mm^3	175 x 183.5 x 152	175 x 183.5 x 152	175 x 183.5 x 152
Mountingl dimensions H x W		mm^2	115 x 165	115 x 165	115 x 165
Mounting clearance (front)		mm	10	10	10
Weight		kg	4.6	4.6	4.6

MCX41	MCX 42	MCX 43	MCX 44	MCX 45	MCX 46	MCX 47
CS97023	CS97024	CS97025	CS97026	CS97027	CS97028	CS94291
IS/IEC 60947-4-1 & IEC 60947-4-1						
0.5	0.5	0.5	0.5	0.5	0.5	0.5
6	6	6	6	6	6	6
4	4	4	4	4	4	4
4	4	4	4	4	4	4
1.2	1.2	1.2	1.2	1.2	1.2	1.2
6	6	6	6	6	6	6
1.1	1.1	1.1	1.1	1.1	1.1	1.1
0.55	0.55	0.55	0.55	0.55	0.55	0.55
0.31	0.31	0.31	0.31	0.31	0.31	0.31
0.27	0.27	0.27	0.27	0.27	0.27	0.27
0.2	0.2	0.2	0.2	0.2	0.2	0.2
2x2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5	2 x 2.5
20 - 45	20 - 45	20 - 45	20 - 45	40 - 70	40 - 70	40 - 70
10 - 25	10 - 25	10 - 25	10 - 25	30 - 60	30 - 60	30 - 60
110,240,415	110, 240, 415	110, 240, 415	110, 240, 415	110, 240, 415	110, 240, 415	110, 240, 415
2100	2100	2100	2100	1000	1000	1000
95	95	95	95	25	25	25
35	35	35	35	10	10	10
80 - 110	80 - 110	80 - 110	80 - 110	80 - 110	80 - 110	80 - 110
35 - 65	35 - 65	35 - 65	35 - 65	35 - 65	35 - 65	35 - 65
690	690	690	690	690	690	690
275x248x221	275 x 248 x 221	275 x 248 x 221	275 x 248 x 221	275 x 248 x 221	275 x 248 x 221	275 x 248 x 221
170x225	170 x 225	170 x 225	170 x 225	170 x 225	170 x 225	170 x 225
10	10	10	10	10	10	10
11.8	11.8	11.8	11.8	12.1	12.1	12.1

Accessories for MCX

Add-on blocks

MNX / MCX
Top Add-on Block

MNX / MCX
Side Add-on Block

Mechanical Interlock Kit

MCX M3
(MCX 22)

Spares for MCX

MCX Spare Kits

Accessories							
			MCX 01 - 04	MCX 11 - 13	MCX 22 - 23	MCX 32 - 34	MCX 41 - 47
	Mounting	Configuration	Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.
Add on Block	Top	4 NO	CS94112	CS94112	CS94112	-	-
		3 NO + 1 NC	CS94113	CS94113	CS94113	-	-
		2 NO + 2 NC	CS94114	CS94114	CS94114	-	-
		1 NO + 3 NC	CS94115	CS94115	CS94115	-	-
		4 NC	CS94116	CS94116	CS94116	-	-
		2 NO	CS94117	CS94117	CS94117	-	-
		1 NO + 1 NC	CS94118	CS94118	CS94118	-	-
		2 NC	CS94119	CS94119	CS94119	-	-
		1 NO	CS94120	CS94120	CS94120	-	-
		1 NC	CS94121	CS94121	CS94121	-	-
	First Left	1 NO + 1 NC	CS94220	CS94201	CS94201	CS94205	CS94205
	First Right	1 NO + 1 NC	CS94221	CS94202	CS94202	CS94206	CS94206
	Second Left	1 NO + 1 NC	-	CS94203	CS94203	CS94207	CS94207
	Second Right	1 NO + 1 NC	-	CS94204	CS94204	CS94208	CS94208
Mechanical Interlock Kit			CS94126	ST50540	CS93095	SS94992	CS94301
Surge Suppressors*			CS94166	CS94163	CS94163	CS94164	CS94165

Spares		
Contactor	Spare Kits	Spare Coil*
MCX 01 - 04	-	CS94105
MCX 11	CS94077	CS94009
MCX 12	CS94078	
MCX 22	CS94331	ST91291
MCX 23	CS90078	
MCX 32	CS94082	CS94196
MCX 33	CS94083	
MCX 34	CS94084	
MCX 41	CS94295	CS94195
MCX 42	CS94296	
MCX 43	CS94297	
MCX 44	CS94298	
MCX 45	CS94299	CS94193
MCX 46	CS94300	
MCX 47	CS90308	

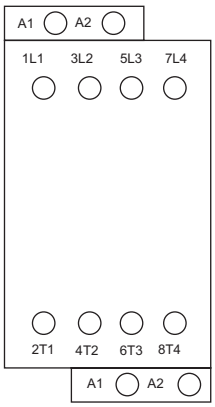
* Add 4 Digit Coil Suffix as per required voltage.
* Ordering suffix for Aux. contact & MIL Kit is OOOO.
Note: Mounting of side Add-on Aux. contact block is not recommended for mechanically interlocked MCX 11/12/13 Contactors.

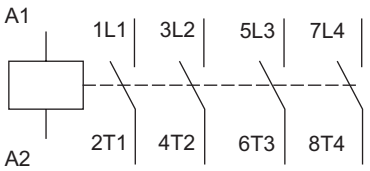
Ordering Suffix for Coil Voltages

Std Coil voltage at 50 Hz	110	220	240	415
Ordering Suffix	AOOO	KOOO	BOOO	DOOO

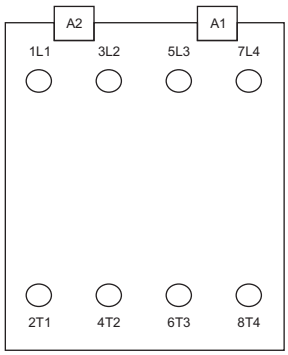
Note : Ordering suffix for MCX 21/22/23: FOOO - 240V AC, ROOO - 415V AC

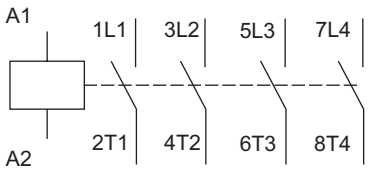
MCX 01-04



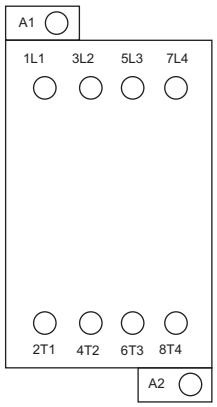


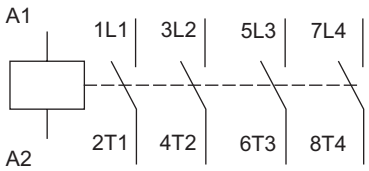
MCX 11-13



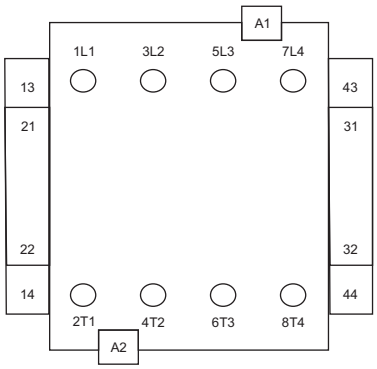


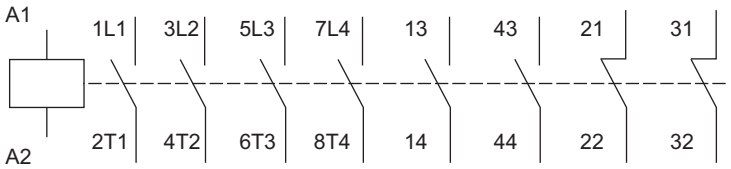
MCX 22-23



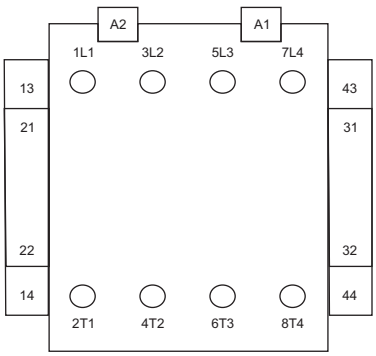


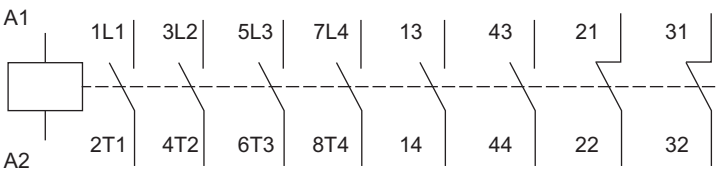
MCX 32-34/MCX 41-44



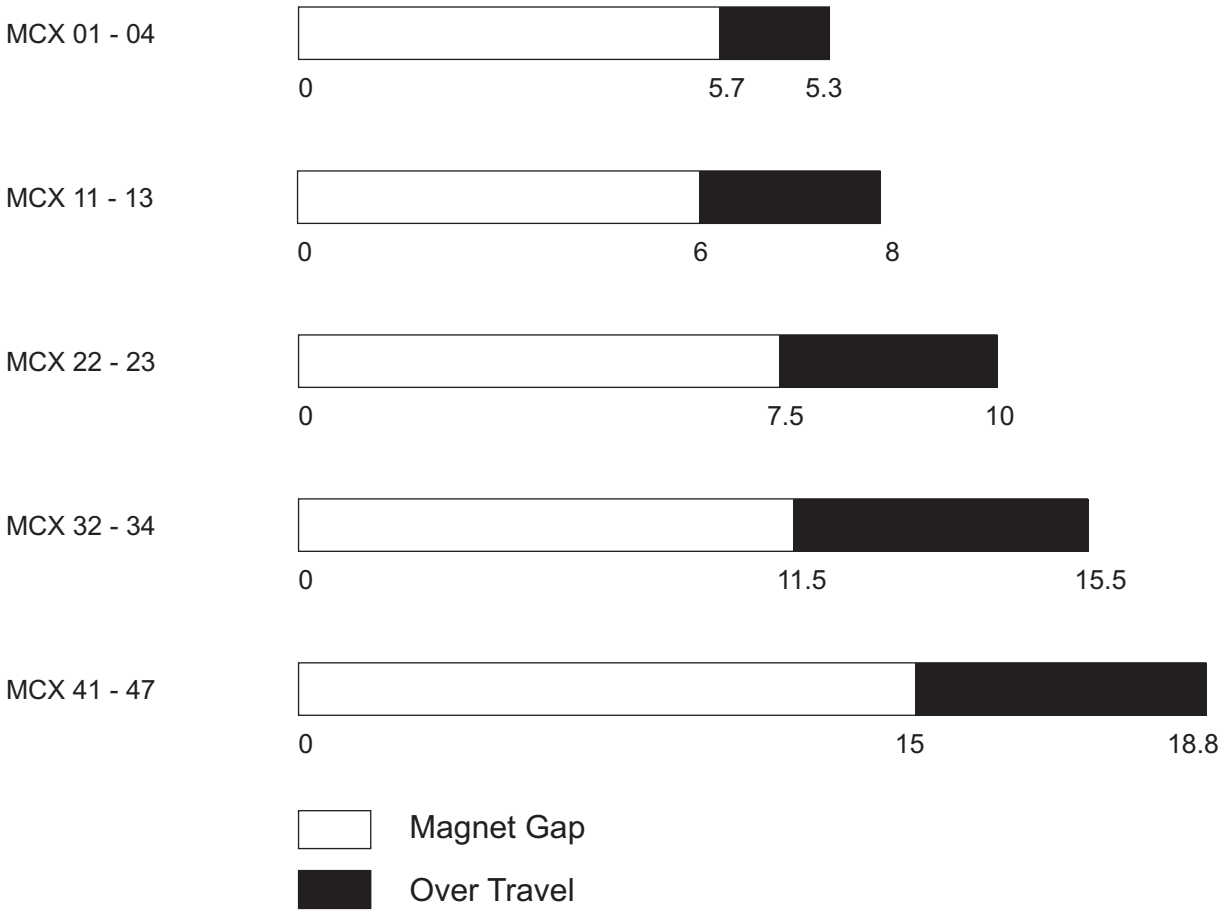


MCX 45-47

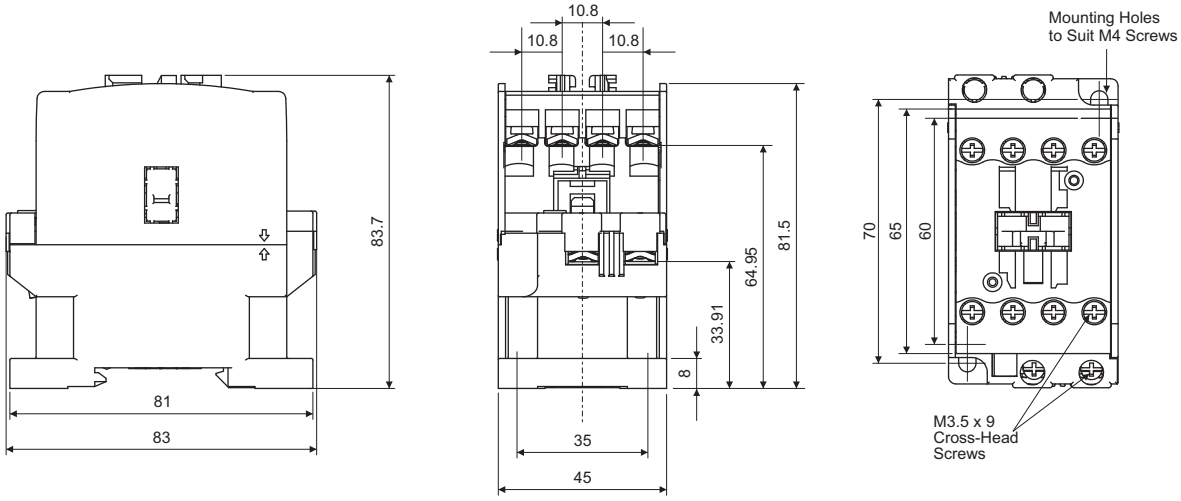




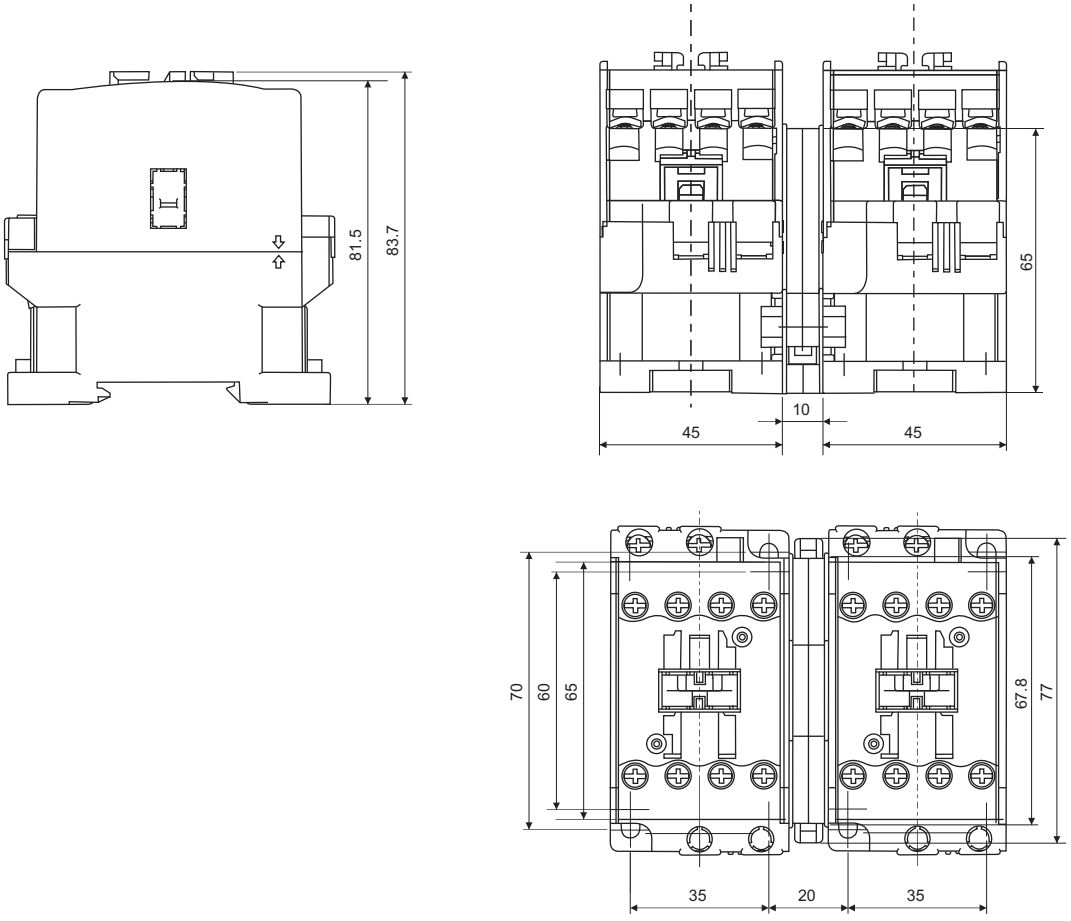
Contact Travel Diagram



MCX 01-04



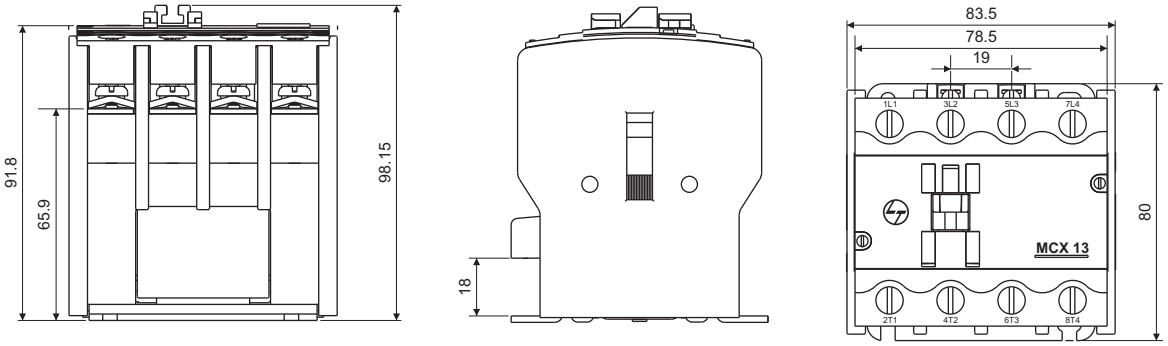
MCX 01-04 (with MIL Kit)



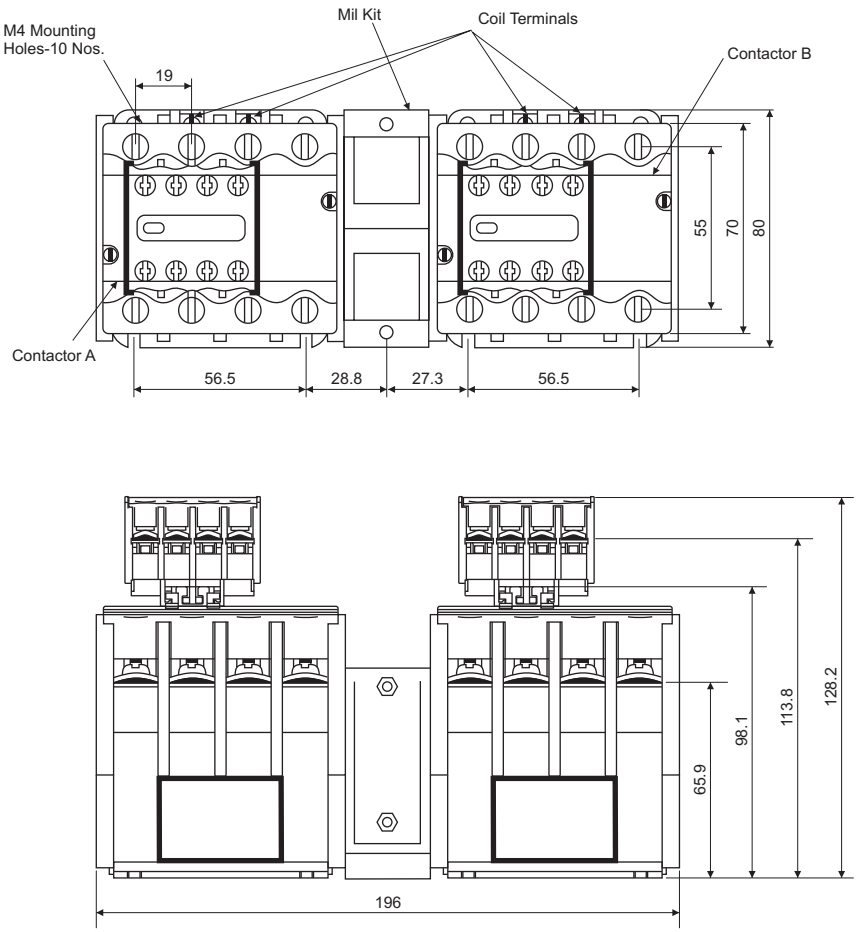
All dimensions in mm.

Overall Dimensions

MCX 11-13

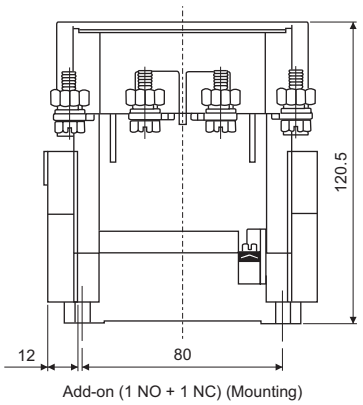


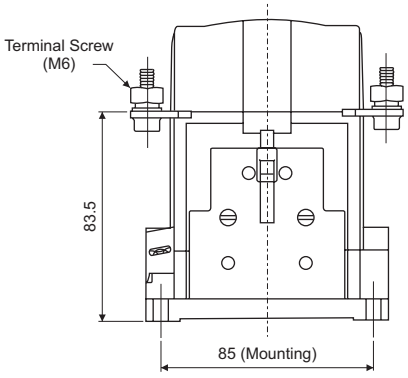
MCX 11-13 (with MIL Kit)

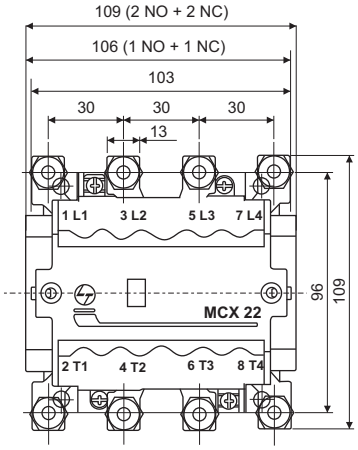


All dimensions in mm.

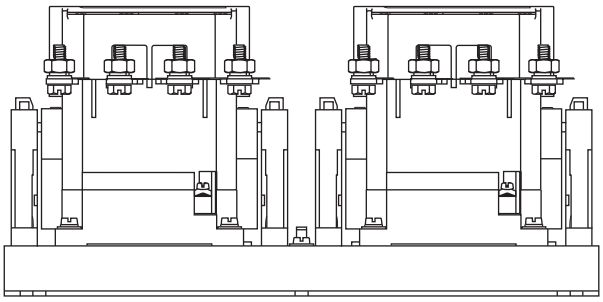
MCX 22-23

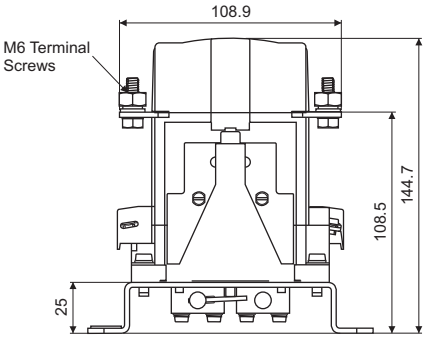


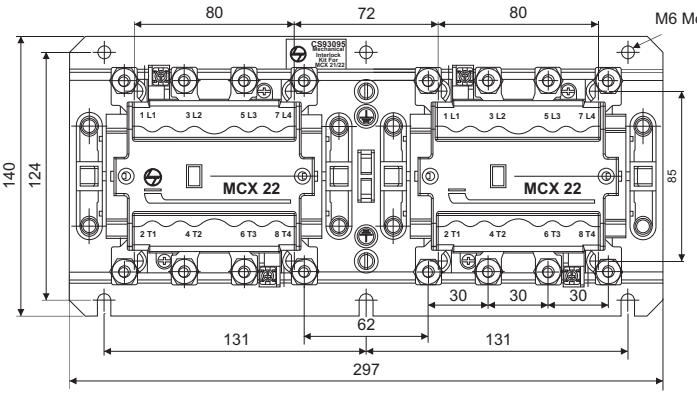




MCX 22-23 (with MIL Kit)



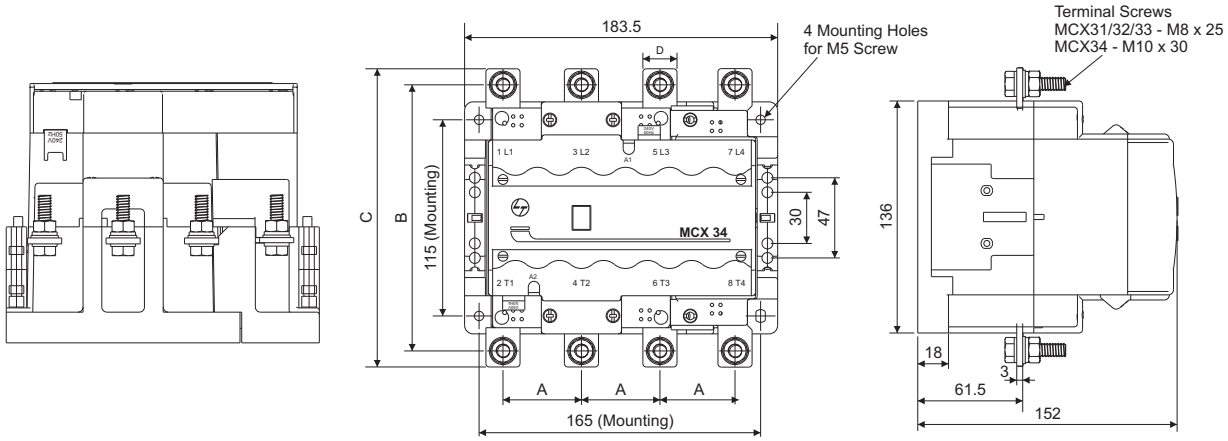




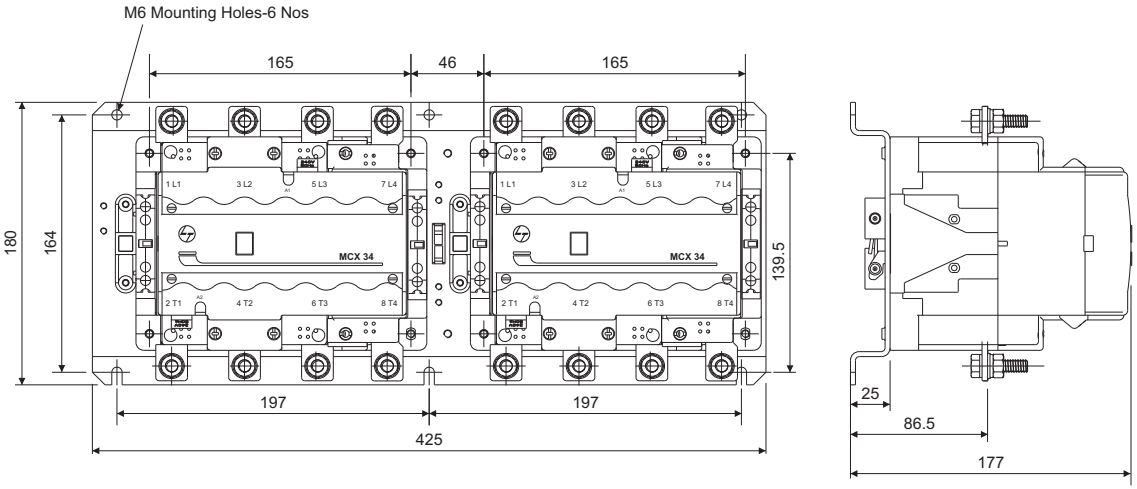
All dimensions in mm.

Overall Dimensions

MCX 32-34

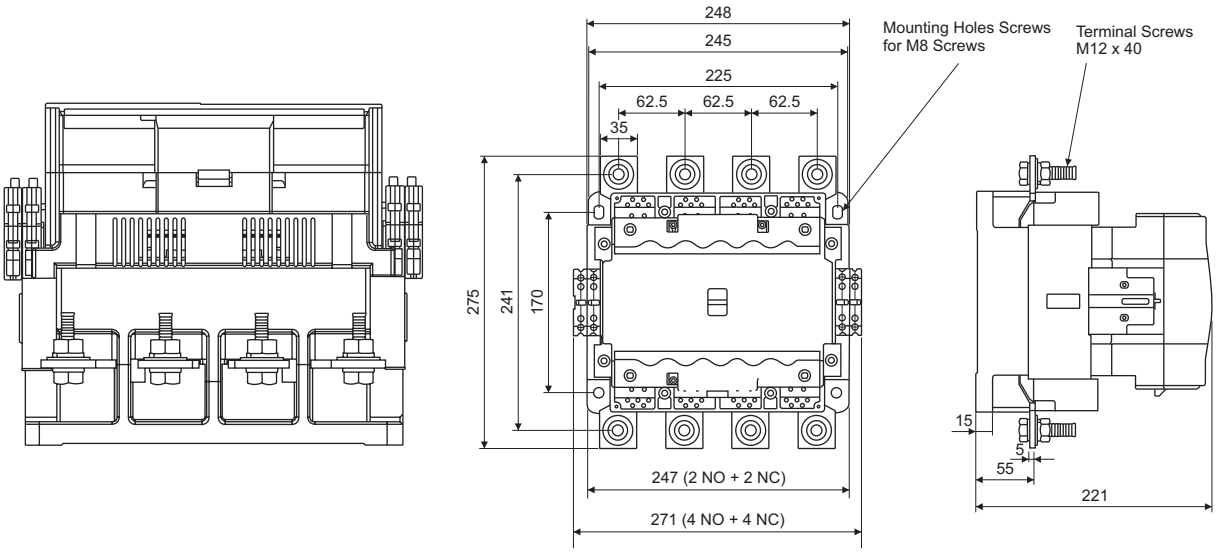


MCX 32-34 (with MIL Kit)

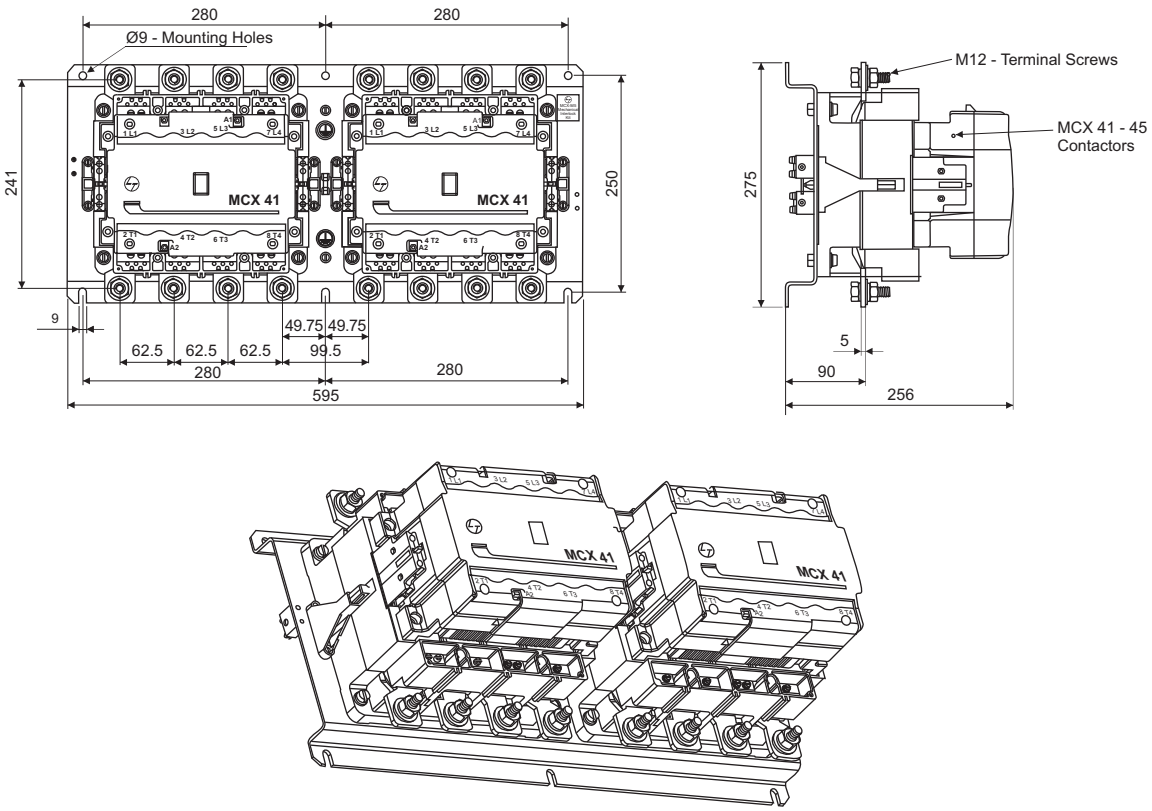


All dimensions in mm.

MCX 41-47



MCX 41-47 (with MIL Kit)



All dimensions in mm.

MO C Capacitor Duty Contactors

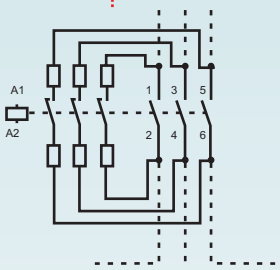
MO C Capacitor Duty Contactors are specially designed for capacitor switching applications. As capacitor switching is associated with high inrush current, the contactors are provided with damping resistors which limit the value of inrush current to a safe value. The contactors are used in APFC panels for switching power capacitors depending upon the amount of reactive power compensation required.

THE ROAD TO HIGHER RELIABILITY

Power Termination

Separate Termination
for damping resistors

DIN rail Mounting



Delatching Auxiliary
contacts

RoHS

In keeping with the mission to deliver the best, Larsen & Toubro understands the requirements of the RoHS directive. The directive restricts the use of hazardous substances in electrical and electronic equipment and bans electrical equipment containing more than permitted levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBS) and polybrominated diphenyl ether (PBDE) flame retardants.

Benefits of using Capacitor Duty Contactors:

Since switching of capacitor banks involves high transient inrush currents, the size of the contactor required to switch these high currents becomes higher. Hence, current limiting inductors are used in series to attenuate this inrush current. This increases the system cost and panel space.

A typical case below illustrates the magnitude of transient inrush current for switching of a capacitor bank. For a 12.5 kVAr capacitor bank:

Rated current of 12.5 kVAr 415 V Capacitor = 18A
Peak Inrush current without Damping Resistors = 1200A

Capacitor Duty Contactors are designed to limit this high transient inrush current by introducing damping resistors with early make auxiliary contacts. The current limiting due to damping resistors protects the APFC system from harmful effects of the capacitor charging inrush current.

Peak Inrush current with Damping Resistors = 260A
It is observed that peak inrush current with damping resistors is one fifth of that without damping resistors.
As the contactor is now required to switch the rated capacitor current, the size of the contactor required is smaller.
Thus the system cost and panel space are significantly lower when Capacitor Duty Contactors are used.

MO C Capacitor Duty Contactors:

MO C Capacitor Duty Contactors are designed for switching 3 phase, single or multi-step capacitor bank. In conventional capacitor switching contactors, early make auxiliary contacts used for insertion of damping resistors used to remain in the circuit continuously. During current breaking these auxiliary contacts would also carry and break the currents due to higher arc resistance in the main pole during arcing. This current breaking by auxiliary contacts at higher transient recovery voltage causes unreliable product performance and premature product failures.

MO C range of capacitor switching contactors have patented mechanism which disconnects the early make auxiliary contacts after the main contacts are closed. This completely eliminates the possibility of auxiliary contacts carrying and breaking the currents during breaking operation. This enhances the product switching performance and improves the product life.

Features and benefits of MO C Capacitor Duty Contactors

Feature	Customer Benefits
De-latching auxiliary contacts	Improved switching performance
	Reduced losses in auxiliary contacts
Dual contact gap for auxiliary contacts	Higher electrical life
Encapsulated resistor assembly	Enhanced product safety
	No flash over between phases
Separate termination of damping resistors	Ease if wiring
	Enhanced operational reliability
Wide and chatter-free operating band	Improved switching performance
	Higher electrical life
	Higher product reliability

Capacitor Duty Contactors

MO C Contactors are available in 9 different ratings within 3 different frame sizes. All Contactors are available with AC coils with a large variety of voltage range for 50 or 60 Hz.

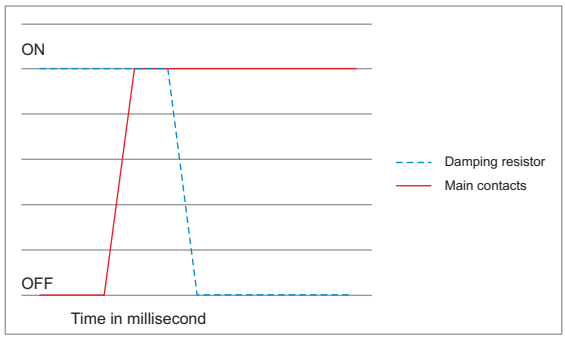
Contactor	Rated operational Current (AC-6b) at 440V, 50Hz	kVAr rating at 440 V
MO C 3	3.9	3
MO C 5	6.6	5
MO C 8.5	11.2	8.5
MO C 10	13.1	10
MO C 12.5	16.4	12.5
MO C 15	19.7	15
MO C 20	26.2	20
MO C 25	32.8	25
MO C 30	39.4	30
MO C 40	52.5	40
MO C 50	65.6	50
MO C 60	78.7	60
MO C 75	98.4	75
MO C 85	111.5	85

Possible Reasons of damage of Capacitor Duty Contactor and how MOC addresses them:

1. Damping resistors are intact but connection terminals are damaged.
   This can happen if the damping resistors are disconnected from the system during switch on. The damage is due to the fact that the main terminals would have seen the entire inrush current as the damping resistors were disconnected and there was no current limiting.
   MOC addresses this by having separate connections for damping resistors which are crimped. Under no circumstances will the damping resistors become loose or disconnecting, thereby the main contacts will never see entire inrush current
2. Burning of discharge resistors over a period of time due to overheating.
   This happens if the damping resistors are continuously in circuit. If the capacitors are overloaded due to harmonics, high current will flow continuously through the damping resistors, thereby causing overheating. MOC addresses this by have resistor with de-latching operation. This means after the initial make operation, the resistors are disconnected from the system and only main contacts are present. Even if there is higher current due to capacitor overload, the resistors will not see that current as they are disconnected. There will be no damage to the main contacts too as they have a high thermal rating.
3. Burning of resistors due to chattering / continuous make-break.
   The band of MO C Contactors coil is 75% - 110% of specified coil voltage. Voltage dips can be absorbed by MOC Contactors as they have a sufficiently high operating band. However, any rise or drop in control voltage beyond this can result in overloading or chattering.

Effect of Under-voltage on Capacitor Duty Contactor

MO C, capacitor duty contactor is designed such that the main contacts never carry the peak inrush current of the capacitor under normal condition. There is a de-latching mechanism in MO C contactor. latching mechanism for opening and closing of the damping resistor assembly. This mechanism puts the resistor system in circuit for first few mili-seconds after the close command is given to contactor. Once the peak inrush current is passed, main contacts are closed and resistors are disconnected from the circuit. This can be understood with the timing diagram shown below in fig 1:



Timing diagram for de-latching and main contacts operation (For illustration purpose only)

But in case of under-voltage condition the electromagnetic force produced in the magnet system is not sufficient to close the magnet system completely, which may result in two scenarios:

1. Damping resistor contacts, which are early make contacts, get closed but the force is insufficient for closing main contacts and as a result de-latching does not occur.
2. Another scenario can be when the contactor starts chattering because of low voltage. And the latching contacts close and open again and again with a frequency higher than the recommended switching frequency.

In both the cases resistors heat up because of repetitive passage of high current through them. This excessive heating can be as high as to burn the resistor block

Because of under-voltage, coil also draws current higher than its rated current. This damages the coil. Burnt or damaged coil again indicates the under-voltage.
As discussed above that in case of under-voltage, electromagnetic force is not sufficient to close the main contacts. And there won't be any damage to main contacts.
It can be inferred now that if capacitor duty contactor's resistor assembly is found burnt along with burnt coil and healthy main contacts, the contactor has failed because of under-voltage.

Solution to protect the contactor from damage because of under-voltage:
There can be two probable solutions to protect the contactor from under-voltage condition:-

1. Use APFC relays with under-voltage setting. Set the under-voltage at 75%. In case of under-voltage APFC relay will give trip command to incomer.
2. Use under voltage relay. Connect coil supply in series with NO contact of under voltage relay (non failsafe relay). When the relay gets healthy supply voltage, the normally open contacts close and only then will coil of the contactor gets supply through APFC relay output. In case of under-voltage this contact will open and coil supply will be withdrawn.

Technical Specification

- Available for capacitor range from 3 - 85 kVAr
- Modular design saving precious panel space
- De-Latching auxiliary contacts
- Separate termination of damping resistors
- Encapsulated resistor assembly ensuring safety
- In-built surge supressor with the coil
- Lug as well as Lugless termination



Type Designation			Units	MO C3	MO C5	MO C8.5
kVAr Rating (at System voltage 440 V)#			kVAr	3	5	9
Catalogue No.		Built in Aux Contacts	1 NO	CS96146	CS96127	CS96320
Conformance to Standards						
Rated Operational Current at 440 V, 50 / 60 Hz (AC-1)		I_e	A	10	10	25
Rated Operational Current at 440 V, 50 / 60 Hz (AC-3)		I_e	A	3.9	6.6	11.2
Short Circuit Protection						
Max. Operational Voltage		U_e	V	690	690	690
Rated insulation Voltage		U_i	V	1000	1000	1000
Rated Impulse Withstand Voltage		U_{imp}	kV	8	8	8
Degree of Protection						
Main Terminal Capacity No. of cable x (Max.Range -Min.Range)	Cable with Ferrule type Lug		mm			
	Cable with Pin type Lug		mm			
	Cable with Fork type Lug		mm			
	Cable with Ring type Lug		mm			
	Solid Conductor		mm^2	2 x 10	2 x 10	2 x 10
	Stranded Conductor		mm^2	2 x 10	2 x 10	2 x 10
	Finely Stranded Conductor		mm^2	2 x 6	2 x 6	2 x 6
Coil Operating Band	Pick-up		V	65 - 110	65 - 110	65 - 110
	Drop-off	% U_c	V	35 - 65	35 - 65	35 - 65
Coil Consumption	Pick-up	% U_c	VA	77	77	77
	Hold-on		VA	9	9	9
			W	3	3	3
Life (Operating Cycles)		Mechanical	Million	10	10	10
		Electrical	Million	0.2	0.2	0.2
Max. Operating Frequency		Operations / Hr		240	240	240
Operating Sequence	Making					
	Breaking					
Overall Dimensions	Height	H	mm	87	87	87
	Width	W	mm	45	45	45
	Depth	D	mm	133.5	133.5	133.5
	Mounting Dimensions		mm	35x60-65-70	35x60-65-70	35x60-65-70

Note: Contact replacement is not permitted in MO C contactors

* Accessories and Spares same as that of MO contactor.
** Dimension is with the spreader link
# kVAr ratings should be selected as per the net kVAr of the capacitor reactor combination irrespective of capacitor voltage (440V/480V/525V)
# While selection it should be ensured that current rating of capacitor is less than the current through the contactor
$ Use spreader while using 16 sq.mm cable
$$ Terminal capacity mentioned is with spreader






MO C10	MO C12.5	MO C15	MO C20	MO C25	MO C30
10	13	15	20	25	30
CS96156	CS96321	CS90019	CS90021	CS96322	CS96148
IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1					
25	40	40	45	50	55
13.1	16.4	19.7	26.2	32.8	39.4
gG type fuses rated at 1.5-2 Ie					
690	690	690	690	690	690
1000	1000	1000	1000	1000	1000
8	8	8	8	8	8
IP20					
1 x (4-10)					-
1 x (4-10)					-
1 x (4-10)					-
-					1 x (10-15)
2 x 10	2 x 10	2 x 10	2 x 10	2 x 10[$]	2 x16[$$]
2 x 10	2 x 10	2 x 10	2 x 10	2 x 10[$]	2 x16[$$]
2 x 6	2 x 6	2 x 6	2 x 6	2 x 6[$]	2 x16[$$]
65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110
35 - 65	35 - 65	35 - 65	35 - 65	35 - 65	35 - 65
77	77	77	77	77	77
9	9	9	9	9	9
3	3	3	3	3	3
10	10	10	10	10	10
0.2	0.2	0.2	0.2	0.2	0.2
240	240	240	240	240	240
Early Make / Main					
Main Contacts Break					
87	87	87	87	87	115**
45	45	45	45	45	56**
133.5	133.5	133.5	133.5	133.5	133.5**
35x60-65-70	35x60-65-70	35x60-65-70	35x60-65-70	35x60-65-70	35x60-65-70

Technical Specification

- Available for capacitor range from 3 - 85 kVAr
- Modular design saving precious panel space
- De-Latching auxiliary contacts
- Separate termination of damping resistors
- Encapsulated resistor assembly ensuring safety
- In-built surge supressor with the coil
- Lug as well as Lugless termination



Type Designation			Units	MO C40	MO C50	MO C60
kVAr Rating (at System voltage 440 V)#			kVAr	40	50	60
Catalogue No.		Built in Aux Contacts	1 NO	CS96147	CS96324	CS96149
Conformance to Standards				IS/IEC 60947-4-1, IEC 60947-4-1, EN 60947-4-1		
Rated Operational Current at 440 V, 50 / 60 Hz (AC-1)		I_e	A	80	90	100
Rated Operational Current at 440 V, 50 / 60 Hz (AC-3)		I_e	A	52.5	65.6	78.7
Short Circuit Protection				gG type fuses rated at 1.5-2 Ie		
Max. Operational Voltage		U_e	V	690	690	690
Rated insulation Voltage		U_i	V	1000	1000	1000
Rated Impulse Withstand Voltage		U_{imp}	kV	8	8	8
Degree of Protection				IP20		
Main Terminal Capacity No. of cable x (Max.Range -Min.Range)	Cable with Ferrule type Lug		mm	1 x (25-35), 2 x (16-25)		-
	Cable with Pin type Lug		mm	1 x (25-35), 2 x (16-25)		-
	Cable with Fork type Lug		mm	-		-
	Cable with Ring type Lug		mm	-		1 x (25-35)
	Solid Conductor		mm^2	-	-	-
	Stranded Conductor		mm^2	2 x 35	2 x 35	2 x 35$^{\$\$}$
	Finely Stranded Conductor		mm^2	2 x 35	2 x 25	2 x 35$^{\$\$}$
Coil Operating Band	Pick-up		V	75 - 110	75 - 110	75-110
	Drop-off	% U_c	V	35 - 65	35 - 65	35 - 65
Coil Consumption	Pick-up	% U_c	VA	144	144	144
	Hold-on		VA	15	15	15
			W	6	6	6
Life (Operating Cycles)		Mechanical	Million	10	10	10
		Electrical	Million	0.2	0.2	0.2
Max. Operating Frequency		Operations / Hr		240	240	240
Operating Sequence	Making			Early Make / Main		
	Breaking			Main Contacts Break		
Overall Dimensions	Height	H	mm	123.5	123.5	174**
	Width	W	mm	55	55	73**
	Depth	D	mm	163	163	163**
	Mounting Dimensions		mm	45x100-105	45x100-105	45x100-105

Note: Contact replacement is not permitted in MO C contactors

* Accessories and Spares same as that of MO contactor.
** Dimension is with the spreader link
# kVAr ratings should be selected as per the net kVAr of the capacitor reactor combination irrespective of capacitor voltage (440V/480V/525V)
# While selection it should be ensured that current rating of capacitor is less than the current through the contactor
$ Use spreader while using 16 sq.mm cable
$$ Terminal capacity mentioned is with spreader



MO C75	MO C85	MO C100
75	85	100
CS96150	CS96160	CS96158
140	140	180
98.4	111.5	111.5
690	690	690
1000	1000	1000
8	8	8
1 x (50-70), 2 x (25-35)		-
1 x (50-70), 2 x (25-35)		-
-		-
-		1 x (50-70)
-	-	-
2 x 70	2 x 70	2 x 95[$$]
2 x 50	2 x 50	2 x 95[$$]
75 - 110	75 - 110	75 - 110
35 - 65	35 - 65	35 - 65
240	240	240
25	25	25
9	9	9
10	10	10
0.2	0.2	0.2
240	240	240
135	135	195**
70	70	95**
175	175	175**
60x115-120	60x115-120	60x115-120

Contactors

Product Designation	kVAr Rating @ 415V 50Hz	In Built Aux contacts	Cat. No.*
MO C3	3	1 NO	CS96146
MO C5	5	1 NO	CS96127
MO C8.5	8.5	1 NO	CS96320
MO C10	10	1 NO	CS96156
MO C12.5	12.5	1 NO	CS96321
MO C15	15	1 NO	CS90019
MO C20	20	1 NO	CS90021
MO C25	25	1 NO	CS96322
MO C30	30	1 NO	CS96148
MO C40	40	1 NO	CS96147
MO C50	50	1 NO	CS96324
MO C60	60	1 NO	CS96149
MO C75	75	1 NO	CS96150
MO C85	85	1 NO	CS96157
MO C100	100	1 NO	CS96158

*Add four digit suffix as per coil voltage

Accessories & Spares

Add on Blocks

Mounting Position	Contacts	Cat. No.
First Left	1 NO + 1 NC	CS94580OOOO
First Right	1 NO + 1 NC	CS94581OOOO
Second Left	1 NO + 1 NC	CS94582OOOO
Second Right	1 NO + 1 NC	CS94583OOOO

Spare Coils

For Contactor	Cat. No.
MO C3 - C30	CS96317
MO C40 - 60	CS96318
MO C75 - 100	CS96319

* Add four digit suffix as per coil voltage

MO C Spreader Link Kit

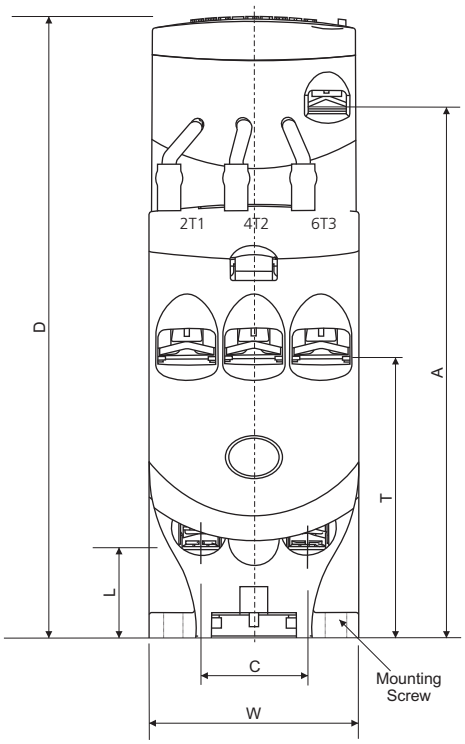
For Contactor	Cat. No.
MO C3-30	CS94274OOOO
MO C40-60	CS94093OOOO
MO C75-100	CS94094OOOO

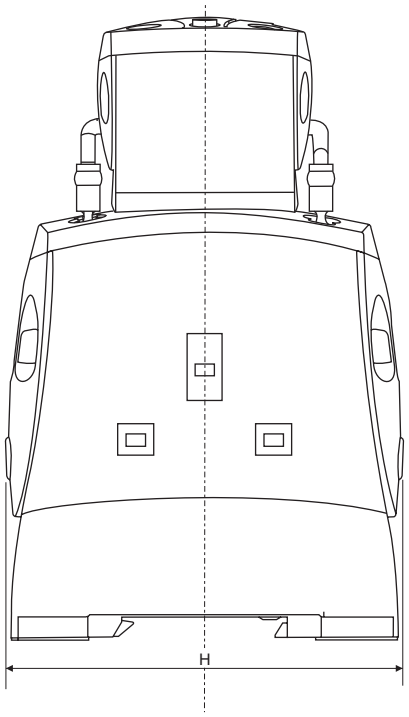
Note: 1) Spreader Link Kit consists of six terminals
2) Use above Spreader Link when using MO C 25 16 sq. mm cable

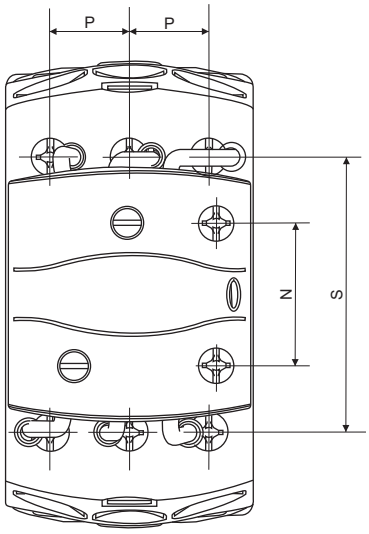
Ordering Suffix for Coil Voltages

Std Coil Voltage	110	220	240	415
Ordering Suffix - 50 / 60 Hz	AOOO	KOOO	BOOO	DOOO

MO C







Label	MO C		
	3 - 30	40 - 60	75 - 100
W	45	55	70
D	133.5	163	175
H	87	123.5	135
N	26	26	26
T	60	68	68
C	22.8	27	35
L	19.6	29.5	30
S	50	82	93
P	14.4	18	23
A	113	142	154

All dimensions in mm.

MO0 & MN0 Auxiliary Contactors

MO0 AC control contactors are basic 5 pole contactor. These contactors can be used for building control logics. With addon blocks these contactor can give you a maximum 9 auxiliary contact (maximum 6 NC). We also have MN0 AC and MN0 DC basic four pole contactor relays. The no. of contacts can be extended upto 8 NO to 8 NC. These contactor are suitable for industrial as well as commercial installations where complex control is required.

THE MASTER KEY TO EVERY CONTROL REQUIREMENT

Technical Details MO0 AC

Salient Features & Benefits

- Compact dimensions saving precious panel space
- In-built surge supressor with the coil
- DIN Rail mounting facility
- Lug as well as Lugless termination
- RoHS compliant

Contact Combination	4 NO + 1NC	3 NO + 2 NC	2 NO + 3 NC	1 NO + 4 NC
Type	MO0 41	MO0 32	MO0 23	MO0 14
AC Control	CS94825	CS94826	CS94827	CS94828

Type		**Units**	**MO0 AC**
Conformance to standards			IS/IEC 60947-5-1, IEC 60947-5-1, EN 60947-5-1
No. of poles			5
Rated insulation voltage (U_i)		V	1000
Rated operation voltage (U_e)	AC-15		690 V AC
	DC-13		220 V DC
Rated impulse withstand voltage		kV	8
Thermal current (I_{th}) @ 55°C		A	10
Rated current at 415, 50Hz, Utilization category AC-15		A	4
Mechanical life		million	10
Electrical life (AC-15 Duty) @ 415 V		million	1
Max. frequency of operations (op. cycle/ hr)	Mechanical	cy / hr	7200
	AC-15	cy / hr	1200
	DC-13	cy / hr	1200
Terminal capacity	Solid conductor	mm	2 x 4
	Stranded conductor	mm	2 x 2.5
Coil			
Rated coil voltages (Uc)	50 Hz	V	24, 110, 220, 240, 415
	60 Hz	V	110, 220, 415
Consumption	Pick up	VA	78 VA
	Hold on	VA	11
Operating limits %Uc	Hold on	W	2.8
	Pick-up	%Uc	65 - 110
	Drop-off	%Uc	30 - 55
Overall dimension H X W X D		mm	86.5 x 45 x 89

Add-on auxiliary contact block

MO Top Add-on Block

Contacts	Cat. Nos.
1 NO	CS94585OOOO
1 NC	CS94586OOOO
2 NO	CS94591OOOO
1 NO + 1 NC	CS94592OOOO
2 NC	CS94593OOOO
4 NO	CS94594OOOO
3 NO + 1 NC	CS94595OOOO
2 NO + NC	CS94596OOOO
1 NO + 3 NC	CS94597OOOO
4 NC	CS94598OOOO

Mechanical Interlock Kit

Description	Cat. No.
Mechanical Interlock Kit	CS94584OOOO
Spare Coil	CS94841OOOO

Note:MO MIL Kit contains inbuilt 2 NC contacts
* Add 4 digit suffix as per required coil voltage given below.

Ordering Suffix for Coil Voltages

Std Coil Voltage at 50 Hz	24	110	220	240	415
Ordering Suffix	GOOO	AOOO	KOOO	BOOO	DOOO

Salient Features & Benefits

- Front ON / OFF indication
- Suitable for DIN Rail / Base mounting
- Easy accessibility to coil & contacts
- Alphanumeric terminal markings eliminate wiring error

Contact Combination	4 NO	3 NO + 1 NC	2 NO + 2 NC	1 NO + 3 NC	4 NC
Type	MN0 40E	MN0 31E	MN0 22E	MN0 13E	MN0 04E
DC Control	SS94665	SS94666	SS94667	SS94668	SS94669

Type		Units	MN0 DC
Rated insulation voltage (U_i)			690 V AC
Rated operational voltage (U_e)			415 V AC
Thermal current (I_{th})		A	10
Rated current at 415, 50 Hz, Utilization category AC-15		A	4
Rated current for AC-15 Utilisation category (Ie)		A	4 at 415 , 50 Hz
Sequence of operations			Break before make
Maximum frequency of operations AC-15 (Operating cycle / hr.)		cy / hr.	1200
Terminal capacity		mm^2	2 x 2.5
Limits of operation	Pick-up (%U_c)	%U_c	80 - 110
	Drop-off (%U_c)	%U_c	35 - 65
Coil consumption	Pick-up	W	6.2
	Hold-on	W	6.2
Standard coil voltages (Uc)		V	24, 42, 110, 220 V DC
Overall dimensions (H x W x D)		mm	81 x 45 x 120

Accessories & Spares

Add on Auxiliary Contact Block

1 NO + 1 NC

2 NO + 2 NC

1 NO / 1 NC	SS94715 / SS94716
2 NO / 2 NC	SS94080 / SS94082
4 NO / 4 NC	SS94083 / SS94087
1 NO + 1 NC	SS94081
2 NO + 2 NC	SS94085
3 NO + 1 NC	SS94084
1 NO + 3 NC	SS94086

Surge Suppressor for MN0

MN - S1

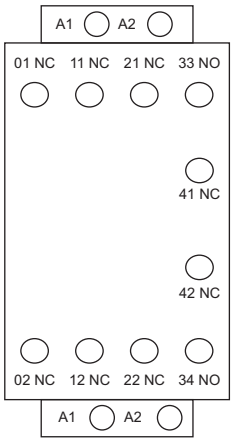
Type	MN0 DC
Mechanical Interlock Kit	SS94071 + SS94766
Surge Supressor	SS94781
Spare Coil	SS94651

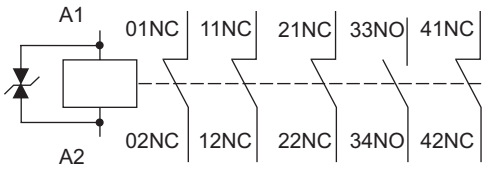
Ordering Suffix for Coil Voltages

Coil Voltage V DC	24	48	110	220
Suffix	4OOO	5OOO	1OOO	2OOO

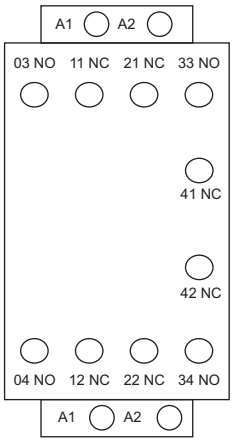
Terminal Designation

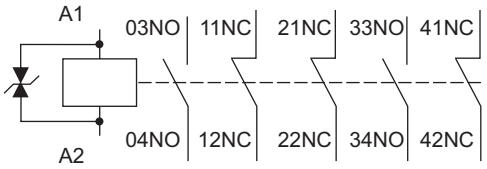
1NO + 4NC



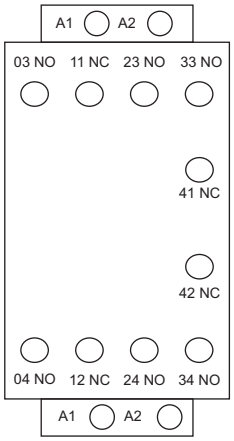


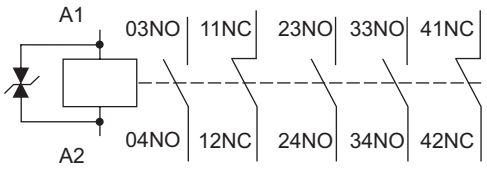
2NO + 3NC



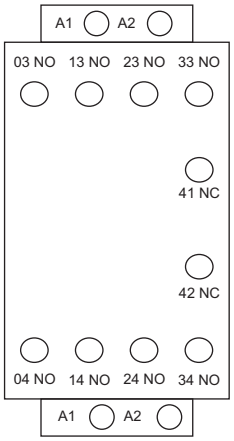


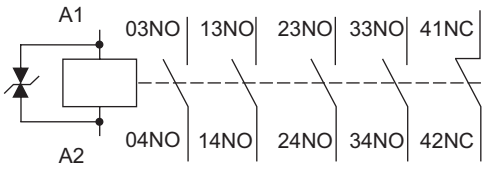
3 NO + 2 NC



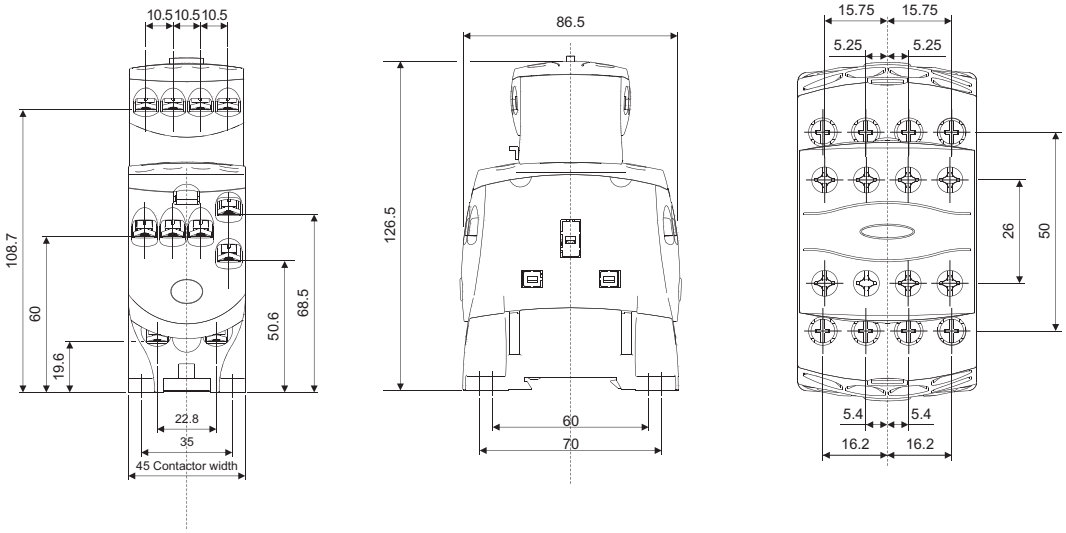


4 NO + 1 NC

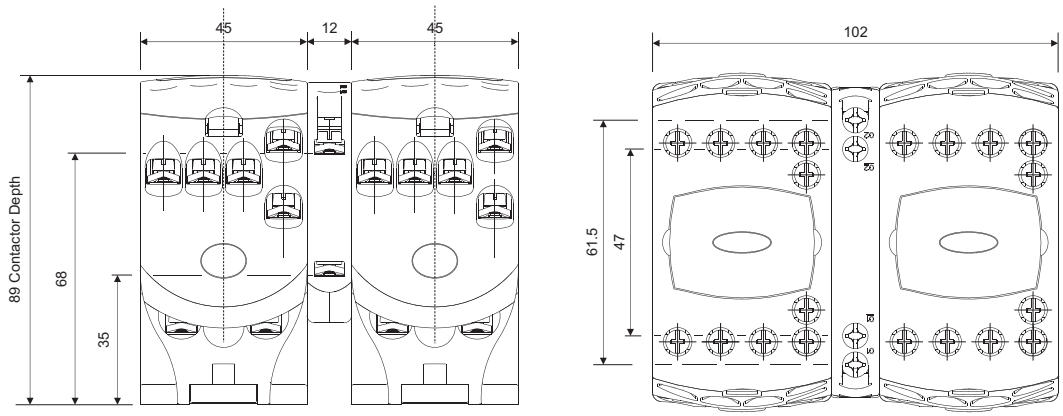




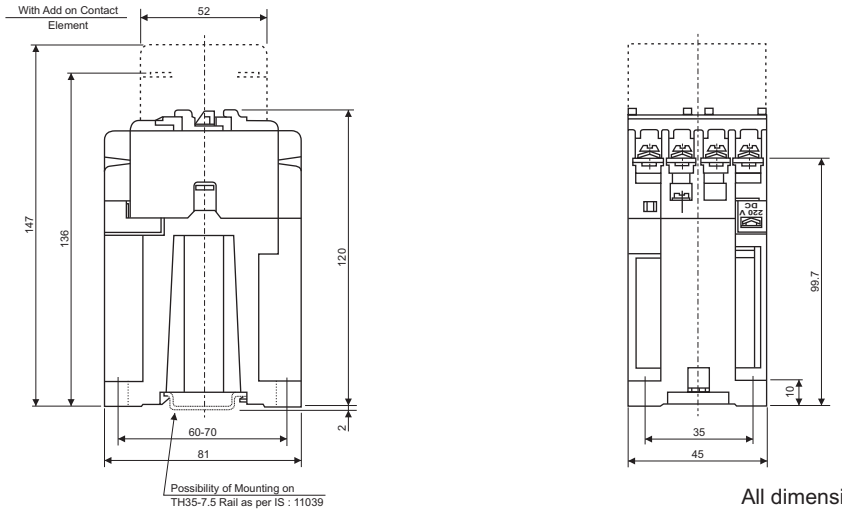
MO0 AC



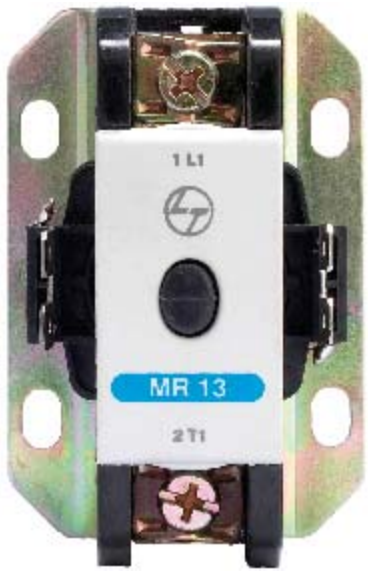
Overall Dimensions with MIL Kit



MN0 DC



All dimensions in mm.



MR Single Pole Contactors

MR range caters to single phase applications. The contactors are rugged and have a wide operating band upto 25A (AC-3). Typical applications include Compressors in air-conditioning equipment, Single Phase Pumps, Single Phase Power Supply, Single Phase Heater etc. Their high AC-1 rating ensures better overload capacity.

ACCESS NEW LEVELS OF VERSATILITY

- Wide operating band upto 25A AC-3
- High AC-1 rating ensuring better overload capacity
- Fast on termination (optional)



Type Designation		Units	MR 11W	MR 11NW	MR 13
Catalogue no.			CS94176	CS94177	CS94992
Conforms to standards			IS/IEC 60947-4-1, IEC 60947-4-1		
Power Contacts					
No. of poles			1	1+ shunted neutral	1
Rated insulation voltage	(U_i)	V	690		
Rated impulse withstand voltage	(U_{imp})	kV		8	
Conventional thermal current, I_{th}	(AC-1)	A	63	63	63
Motor duty : single phase 240 V, 50 Hz	(AC-3)	kW/hp/A	3.7 / 5 / 25	3.7 / 5 / 25	5.5 / 7.5 / 40
Motor duty : single phase 240 V, 50 Hz	(AC-4)	kW/hp/A	3.7 / 5 / 25	3.7 / 5 / 25	5.5 / 7.5 / 40
Short-circuit protection	gG fuse at 240 V	A	63	63	100
Mechanical life		Million	10	10	10
Maximum frequency :	(No Load)	Cy/h	7200		
	(AC-1)	Cy/h	3000		
	(AC-3)	Cy/h	750		
	(AC-4)	Cy/h	300		
Service temperature		°C	-5°C to 55°C		
Main terminal capacity	Solid conductor	Sq. mm	1 x 10		
	Multi strand	Sq. mm	2 x 10		
Coil					
Voltages available at 50 Hz, Uc		V	24, 220, 240		
	Pick-up	VA	40		
	Hold-on	VA	8.5		
		W	2.5		
Limits of operation	Pick-up	(% Uc)	60 - 110	60 - 110	80 - 110
	Drop-off	(% Uc)	20 - 50	20 - 50	20 - 65

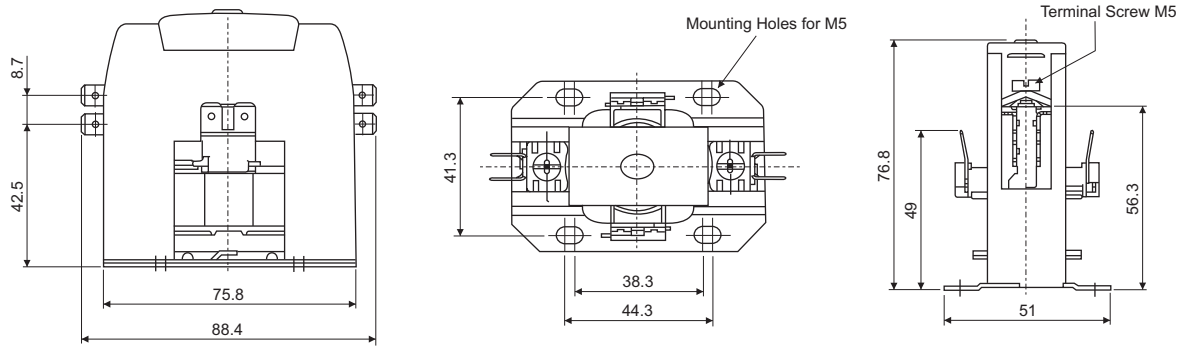
Note: Ordering suffix BOOO-240 V, 50 Hz

MR 1 NO

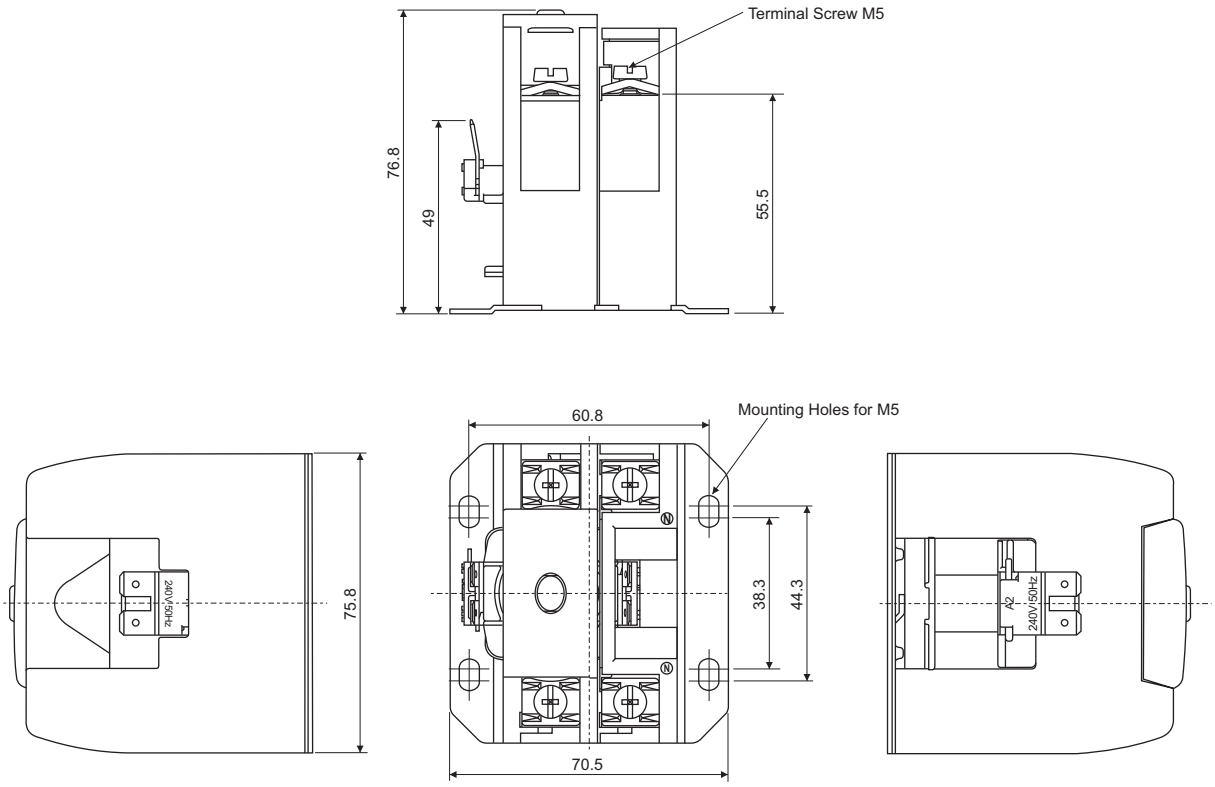
Add on Auxiliary Contact Block for MR

Auxiliary contact block		Units	
Type designation			MR-A1
Catalogue no.			CS94179
Conforms to standards			IS /IEC 60947-5-1, IEC 60947-5-1
For contactors		W	MR 11W / MR 11NW
Contacts			
No. of poles			1
Contact details			1 NO
Rated insulation voltage, U_i		V	690
Conventional thermal current, I_{th}		A	10
Rated current at 240 V, 50 Hz	Utilization category AC-15	A	4
Short-circuit protection	gG fuse at 240 V	A	10
Electrical durability (AC-15) at 240 V, 50 Hz		Million	1
Maximum frequency of operation at UC for AC-15		Cy/h	1200
Service temperature		°C	-5°C to 55°C
Terminal capacity	Solid conductors	mm^2	2 x 2.5
	Multi-stranded conductors	mm^2	2 x 2.5

MR 11W / MR 13



MR 11NW



All dimensions in mm.

MU-2P Single Phase Motor Starter

MU Contactors are true 2 pole contactors with isolated neutral useful in motor starters. Available for 16 – 40 A current rating suitable for low voltage conditions.

ONE STEP TOWARDS SMOOTHER START

Features

- True 2 pole contactor
- Top mounted relay

Wide Band Potted Coil

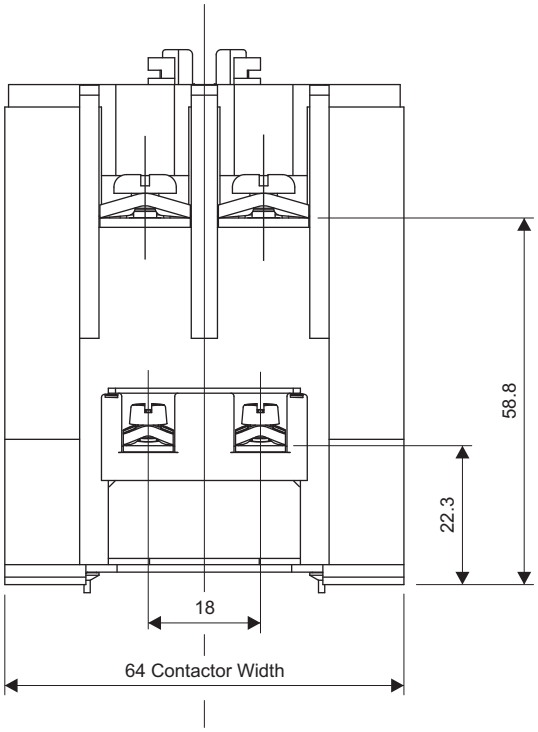
Applications

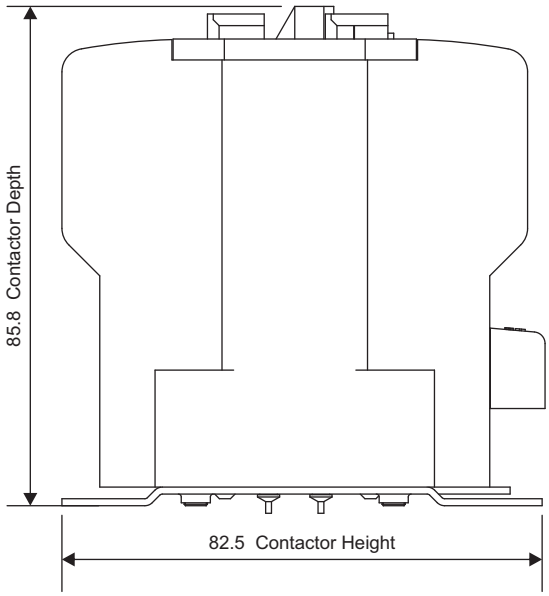
- Single phase pump control
- Single phase motors

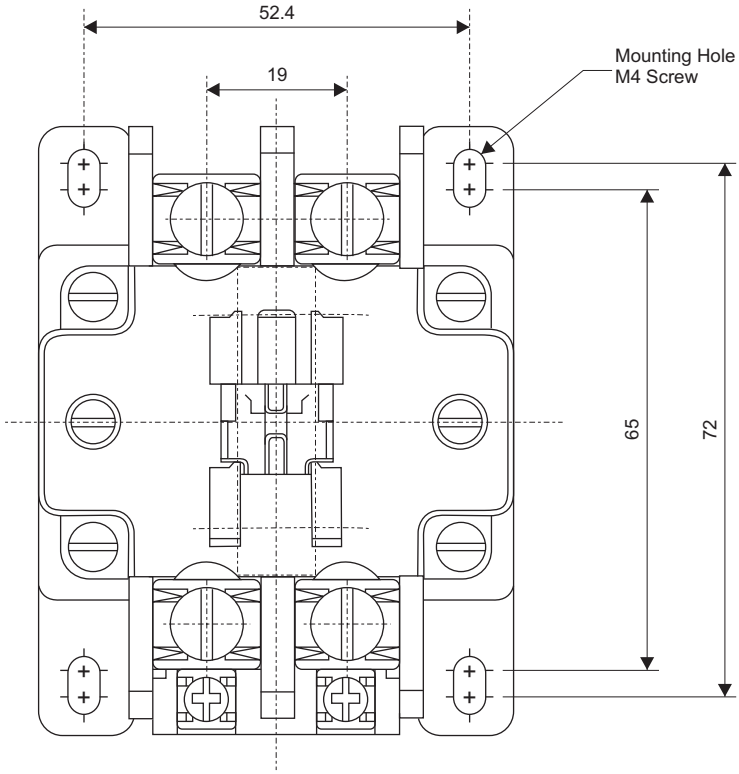
Benefits

- Neutral isolation
- Suitable for low voltage condition
- High temperature withstand capability
- Coil protection from humid environment

		Units	MU 16-2P	MU 25-2P	MU 40-2P
Catalogue No.			CS90117	CS90118	CS90119
Conformance to standards			IS/IEC 60947-4-1, IEC 60947-4-1		
No. of poles			2		
Rated operational voltage U_e		V	240V AC 50 Hz		
Rated insulation voltage U_i		V	690V AC 50 Hz		
Rated operation current I_e AC-3 at 240V 50 Hz		A	16	25	40
Rated thermal current I_{th}		A	32	45	50
Backup fuse rating		A	40	63	63
Mechanical life	Cycles	million	5		
Electrical life at 240V, at rated AC-3 current	Cycles	million	1		
Operations per hour	Mechanical	cy/hr	7200		
	AC-3	cy/hr	750		
Main terminal capicity	Al cable/Al Lug	mm	1 x 16		
	Bare conductors	mm	2 x 10		
	Multi strand conductors	mm	2 x 6		
Service temperature		°C	-5°C to +55°C		
Coil Circuit					
Rated coil voltages	Standard	V	220, 240		
	Wide band coil	V	160 - 220		
Coil consumption	Pick up VA	VA	75		
	Hold on VA	VA	13		
	Hold on W	W	4		
Coil operating band	Pick up		55% - 120% for Standard coil		
			75% - 120% for Wide band coil		
	Drop Off		30% - 50%		
Overall dimension (H X W X D)		mm^3	82.5 x 64 x 85.8		
Accessories			Top mounted 2 pole add-on		
Spares			Spare coil and Spare kit		


58.8
22.3
18
64 Contactor Width


85.8 Contactor Depth
82.5 Contactor Height


52.4
19
Mounting Hole
M4 Screw
65
72

MU-2P Relay

Features

- Available in 1 frame size from 1 - 40 A
- Direct mounting on MU-2P Contactors
- Trip class 10A
- Ambient temperature compensated
- Built-in single phasing protection

Type Designation		Units	MU-2P
Poles			2
Rated insulation voltage (U_i)		V	690
Rated impulse voltage (U_{imp})		kV	8
Rated operational current for AC-15 utilization category at 50 Hz	24 V	A	6
	110 V	A	5
	220 V	A	3
	415 V	A	2
Controls			Start and Off / Reset
Built in contacts			1NO (Start) and 1NC (Off/Reset)
Trip class		A	10
Ambient compensated			Yes
Service temperature		°C	-5°C to +55°C
Short circuit protection device			Fuse link, 63 A type HF
Mounting			Direct with MU-2P contactor
Terminal capacity (Unprepared conductor)	Main	mm^2	10
	Auxiliary	mm^2	2.5
Overall dimensions (H x W x D)		mm^3	70 x 84 x 82

MU-2P Contactor

Description	Catalogue Numbers		
	220V Coil	240V Coil	160-220V Coil
MU 16-2P	CS90117KOOO	CS90117BOOO	CS90117NOOO
MU 25-2P	CS90118KOOO	CS90118BOOO	CS90118NOOO
MU 40-2P	CS90119KOOO	CS90119BOOO	CS90119NOOO
Top add on block			
2 NO	CS90692OOOO		
1 NO + 1 NC	CS90693OOOO		
2 NC	CS90694OOOO		
1 NO	CS90695OOOO		
1 NC	CS90696OOOO		
Spare coil	CS90793KOOO	CS90793BOOO	CS90793NOOO
Spare contact kit			
MU 16-2P	CS90217OOOO		
MU 25-2P	CS90218OOOO		
MU 40-2P	CS90219OOOO		

MU-2P Relay

Description	Cat. No.
MU-2P Relay, 1 - 1.6 A	CS90207OOMO
MU-2P Relay, 1.5 - 2.5 A	CS90207OOPO
MU-2P Relay, 2.5 - 4 A	CS90207OORO
MU-2P Relay, 4 - 6.5 A	CS90207OOTO
MU-2P Relay, 6 - 10 A	CS90207OOVO
MU-2P Relay, 9 - 14 A	CS90207OOAO
MU-2P Relay, 11 - 18 A	CS90207OOCO
MU-2P Relay, 13 - 22 A	CS90207OODO
MU-2P Relay, 16 - 26 A	CS90207OOBO
MU-2P Relay, 20 - 32 A	CS90207OOEO
MU-2P Relay, 26 - 40 A	CS90207OOFO

MOG Motor Protection Circuit Breakers

MOG MPCB integrates short circuit protection and overload relay function into a highly compact unit. The MPCB can be used in numerous small and medium motor loads requiring high breaking capacity. Also, the compact size of the MPCB enables a smaller installation area with less wiring space, thus reducing panel space.

UNLOCK THE BENEFITS OF DOUBLE PROTECTION

Functions

Moulded Case Circuit Breaker and Thermal Overload Relay functions integrated into a highly compact unit known as Motor Protection Circuit Breaker.

Circuit Breaker Functions

- Short circuit protection
- Overcurrent protection
- Line protection

Thermal Overload Relay Functions

- Overload protection
- Phase loss protection
- Rated current adjustment
- Ambient temperature compensation

MPCB - Advantages

- Compact
- High breaking capacity
- Short circuit protective coordination
- Reduction in wiring work
- Ecological design standards

Selecting the Appropriate Model

Procedure for selecting the appropriate model:

Confirm the motor's full load current

↓ ↓

Three-phase load / Single-phase load

↓ ↓ For applications in a single-phase circuit, connect the 3-pole in series

Select the rated current of MPCB

↓

Select the branch circuit cable & confirm the control panel specifications

↓

Confirm the short-circuit current of the circuit

↓

Select the operating characteristics

↓ Same characteristics as desired for a standard thermal overload relay

↓ Long-time operating type or quick operating type thermal overload relay desired

Adjustable thermal magnetic trip type MPCB

Instantaneous trip type MPCB

Typical Problem in the Conventional System and their Solution by using MPCB

Short-Circuit Breaking Capacity

When numerous small and medium motor loads exist in a circuit requiring high breaking capacity, there is no high breaking capacity circuit breaker with a small rated current for a short circuit protection.

The MPCB can be used in 100kA short circuit current circuits for three-phase, 240V motors with rated capacity upto 15kW, and in 50kA short circuit current circuits for three phase, 415V motors with rated capacity up to 30kW.

Back-up Breaking System

When back-up MCCB is installed upstream to solve the problem described in " Short-circuit breaking protection " above, a short in one of the load circuits also trips the upstream breaker and stops the other operating circuits.

Despite their compact size, the MPCB provides high-performance short-circuit current breaking. They eliminate the need for an upstream circuit breaker for back-up use.

Overload Protection

Motor Protection breakers cannot be adjusted to match the rated current of the motor being protected.

Equipped with a wide range current adjustment dial (with maximum/minimum ratio of 1.4 to 1.6), the MPCB easily adjusts to match the rated current of the motor, for optimum protection.

Control Panel Size

Considerable space is required to install a back-up circuit breaker or a combination starter consisting of a circuit breaker and a thermal overload relay. As a result, the panel size has to be increased.

The compact size of the MPCB, including overload relay functions, enables a smaller installation area with less wiring space, for a reduction in panel size.

Problem with Co-ordination of Contactors & Overload Relays with MCBs

Basics of Type 1 and Type 2 Co-ordination
As per the standard two types of co-ordination are permissible, Type "1" and "2".

Type "1" co-ordination requires that under short-circuit conditions; the contactor or the starter shall cause no danger to persons or installation. The motor feeder may not be suitable for further service without repair and replacement of parts (Not remaining suitable is NOT a requirement and hence you may find separating in a different sentence could avoid possibility of misconception)

Type "2" co-ordination requires that under short-circuit conditions; the contactor or the starter shall cause no danger to persons or installation and shall be suitable for further use. However contact welding is recognized. Also the time-current characteristics of the over load protection device should not change. **This in other words means safety, low down time and continued protection.**

Types of MCBs
The Classes of MCBs and the corresponding magnetic settings are tabulated below:

Curve Type	Magnetic setting (Multiples of In)
B	3-5 times
C	5-10 times
D	10-20 times

C MCBs are popularly used for Motor protection applications

Main problem while using an MCB for Motor protection

Unlike a Fuse unit the MCB is a peak sensing device. While providing SC protection to the motor it is imperative that the MCB does not trip on the starting transients of the motor. This care has to be taken while selecting the rating of the MCB. These transients are usually of the tune of 12 times the full load current.

Now suppose a C curve MCB is selected, in order to ensure it does not trip during the starting of the motor, 12 times the motor full load current should be lesser than 5 times the MCB's nominal current

For e.g.: for a Motor having a full load current of 6 A, 12 x 6 = 72A (starting current), a C curve MCB of rating = 72/5 = 14.5, i.e. 15A will have to be selected.

Select a 6AAC3 rated contactor and a relay having a range of 4-6 A

Suppose a fault occurs and the motor starts drawing a current of 60A, The MCB will not trip as 60A is lesser than 15 x 5 = 75A. As a result the overload relay will have to give a trip signal to the contactor to break this current.

The IEC standard specifies the breaking capacity of a contactor to be 8 times its AC3 rating. 60 A is greater than 8 x 6 = 48A as a result the contactor will get damaged. This problem can be rectified by de-rating the contactor.

The second more serious problem can be described by considering the below case:

Consider a 0.16 hp motor with a Full load current of 0.45A. The initial starting current will be around 5.4A. As in the earlier case a C curve MCB of 2A will have to be selected. With proper de-rating, an 18A Contactor is selected with a relay having rating of 0.3 - 0.5A.

Now in this case, the crossover between the relay and the MCB will take place at 5 x 2 = 10A which is 20 times the upper limit of the relay. This will cause permanent damage to the relay. There is no solution to this problem as de rating a relay is not possible.

This is type 1 Co-ordination and not type 2

Suppose a D curve MCB is selected, then for the above case, a 72/10= 7.2 A i.e. an 8 A MCB will have to be selected. Now the MCB has to trip for currents between 10-20 times its nominal current. For the worst case in which the MCB trips at 20 times (i.e. 160A), for a fault current of 140A, the overload relay will have to give a tripping command to the MCB and there will be similar consequences as in the previous case.

Thus in conclusion; while selecting an MCB for motor protection which may be a cost effective solution, one must be fully aware of the possible damages that might be caused to the contactor and overload relay.

We recommend that if a customer wants fuseless protection for a feeder, MPCB be used

Technical Details

Type		MOG - S1		MOG - H1	
Standards / Approval		IEC 60947 -1, -2, -4 -1		IEC 60947 -1, -2, -4 -1	
Handle type		Rocker		Rotary	
Number of poles		3		3	
Frame size available (upto A)		32 A		32 A	
Rated insulation voltage (U_i)		AC690 V		AC690 V	
Rated operational voltage (U_e)		AC200 - 690 V		AC200 - 690 V	
Rated impulse withstand voltage (U_{imp})		6 kV		6 kV	
Rated frequency		50 / 60 Hz		50 / 60 Hz	
Class of protection		10		10	
Utilization category (IEC947 - 4 - 1 / 947 - 2)		AC - 3 / Cat. A		AC - 3 / Cat. A	
Maximum motor capacity AC3		7.5 kW (at 200 - 240 V), 15 kW (at 380 - 440 V)		7.5 kW (at 200 - 240 V), 15 kW (at 380 - 440 V)	
AC3 Electrical/Mechanical endurance		100000 (32A:70000) / 100000 (32A:70000), (25 cycles / hour)		100000 (32A:70000) / 100000 (32A:70000), (25 cycles / hour)	
Tripping device		Thermal - Magnetic		Thermal - Magnetic	
Ambient temperature compensation		-20°C ~ + 60°C		-20°C ~ + 60°C	
Overload		Yes (according to IEC60947 - 4 - 1)		Yes (according to IEC60947 - 4 - 1)	
Phase loss protection		Yes		Yes	
Trip indicator		Yes		Yes	
Test trip function		Yes		Yes	
Instantaneous trip current		13 x Ie max.		13 x Ie max.	
Terminal type		Screw terminal, M4 slotted		Screw terminal, M4 slotted	
Wire size	Solid/Stranded	1 - 10 mm^2 x 1 / 18 - 8 AWG x 1		1 - 10 mm^2 x 1 / 18 - 8 AWG x 1	
	Without / With end sleeve	1 - 6 mm^2 x 2 / 18 - 10 AWG x 2		1 - 6 mm^2 x 2 / 18 - 10 AWG x 2	
Product weight (Kg)		0.35		0.35	
Dimensions (mm) W x H x D		45 x 90 x 66		45 x 90 x 79	
Standard service condition	Relative humidity	45 ~ 85% Rh	No dew formation or freezing due to rapid temperature change allowed	45 ~ 85% Rh	No dew formation or freezing due to rapid temperature change allowed
	Operation altitude	Upto 2000 m		Upto 2000 m	
	Atmosphere	Atmosphere having no excess Vapour, Steam, Dust, Corrosive gas, Salt, Flammable gas		Atmosphere having no excess Vapour, Steam, Dust, Corrosive gas, Salt, Flammable gas	

MOG - H2	MOG - H1M	MOG - H2M
IEC 60947 -1, -2, -4 -1	IEC 60947 -1, -2, -4 -1	IEC 60947 -1, -2, -4 -1
Rotary	Rotary	Rotary
3	3	3
63 A	32 A	63 A
AC1000 V	AC690 V	AC1000 V
AC200 - 690 V	AC200 - 690 V	AC200 - 690 V
8 kV	6 kV	8 kV
50 / 60 Hz	50 / 60 Hz	50 / 60 Hz
10	10	10
AC - 3 / Cat. A	AC - 3 / Cat. A	AC - 3 / Cat. A
15 kW (at 200 - 240 V), 30 kW (at 380 - 440 V)	7.5 kW (at 200 - 240 V), 15 kW (at 380 - 440 V)	15 kW (at 200 - 240 V), 30 kW (at 380 - 440 V)
25000 / 50000, (25 cycles / hour)	100000 (32A:70000) / 100000 (32A:70000), (25 cycles / hour)	25000 / 50000, (25 cycles / hour)
Thermal - Magnetic	Magnetic	Magnetic
-20°C ~ + 60°C	-20°C ~ + 60°C	-20°C ~ + 60°C
Yes (according to IEC60947 - 4 - 1)	None	None
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
13 x Ie max.	13 x Ie max.	13 x Ie max.
Box terminal, M6 slotted	Screw terminal, M4 slotted	Box terminal, M6 slotted
1 - 25 mm^2 x 1 / 18 - 4 AWG x 1	1 - 10 mm^2 x 1 / 18 - 8 AWG x 1	1 - 25 mm^2 x 1 / 18 - 4 AWG x 1
1 - 16 mm^2 x 2 / 18 - 4 AWG x 2	1 - 6 mm^2 x 2 / 18 - 10 AWG x 2	1 - 16 mm^2 x 2 / 18 - 4 AWG x 2
0.78	0.37	0.78
55 x 110 x 96	45 x 90 x 79	55 x 110 x 96
45 ~ 85% Rh, No dew formation or freezing due to rapid temperature change allowed	45 ~ 85% Rh, No dew formation or freezing due to rapid temperature change allowed	45 ~ 85% Rh, No dew formation or freezing due to rapid temperature change allowed
Upto 2000 m	Upto 2000 m	Upto 2000 m
Atmosphere having no excess Vapour, Steam, Dust, Corrosive gas, Salt, Flammable gas	Atmosphere having no excess Vapour, Steam, Dust, Corrosive gas, Salt, Flammable gas	Atmosphere having no excess Vapour, Steam, Dust, Corrosive gas, Salt, Flammable gas

Breaking Capacity at Different Voltages

MOG - S1

Rating	Ie: Min - Max (A)	240 V AC 230 V AC		415 V AC 400 V AC		460 V AC 440 V AC		500 V AC		690 V AC 600 V AC	
		Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)
0016	0.1 - 0.16	100	100	100	100	100	100	100	100	100	100
0025	0.16 - 0.25	100	100	100	100	100	100	100	100	100	100
0040	0.25 - 0.4	100	100	100	100	100	100	100	100	100	100
0063	0.4 - 0.63	100	100	100	100	100	100	100	100	100	100
0100	0.63 - 1	100	100	100	100	100	100	100	100	100	100
0160	1 - 1.6	100	100	100	100	100	100	100	100	100	100
0250	1.6 - 2.5	100	100	100	100	100	100	100	100	3	2
0400	2.5 - 4	100	100	100	100	100	100	100	100	3	2
0630	4 - 6.3	100	100	100	100	50	38	50	38	3	2
1000	6.3 - 10	100	100	100	100	15	11	10	8	3	2
1300	9 - 13	100	100	50	38	10	8	6	5	3	2
1600	11 - 16	100	100	25	19	10	8	6	5	3	2
2000	14 - 20	50	38	25	19	10	8	6	5	3	2
2500	19 - 25	50	38	25	19	10	8	6	5	3	2
3200	24 - 32	50	38	25	19	10	8	6	5	3	2

MOG - H1 and MOG - H1M

Rating	Ie: Min - Max (A)	240 V AC 230 V AC		415 V AC 400 V AC		460 V AC 440 V AC		500 V AC		690 V AC 600 V AC	
		Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)
0016	0.1 - 0.16	100	100	100	100	100	100	100	100	100	100
0025	0.16 - 0.25	100	100	100	100	100	100	100	100	100	100
0040	0.25 - 0.4	100	100	100	100	100	100	100	100	100	100
0063	0.4 - 0.63	100	100	100	100	100	100	100	100	100	100
0100	0.63 - 1	100	100	100	100	100	100	100	100	100	100
0160	1 - 1.6	100	100	100	100	100	100	100	100	100	100
0250	1.6 - 2.5	100	100	100	100	100	100	100	100	8	6
0400	2.5 - 4	100	100	100	100	100	100	100	100	8	6
0630	4 - 6.3	100	100	100	100	100	100	100	100	6	5
1000	6.3 - 10	100	100	100	100	50	38	50	38	6	5
1300	9 - 13	100	100	100	100	50	38	42	32	6	5
1600	11 - 16	100	100	50	38	35	27	10	8	4	3
2000	14 - 20	100	100	50	38	35	27	10	8	4	3
2500	19 - 25	100	100	50	38	35	27	10	8	4	3
3200	24 - 32	100	100	50	38	35	27	10	8	4	3

MOG - H2 and MOG - H2M

Rating	Ie: Min - Max (A)	240 V AC 230 V AC		415 V AC 400 V AC		460 V AC 440 V AC		500 V AC		690 V AC 600 V AC	
		Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)	Icu (kA)	Ics (kA)
3200	24 - 32	100	100	50	38	35	27	10	8	5	4
4000	28 - 40	100	100	50	38	35	27	10	8	5	4
5000	35 - 50	100	100	50	38	35	27	10	8	5	4
6300	45 - 63	100	100	50	38	35	27	10	8	5	4

Thermal & Magnetic Trip - Rocker Type

Frame size (mm)	Rating (A)	Motor Rating at 415 V, 50 Hz (kW)	Type Designation	Thermal Release Range (A)	Cat. Nos.	Breaking Capacity
45 mm	0.16	-	MOG - S1	0.1 - 0.16	ST41889OOOO	100 kA
	0.25	-		0.16 - 0.25	ST41890OOOO	
	0.4	0.09		0.25 - 0.4	ST41891OOOO	
	0.63	0.12		0.4 - 0.63	ST41892OOOO	
	1	0.25		0.63 -1	ST41893OOOO	
	1.6	0.55		1 - 1.6	ST41894OOOO	
	2.5	0.75		1.6 - 2.5	ST41895OOOO	
	4	1.5		2.5 - 4	ST41896OOOO	
	6.3	2.2		4 - 6.3	ST41897OOOO	
	10	4		6.3 - 10	ST41898OOOO	
	13	5.4		9 - 13	ST41899OOOO	50 kA
	New 16	7.5		11 - 16	ST41900OOOO	25 kA
	New 20	9		14 - 20	ST41901OOOO	
	New 25	12.5		19 - 25	ST41902OOOO	
	New 32	15		24 - 32	ST41903OOOO	

Thermal & Magnetic Trip - Rotary Type

Frame size (mm)	Rating (A)	Motor Rating at 415 V, 50 Hz (kW)	Type Designation	Thermal Release Range (A)	Cat. Nos.	Breaking Capacity
45 mm	0.16	-	MOG - H1	0.1 - 0.16	ST41904OOOO	100 kA
	0.25	-		0.16 - 0.25	ST41905OOOO	
	0.4	0.09		0.25 - 0.4	ST41906OOOO	
	0.63	0.12		0.4 - 0.63	ST41907OOOO	
	1	0.25		0.63 - 1	ST41908OOOO	
	1.6	0.55		1 - 1.6	ST41909OOOO	
	2.5	0.75		1.6 - 2.5	ST41910OOOO	
	4	1.5		2.5 - 4	ST41911OOOO	
	6.3	2.2		4 - 6.3	ST41912OOOO	
	10	4		6.3 - 10	ST41913OOOO	
	13	5.4		9 - 13	ST41914OOOO	
	16	7.5		11 - 16	ST41915OOOO	50 kA
	20	9		14 - 20	ST41916OOOO	
	25	12.5		19 - 25	ST41917OOOO	
	32	15		24 - 32	ST41918OOOO	
55 mm	32	15	MOG - H2	24 - 32	ST41919OOOO	
	40	20		28 - 40	ST41920OOOO	
	50	25		35 - 50	ST41921OOOO	
	63	34		45 - 63	ST41922OOOO	

Instantaneous Trip - Rotary Type

Frame size (mm)	Rating (A)	Motor Rating at 415 V, 50 Hz (kW)	Type Designation	Instantaneous Trip Current (A)	Cat. Nos.	Breaking Capacity
45 mm	0.16	-	MOG - H1M	2.1	ST41923OOOO	100 kA
	0.25	-		3.3	ST41924OOOO	
	0.4	0.09		5.2	ST41925OOOO	
	0.63	0.12		8.2	ST41926OOOO	
	1	0.25		13	ST41927OOOO	
	1.6	0.55		20.8	ST41928OOOO	
	2.5	0.75		32.5	ST41929OOOO	
	4	1.5		52	ST41930OOOO	
	6.3	2.2		81.9	ST41931OOOO	
	10	4		130	ST41932OOOO	
	13	5.4		169	ST41933OOOO	
	16	7.5		208	ST41934OOOO	
	20	9		260	ST41935OOOO	50 kA
	25	12.5		328	ST41936OOOO	
	32	15		416	ST41937OOOO	
55 mm	32	15	MOG - H2M	416	ST41938OOOO	
	40	20		520	ST41939OOOO	
	50	25		650	ST41940OOOO	
	63	34		819	ST41941OOOO	

Features

- All accessories can be used with MOG S1 (45 mm wide), MOG H1 (45 mm wide) and MOG H2 (55 mm wide) frames
- Shunt trip and undervoltage trip devices are available in a wide range of operating voltages
- IP20 terminal cover prevents accidental contact to electrically charged parts

Auxiliary Contact Blocks : MOG-AXF, MOG-AXL

These blocks are linked to the ON/OFF operation of the MPCB. Upto two contact blocks can be mounted to the right/left front and upto two contact blocks can be mounted to the left side.

Alarm Contact Blocks : MOG-TAF

This block operates when the MPCB trips due to overload, phase-loss, or short-circuit. It is not linked to the ON/OFF operation of the MPCB.

Note : Operation can be checked with the test trip function.

Auxiliary and Alarm Contact Blocks : MOG-ATL

- This contact block combines auxiliary contact and alarm contact that operate in the event of an overload, phase loss, or short-circuit. Alarm contact is not linked to the ON/OFF operation of the MPCB
- An alarm is displayed in the contact block's indicator when the alarm contact operates

Note : Operation can be checked with the test trip function.

Short-circuit Alarm Contact Block : MOG-SAL

- The contacts operate only when the MPCB has tripped due to a short-circuit
- When these contacts operate, the blue reset button extends out, and a trip indication is displayed
- The power to the MPCB can be turned ON after pressing the reset button

Note : Operation can not be checked with the test trip function. Be sure to press the reset button before mounting to the MPCB.

Shunt Trip Devices : MOG-ST

This device is used to remotely trip the MPCB.

Notes :
- This device cannot be used together with an undervoltage trip device
- When the MPCB trips with the shunt trip device, press the reset button before turning ON the power

Undervoltage Trip Devices : MOG-UV

This device automatically trips the MPCB when the control circuit voltage drops below the specified value.

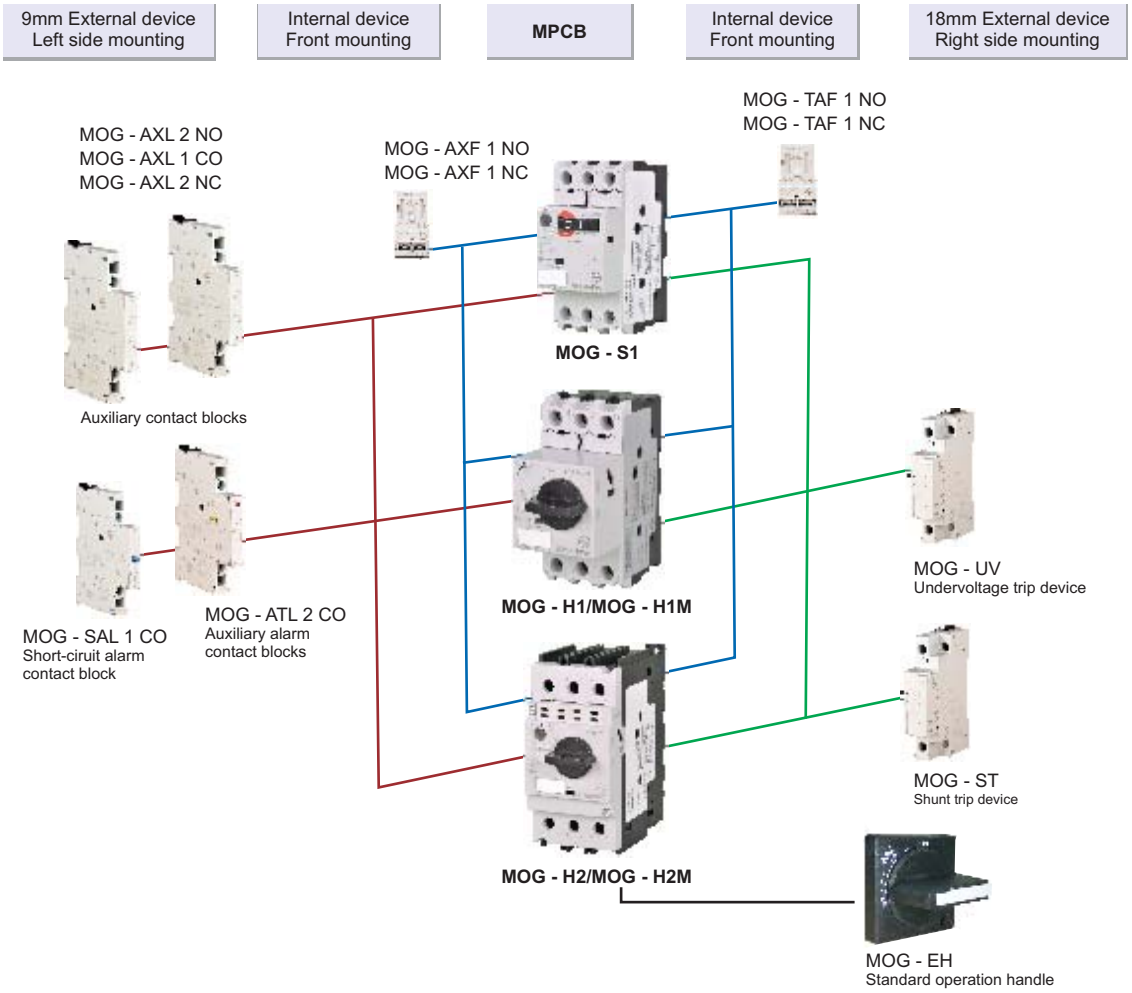
Notes:
- This device cannot be used with a shunt trip device
- When the MPCB has been tripped by undervoltage trip device, press the reset button before turning ON the power

External Operating Handles : MOG-EH

- To operate the MPCB without opening the panel door
- Equipped with an interlock mechanism that prevents someone from opening the panel door when the MPCB is in the ON state
- The shaft can be cut to match the distance between the MPCB and the panel door
- Door interlock function
- OFF lock function

Notes: Padlocks not included.

- Release screw allows the door to be opened with the handle in the ON position
- IP54 enclosure



Cat. Nos.	Description	Model Numbers	Position	Terminal Marking	
				NO	NC
ST41942OOOO	Auxiliary Contact Front mtg. 1NO	MOG-AXF 1NO	F (Slot1 / Slot 2)	13, 14 (23, 24)	
ST41943OOOO	Auxiliary Contact Front mtg. 1NC	MOG-AXF 1NC	F (Slot1 / Slot 2)		11, 12 (21, 22)
ST41944OOOO	Auxiliary Contact Left side mtg. 2NO	MOG-AXL 2NO	L	"33, 34 (133, 134) 43, 44 (143, 144)"	
ST41945OOOO	Auxiliary Contact Left side mtg. 1NO + 1NC	MOG-AXL 1CO	L	43, 44 (143, 144)	31, 32 (131, 132)
ST41946OOOO	Auxiliary Contact Left side mtg. 2NC	MOG-AXL 2NC	L		"31, 32 (131, 132) 41, 42 (141, 142)"
ST41947OOOO	Trip Alarm Contact Front mtg. 1NO	MOG-TAF 1NO	F (Slot 2 only)	27, 28	
ST41948OOOO	Trip Alarm Contact Front mtg. 1NC	MOG-TAF 1NC	F (Slot 2 only)		25, 26
ST41949OOOO	Auxiliary + Alarm Left side mtg. 2NO	MOG-ATL 2NO	L	"73, 74(Aux) 77, 78"(Alarm)	
ST41950OOOO	Short circuit alarm Left side mtg. 1NO + 1NC	MOG-SAL 1CO	L	87, 88	85, 86
ST41951OOOO	Shunt trip 24 V DC	MOG-ST	R (one at a time)	C1, C2	
ST41952OOOO	Shunt trip 110 V, 50 Hz	MOG-ST			
ST42952OOOO	Shunt trip 230 V, 50 Hz	MOG-ST			
ST41953OOOO	Under Voltage release, 110 V, 50 Hz	MOG-UV		D1, D2	
ST41954OOOO	Under Voltage release, 415 V, 50 Hz	MOG-UV			

F - Front Mounting L - LHS Mounting R - RHS Mounting

Note : 1) On LHS any 2 accessories can be fitted (Alarm contact followed by Auxiliary contact)
✦ MOG - ATL 2NO + MOG - AXL 1CO ✦ MOG-SAL 1CO + MOG - AXL 1CO
2) On RHS only 1 accessory can be fitted (Shunt trip release or Undervoltage release)
3) Any 2 Front mounted accessories are possible at a time
✦ Front mounted TAF to be fitted only in slot 2 ✦ Front mounted auxiliary contact can be fitted in slot1 / slot 2

Ratings of Accessories

Accessory type		Auxiliary contact block/front	Auxiliary contact block/side	Alarm contact block	Aux. and alarm contact block	Short-circuit alarm contact block
Part number		MOG-AXF	MOG-AXL	MOG-TAF	MOG-ATL	MOG-SAL
Standard		IEC 60947-5-1				
Rated operational current (A)	48 V AC AC-15	5	6	5	6	6
	125 V AC	3	4	3	4	4
	230 V AC	1.5	4	1.5	4	4
	400 V AC	-	2.2	-	2.2	2.2
	500 V AC	-	1.5	-	1.5	1.5
	690 V AC	-	0.6	-	0.6	0.6
	48 V DC DC-13	1.38	5	1.38	5	5
	110 V DC	0.55	1.3	0.55	1.3	1.3
	220 V DC	0.27	0.5	0.27	0.5	0.5
Min. voltage and current		17 V, 5 mA				

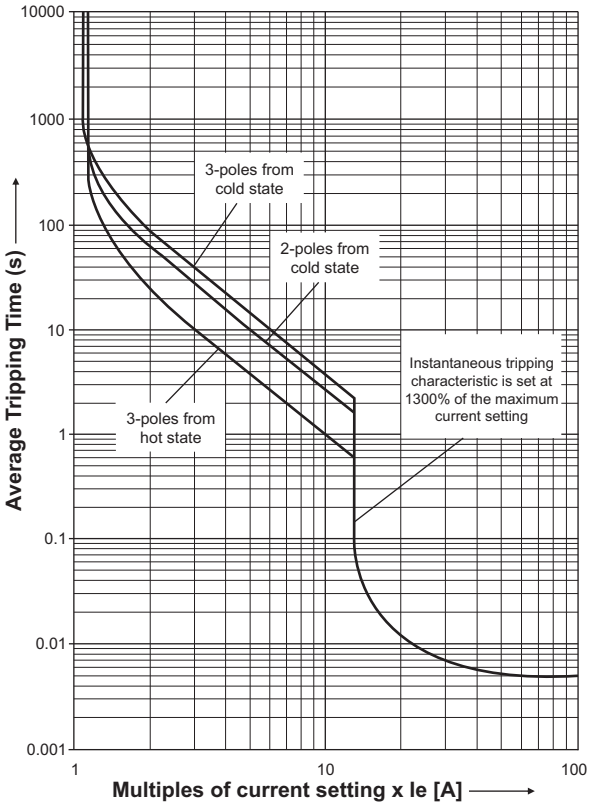
Accessory type		Shunt trip device MOG-ST	Undervoltage device MOG-UV
Standard		IEC 60947-1	
Rated insulation voltage (V AC)		690	
No. of operations		5000	
Operating time (ms)		20	
Power consumption	Inrush (VA/W)	21/12	
	Sealed (VA/W)	8/1.2	
Voltage range	Tripping voltage (V)	0.7 to 1.1Ue	0.35 to 0.7Ue
	Closing voltage (V)	-	0.85 to 1.1Ue
Time rating of coil (s)		AC: Continuous DC: 5	AC: Continuous

Note : Ue: Rated Voltage

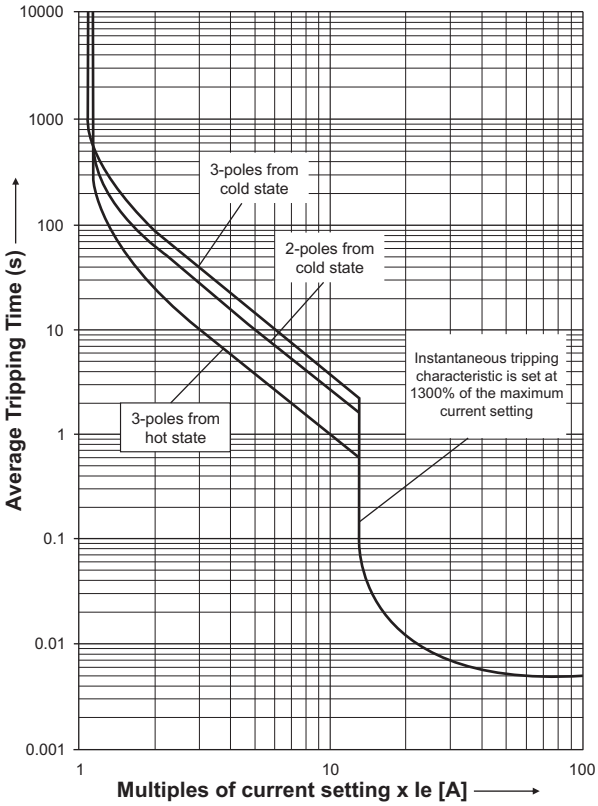
Accessory	Used with	Specification	Description	Cat. No.
Busbar Simple power supply for 2 to 5 MPCBs without the need for wiring 	MOG S1/H1/H1M	Rated current: 64A max Pin connection	2 MPCB without accessory	ST41957OOOO
			3 MPCB without accessory	ST41958OOOO
			4 MPCB without accessory	ST41959OOOO
			5 MPCB without accessory	ST41960OOOO
			2 MPCB with one accessory 9 mm	ST41961OOOO
			3 MPCB with one accessory 9 mm	ST41962OOOO
			4 MPCB with one accessory 9 mm	ST41963OOOO
			5 MPCB with one accessory 9 mm	ST41964OOOO
	MOG H2/H2M	Rated current: 126A max Pin connection	2 MPCB without accessory	ST41966OOOO
			3 MPCB without accessory	ST41967OOOO
			4 MPCB without accessory	ST41968OOOO
			2 MPCB with one accessory 9 mm	ST41969OOOO
			3 MPCB with one accessory 9 mm	ST41970OOOO
			4 MPCB with one accessory 9 mm	ST41971OOOO
			2 MPCB with two accessories 9mm or one accessory 18 mm	ST41972OOOO
			4 MPCB with two accessories 9mm or one accessory 18 mm	ST41973OOOO
3 Phase Feed in terminal Used to connect the wire for the power supply circuit 	MOG S1/H1/H1M	Rated current: 64A	Feed in terminal for 45 mm width	ST41965OOOO
	MOG H2/H2M	Rated current: 126A	Feed in terminal for 55 mm width	ST41974OOOO
Busbar Safety cover Prevents contact with charged parts when part of the busbar is not connected to MPCB. 	MOG S1/H1/H1M	For pin connection	Bus bar safety cover 45 mm width	ST41975OOOO
	MOG H2/H2M	For pin connection	Bus bar safety cover 55 mm width	ST41976OOOO

4 MPCBs with busbar connection

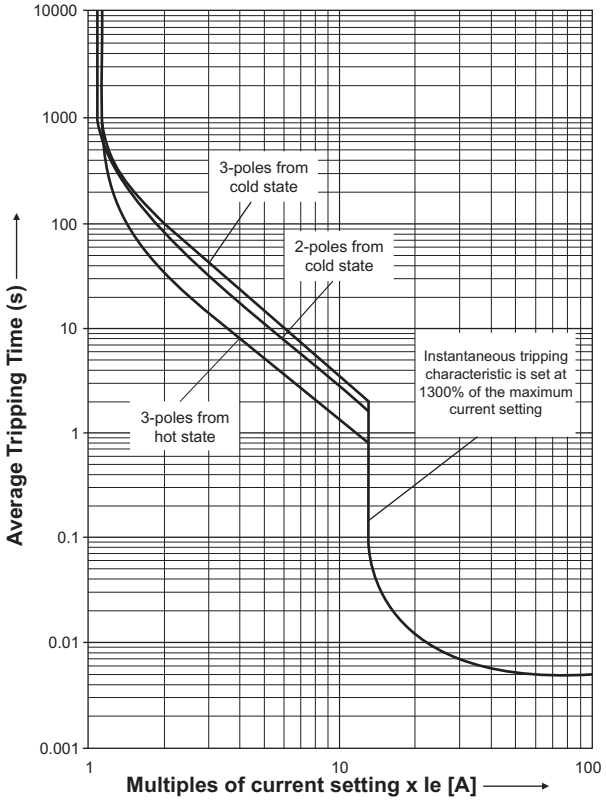
Type MOG - S1 (0.16A - 32A)



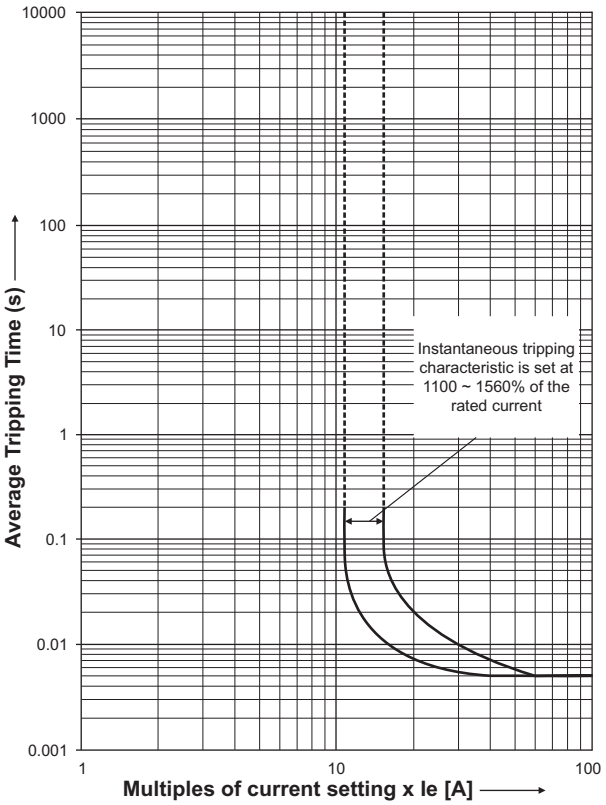
Type MOG - H1 (0.16A - 32A)



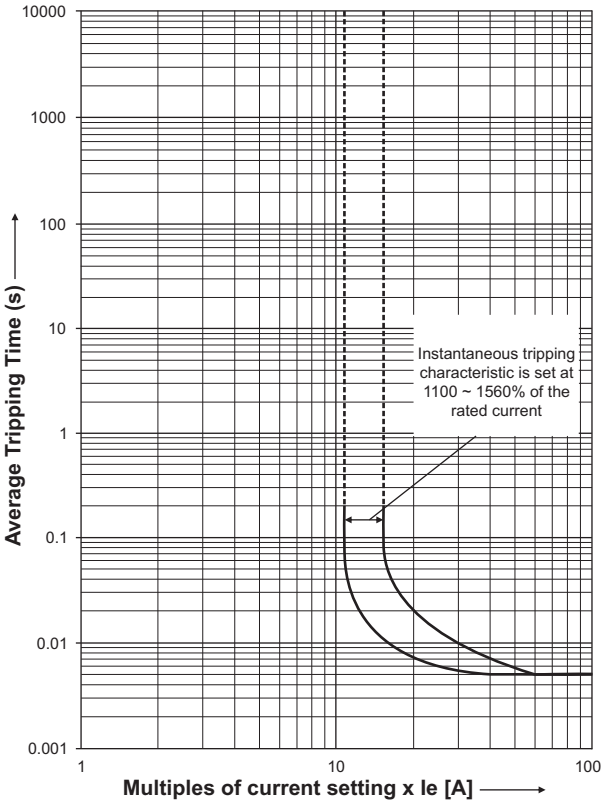
Type MOG - H2 (32A - 63A)



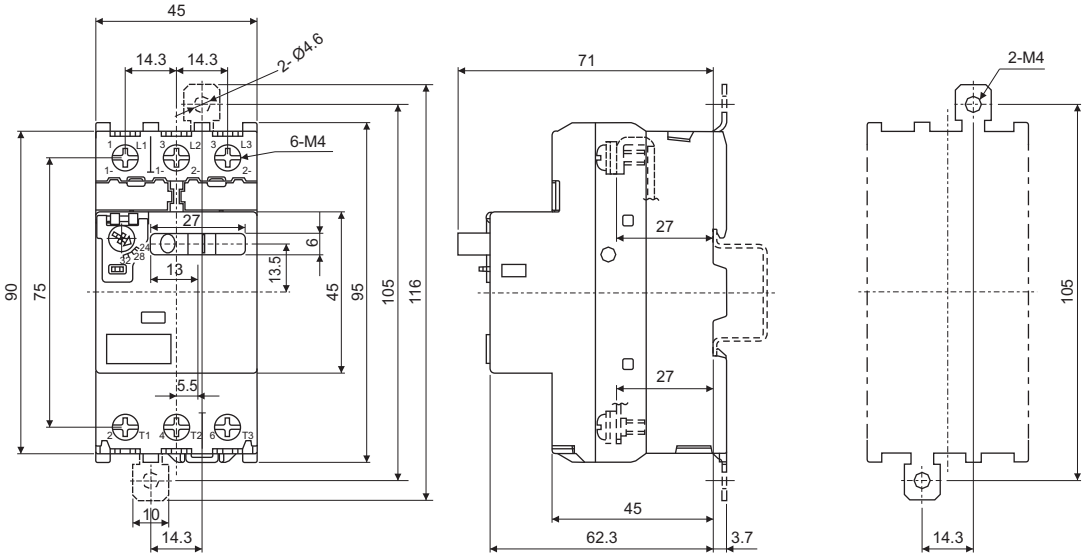
Type MOG - H1M (0.16A - 32A)



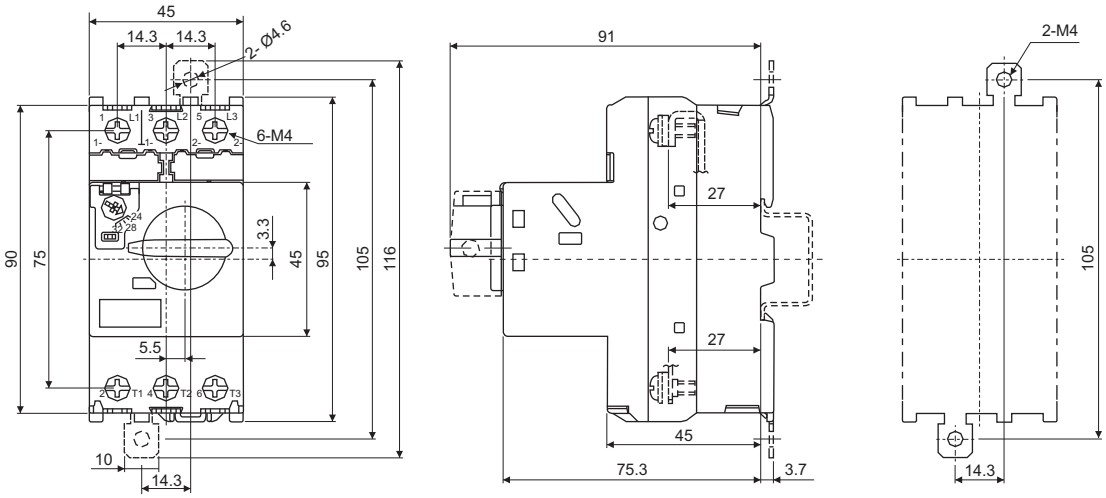
Type MOG - H2M (32A - 63A)



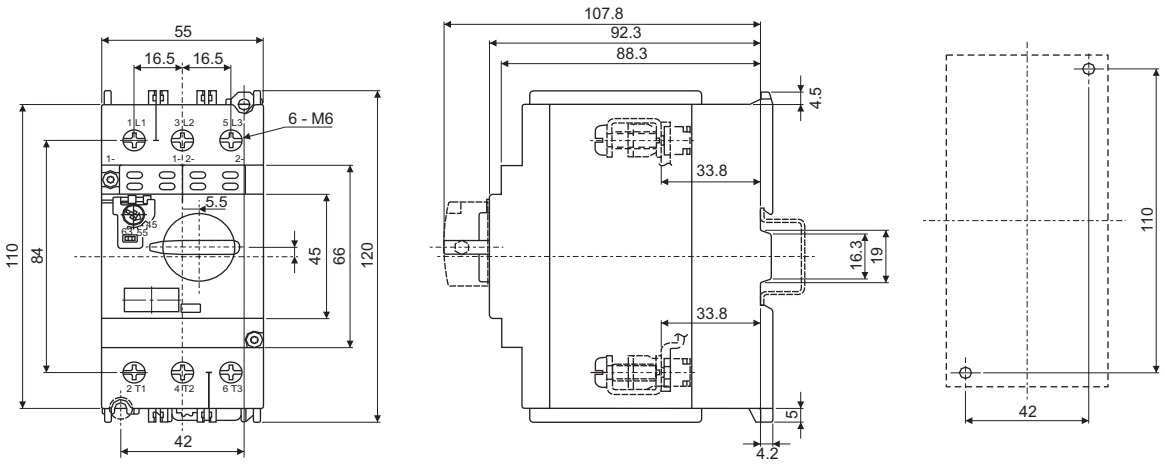
Type MOG - S1 (0.16A - 32A)



Type MOG - H1 & MOG - H1M (0.16A - 32A)

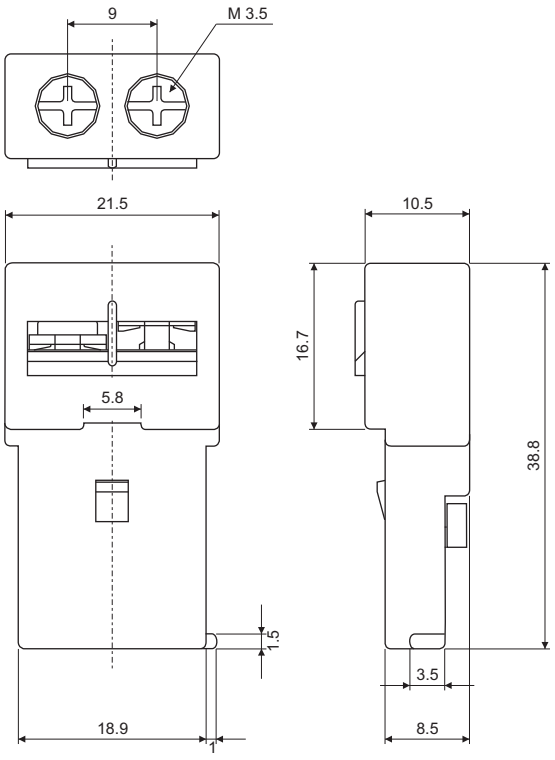


Type MOG - H2 & MOG - H2M (32A - 63A)

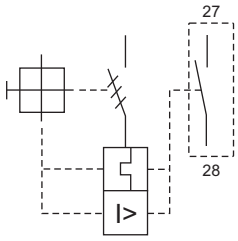


All dimensions in mm.

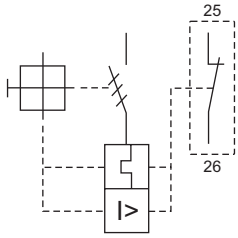
Trip Alarm Contact Front 1 NO



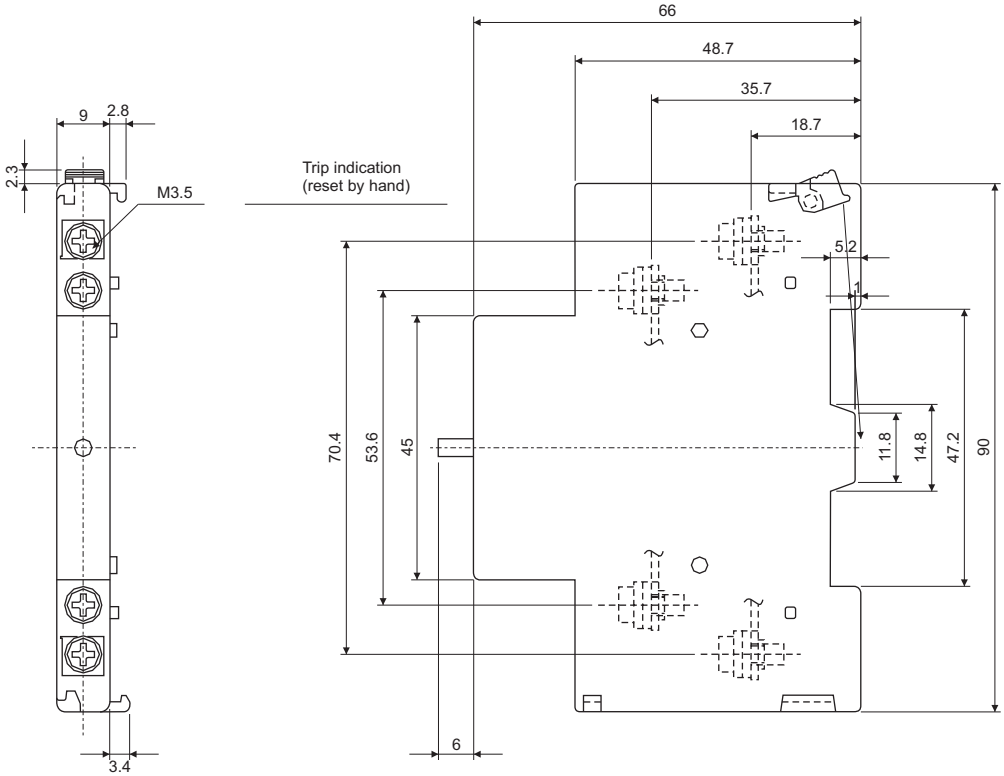
MOG - TAF 1 NO



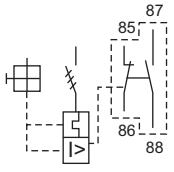
MOG - TAF 1 NC



S/C Alarm Left 1 NO + 1 NC

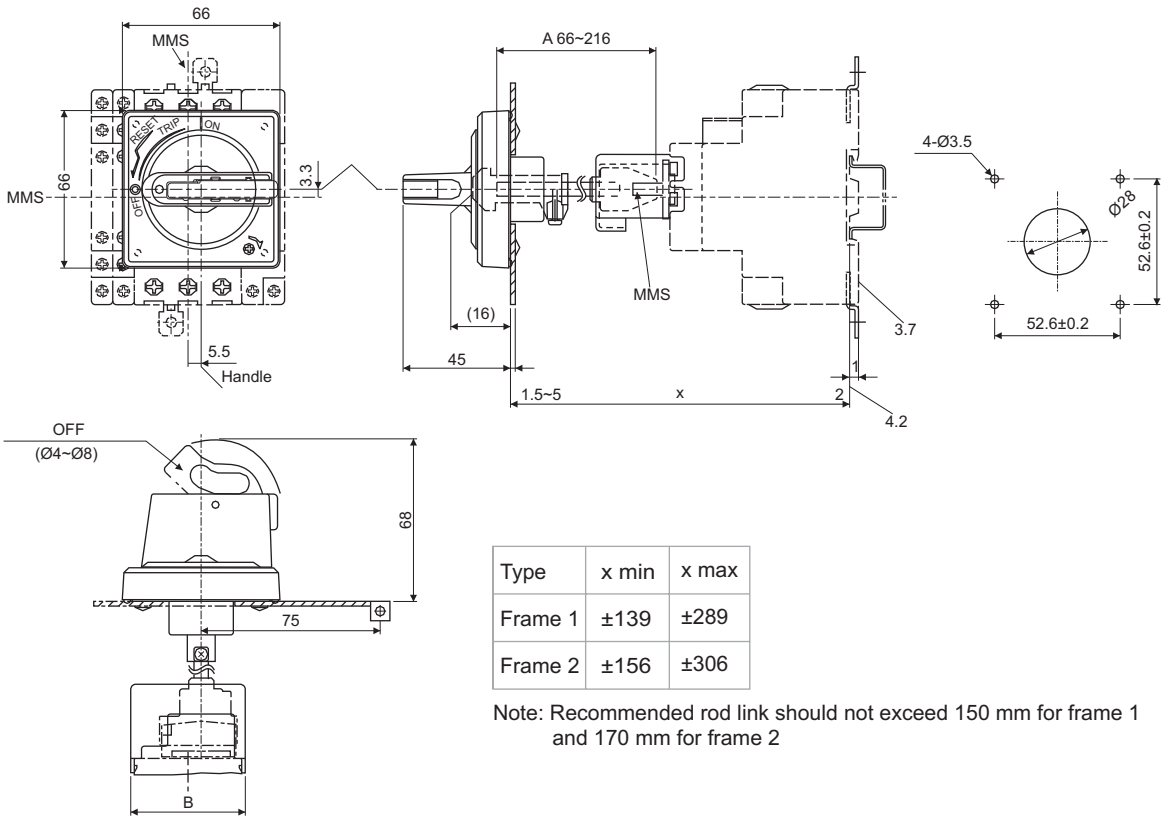


MOG - SAL 1 CO



All dimensions in mm.

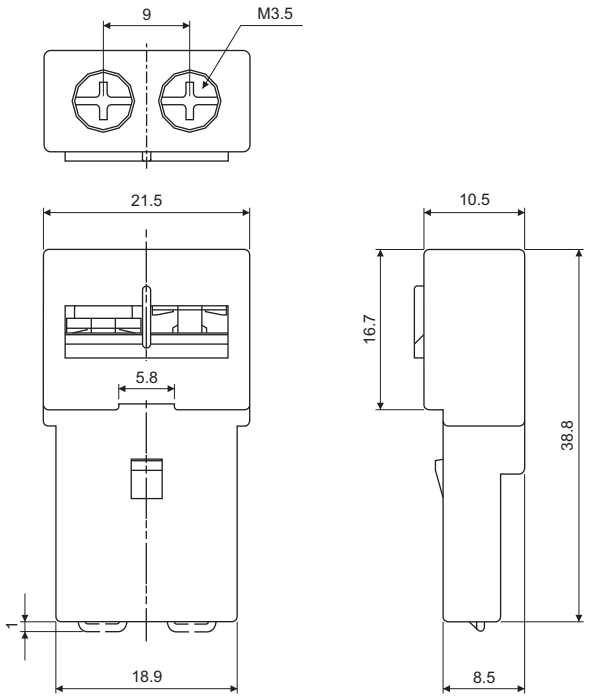
External Operating Handle (Applicable for Frame 1 & 2)



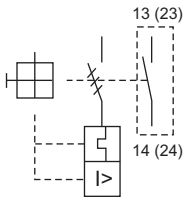
Type	x min	x max
Frame 1	±139	±289
Frame 2	±156	±306

Note: Recommended rod link should not exceed 150 mm for frame 1 and 170 mm for frame 2

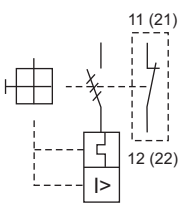
Aux. Contact Front 1 NO



MOG - AXF 1 NO

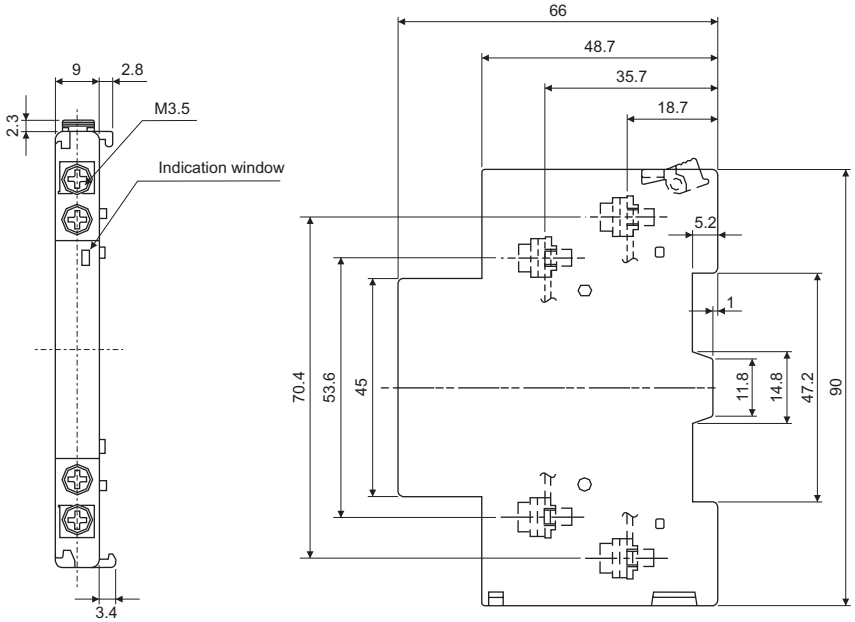


MOG - AXF 1 NC

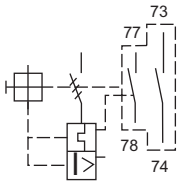


All dimensions in mm.

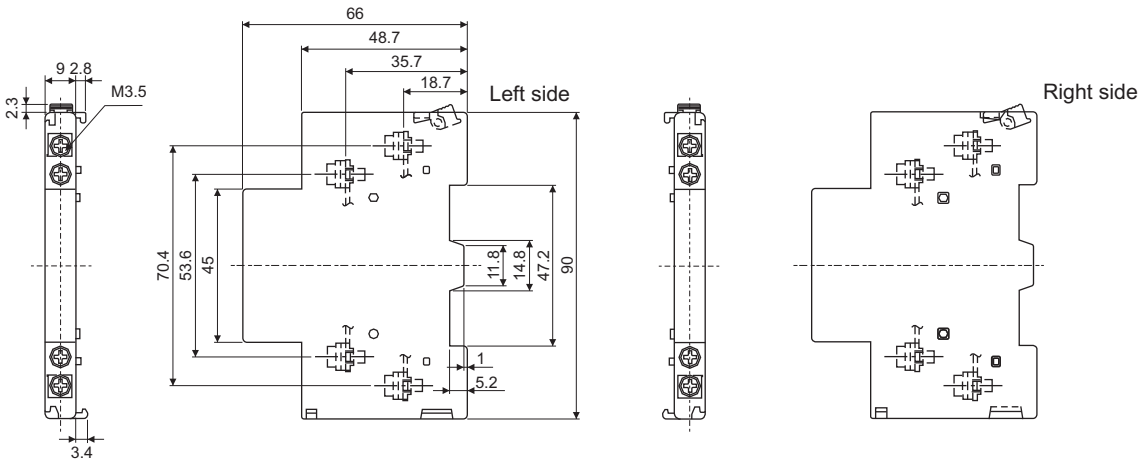
Aux. Alarm Left 2 NO



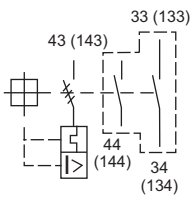
MOG - ATL 2 NO



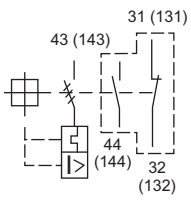
Aux. Contact Left 2 NO



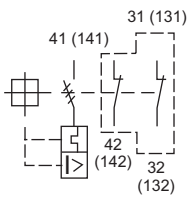
MOG - AXL 2 NO



MOG - AXL 1 CO



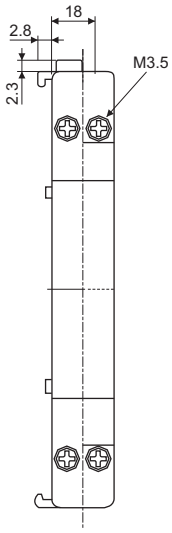
MOG - AXL 2 NC

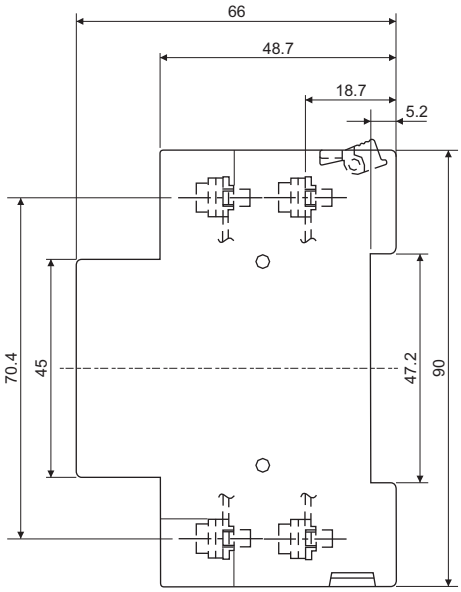


All dimensions in mm.

Shunt Trip and under Voltage Release

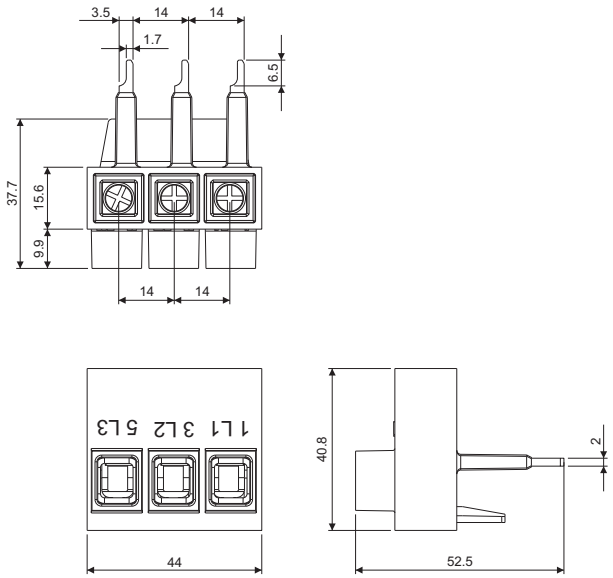
MOG - ST & MOG - UV





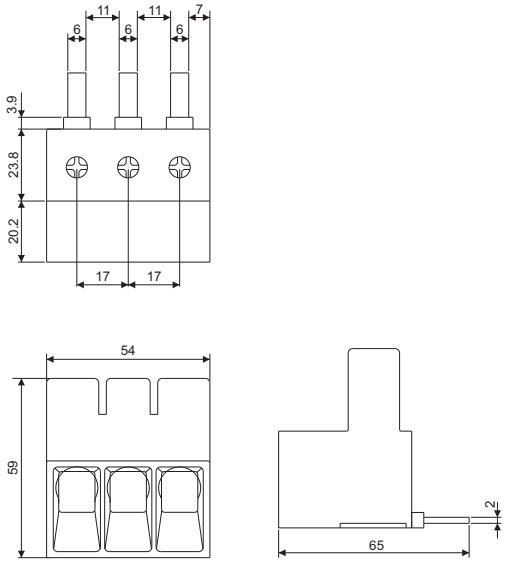
MPCB Busbar Accessories

3 Phase Feed in Terminals (Frame 1)



ST41965OOOO

3 Phase Feed in Terminals (Frame 2)



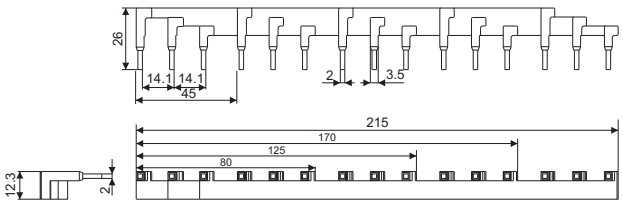
ST41974OOOO

All dimensions in mm.

MPCB Busbar Accessories

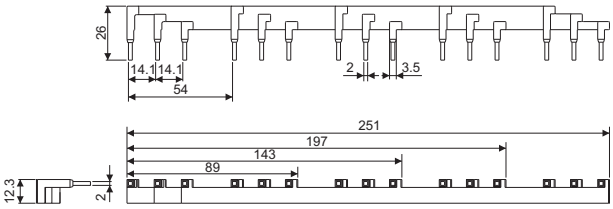
For MOG-S1, MOG-H1/H1M (Frame 1)

Without external accessory



ST41957OOOO: 80 mm
ST41958OOOO: 125 mm
ST41959OOOO: 170 mm
ST41960OOOO: 215 mm

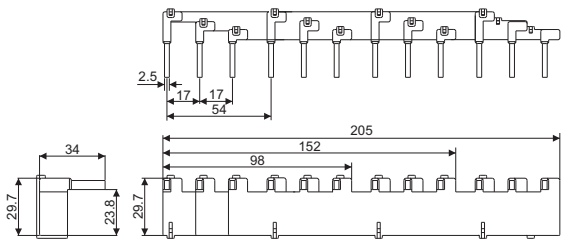
With 1 external accessory



ST41961OOOO: 89 mm
ST41962OOOO: 143 mm
ST41963OOOO: 197 mm
ST41964OOOO: 251 mm

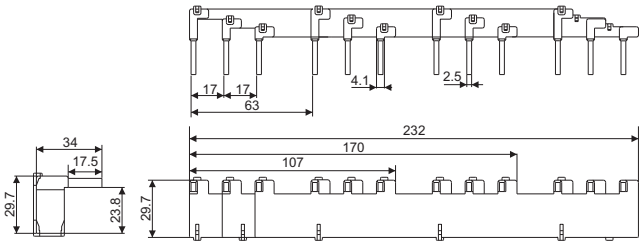
For MOG-H2/H2M (Frame 2)

Without external accessory



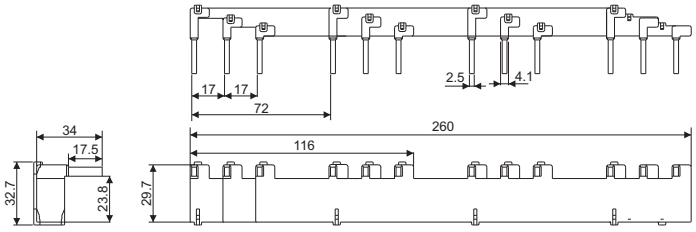
ST41966OOOO: 98 mm
ST41967OOOO: 152 mm
ST41968OOOO: 205 mm

With one external accessory



ST41969OOOO: 107 mm
ST41970OOOO: 170 mm
ST41971OOOO: 232 mm

With 2 external accessory, 9 mm wide
With 1 external accessory, 18 mm wide



ST41972OOOO: 116 mm
ST41973OOOO: 260 mm

All dimensions in mm.

MN
Industrial Starter

MN & ML range of industrial starters offers complete motor starting solution for industrial applications. These starters are time tested for reliable performance. These starters are proven work horse for stand alone motor in the industry.

COMPACT, RELIABLE & COMPLETE SOLUTION

Salient Features

Features & Benefits

Single Phasing Protection

MN relays having phase failure sensitive tripping mechanism provides reliable protection against single phasing & overload conditions. MN relays are compensated for variation in ambient temperature from -5°C to 55°C.

IP54 degree of protection

Corrosion resistant powder coated enclosure with IP 54 degree of protection makes MN starters most suitable for chemical factories, polluted industrial and dusty

agricultural environments.

Terminal Block

MN Star-Delta starters are provided with terminal block with proper terminal marking for ease of wiring. Terminal block can accommodate both aluminum & copper cables.

Base Plate Mounting

MN Star-Delta starters are mounted on base plate that can absorb vibrations and it makes MN starters maintenance friendly.

Electronic Timer

MN Fully Automatic Star-Delta starters are provided with electronic timer for high repeat accuracy.

Trip Test Facility

This facility enables the user to manually check the operation of the trip mechanism. Move the trip slide in the direction shown on the relay. The relay trips with an audible 'Click' sound, indicating that the trip mechanism is in good working order.

Off / Reset Push-Button

The relay will trip in case of overloads or single phasing conditions.

Simultaneously 'Alarm Contact' (97-98) will close. The motor cannot be restarted until the relay has been reset. To reset the relay, allow the bimetals to cool down sufficiently & push this button to reset the trip contact (95-96).

If the relay is in reset condition, pressing this push-button will open 'Trip Contact'. But now the alarm contact will not close. This indicates healthy operation of the relay mechanism. The trip contact will again close when this button is released.

Auto-Manual Reset Switch

There are two modes of reset available : Manual and Auto. By default the relay is in the Manual reset mode and can be converted to Auto reset mode by moving the switch to Auto position marked on the label.

Chart for MN DOL starters

Type	Maximum Motor Rating at 415V, 3 Ø, 50Hz		Approx. Full Load Current In (A)	Relay Range (A)	Relay	Contactor	Recommended Back-up HRC Fuse		Switch Disconnector Fuse Unit
	HP	kW					Type	Rating (A)	
MN 16 DOL	2	1.5	3.5	3 - 5	MN 2	MNX 18	HF	16	FN 32
	2.5	1.8	4.8	3 - 5			HF	16	FN 32
	3	2.2	5	4.5 - 7.5			HF	16	FN 32
	4	3	6.2	4.5 - 7.5			HF	20	FN 32
	5	3.7	7.5	6 - 10			HF	20	FN 32
	6	4.5	9	6 - 10			HF	25	FN 32
	7.5	5.5	11	9 - 15			HF	32	FN 32
	10	7.5	14	9 - 15			HF	32	FN 32
MN 25 DOL	7.5	5.5	11	9 - 15	MN 2	MNX 25	HF	32	FN 32
	10	7.5	14	9 - 15			HF	32	FN 32
	12.5	9.3	18	14 - 23			HF	50	FN 63
	15	11	21	14 - 23			HF	63	FN 63
MN 32 DOL	15	11	21	20 - 33	MN 2	MNX 32	HF	63	FN 63
	17.5	13	24	20 - 33			HF	63	FN 63
	20	15	28	20 - 33			HN/100	63	FN 100
MN 45 DOL	25	18.5	35	30 - 50	MN 5	MNX 50	HN/100	80	FN 100
	30	22	40	30 - 50			HN/100	80	FN 100
MN 65 DOL	30	22	40	30 - 50	MN 5	MNX 70	HN/100	80	FN 100
	35	26	47	30 - 50			HN/100	100	FN 100
	40	30	55	45 - 75			HN/100	100	FN 100
	40	30	60	45 - 75			HN/100	100	FN 100

Selection Chart for MN DOL Starters

Chart for MN Star-Delta starters

Type	Maximum Motor Rating at 415V, 3 Ø, 50Hz		Approx. Full Load Current In (A)	Phase Current $i_n/\sqrt{3}$	Relay Range (A)	Relay	Contactor	Recommended Back-up HRC Fuse		Switch Disconnector Fuse Unit
	HP	kW						Type	Rating (A)	
MN 16 FASD	10	7.5	14	8.08	6 - 10	MN 2	MNX 18	HF	20	FN32
	12.5	9.3	18	10.4	9 - 15			HF	32	FN32
	15	11	21	12.1	9 - 15			HF	32	FN32
	17	13	25	24.4	9 - 15			HF	32	FN32
MN 25	20	15	28	16.2	14 - 23	MN 2	MNX 25	HF	40	FN63
	25	18.5	35	20.2	14 - 23			HF	50	FN63
MN 32 FASD	35	22.5	40	23	20 - 33	MN 2	MNX 32	HF	63	FN63
	40	30	47	27	20 - 33			HN/00	63	FN100
MN 45 FASD	40	30	55	31.8	30 - 50	MN 5	MNX 50	HN/00	63	FN100
	45	33.5	60	34.6	30 - 50			HN/00	80	FN100
	50	37	66	38.2	30 - 50			HN/00	80	FN100
MN 65 FASD	60	45	80	46.2	45 - 75	MN 5	MNX 70	HN/00	100	FN100
	65	48.5	87	50	45 - 75			HN/00	100	FN100
	70	52	94	54.5	45 - 75			HN/00	125	FN125
	75	55	100	57.5	45 - 75			HN/00	125	FN125
MN 80 FASD	90	67.5	120	69.2	45 - 75	MN 5	MNX 80	HN/0	160	FN 200
MN 110 FASD	100	75	135	77.9	66 - 110	MN 5	MNX 110	HN/0	160	FN200
	150	110	165	95	66 - 110			HN/0	200	FN200
MN 140 FASD	150	110	200	115	90 - 150	MN 12L	MNX 140	HN/1	250	FN250
	180	132	230	132.8	90 - 150			HN/1	250	FN250

Selection Chart for MN Star-Delta Starters

Ordering Information - MN DOL Starter*

Example: MN 16 DOL - 240 V with relay range 9 - 15 A Ordering Information - SS94015BOBO

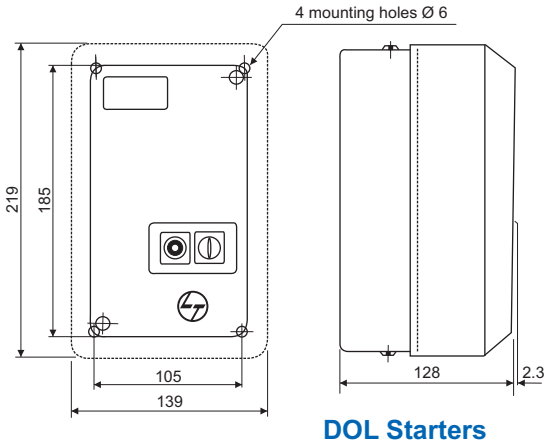
Starter Type	Version	MN 16	MN 25	MN 32	MN 45	MN 65
Cat. No.		SS94351	SS94352	SS94353	SS94017	SS94018
Rated control voltage (Us) V AC	Relay Range					
240	2.0 - 3.3	DOQO	—	—	—	—
	3.0 - 5.0	—	—	—	—	—
	4.5 - 7.5	—	—	—	—	—
	6.0 - 10	—	BOBO	—	—	—
	9.0 - 15	—	BODO	—	—	—
	14 - 23	—	—	BOEO	—	—
	20 - 33	—	—	—	—	—
	30 - 50	—	—	—	—	—
	45 - 75	—	—	—	—	—
360	3.0 - 5.0	COSO	—	—	—	—
	4.5 - 7.5	COUO	—	—	—	—
	6.0 - 10	COVO	—	—	—	—
	9.0 - 15	COBO	COBO	—	—	—
	14 - 23	—	CODO	—	—	—
	20 - 33	—	—	COEO	—	—
	30 - 50	—	—	—	COGO	—
	45 - 75	—	—	—	—	COJO
415	3.0 - 5.0	DOSO	—	—	—	—
	4.5 - 7.5	DOUO	—	—	—	—
	6.0 - 10	DOVO	—	—	—	—
	9.0 - 15	DOBO	DOBO	—	—	—
	14 - 23	—	DODO	DODO	—	—
	20 - 33	—	—	DOEO	—	—
	30 - 50	—	—	—	DOGO	DOGO
	45 - 75	—	—	—	—	DOJO

Ordering Information - MN Star- Delta Starter*

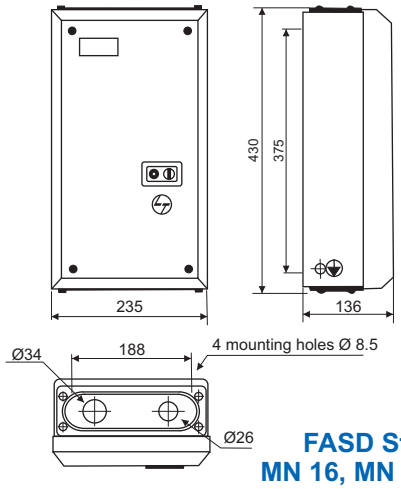
Example: MN 16 SASD - 360 V with relay range 9 - 15 A Ordering Information - SS94019COBO

Starter Type	Version	MN 16	MN 25	MN 32	MN 45	MN 65	MN 80	MN 110	MN 140
Cat. No.	FASD	SS94362	SS94364	SS94366	SS94021	SS94022	SS94705	SS94706	SS94707
Rated control voltage (Us) V AC	Relay Range								
360	6.0 - 10	COVO	—	—	—	—	—	—	—
	9.0 - 15	COBO	—	—	—	—	—	—	—
	14 - 23	—	CODO	DODO	—	—	—	—	—
	20 - 33	—	—	COEO	—	—	—	—	—
	30 - 50	—	—	—	—	—	—	—	—
	45 - 75	—	—	—	—	—	—	—	—
	66 - 110	—	—	—	—	—	—	—	—
	90 - 150	—	—	—	—	—	—	—	—
415	6.0 - 10	DOVO	—	—	—	—	—	—	—
	9.0 - 15	DOBO	—	—	—	—	—	—	—
	14 - 23	—	DODO	—	—	—	—	—	—
	20 - 33	—	—	DOEO	—	—	—	—	—
	30 - 50	—	—	—	DOGO	—	—	—	—
	45 - 75	—	—	—	—	DOJO	DOJO	—	—
	66 - 110	—	—	—	—	—	—	DOKO	—
	90 - 150	—	—	—	—	—	—	—	DOMO

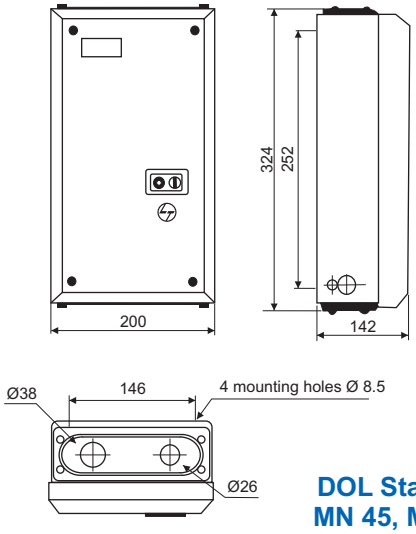
* Note: These are the standard combinations of relay and contactor. Any other combinations can be supplied on request.



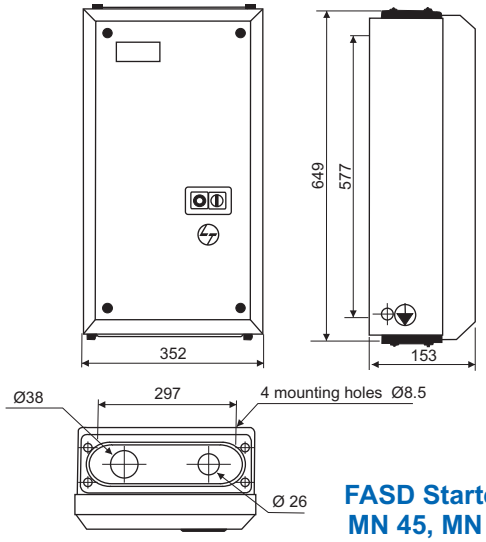
DOL Starters
MN 16, MN 25, MN 32



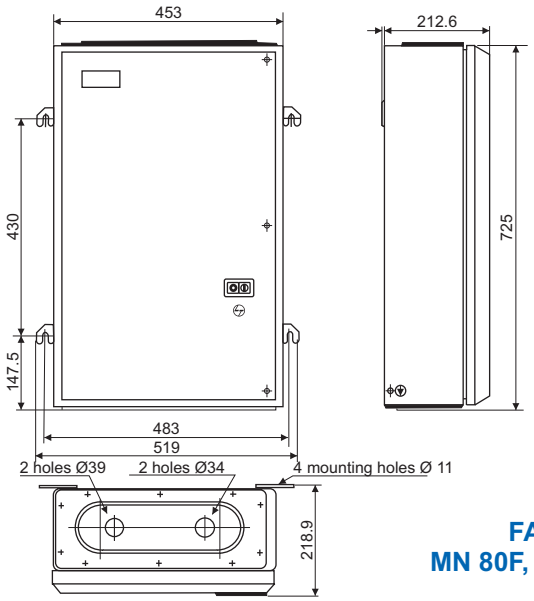
FASD Starters
MN 16, MN 25, MN 32



DOL Starters
MN 45, MN 65



FASD Starters
MN 45, MN 65



FASD Starters
MN 80F, MN 110F, MN 140F

All dimensions in mm.

Glossary

Altitude	The height (above the sea level) of the site where the equipment is located.
Ambient Temperature	Air temperature surrounding the equipment.
Auxiliary Circuit	All the conducting parts of a contactor, intended to be included in a circuit different from the main circuit and the control circuit of the contactor e.g. signalization, interlocking circuits etc.
Control Circuit	Circuit used for the closing operation and opening operation of the contactor.
Main Circuit	Main contact system.
Limits of operation	Minimum and maximum coil operating limits, which are expressed as a percentage of the rated control circuit voltage.
Electrical Endurance	Number of on-load operating cycles (i.e. with current on the main contacts) a contactor can achieve. It might be different for different utilization categories.
Mechanical Endurance	Number of off-load operating cycles (i.e. without current on the main contacts) a contactor can achieve.
Inching	Energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.
Plugging	Plugging is defined as a system of braking, in which the motor connections are reversed so that the motor develops a counter torque, which acts as a retarding force. Plugging controls provide for the rapid stop and quick reversal of motor rotation.
Rated breaking capacity	The RMS value of current that contactor can break without damage to the contactor.
Rated making capacity	The peak value of current that contactor can make without damage to the contactor.

Rated control circuit voltage Uc	Control voltage value for which the coil of the contactor is designed.
Rated insulation voltage Ui	The highest operating voltage that will not cause a dielectric strength failure. It is used as a parameter for dielectric strength tests and for the creepage distance.
Rated impulse withstand voltage Uimp	It is the maximum voltage impulse which the product can withstand without failing.
Rated operating voltage Ue	Voltage value to which utilization characteristics of the contactor are referred, i.e. phase to phase voltage in 3 phase circuits.
Rated operating current Ie	Current value stated by the manufacturer and taking into account the rated operating voltage Ue, the rated frequency, the rated duty, the utilization category, the electrical contact life and the type of the protective enclosure.
Conventional thermal current Ith	Value of current the contactor can withstand with poles in closed position, in free air for an eight hour duty, without the temperature rise of its various parts exceeding the imits specified by the standards.
Permissible Short Time ratings	Value of current which the contactor can withstand in closed position for a short time period and within specified conditions.
Switching frequency	Number of operating cycles per hour.
Pick Up VA	Load of the coil in VA at the moment when the supply is given to the coil, till the time the contacts of the contactor close.
Hold On VA	It is the continuous load of the coil in VA, after the contacts are closed.
Closing time	Time between energization of the coil until the moment the contacts of the first current path to be closed actually close.
Opening time	Time from the beginning of state causing breaking until the moment when the contacts of the last current path to be opened are open.
Mounting Positions	Stated by the manufacturer. Please note restrictions when applicable.

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