



Medium voltage products

V-Contact VSC

Medium voltage vacuum contactors

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1. Description



General

The medium voltage V-Contact VSC contactors are apparatus suitable for operating in alternating current and are normally used to control users requiring a high number of hourly operations.

The V-Contact VSC contactor introduces the drive with permanent magnets, already widely used, experimented and appreciated in medium voltage circuit-breakers, into the worldwide panorama of medium voltage contactors.

The experience acquired by ABB in the field of medium voltage circuit-breakers fitted with drives with "MABS" permanent magnets, has made it possible to develop an optimised version of the actuator (bistable MAC drive) for medium voltage contactors.

The drive with permanent magnets is activated by means of an electronic multi-voltage feeder. The feeders differ according to the integrated functions and to the auxiliary power supply voltage.

Each feeder is able to take any voltage value within its own operating band.

Versions available

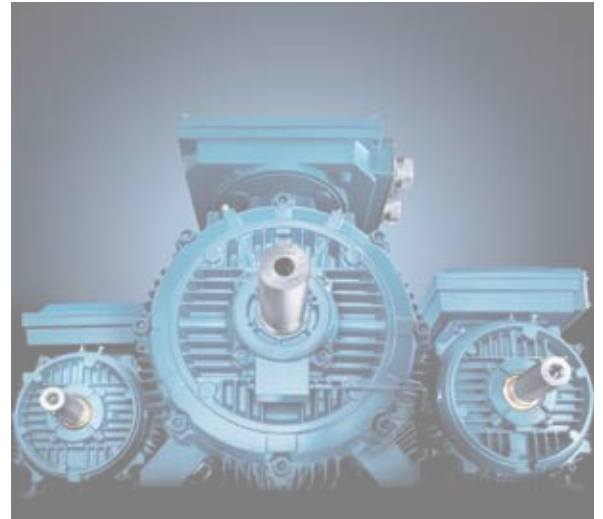
The V-Contact VSC contactors are available in the following versions:

Version	Rated voltage	Type
Fixed	7,2 kV	VSC 7 - VSC 7/F - VSC 7/G
	12 kV	VSC 12 - VSC 12/F - VSC 12/G - VSC S/G - VSC S/F
Withdrawable	7,2 kV	VSC 7/P - VSC 7/PN - VSC 7/PG - VSC 7/PNG
	12 kV	VSC 12/P - VSC 12/PN - VSC 12/PG - VSC S/PG - VSC S/PNG

The withdrawable versions are foreseen for use with UniGear switchgear, PowerCube units and CBE1 enclosures. For use with the CBE11 enclosures, please contact ABB.

All the contactors mentioned above are available, on request, in one of the two following versions.

- **SCO** (Single Command Operated): closing takes place by supplying auxiliary power to the special input of the multi-voltage feeder. On the other hand, opening takes place when the auxiliary power is either voluntarily cut off (by means of a command) or involuntarily (due to lack of auxiliary power in the installation).
- **DCO** (Double Command Operated): closing takes place by supplying the input of the closing command of the apparatus in an impulsive way. On the other hand, opening takes place when the input of the opening command of the contactor is supplied in an impulsive way.



Fields of application

The V-Contact VSC contactors are suitable for controlling electrical apparatus in industry, in the service sector, in the marine sector, etc. Thanks to the breaking technique with vacuum interrupters, they can operate in particularly difficult environments. They are suitable for control and protection of motors, transformers, power factor correction banks, switching systems, etc.

Fitted with suitable fuses, they can be used in circuits with fault levels up to 1000 MVA (VSC7 - VSC12).

Compliance with Standards

V-Contact VSC contactors comply with the Standards of the major industrialised countries and in particular with the IEC 62271-106 (2011).

Type approvals

Type-approval by Shipping Registers DNV and LL.RR for the VSC/PN versions is available.

Ask ABB for other versions and type approvals.

Operating characteristics

- Ambient temperature: $-5\text{ °C} \dots +40\text{ °C}$
- Relative humidity: $< 95\%$ (without condensation)
- Altitude: $< 1000\text{ m s.l.m.}$

For other conditions, please contact us.

Main technical characteristics

- Maintenance-free
- Suitable for installation in prefabricated substations and switchgear both of the card (slim line) and traditional type
- High number of operations
- Direct checking of contact wear
- Long electrical and mechanical life
- Remote control
- Multi-voltage feeder
- Bistable drive of the type with permanent magnets.

1. Description

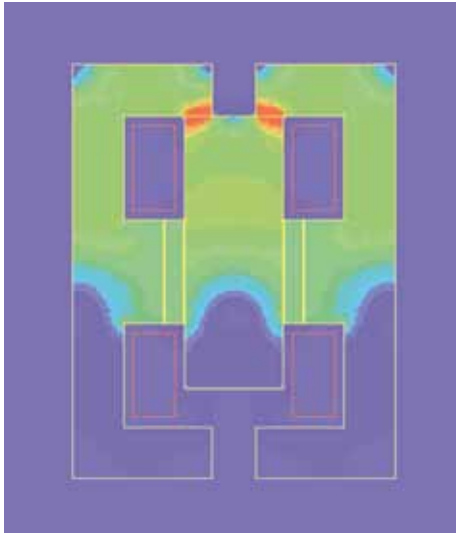


Fig. A - Magnetic circuit in the closed position.

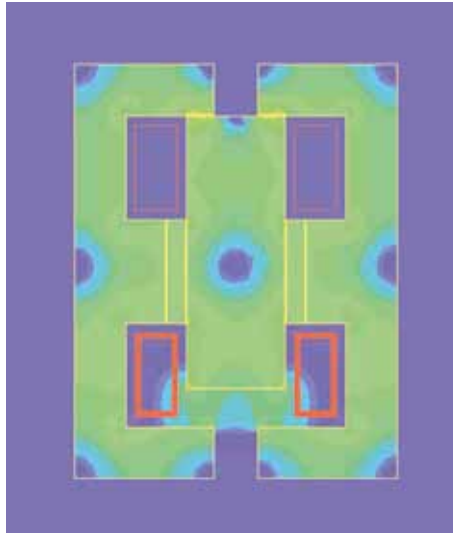


Fig. B - Magnetic circuit with the opening coil supplied.

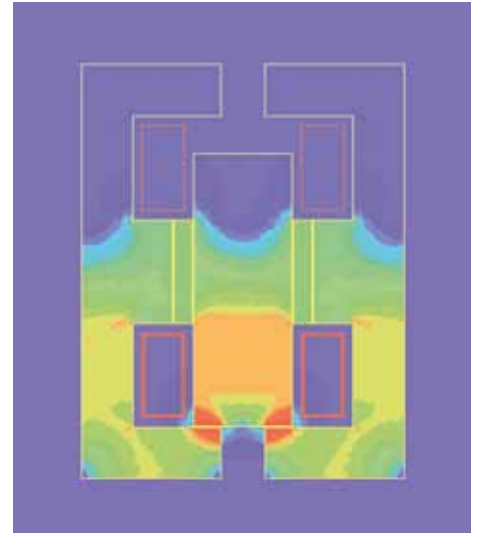
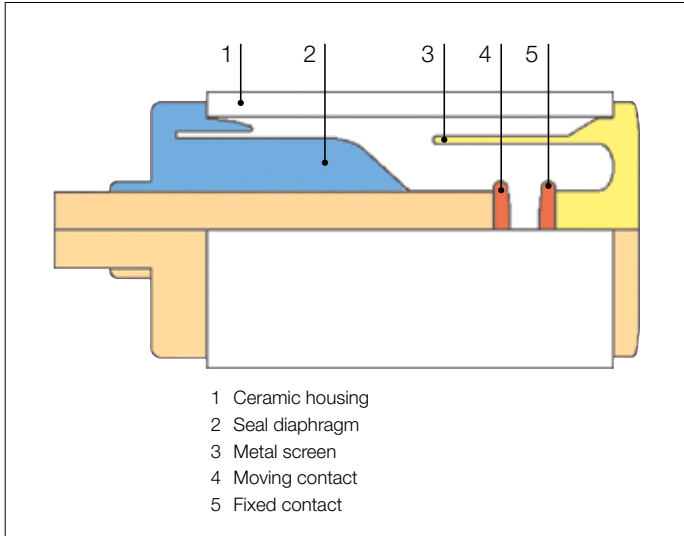


Fig. C - Magnetic circuit in the open position.

“MAC” magnetic drive

ABB has implemented this technology in the field of contactors on the basis of experience gained in the field of circuit-breakers with magnetic drive. The magnetic drive adapts perfectly to this type of apparatus thanks to its precise and linear travel. The drive, which is of bistable type, is fitted with an opening and a closing coil. The two coils - individually energised - allow the drive mobile armature to be moved from one of the two stable positions to the other.

The drive shaft is solid with the mobile armature and held in position in a field generated by two permanent magnets (fig. A). Energising the coil opposite to the magnetic latching position (fig. A) of the core, the magnetic field is generated (fig. B), which attracts and moves the mobile armature into the opposite position (fig. C). Every opening and closing operation creates a magnetic field concordant with the one generated by the permanent magnets, with the advantage of keeping the intensity of the field itself constant during service, regardless of the number of operations carried out.



Schematic cross-section of the vacuum interrupter.



The energy needed for operation is not supplied directly by the auxiliary power supply, but is always “stored” in the capacitor which acts as an energy accumulator, and therefore operation always takes place with constant speeds and times, independently of the divergence of the power supply voltage from the rated value.

The auxiliary power supply has the only aim of keeping the capacitor charged.

Consumption is therefore minimal.

For the reasons indicated above, both for the DCO and for the SCO version it is necessary to supply the auxiliary circuits which recharge the capacitor with a continuous auxiliary power supply.

Breaking principle

The main contacts operate inside the vacuum interrupters (the level of vacuum is extremely high: 13×10^{-5} Pa).

On opening, there is rapid separation of the fixed and moving contacts in each contactor interrupter.

Overheating of the contacts, generated at the moment they separate, causes formation of metallic vapours which allow the electric arc to be sustained up to the first passage through zero current.

On passage of zero current, cooling of the metallic vapours allows recovery of high dielectric resistance able to withstand high values of the return voltage.

Power rating of electronic device

Supply voltage	Starting (1) Inrush for 6 sec	After closing Inrush for 1.2 sec	After opening Inrush for 1.2 sec	Continuous power consumption
24...250 V d.c.	35 W	25 W	30 W	5 W
110...250 V a.c.				

(1) This value refers to a discharged capacitor; 42 A are required for 2 ms upon start up.

1. Description

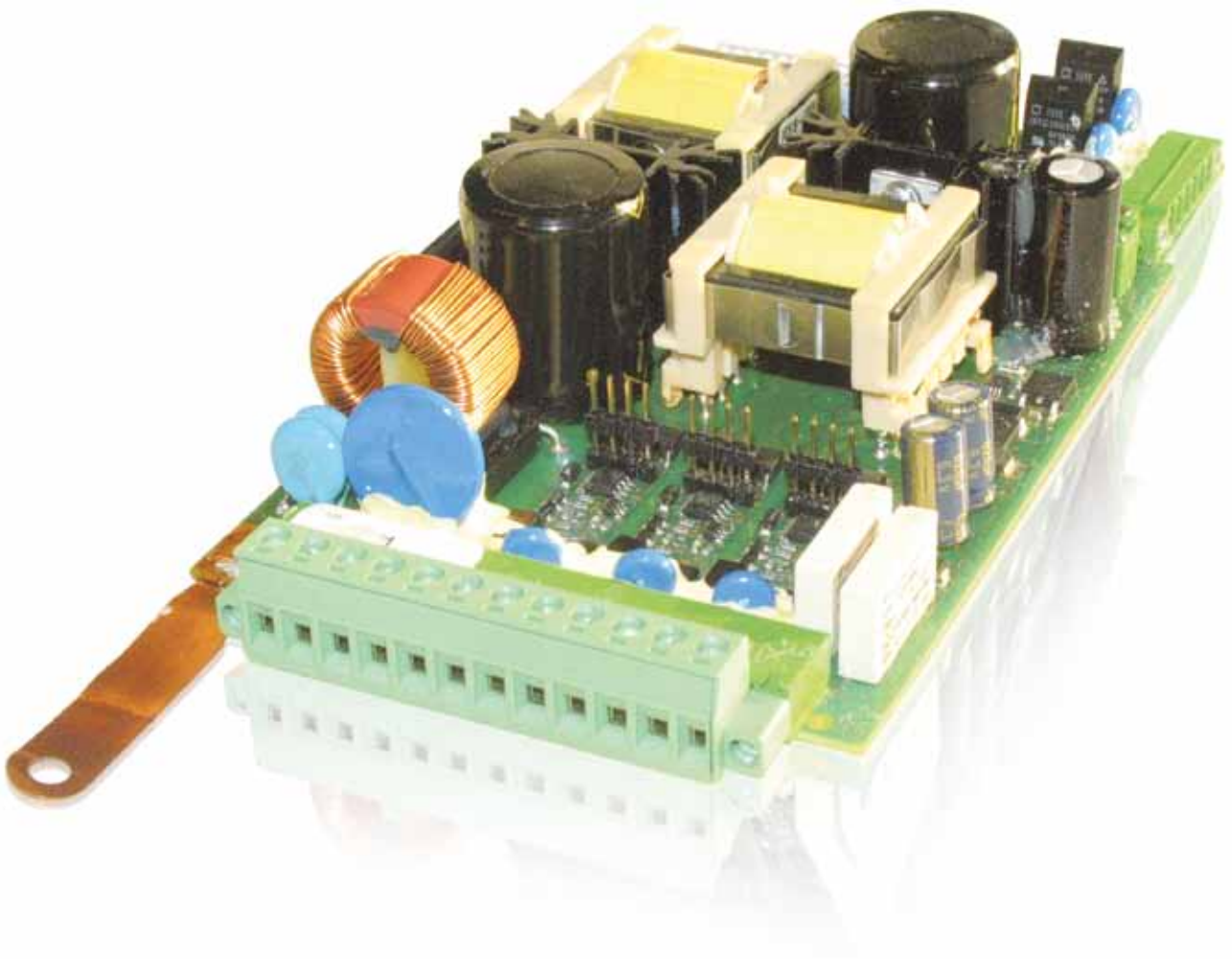
Control module/feeder

The careful selection of components and precise design make the electronic multi-voltage feeder extremely reliable, immune to electromagnetic interference generated by the surrounding environment and free of emissions able to influence other apparatus in the vicinity.

These characteristics have allowed the V-Contact VSC contactors to pass the electromagnetic compatibility tests (EMC).

As standard, the electronic control module is fitted with:

- a connector with screw terminal box for connection of the auxiliary circuits of the fixed versions
- a signalling contact for controlling the closing and opening coil continuity
- the possibility, only at the time of ordering, of defining the reference Standard for the operating thresholds of the auxiliary voltage (available: IEC - GB)
- a dedicated input for opening the contactor regardless of the functionality of the electronics by means of an external accessory which directly controls the opening coil.





Technical documentation

For more in-depth technical and application aspects of the VSC contactors, also consult the publication on the REF542*plus* multi-function control and protection unit - code 1VTA100001.

Test laboratory

Conforms to the UNI CEI EN ISO/IEC 17025 Standards.

Environmental Management System

Conforms to the ISO 14001 Standards, certified by an external independent organization.

Health and Safety Management System

Conforms to the OHSAS 18001 Standards, certified by an external independent organization.



2. Contactor selection and ordering

General characteristics		Ref. to the IEC 62271-106 Standard
Rated voltage	[kV]	4.1
Rated insulation voltage	[kV]	–
Withstand voltage at 50 Hz	(1 min) [kV]	6.2
Impulse withstand voltage	[kVp]	6.2
Rated frequency	[Hz]	4.3
Rated service current	[A]	4.101
Short-time withstand current for 1 s	[A]	6.6
Rated peak current	[kA peak]	6.6
Breaking capacity up to	[kA]	4.107
Short-circuit making capacity up to	[kA]	4.107
Number of operations (rated values)	Contactor SCO	[op./hour] 4.102.2
	Contactor DCO	[op./hour] 4.102.2
Maximum rated admissible overcurrent for ½ period (peak value)	[kA]	–
Rated load and overload characteristics in category of use:		
(Category AC4) 100 closing operations	[A]	6.102.4
(Category AC4) 25 opening operations	[A]	6.102.5
Rated voltage of the switching devices and auxiliary circuits		4.8,4.9
Feeder type 1: 24÷60 V dc (basic version)		–
Feeder type 2: 24÷60 V dc (full option version)		–
Feeder type 3: 110÷250 V ac/dc (basic version)		–
Feeder type 4: 110÷250 V ac/dc (full option version)		–
Normal current	[A]	4.4.101
Mechanical life - number of cycles / number of operations ⁽⁶⁾	[op.]	6.101
Apparatus wear classification (type)	[op.]	4.107.3
Short-circuit breaking capacity (O-3min-CO-3min-CO)	[A]	6.104
Short-circuit making capacity (O-3min-CO-3min-CO)	[A peak]	6.104
Limit above which the fuse blows ⁽⁵⁾	[A]	4.107.3
Switching times	Opening time (lower and upper limit)	[ms] –
	Closing time (lower and upper limit)	[ms] –
Tropicalisation	(IEC 721-2-1)	–

Ultimate performances for (value refers to fixed versions without fuseholder)

Rated voltage	[kV]
Motors	[kW]
Transformers	[kVA]
Capacitors (only for VSC-S versions)	[kVAr]

Ultimate performances for back-to-back capacitor banks

Rated voltage	[kV]
Rated current	[A]
Maximum transient current of the capacitor	[kA]
Maximum transient frequency of capacitor connection	[kHz]

Weights and overall dimensions

Weight (excluding the fuses)	[kg]	
Overall dimensions	Height	H [mm]
	Width	W [mm]
	Depth	D [mm]



⁽¹⁾ Version for 42 kV 50 Hz x 1 min. between phases and between phase and earth available on request - (only fixed VSC12/G contactors without fuseholders and withdrawable VSC12/PG for UniGear panels I = 650 mm).

⁽²⁾ Depending on the capacity of the coordinated fuse.

⁽³⁾ Value linked to the breaking capacity of the fuse: refer to the fuse manufacturer's documentation.

⁽⁴⁾ Indicate the reference fuses.

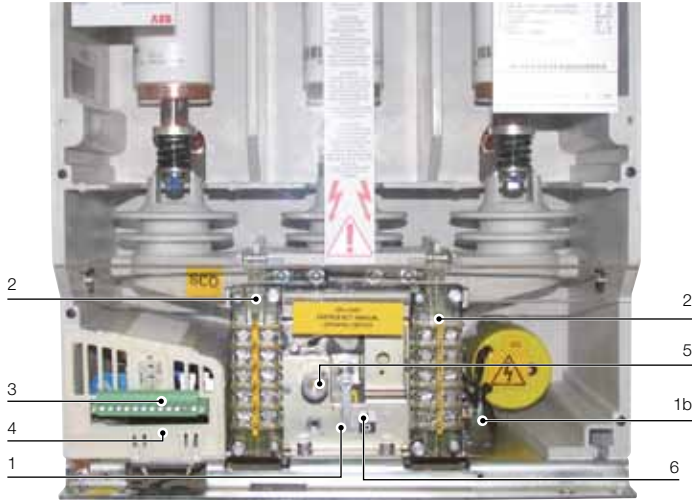
⁽⁵⁾ This is the current value determined by intersection of the time-current trip curves of two protection devices - in this case the fuse and any thermal protection relay.

⁽⁶⁾ Not applicable for VSC-S versions.

⁽⁷⁾ Version with 32 kV -50Hz x 1 min between phases and between phase and earth available on request - (only fixed VSC7/G contactors without fuseholders, withdrawable VSC7/PG for UniGear panels I = 650 mm and VSC7/PNG for UniGear MCC).

VSC 7 - VSC 7/F - VSC 7/P - VSC 7/PN 400A VSC 7/G 400A - VSC 7/PG 400A - VSC 7/PNG 400A			VSC 12 - VSC 12/F - VSC 12/P - VSC 12/PN - VSC 12/G - VSC 12/PG - VSC S/G - VSC S/F - VSC S/PG - VSC S/PNG					
Contactor	Starter	Combined with fuses	Contactor	Starter	Combined with fuses			
3.4.105	3.4.110	3.4.110.5	3.4.105	3.4.110	3.4.110.5			
7,2	7,2	7,2	12	12	12			
7,2	7,2	7,2	12	12	12			
20 ⁽⁷⁾	20 ⁽⁷⁾	20 ⁽⁷⁾	28 ⁽¹⁾	28 ⁽¹⁾	28 ⁽¹⁾			
60	60	60	75	75	75			
50-60	50-60	50-60	50-60	50-60	50-60			
400	400	- ⁽²⁾	400 ⁽⁶⁾	400 ⁽⁶⁾	- ⁽²⁾			
6,000	6,000	6,000	6,000	6,000	6,000			
15	15	15	15	15	15			
-	-	50 ⁽³⁾	-	-	50 ⁽³⁾			
-	-	50 ⁽³⁾	-	-	50 ⁽³⁾			
1,200	1,200	1,200	1,200	1,200	1,200			
1,200	1,200	1,200	1,200	1,200	1,200			
55	-	-	55	-	-			
4,000	4,000	4,000	4,000	4,000	4,000			
4,000	4,000	4,000	4,000	4,000	4,000			
•	•	•	•	•	•			
•	•	•	•	•	•			
•	•	•	•	•	•			
•	•	•	•	•	•			
400	400	- ⁽²⁾	400	400	- ⁽²⁾			
1,000,000 / 2,000,000	1,000,000 / 2,000,000	1,000,000 / 2,000,000	1,000,000 / 2,000,000	1,000,000 / 2,000,000	1,000,000 / 2,000,000			
C	C	C	C	C	-			
5,000	5,000	-	5,000	5,000	-			
13,000	13,000	-	13,000	13,000	-			
-	-	5,000	-	-	4,000			
35...60	35...60	35...60	35...60	35...60	35...60			
60...90	60...90	60...90	60...90	60...90	60...90			
•	•	•	•	•	•			
VSC 7 - 400A⁽⁶⁾			VSC 12 - 400 A⁽⁶⁾					
2,2/2,5	3,3	3,6/5	6,2/7,2	12				
1,000	1,500	1,500	3,000	5,000				
1,100	1,600	2,000	4,000	5,000				
1,000	1,500	1,500	3,000	4,800				
VSC-S/G - VSC-S/F - VSC-S/PG - VSC-S/PNG								
2,2/2,5	3,3	3,6/5	6,2/7,2	12				
250	250	250	250	250				
8	8	8	8	8				
2,5	2,5	2,5	2,5	2,5				
Fixed contactor					Withdrawable contactor			
VSC 7	VSC 12	VSC 12/G	VSC S/G	VSC 12/F	VSC 7/P	VSC 12/P	VSC 7/PN	VSC 12/PN
VSC 7/G				VSC S/F	VSC 7/PG	VSC 12/PG	VSC 7/PNG	VSC 12/PNG
						VSC S/PG		
20	20	35	35	35	52	52	54	54
371	424	494	598	532	636	636	653	653
350	350	466	466	466	531	531	350	350
215	215	622	623	702	657	657	673	673

2. Contactor selection and ordering



VSC 7 - VSC 12



VSC/F

Standard fittings

1 MAC Drive with permanent magnets with capacitor for storing energy (1b)

2 Auxiliary contacts available to the customer

Contactors	Normally open	Normally closed
VSC 7 400 A	5	5
VSC 12	5	5
VSC 7/P VSC 7/PN VSC 7/F	5 (SCO) - 4 (DCO)	5
VSC 12/P VSC 12/PN VSC 12/F	5 (SCO) - 4 (DCO)	5

3 Feeder

The contactor has been tested for all the auxiliary operating voltages foreseen, indicated in the table:

Feeder type 1 and 2 V d.c.	Feeder type 3 and 4 V d.c. / V a. c. (50/60 Hz)	
24	110	220
30	120	230
48	125	240
60	127	250
	130	

The contactor is, however, preset with the operating voltage defined in the order confirmation. The power supply voltage is indicated on the nameplate of the contactor itself. Should it be indispensable to change the power supply voltage, please contact ABB.

The voltage value tolerances conform to what is defined by the IEC 62271-106 or GB 14808 depending on customer's requirements.

The card is guaranteed to become operational 15 seconds after the power supply voltage is applied because the card controls functionality during this time interval.

The feeder is available in either the "Standard" or "Full option" version. Apart from the functions indicated on page 8, the "Full option" version also ensures:

- control of capacitor operating conditions
- verification of operating temperature of electronic board

4 Socket/plug with terminal at terminal box

5 Manual emergency opening operation

6 Mechanical Open/Closed indicator



VSC/P

7 Fuseholders (only VSC/F and withdrawable versions).

The VSC/F or VSC/P contactor is fitted with fuseholders able to hold DIN or BS type fuses according to what the customer requests.

The fuses must have the dimensions and striker of average type according to DIN 43625 Standards with maximum cartridge size $e=442\text{mm}$ and BS 2692 (1975) with maximum cartridge size $L=553\text{mm}$.

The electrical characteristics must conform to the IEC 282-1 (1974) Standards.

ABB fuses type CMF-BS cannot be installed on V-Contact VSC contactor.

“Control Coil Continuity” and “Capacity Survey” contacts characteristics

Technology	Wipe contacts relay
Switching characteristics:	
Maximum switching power	1200 VA (on resistive load)
Maximum switching voltage	277 V AC, 30 V DC
Maximum switching current	3 A
Maximum rated current	5 A @ 4 s
Contacts characteristics:	
Maximum on resistance (Ron)	150 m (measured by voltage drop 6 V DC 1 A)
Maximum capacitance	1.5 pF
Timing characteristics:	
Maximum actuating time	5.0 ms
Maximum releasing time	2.0 ms
Insulation:	
Between contacts and coil	3000 V rms (50 Hz / 1 min.)
Between open contacts	750 V rms (50 Hz / 1 min.)
Resistance (Roff)	Min. 103 M at 500 V DC



VSC/PN

The fuseholder is fitted with a special kinematics mechanism which automatically opens the contactor when even a single fuse blows and prevents contactor closing when even a single fuse is missing.

8 Isolation interlock with the truck (only withdrawable contactor). This prevents isolation or racking-in the contactor into the switchgear if the apparatus is in the closed position, and also prevents contactor closing during the isolation run.

Characteristics of the auxiliary contacts of the contactor

Rated voltage:	24 ... 250 V AC-DC
Rated current I_{th}^2 :	10 A
Insulation voltage:	2500 V 50 Hz (1 min)
Electric resistance:	3 mOhm

The rated current and breaking capacity values in category AC11 and DC11 are indicated below.

Un	Cosφ	T	In	Icu
220 V ~	0.7	—	2.5 A	25 A
24 V –	—	15 ms	10 A	12 A
60 V –	—	15 ms	6 A	8 A
110 V –	—	15 ms	4 A	5 A
220 V –	—	15 ms	1 A	2 A

2. Contactor selection and ordering

Optional accessories

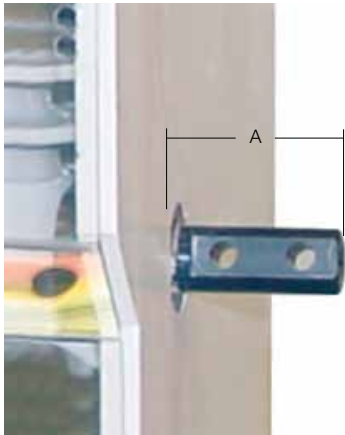
The table below indicates availability of the accessories in relation to the various types of contactor.

Table of accessory availability		VSC 7 VSC 7/G	VSC 7/F	VSC 7/P VSC 7/PG
1a	Interfacing shaft on feeder side	•	•	-
1b	Interfacing shaft on capacitor side	•	•	-
2	Electric operation counter (impulse counter)	•	•	•
3	Undervoltage function (only DCO version)	•	•	•
4	Adapter for fuses	-	•	•
5	Connection alternative to the fuses	-	•	•
6	Position contacts for connected isolated position in the truck	-	-	•
7	Isolation lock	-	-	•
8	Locking magnet in the withdrawable truck	-	-	•
9	Anti-insertion lock for different currents ⁽¹⁾	-	-	•
10	Motorisation of the truck ⁽²⁾	-	-	•

⁽¹⁾ Compulsory for UniGear switchgear.

⁽²⁾ Assembly at a later stage is not possible.

1 Interfacing shafts



These can be used to interface the apparatus with the kinematics of the switchgear to make interlocks and/or signals.

The interfacing shafts are available in two different lengths (A = 22 mm and 70 mm) and can be mounted on one or both sides of the contactor (as indicated in the following table).

Lenght A	22/70 mm	
	Feeder side	Capacitor side
VSC 7 400 A - VSC 7/F 400 A	•	•
VSC 12 400 A - VSC 12/F 400 A	-	•

Note: for the utilisation parameters (angles and forces applicable), please refer to the instruction manual.

VSC 7/PN VSC 7/PNG	VSC 12 VSC 12/G VSC S/G	VSC 12/F VSC S/F	VSC 12/P VSC 12/PG VSC S/PG	VSC 12/PN VSC S/PNG
-	-	-	-	-
-	•	•	-	-
•	•	•	•	•
•	•	•	•	•
•	-	•	•	•
•	-	•	•	•
-	-	-	•	-
•	-	-	•	•
•	-	-	•	•
•	-	-	•	•
-	-	-	•	-

2 Impulse counter



This is a device which counts the contactor closing cycles.

3 Undervoltage function (only available for DCO)



First of its type, the V-Contact VSC contactor is fitted with an undervoltage function with selectable delays of 0; 0,3; 1; 2; 3; 4; 5 s.

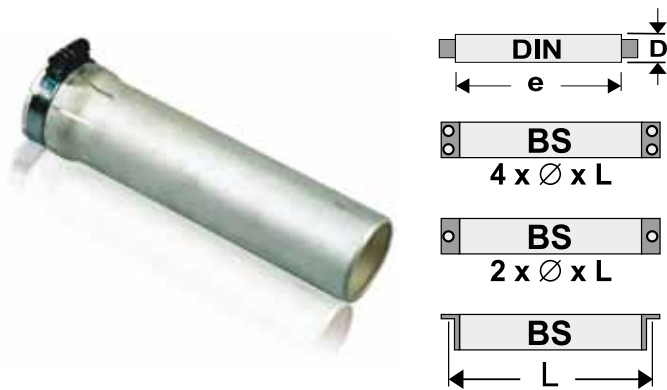
This accessory must be specified at the time of order because it cannot be mounted at a later stage.

The undervoltage function cannot be deactivated in boards with the undervoltage function.

2. Contactor selection and ordering

Optional accessories

4 Adapter for application of fuses



The kit includes all the accessories needed to adapt and mount three fuses (according to DIN Standards with dimension **e less than 442 mm**; according to BS Standards with dimension **L less than 553 mm**).

The kit can be installed directly onto the fuseholder supports. The fuses must have dimensions and striker of average type according to DIN 43625 and BS 2692 (1975) Standards. The electrical characteristics must conform to the IEC 282-1 (1974) Standards.

To select the fuses, see "Conditions of use according to the load" - chapter 3.

The adaptation kits are available in the following types:

- 4A** For fuses according to DIN Standards with distance **e = 192 mm**
- 4B** For fuses according to DIN Standards with distance **e = 292 mm**
- 4C** For fuses according to BS Standards (2 x 8 x **L = 235 mm**)
- 4D** For fuses according to BS Standards (4 x 10 x **L = 305 mm**)
- 4E** For fuses according to BS Standards (4 x 10 x **L = 410 mm**)
- 4F** For fuses according to BS Standards (4 x 10 x **L = 454 mm**)
- 4G** For fuses in parallel according to BS Standards (4 x 10 x **L = 410 mm**)

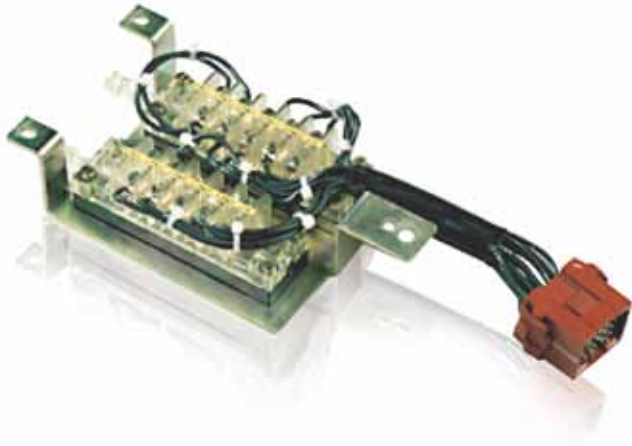
5 Connections alternative to the fuses



The kit includes three flat copper busbars and fixing screws to be installed when the fuses are not needed.

The kit can be installed directly onto the fuseholder supports.

6 Position contacts for connected/isolated position in the withdrawable truck



These signal the position of the truck (accessory not available for V-Contact VSC/PN contactors).

The kit includes a set of 10 auxiliary contacts. This accessory must always be requested for contacts to be used in UniGear type ZS1 switchgear if the same application is not already present on the fixed part.

6A Standard diagram

6B Calor Emag diagram.

Electrical characteristics of the contact

Un	Icu	cosφ	T
220 V~	10 A	0.4	-
220 V~	5 A	0.4	-
220 V-	1 A	-	10 ms

7 Isolation lock



Isolation lock for UniGear switchgear and PowerCube modules. It prevents the apparatus from being racked-in if the unit door is open.

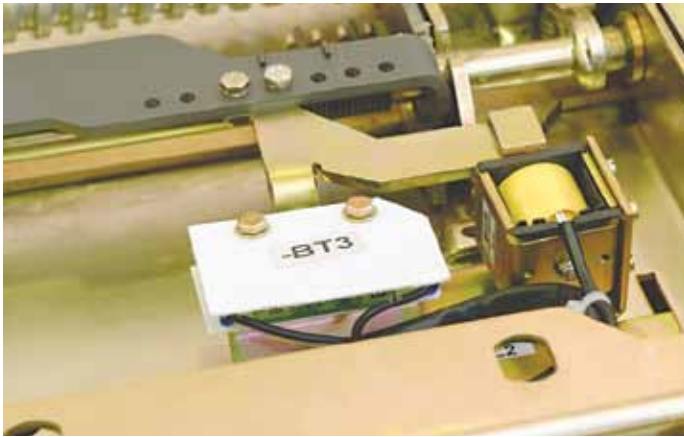
This lock only works if the door of the switchgear/enclosure is also fitted with the corresponding lock.

This accessory is not compatible with use in CBE enclosures.

2. Contactor selection and ordering

Optional accessories

8 Locking magnet in the truck



This only allows the withdrawable contactor to be racked into/out of the enclosure with the electromagnet energised and the contactor open.

The table below shows the power supply voltages available.

Un	Un	F	Un	F
24 V –	24 V ~	50 Hz	110 V ~	60 Hz
30 V –	48 V ~	50 Hz	120 V ~	60 Hz
48 V –	60 V ~	50 Hz	127 V ~	60 Hz
60 V –	110 V ~	50 Hz	220 V ~	60 Hz
110 V –	120 V ~	50 Hz	230 V ~	60 Hz
125 V –	127 V ~	50 Hz	240 V ~	60 Hz
220 V –	220 V ~	50 Hz		
	230 V ~	50 Hz		
	240 V ~	50 Hz		

9 Lock for different rated currents (only withdrawable versions)



In the VSC/P contactors, it prevents insertion of the plug-socket and therefore apparatus closing, in a panel provided for a circuit-breaker.

This lock, which is compulsory for UniGear switchgear, requires the same lock provided on the enclosure / switchgear, and is associated with the presence of the locking magnet on the truck.

10 Motorised truck



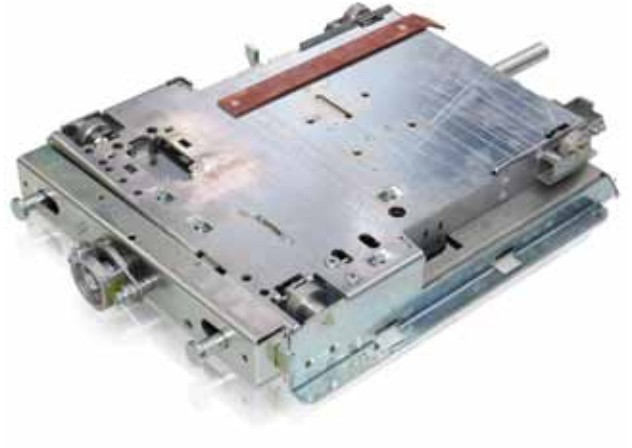
Only available for VSC/P for use in UniGear type ZS1 switchgear and PowerCube units. This application must be specified at the time of ordering the contactor and cannot be mounted at a later stage.

Not available on VSC/PN.

Characteristics

Un:	110 / 220V-
Operating limits:	85...110% Un
Rated power (Pn):	40 W

11 Sliding earthing contact



Available on request for VSC/PN.

This application must be specified at the time of ordering the contactor and cannot be mounted at a later stage.

3. Specific product characteristics

Electromagnetic compatibility



The V-Contact VSC vacuum contactors ensure operation without unwarranted trips when there are interferences caused by electronic apparatus, by atmospheric disturbances or by discharges of electrical type. Moreover they do not produce any interference with electronic apparatus in the vicinity of the apparatus.

The above is in compliance with IEC 62271-1, 62271-106, 61000-6-2, 61000-6-4, Standards, as well as with the EEC 89/336 European Directive regarding electromagnetic compatibility (EMC).

Tropicalisation



V-Contact vacuum contactors are manufactured in compliance with the prescriptions regarding use in hot-humid-saline climates. All the most important metal parts are treated against corrosive factors corresponding to class C in compliance with the UNI 3564-65 Standards.

Galvanization is carried out in compliance with the UNI ISO 2081 Standard, classification code Fe/Zn 12, with thickness of 12×10^{-6} m, protected by a layer of conversion mainly consisting of chromates in compliance with the UNI ISO 4520 Standard. These construction characteristics mean that all the V-Contact VSC series apparatus and their accessories comply with climate graph no. 8 of the IEC 721-2-1 and IEC 68-2-2 (Test B: Dry Heat) / IEC 68-2-30 (Test Db: Damp Heat, cyclic) Standards.

Altitude



It is well-known that the insulating properties of air decrease as the altitude increases.

This phenomenon must always be taken into account during the design stage of insulating parts of equipment which is to be installed over 1000 m above sea level.

In this case a correction coefficient must be applied, which can be taken from the graph drawn up according to the indications given in the IEC 62272-1.

The following example gives a clear interpretation of the indications given above.

For altitudes above 2000 m, ask ABB.

Graph for determining the Ka correction factor according to the altitude

Example

- Installation altitude: 2000 m
- Service at a rated voltage of 7 kV
- Withstand voltage at power frequency 20 kV rms
- Impulse withstand voltage 50 kVp
- Ka Factor = 1.13 (see graph).

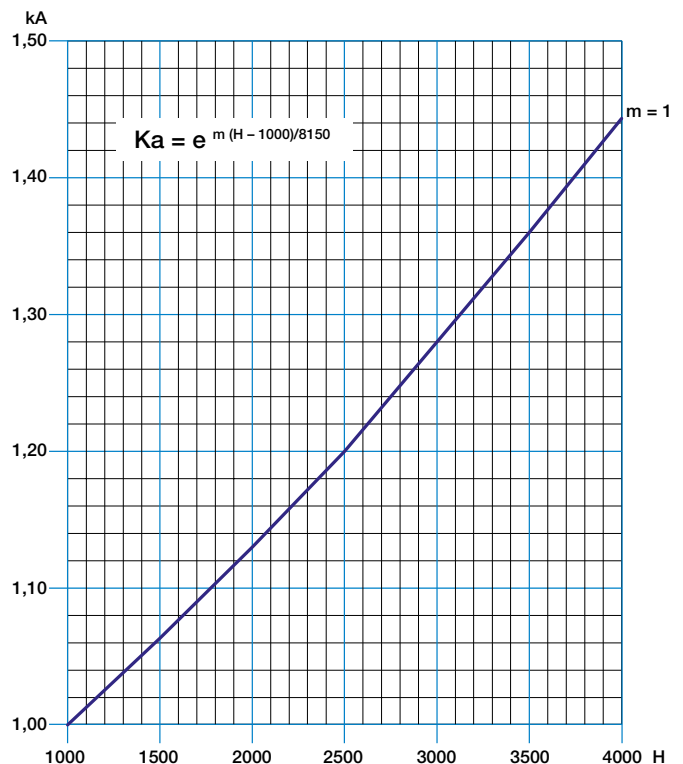
Taking the above parameters into consideration, the apparatus will have to withstand the following values (under test at zero altitude i.e. at sea level):

- withstand voltage at power frequency equal to:
 $20 \times 1.13 = 22,6$ kVrms
- impulse withstand voltage equal to:
 $50 \times 1.13 = 56,5$ kVp.

From the above, it can be deduced that for installations at an altitude of 2000 m above sea level, with a service voltage of 7 kV, apparatus with a rated voltage of 12 kV characterized by insulation levels at power frequency of 28 kV rms and with 60/75 kVp impulse withstand voltage must be provided.

H = altitude in metres;

m = value referring to power frequency and to the lightning withstand impulse and between phases.



3. Specific product characteristics

Installation of fixed contactors

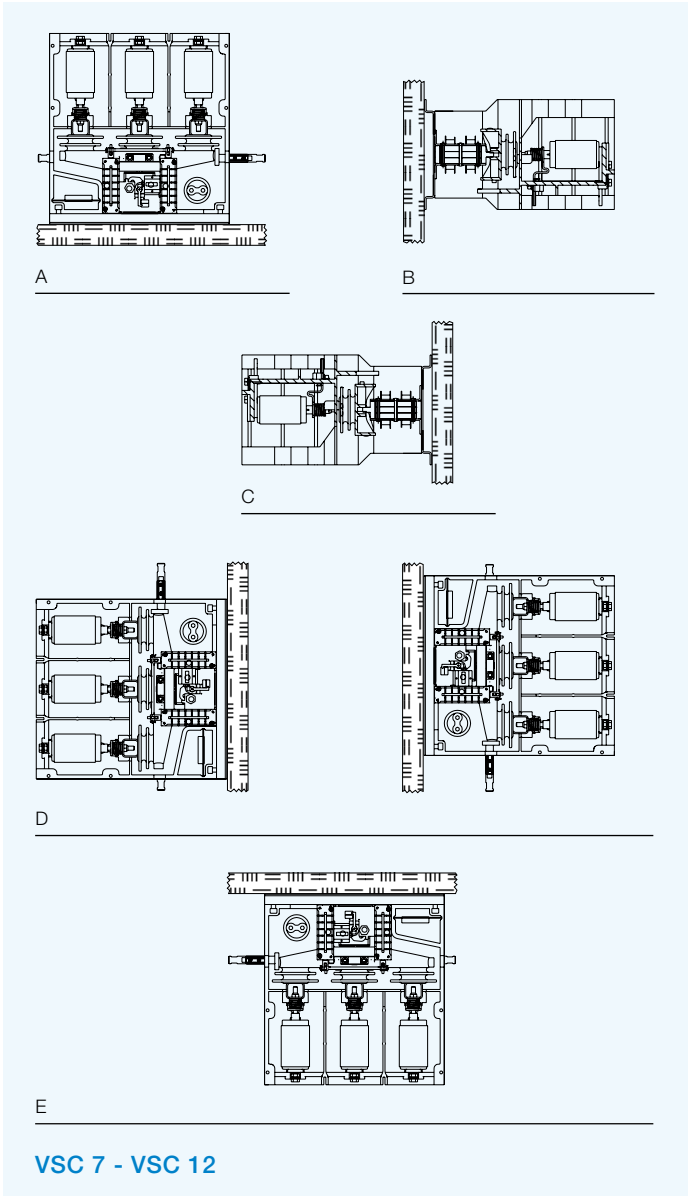
The performance of the contactor remains unaltered in the installation positions indicated:

VSC 7 - VSC 12

- A) Floor-mounted with moving contacts at the bottom.
- B) Wall-mounted with horizontal moving contacts and terminals at the bottom.
- C) Wall-mounted with horizontal moving contacts and terminals at the top.
- D) Wall-mounted with horizontal moving contacts with interrupters on the front (or rear) with vertical terminals.
- E) Ceiling-mounted with moving contacts at the top.

VSC 7/F - VSC 12/F

- A) Floor-mounted with moving contacts at the bottom.



Use of fuses according to the load

Motor control and protection

The motors are supplied in low voltage, normally up to a power of 630 kW. Over the latter power, medium voltage power supply is preferable (from 3 to 12 kV) with the aim of reducing costs and dimensions of all the apparatus which are part of the circuit. The V-Contact can be used for voltages from 2.2 kV up to 12 kV and for motors up to a power of 5000 kW, thanks to the simplicity and sturdiness of the control mechanisms and the long life of the main contacts. To ensure protection against short-circuit, it is necessary to combine the contactors with appropriate current-limiting fuses. This solution allows the costs of the load-side apparatus (cables, current transformers, busbar and cable anchoring devices, etc.) to be further reduced and to make the user practically independent of any subsequent enlargements of the plant and of the consequent increased in network power.

Motor protection fuses

How to choose motor protection fuses

V-Contact VSC contactors can be used with fuses with dimensions and striker of the medium type in accordance with Standards DIN 43625 and BS 2692 (1975).

The electrical characteristics must conform to Standard IEC 282-1 (1974).

The customer is responsible for choosing a brand of fuse that conforms to the specifications above and for selecting the fuse, which must be done on the basis of the trip curves supplied by the manufacturer and the characteristics of the contactor.

Consult chapter 2 section 4 of this publication for maximum fuse length and availability of adapters for installing fuses that are smaller than the maximum length.

Among the vast array of applicable fuses, ABB has tested two brands of fuses for coordination in class C, in accordance with standard IEC62271-106:

- Fuses to DIN standards: ABB type CMF
- Fuses to BS standards: SIBA type HHBM-BM

Instructions on how to correctly select the fuses tested by ABB are given below.

DIN fuses

ABB fuses type CMF for protecting motors must be chosen by assessing the service conditions.

Consider the following parameters:

- supply voltage
- starting current
- starting time
- number of starts/hour
- full load current of motor
- short circuit current of installation.

One of the criteria to bear in mind when choosing is trip coordination with the other protection relays so as to adequately protect the contactor, current transformers, cables, the motor itself and all the other equipment in the circuit that could be damaged by prolonged overloads or by specific let-through energy (I₂t) that exceeds the withstand rating. Protection against short-circuit is carried out by the fuses, always selected with a rated current higher than that of the motor to prevent their intervention on start-up. This method of selection does not, however, allow their use as protection against repeated overloads - a function already not guaranteed by them, especially with current values included up to the end of the initial asymptotic stretch of the characteristic curve.

A release with inverse or independent time is therefore always needed for protection against overloads. This protection must be coordinated with the one carried out by the fuse, working so that the release and fuse curves intersect at a point to allow the following:

- 1) Motor protection against overcurrents due to overloads, single-phase running, blocked rotor and repeated start-ups. Protection entrusted to an indirect relay with inverse or definite time delay trip which acts on the contactor.
- 2) Protection of the circuit against fault currents, between phases and towards earth, of low value, entrusted to a release with inverse or definite time delay trip, which must only intervene for the short-circuit values which can be interrupted by the contactor.
- 3) Protection of the circuit against fault currents higher than the breaking capacity of the contactor up to the maximum fault withstand current. Protection entrusted to the fuse.

To verify the service conditions, proceed as follows:

- **Rated voltage Un.** This must be equal to or higher than the service voltage of the installation.

Check that the level of insulation of the network is higher than the switching overvoltage value generated by the fuses, which for the fuses used by ABB is widely below the limit fixed by the IEC 282-1 Standards.

3. Specific product characteristics

- Rated current I_n .** This must be selected by consulting the diagrams indicated in fig. A which refer to the case of starting at regular time intervals, except for the first two start-ups of each hourly cycle which can take place in immediate succession. Each diagram refers to a different starting time: 6 s - 15 s - 60 s, respectively. In the case of start-ups close together, it must be checked that the starting current does not exceed the value of $I_f \times K$, where I_f is the fuse blowing current in correspondence with the starting time of the motor, and K is a minor factor of the unit, a function of the I_n of the fuse and which can be taken from the table given in figure B.
- Full load motor current.** The rated current of the fuse must be of a value equal to or higher than 1.33 times the rated current value of full motor load. This condition is, in any case, always obtained for motors started at full voltage for which the procedure described for selection of the rated fuse current necessarily imposes values which are always higher than 1.33 I_n .
- Short-circuit current.** The short-circuit current limiting curves in fig. C allow the short-circuit current limitation on the load side of the fuses involved in the fault to be appreciated. And this implies smaller sizing of the load side apparatus.

Example of coordination for overload of a fuse-relay with inverse time delay trip

Motor characteristics:

P_n	= 1000 kW
U_n	= 6 kV
I_{start}	$\approx 5 I_n = 650 A$
T_{start}	= 6 s
No. hourly operations	= 16.

In the curve with starting time of 6 s in fig. A, in correspondence with the 650 A starting current value, the straight line, traced for 16 hourly start-ups, intersects in the range of the 250 A fuse.

In the fuse blowing time curve, it can be noted that the 250 A fuse blows in 6 s (starting time) when it is passed through by a current of 1800 A.

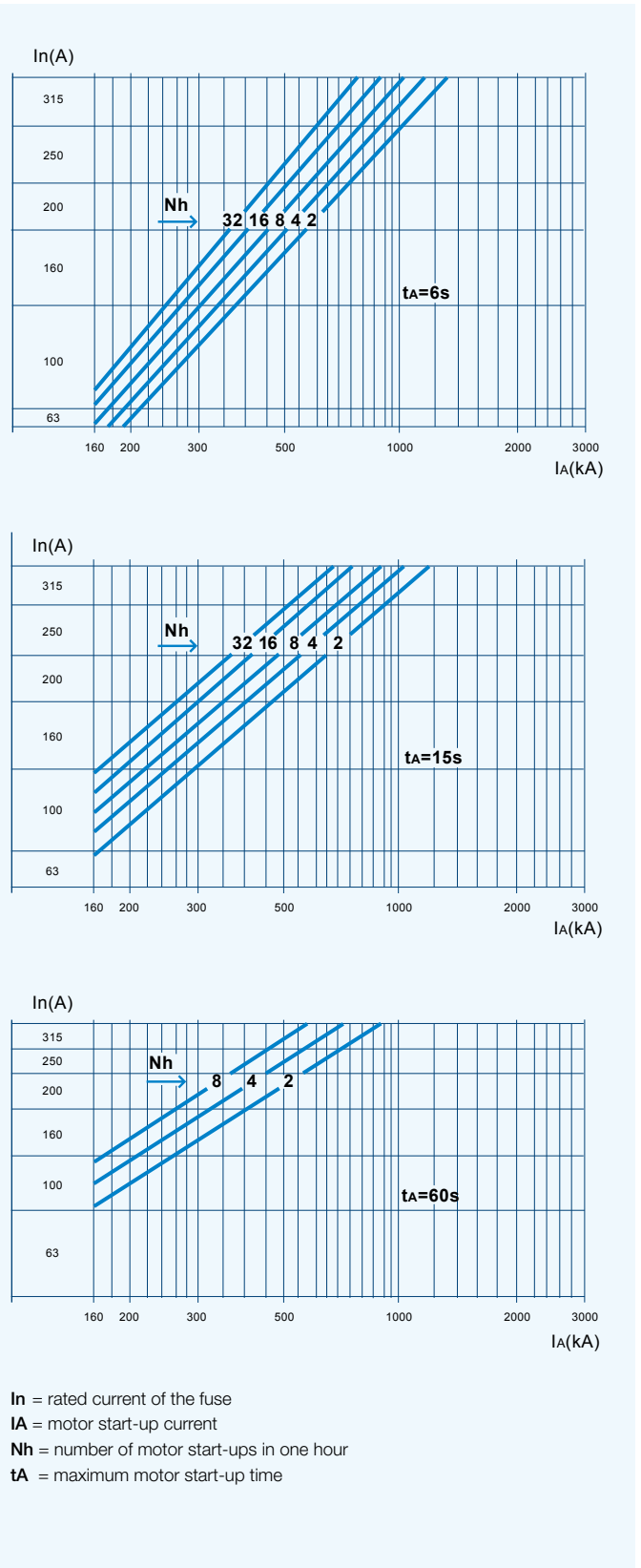


Fig. A - Fuse selection curves for motor start-up. ABB CMF type fuses.

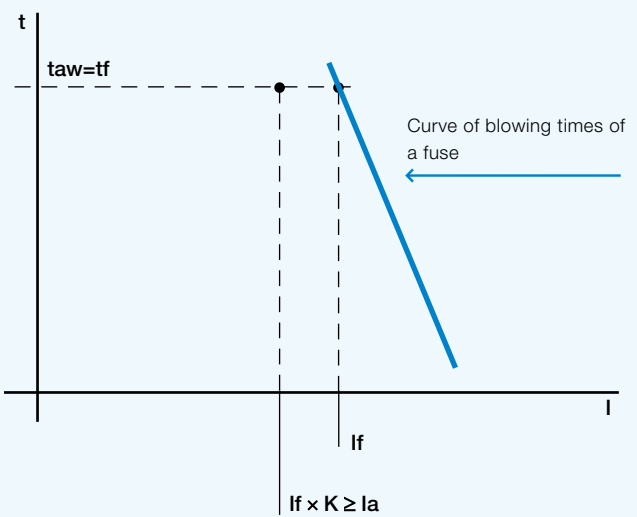
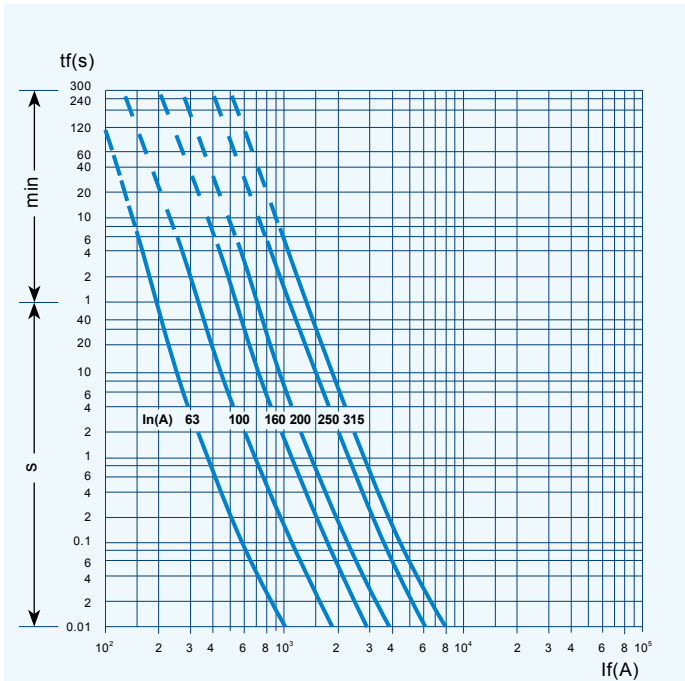


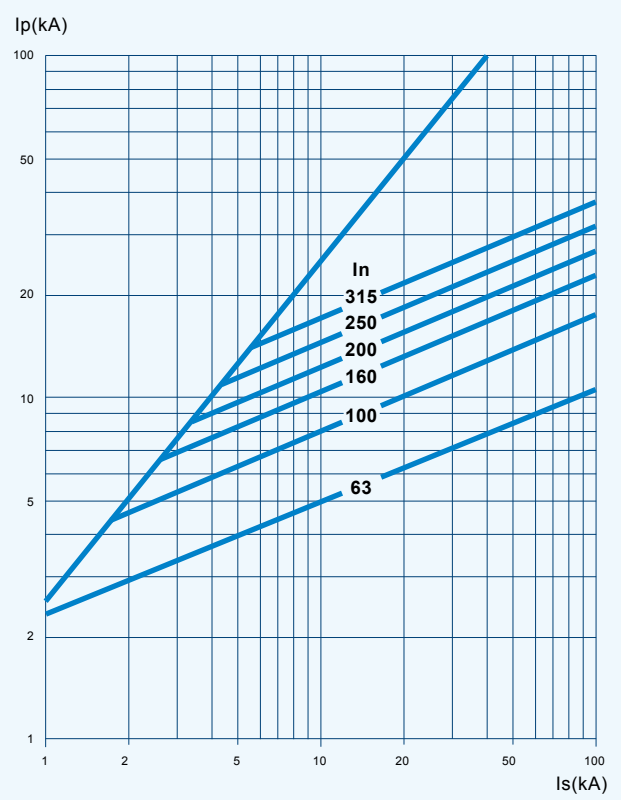
Table for selection of factor K

Un [kV]	In [A]					
3.6	63	100	160	200	250	315
7,2	63	100	160	200	250	315
12	63	100	160	200	-	-
K	0.75	0.75	0.7	0.7	0.6	0.6

Fig. B - Curve of fuse blowing times and table for selection of factor K. ABB CMF type fuses.

In the table in fig. B, the K coefficient for the 250 A size is 0.6, from which the value $I_f \times K = 1080 \text{ A}$ is taken, which is higher than the start-up current (650 A), so use of the 250 A fuse is also legitimate in respect of this condition, which regards the possibility of start-ups close together.

By observing the blowing curve of the 250 A fuse, the need to use a relay with inverse time delay trip, or a relay with definite time delay trip for protection against overloads can be noted. It must be remembered that prolonged overheating, above the temperature foreseen for the class of insulating materials, is harmful and strongly prejudices the life of electric machines.



I_s = prospective short-circuit symmetrical current
 I_p = current limited by the fuse (peak value)

Fig. C - Short-circuit current limitation curves. ABB CMF type fuses.

3. Specific product characteristics

Fig. D shows the graph relative to the motor considered in the example.

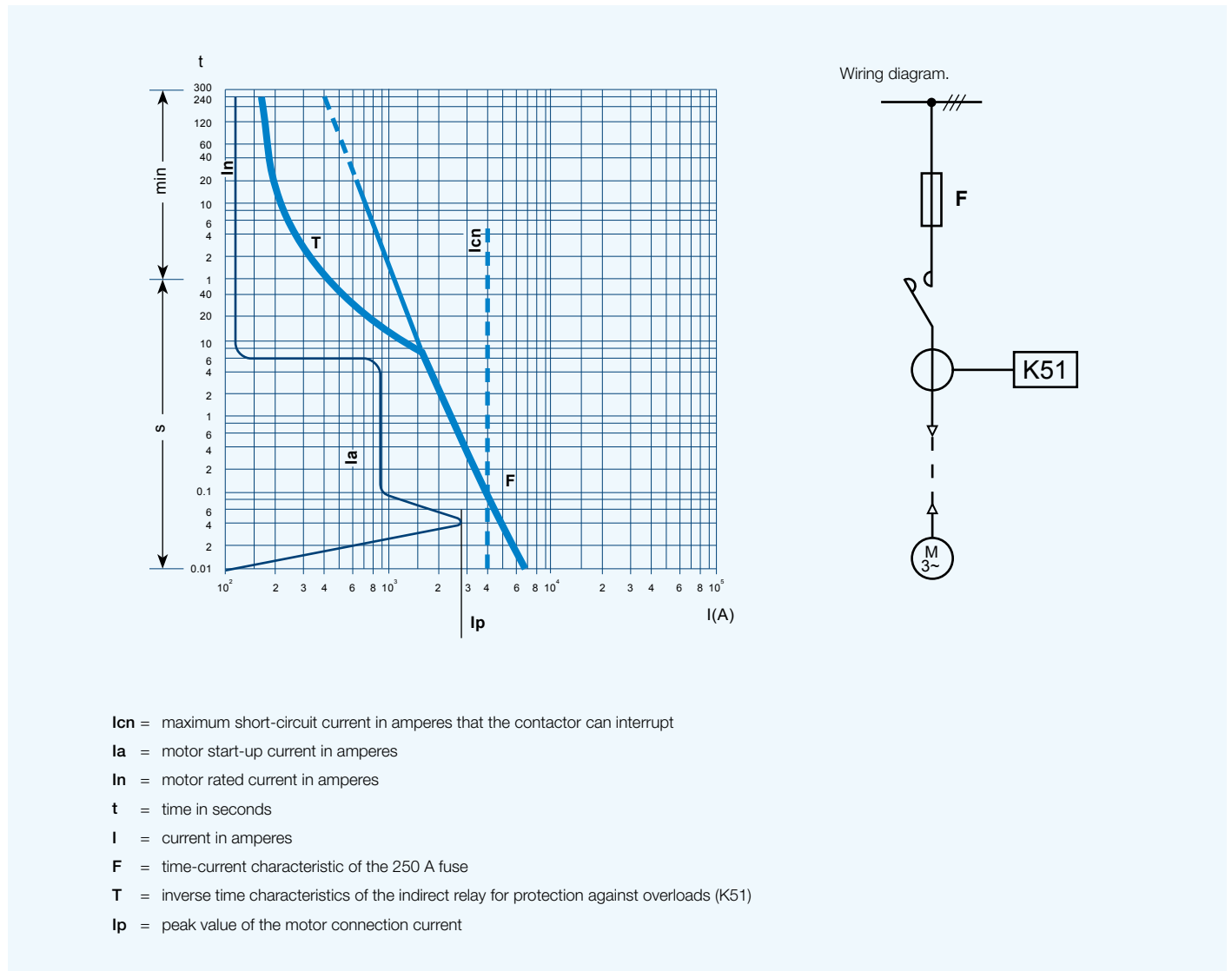


Fig. D - Graph showing the coordination between 250 A ABB CMF fuse and relay with inverse time delay trip.

BS fuses

The HHBM-BM fuse produced by SIBA has been tested. An important parameter is the magnetic inrush. The magnetic inrush current of a motor is significantly smaller than that of a transformer and of shorter duration, which is due to the fact that there is much less copper and iron in a motor than in a (power-wise) comparable transformer.

The main stress criteria applicable to a motor and the accompanying fuse are therefore the starting time t_{start} and the starting current I_{start} . The stress to the fuse is at its maximum when the motor is starting. Consequently, special attention must be paid to these parameters.

The number of starts per hour is determined by the system and shall in any case be specified by the user. The normal operating current must of course also be taken into account for dimensioning. This is required in order to be able to ensure thermal stability in continuous operation. For this, the environmental conditions and the technical data of the switchgear (heat dissipation) need to be considered. An important requirement for fuses installed in motor circuits is to be highly resistant to repeated motor start-ups. Therefore, the fuse must be designed and dimensioned in order to be insensitive to this type of cyclic stresses. Depending on the starting frequency, the possible operating current of the fuses decreases as shown in the following table.

It is permissible to have two starts immediately following each other.

Start-up/h	Reduction factor
2	0.59
4	0.53
8	0.48
16	0.43
32	0.39

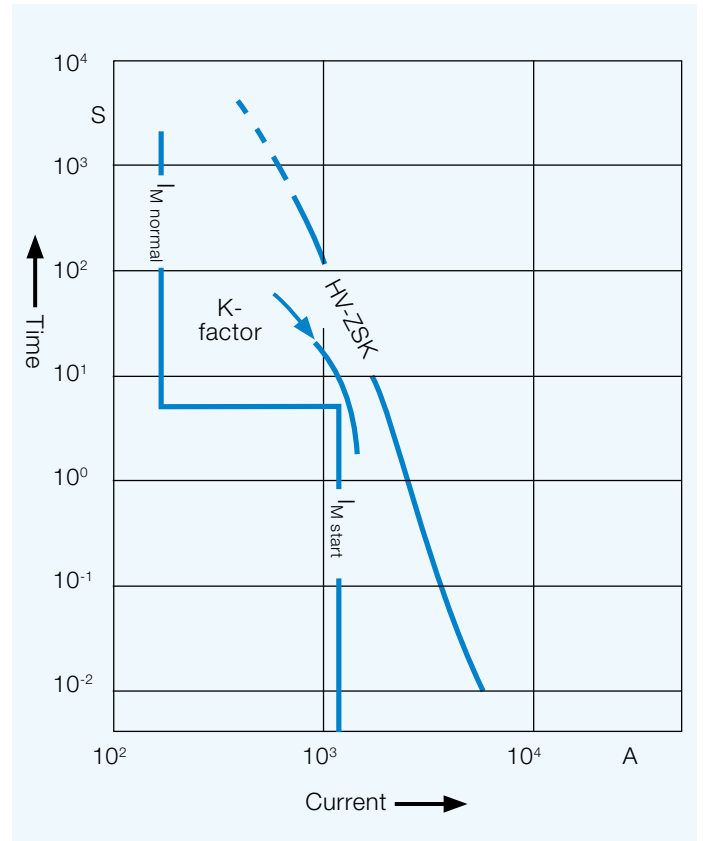


Fig. E - Motor circuit protection as specified in the relevant standards

The diagram shows the motor starting current and the motor starting time.

It is easy to see that the time-current curve of the fuse needs to be on the right-hand side of the motor starting curve, otherwise the fuse would operate and switch-off the current during the run-up period.

The distance between motor and fuse curve represents the safety factor for two consecutive starts. The curve for the K-factor is therefore always within the area limited by the fuse and motor curves.

3. Specific product characteristics

K-factor

The K-factor ($K < 1$) is based on the following assumptions:

- Starting time $t_{start} < 10$ seconds
- Max. 6 starts per hour
- Max. 2 consecutive starts (immediately following each other)

The K-factor is essentially a safety margin for the heat dissipation during consecutive starts.

It can be seen that the factor K is not a constant. In case of intention to deviate from these assumptions, the fuse manufacturer should be consulted in order to ensure proper fuse selection.

The K- factor is therefore integrated into the selection diagrams with means that the safety factor provided by the fuse standard is already included in order to simplify matters for the user.

HV fuse-links, determined for the protection of motor-circuits, are distinguished by their particular low power-losses.

They also respond relatively slow in the time range between 1 s up to approx. 30 s in order to withstand starting currents repeatedly without changing their characteristic.

Selection diagrams are available for determination of the rated fuse current.

Using the motor starting current, starting time, and starting frequency the rated fuse current can be read out directly.

It is important to use the right diagram fitting to the fuse system selected, because only in this case the K-factor, provided by the fuse standard, is taken into account "automatically." In the following example the selection diagram (Figure E) represents high-voltage fuses with motor circuit protection characteristics.

Selection in three steps

Step 1:

The following information is required:

- Rated voltage U_r of the system
- Motor data:
 - Rated power P_n of the motor
 - Power factor $\cos\phi$
 - Efficiency (η_M)or
- Rated current I_r of the motor
- Maximum starting current I_{start}
- Maximum starting time t_{start}
- Maximum number of starts per hour

For motors reference is made to the mechanical power at the shaft. Therefore, if the rated current I_r of the motor is not indicated, the actual motor current is to be derived from the stated rated power taking into consideration the power factor as well as the efficiency.

This information and additional data will always be indicated by the motor manufacturer because they are essential for design and dimensioning of the system.

Step 2:

The motor starting current is plotted into the selection diagram and the rated fuse current may be read out taking into consideration the starting time and starting frequency (see the example). In limit cases, the next higher nominal fuse current should be chosen, which has the advantage of lower ohmic losses in nominal operation and improved withstand capability in the event of unusual or more frequent starts.

Step 3:

It is mandatory to check whether the rated current of the motor will not lead to inadmissible temperature-rise inside the enclosure. According to actual fuse standards the temperature-rise at the metal contact parts is limited to 75 Kelvin at a maximum ambient temperature of 40 °C. This is required in order to ensure that neither the fuse nor the switchgear is subjected to thermal overload.

Example:

1. Motor data:

- $U_r = 7.2 \text{ kV}$
- $P_n = 1\,100 \text{ kW}$
- $\cos\varphi = 0.93$
- $\eta_M = 0.95$

2. Calculation of rated current I_r of motor:

$$I_r = \frac{P_n}{\sqrt{3} \cdot U_r \cdot \cos\varphi \cdot \eta_M} = \frac{1\,100 \text{ kW}}{\sqrt{3} \cdot 7.2 \text{ kV} \cdot 0.93 \cdot 0.95} = 99.84 \text{ A} \approx 100 \text{ A}$$

3. Additional system data:

- Starting current
 $I_{\text{start}} = 6 \times I_r = 600 \text{ A}$
- Starting time $t_{\text{start}} = 30 \text{ s}$
- Number of starts/h = 16

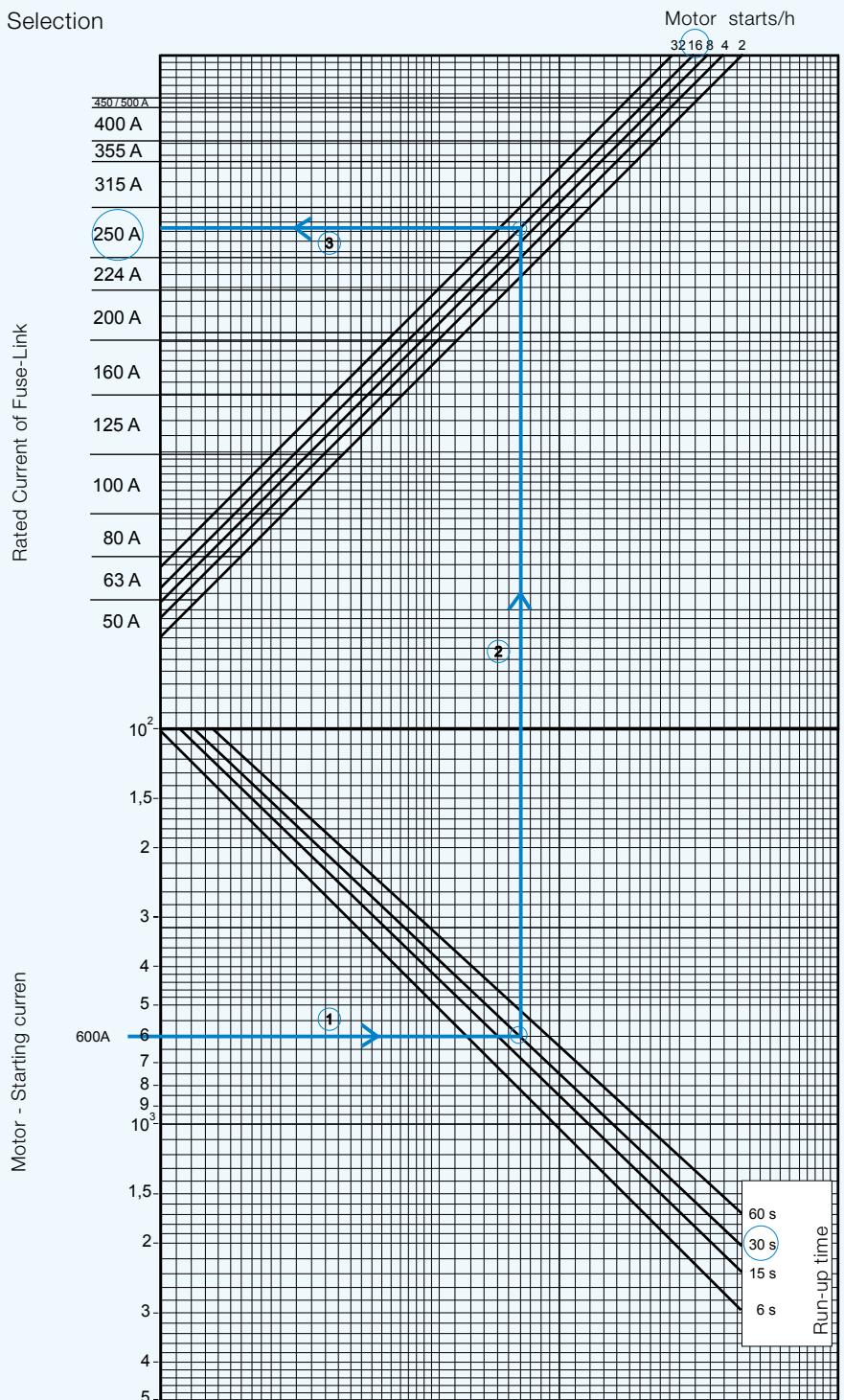
Plot into the diagram in Fig. E the starting current of 600 A, go to the right (1) up to the intersection with the 30 s line, then go upwards (2) to the intersection with the 16 starts/h line, then read off 250 A for the rated fuse current on the left (3). The 7.2 kV – 250 A HV fuse-link is the correct type for this application.

Special conditions:

Consult ABB about the contactor and fuse manufacturer if there are special operating conditions, such as:

- Ambient temperature $> 40 \text{ }^\circ\text{C}$
- Tstart time $> 60 \text{ s}$
- Number of trips $> 32/\text{hour}$

Example for Selection



3. Specific product characteristics

Motor starting

Motor starting poses the problem of the high current consumption on inrush.

In most cases, since these are asynchronous motors, the start-up current can take on the following values:

- asynchronous with simple squirrel cage 4.5 ... 5.5 I_n
- asynchronous with double squirrel cage 5 ... 7 I_n
- asynchronous with wound motor: low values, dependent on selection of the starting resistances.

This current cannot be available if the short-circuit power of the network is not sufficiently high and, in any case, can give rise to a drop in voltage for the whole duration of starting, which cannot be tolerated, from the loads derived from the network itself. Normally a voltage drop between 15 and 20% is considered acceptable except for verification needed in the case of special users.

The full voltage start-up condition can be checked analytically and turns out to be possible in most cases.

If the calculations show that the start-up power causes a voltage drop higher than the admissible one, starting with reduced voltage must be used, with consequent reduction in the start-up current. For this purpose, starting with a step-down autotransformer is generally used.

For large motors it may be more convenient to use a transformer, whose sizing can be a little higher than the power required by the motor, dedicated exclusively to the machine: start-up therefore takes place with reduced voltage without the rest of the plant being affected.

By suitably combining different enclosures, with withdrawable contactors appropriately fitted with accessories, any motor starting, control, protection and measurement diagram can be made.

Fig. F shows some typical electric diagrams which can be made with withdrawable contactors.

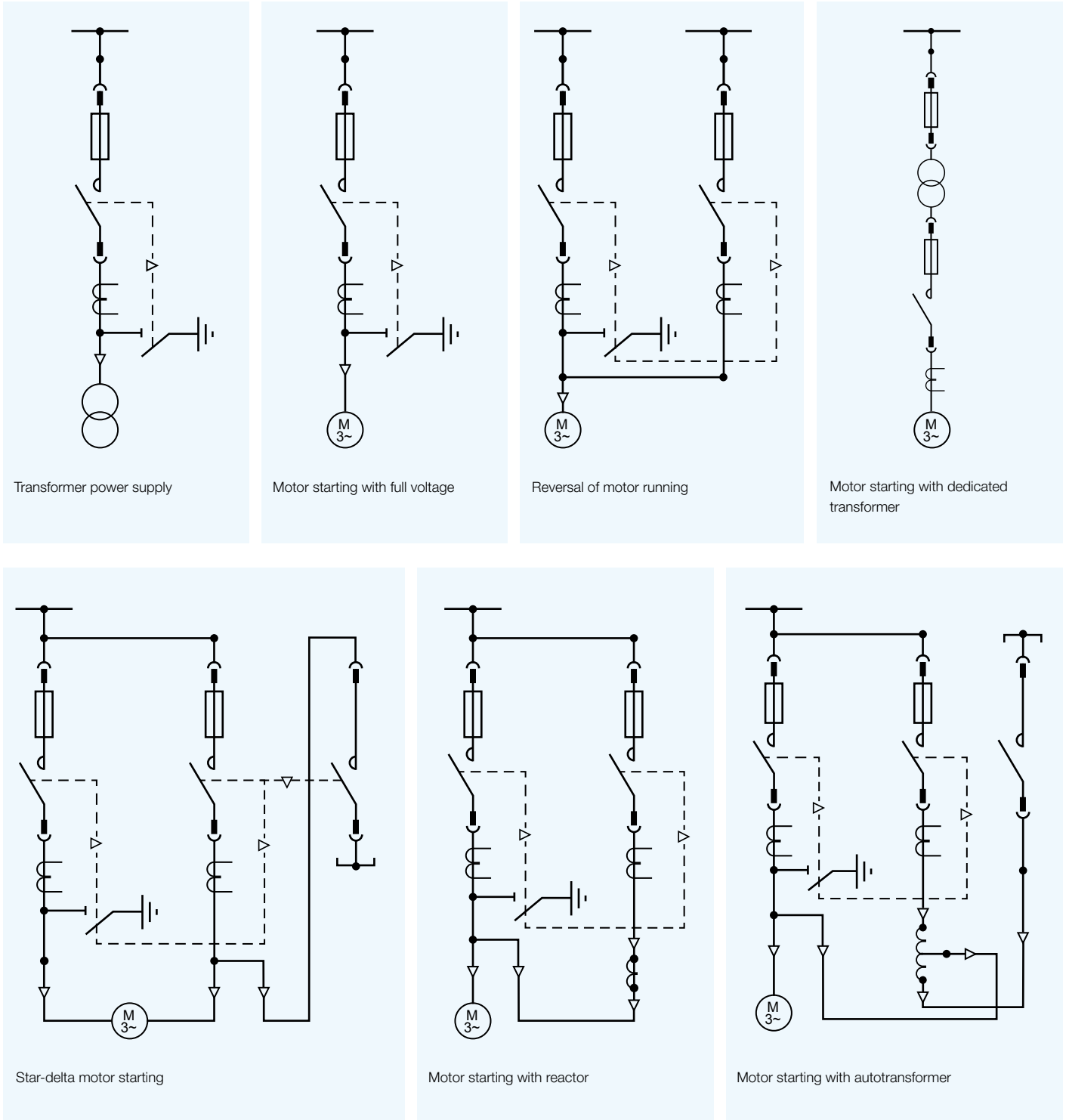


Fig. F - Typical diagrams of transformer power supply and motor starting

3. Specific product characteristics

Transformer protection and fuse selection (1)

When contactors are used for transformer control and protection, they are fitted with special types of current-limiting fuses which guarantee selectivity with other protection devices and which can take the high transformer connection currents without deterioration.

Unlike what has been seen for motors, in this case protection against overcurrents on the medium voltage side of the transformer is not indispensable since this task is carried out by the protection provided on the low voltage side. The protection on the medium voltage side can be entrusted to the fuse alone, which must be selected taking into account the no-load connection current, which can reach values up to 10 times the rated current for smaller transformers built with orientated crystal core laminations.

The maximum connection current is reached when circuit-breaker closing takes place in correspondence with passage through zero of the voltage.

Another result to be guaranteed is protection against faults in the low voltage winding and in the connection stretch from this to the circuit-breaker located on the secondary winding, avoiding the use of fuses with rated current which is too high, to be able to ensure tripping within a short time even under these fault conditions.

A rapid check of the short-circuit current at the secondary terminals of the transformer and on the supply side of the circuit-breaker on the secondary, if placed at a significant distance, allows the trip time to be verified on the fuse blowing curve.

The table of use given below takes both the required conditions into account, i.e. rated current sufficiently high to prevent unwarranted blowing during the no-load connection phase and, in any case, of a value which guarantees protection of the machine against faults on the low voltage side.

(1) Selection criteria relative to ABB CEF type fuses.

Selection table for fuses for transformers

Rated voltage of the transformer	Rated transformer power [kVA]																		Rated voltage of the fuse	
	25	50	75	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500		
[kV]	Rated current of fuse CEF [A]																		[kV]	
3	16	25	25	40	40	50	63	80	100	125	160	200	250	315	2x250 ⁽¹⁾	2x315 ⁽¹⁾				3.6/7.2
5	10	16	25	25	25	40	40	50	63	80	100	125	160	200	250	315	2x250 ⁽¹⁾	2x315 ⁽¹⁾		
6	6	16	16	25	25	25	40	40	50	63	80	100	125	160	200	250	315	2x250 ⁽¹⁾		
10	6	10	16	16	16	20	20	25	31.5	40	50	63	80	100	125	160	200	2x160 ⁽¹⁾		12
12	6	6	10	16	16	16	20	20	25	40	40	50	63	80	100	125	160	200		

Use CMF fuses.

(1) External fuse carrier required.

Connection of capacitors

The presence of current transients, which occur during switching-in of a capacitor bank, requires attention during the calculation procedures. In fact, assessment of the size of the phenomenon provides the elements for selecting the switching apparatus suitable for connecting/disconnecting the bank and for guaranteeing its protection in the case of overload.

To make this calculation, the power factor correction installations must be divided into two types:

- installations with a single three-phase capacitor bank (single bank installations)
- installations with several three-phase capacitor banks, which can be connected separately (multiple bank installations).

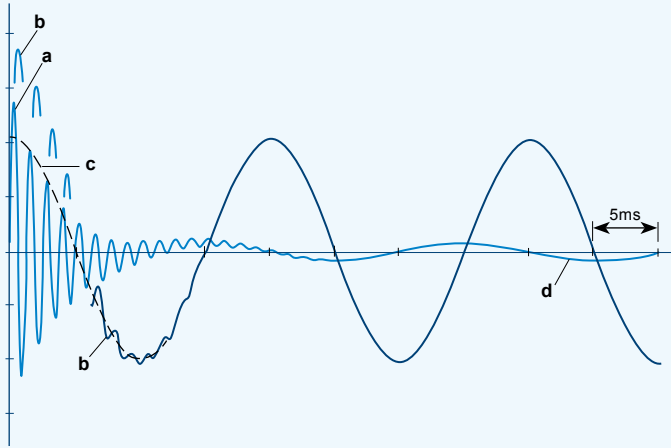
In the first type of installations there is only one type of switching-in transient, called switching-in transient of a single capacitor bank to the network. An example of a typical current transient is shown in fig. A.

In the second type of installations there are two types of switching-in transients:

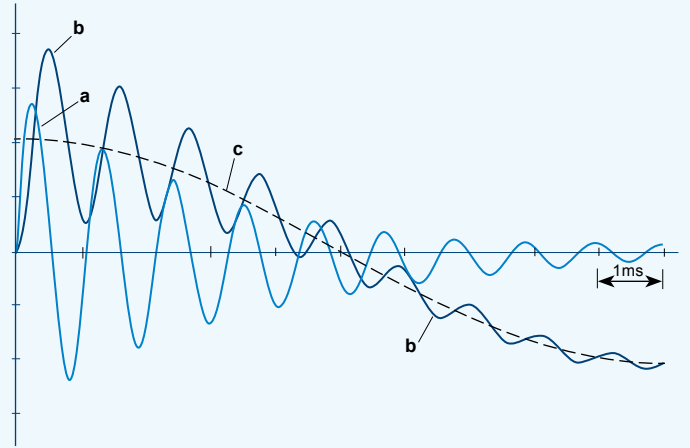
- on connection of the first capacitor bank there is the switching-in transient of a capacitor bank to the network
- on connection of the other banks there is a switching-in transient of a capacitor bank to the network with other banks already supplied in parallel. In this case, the current transient is the type shown in fig. B.

Selection of contactors suitable for connection of capacitor banks

The CEI 33-7 and IEC 871-1/2 Standards specify that the capacitor banks "... must be able to operate correctly under overload with an effective line current value up to 1.3 In, not taking into account the transients".



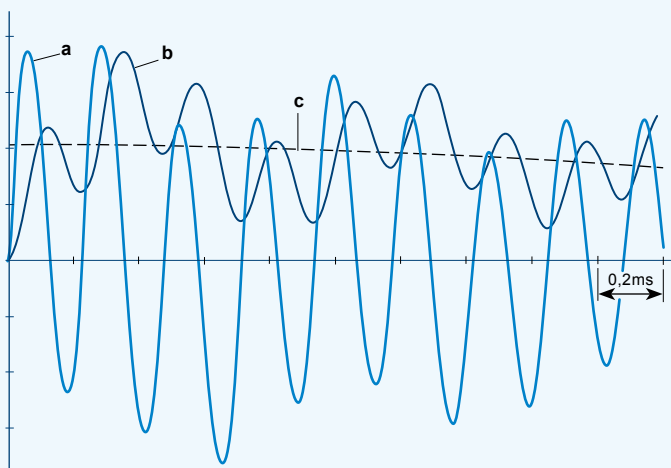
Trend of the current and voltage during and after the switching-in transient.



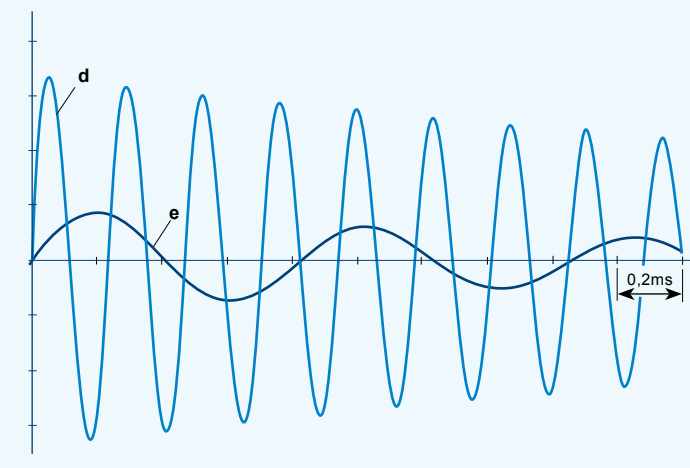
Trend of the current and voltage during the first 10 ms of the switching-in transient.

- a** = Transient switching-in current: first peak at 600 A peak and 920 Hz frequency.
- b** = Transient voltage at the 400 kVAR bank terminals.
- c** = Power supply phase voltage $10/\sqrt{3} = 5.8$ kV.
- d** = Rated bank current at 50 Hz: 23.1 A.

Fig. A - Example of a current transient during connection of a single capacitor bank.



Trend of the current and voltage during the first 2 ms of the switching-in transient.



Trend of the two components of the total current (see graph above).

- a** = Transient switching-in current: 1800 A peak and 4280 Hz frequency.
- b** = Transient voltage at the 400 kVAR bank terminals
- c** = Power supply phase voltage: $10/\sqrt{3} = 5.8$ kV.
- d** = Component at 4280 Hz frequency of the transient switching-in current.
- e** = Component at 1260 Hz frequency of the transient switching-in current.

Fig. B - Example of a current transient during connection of a capacitor bank with another one already supplied with voltage.

3. Specific product characteristics

The switching, protection and connection devices must therefore be designed to withstand continuously a current 1.3 times the current there would be at the rated sinusoidal voltage and at the rated frequency.

According to the effective value of the capacity, which may also be 1.10 times the rated value, this current can have a maximum value of $1.3 \times 1.10 = 1.43$ times the rated current. It is therefore advisable to select the rated normal current of the contactor for operating the capacitor bank at least equal to 1.43 times the rated current of the bank.

The V-Contact VSC contactors completely fulfil the requirements of the Standards, particularly those regarding connection and disconnection operations of banks and the overvoltages which, in any case, do not exceed three times the peak value of the rated phase voltage of the installation.

Single bank

The parameters of the current transient, peak values and own frequency, which are present in the case of connection of the bank to the network, are usually of notably smaller size than those in the case of multiple banks.

Two or more banks (back-to-back)

In the case of several capacitor banks, it is necessary to make the calculations regarding the installation, considering operation of a single bank with the other capacitor banks already connected.

Under these conditions, it is necessary to check that:

- the maximum switching-in current does not exceed the value given below (see table);
- the switching-in current frequency does not exceed the value given below (see table).

Contactor	Peak current	Maximum switching-in frequency	$I_p \text{ (kA)} \times f \text{ (Hz)}$
VSC-S	8 kAp	2,500 Hz	20,000

For switching-in current values under the values indicated, the switching-in frequency can be increased so that the product - **$I_p \text{ (kA)} \times f \text{ (Hz)}$** - is as indicated in the table.

For example, in the case of the **VSC-S** contactor, the $I_p \text{ (kA)} \times f \text{ (Hz)}$ value must not exceed $8 \times 2,500 = 20,000$.

To calculate the switching-in current and frequency, refer to the ANSI C37.012 Standards or to the IEC 62271-100 Annex H Standards.

Should higher values than those indicated be obtained in the calculations, it is necessary to connect air reactors of suitable value in the circuit.

The use of reactors is, however, recommended in the case of frequent operations with high switching-in frequencies.

Environmental protection programme

The V-Contact VSC contactors are constructed in compliance with the ISO 14000 Standards (Guidelines for environmental management).

The production processes are carried out in compliance with the Standards for environmental protection both in terms of reduction of energy consumption and raw materials and of production of waste. All this is thanks to the environmental management system in the production facility conforming to what is certified by the certifying Organisation.

The minimal environmental impact during the life cycle of the product (LCA - Life Cycle Assessment), is obtained by targeted selection of materials, processes and packing made during the design stage.

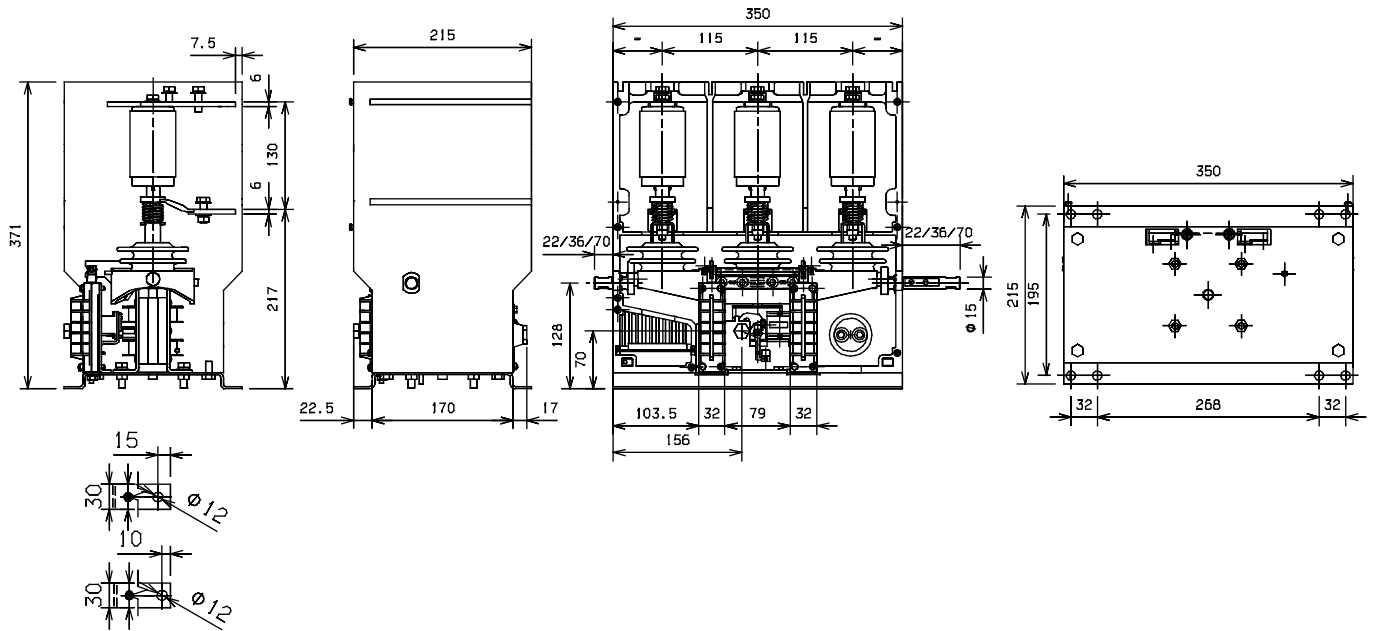
The production techniques prepare the products for easy dismantling and easy separation of the components to allow maximum recycling at the end of the useful life cycle of the apparatus.

For this purpose, all the plastic components are marked according to ISO 11469 (2nd ed. 15.05.2000).

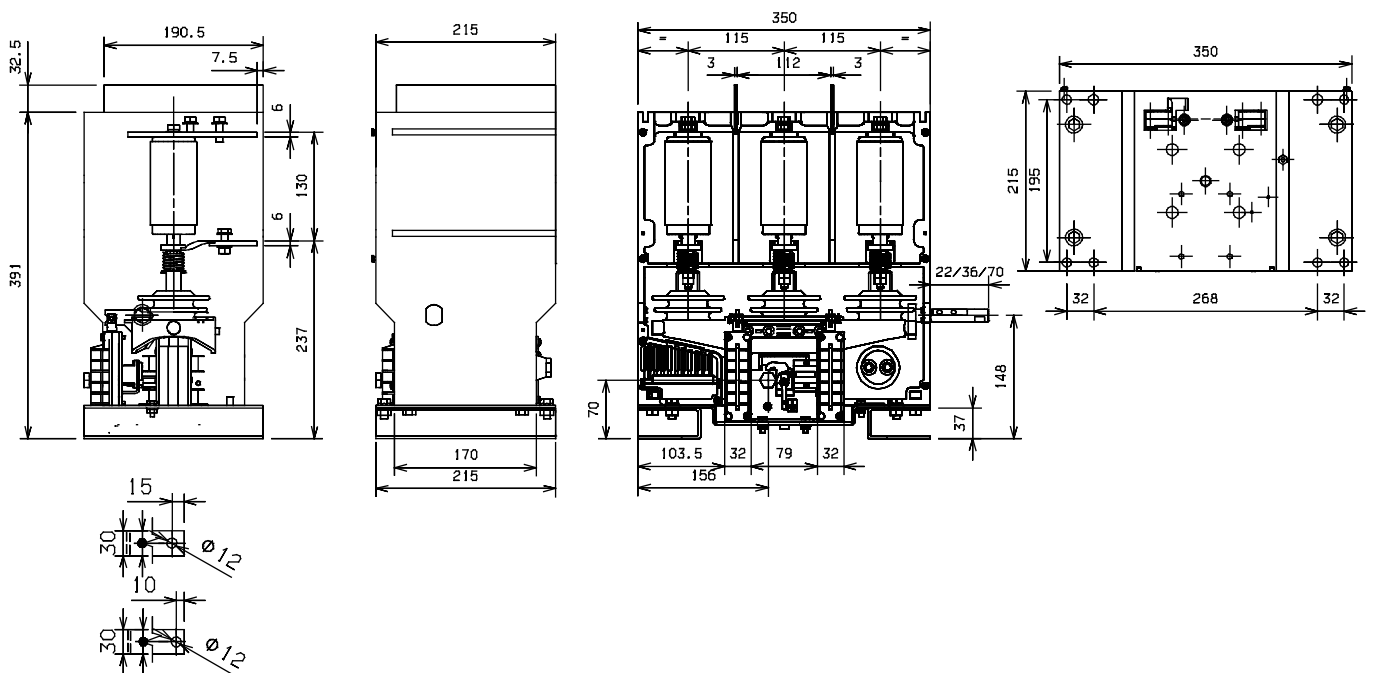
When compared with a contactor fitted with a traditional operating mechanism, V-Contact VSC contactors allow an energy saving which prevents emission into the atmosphere of about 7000 kg of carbon dioxide (CO₂).

4. Overall dimensions

VSC 7 fixed contactor

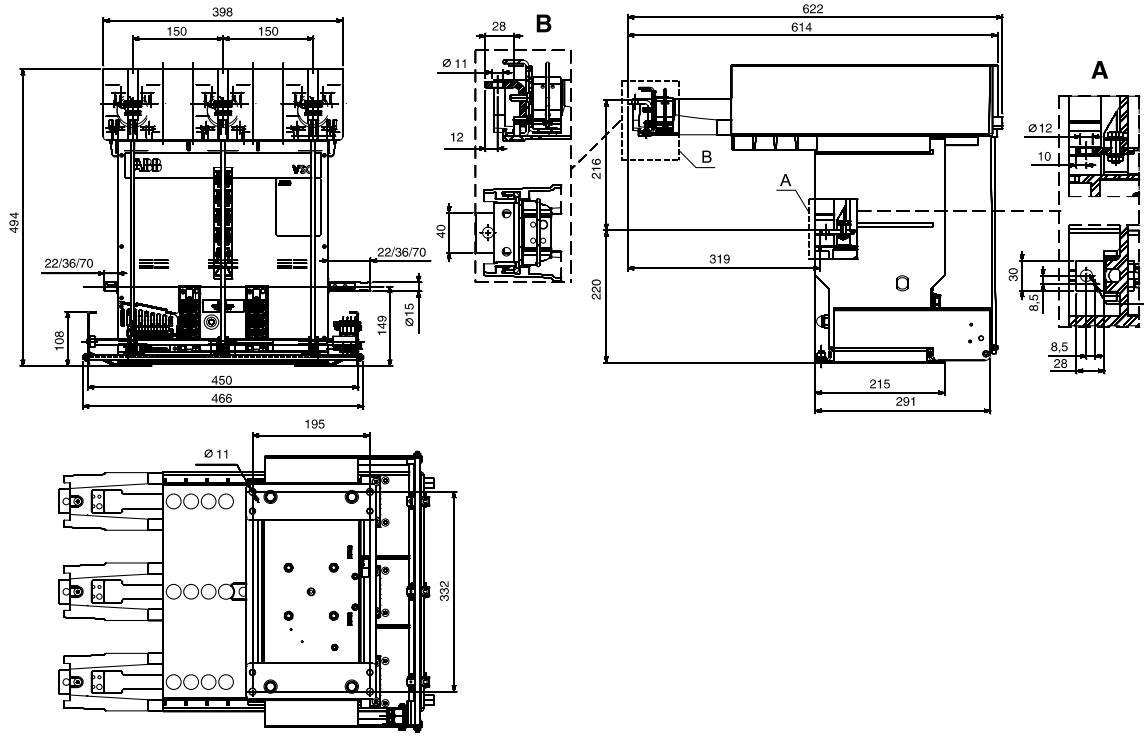


VSC 12 fixed contactor

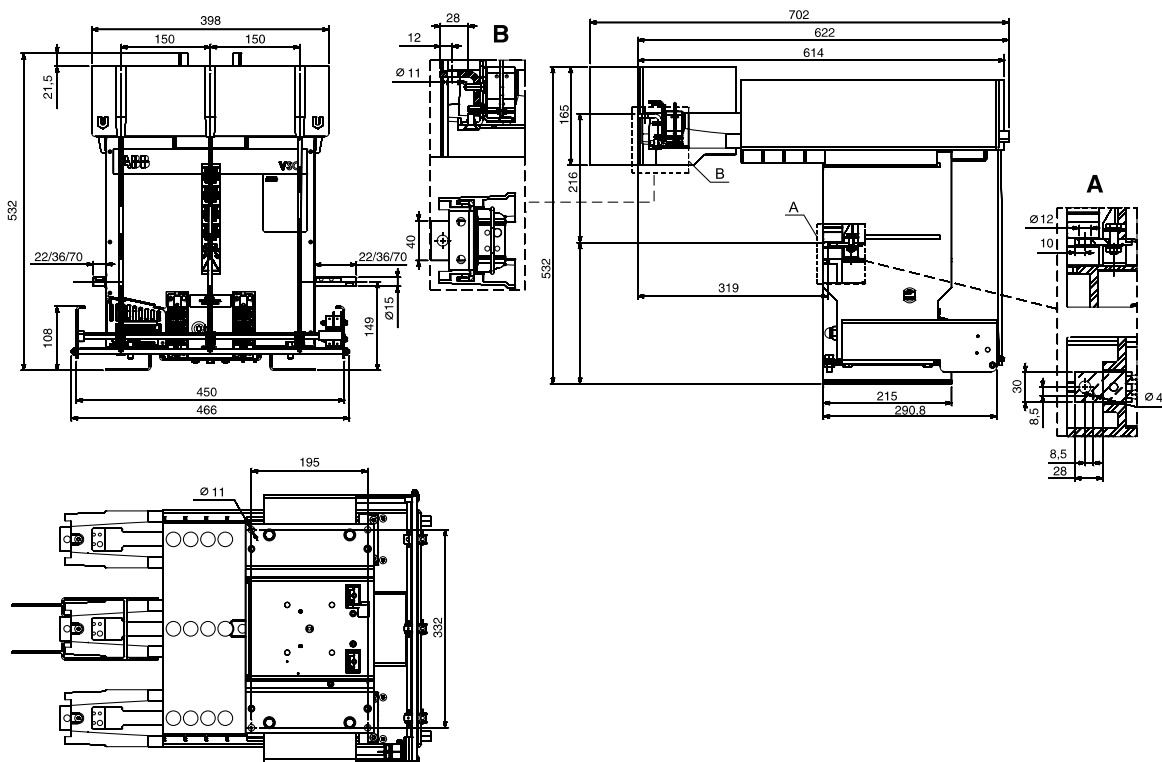


4. Overall dimensions

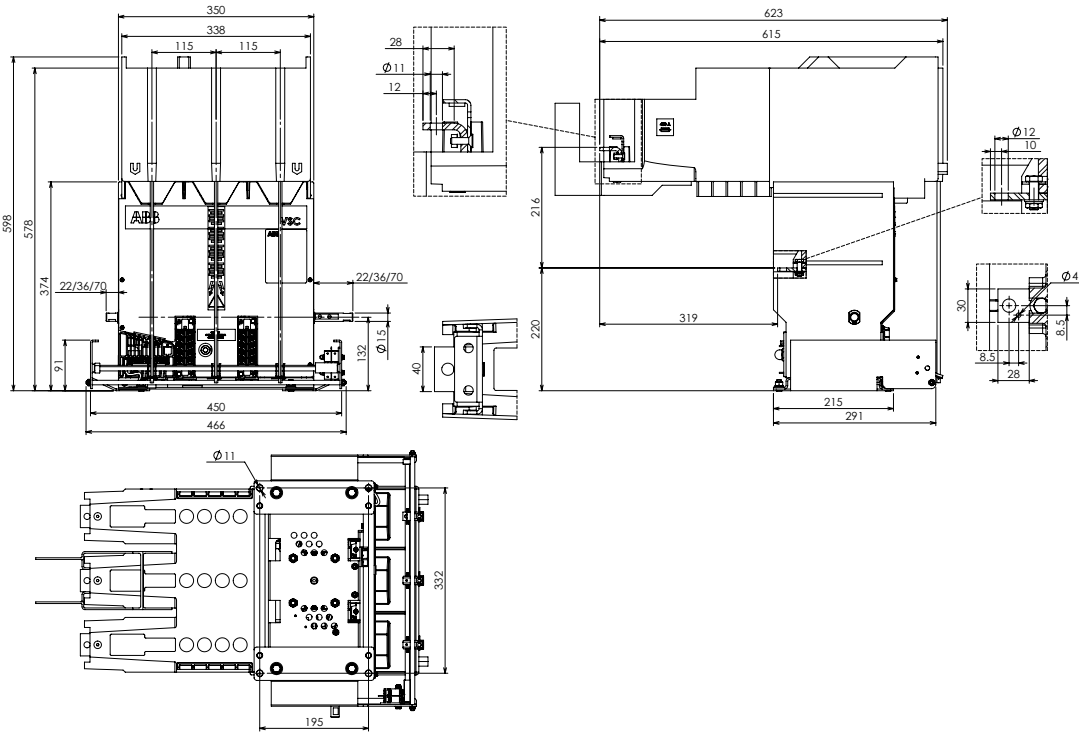
VSC 7 fixed contactor with fuses



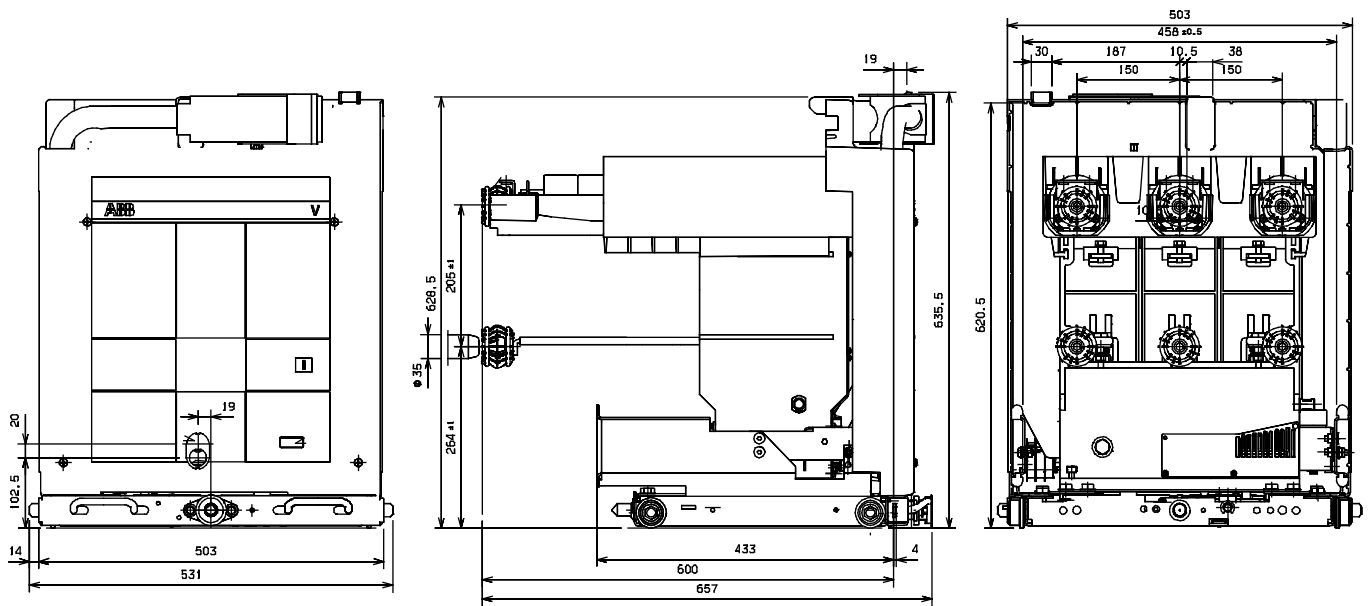
VSC 12 fixed contactor with fuses



VSC 7 Contactor preset for 2 BS fuses in parallel

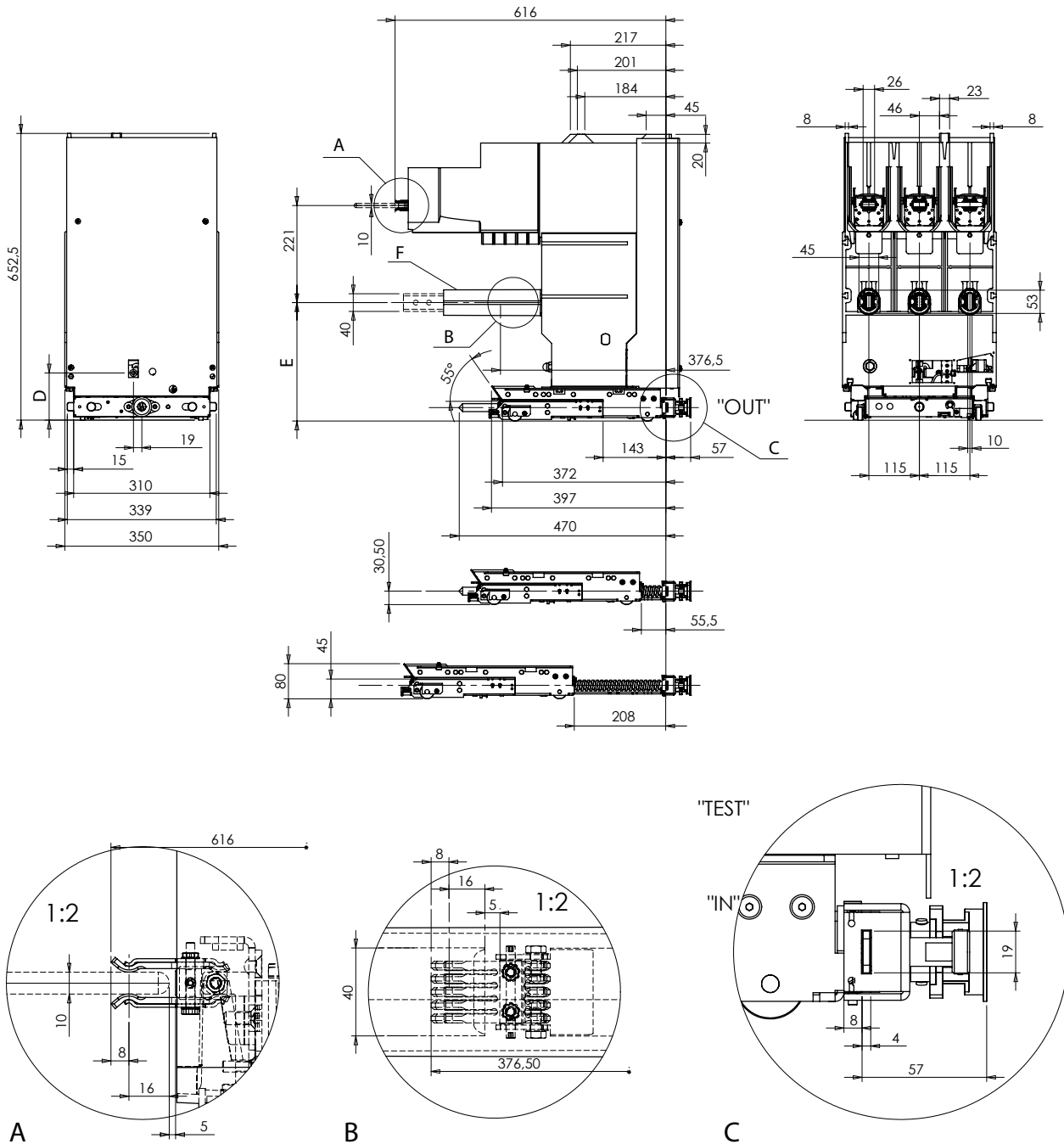


VSC 7/P - VSC 12/P withdrawable contactor



4. Overall dimensions

VSC 7/PN - VSC 12/PN withdrawable contactor



Contactor	D	E	Protection "F"
VSC 7/PN	270.5	108	Not present
VSC 7/PNG	269.5	108	Present
VSC 12/PN	269.5	129	Present

5. Electric circuit diagram

The diagrams given below show, as an example, the contactor circuits.

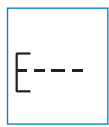
In any case, to take into account product development and for specific applications, it is always useful refer to the electric circuit diagram provided with each piece of apparatus.

State of operation represented

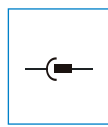
The diagram indicates the following conditions:

- circuit-breaker open
- circuits de-energized
- in service position (withdrawable contactor).

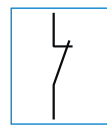
Graphic symbols for electric diagrams (IEC Standards)



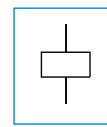
Pushbutton control



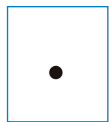
Socket and plug
(female and male)



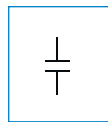
Break contact



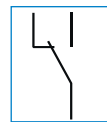
Control coil
(general symbol)



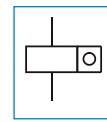
Connections of
conductors



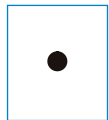
Capacitor
(general symbol)



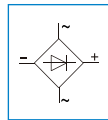
Changeover contact with
momentary interruption



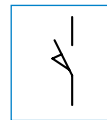
Electric impulse counter



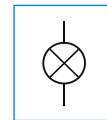
Terminal or clamp



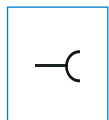
Rectifier in full wave
(bridge) connection



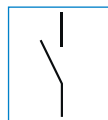
Position switch (limit
switch), make contact



Lamp (general symbol)



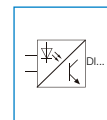
Socket



Make contact



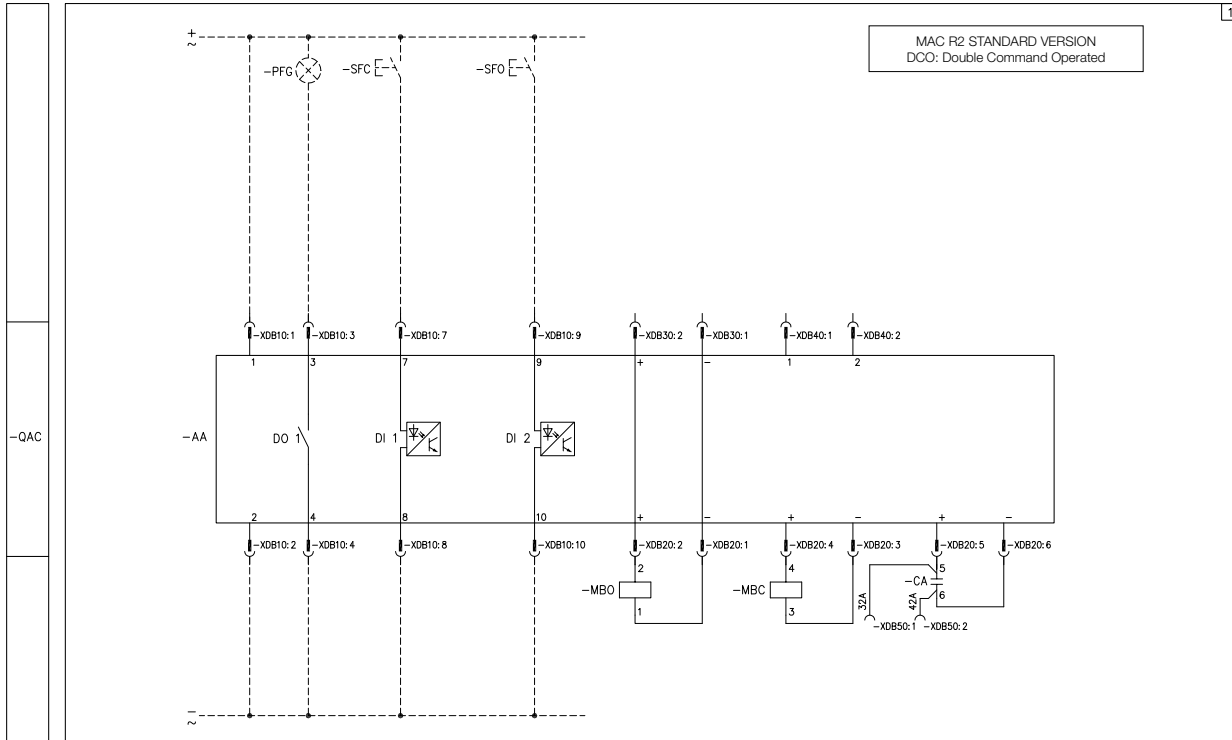
Position switch (limit
switch), break contact



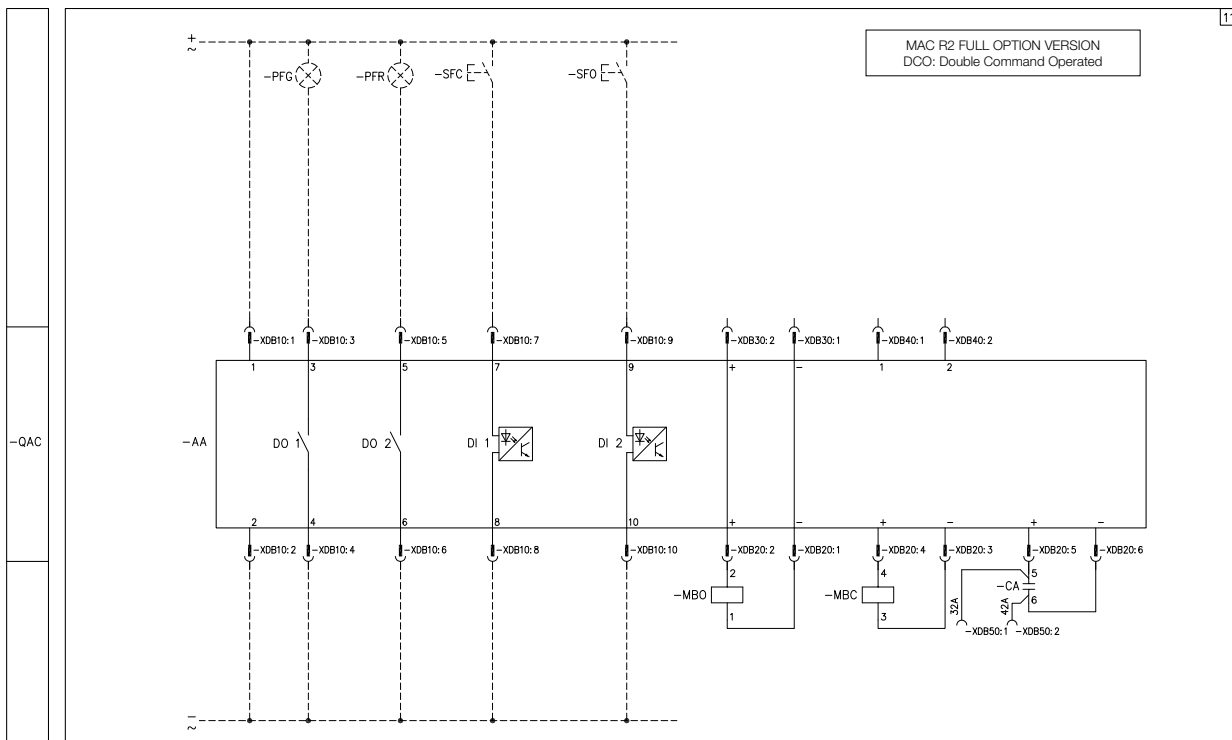
Digital isolated binary
inputs

5. Electric circuit diagram

Circuit diagram for fixed contactors - 1VCD400138 - V5207

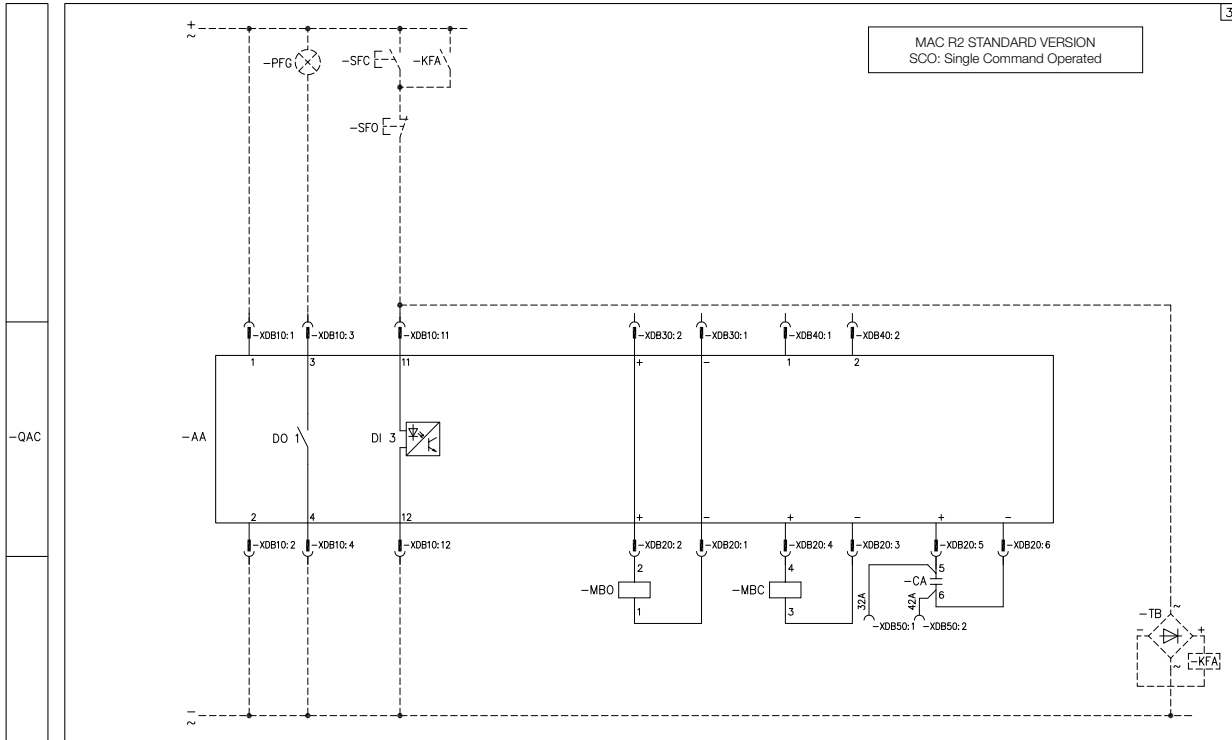


CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-7-9, 2-4-8-10 of fig.1 and terminals 11, 12 of fig. 2) must come from the same supply source as the auxiliary circuits and from the same protection device.

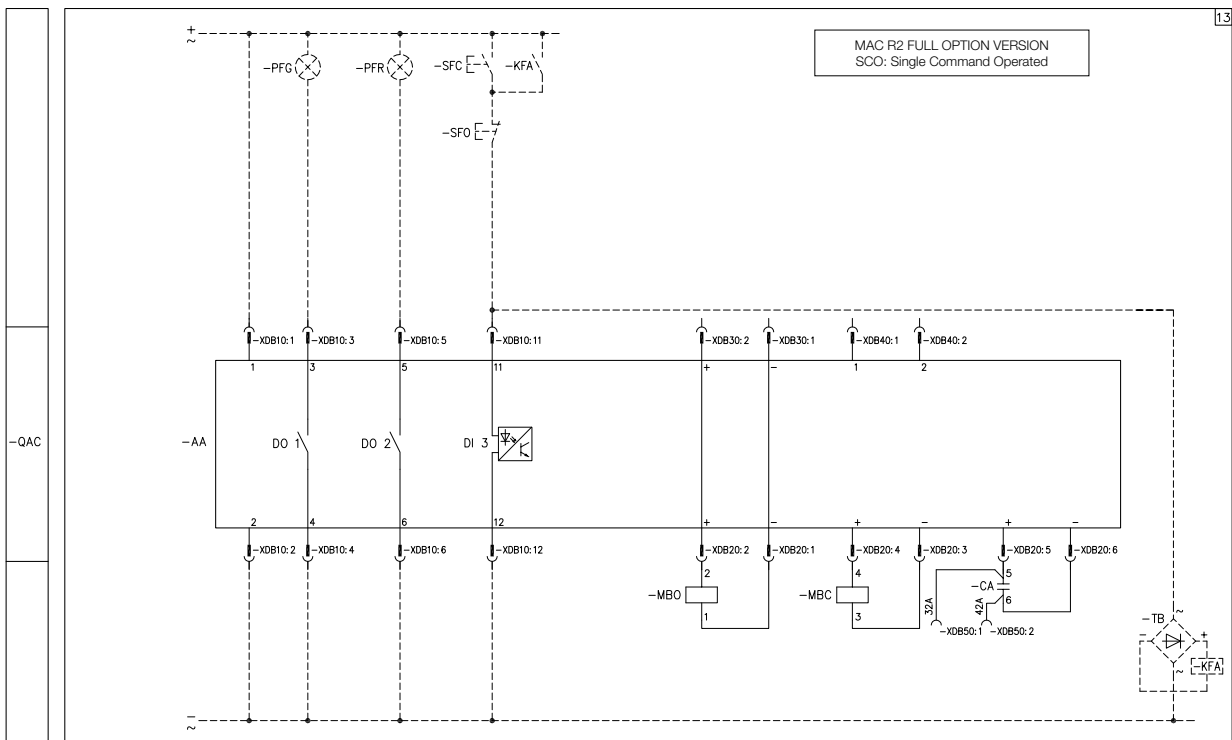


CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-7-9, 2-4-8-10 of fig.11 and terminals 11, 12 of fig. 2) must come from the same supply source as the auxiliary circuits and from the same protection device.

Circuit diagram for fixed contactors - 1VCD400138 - V5207



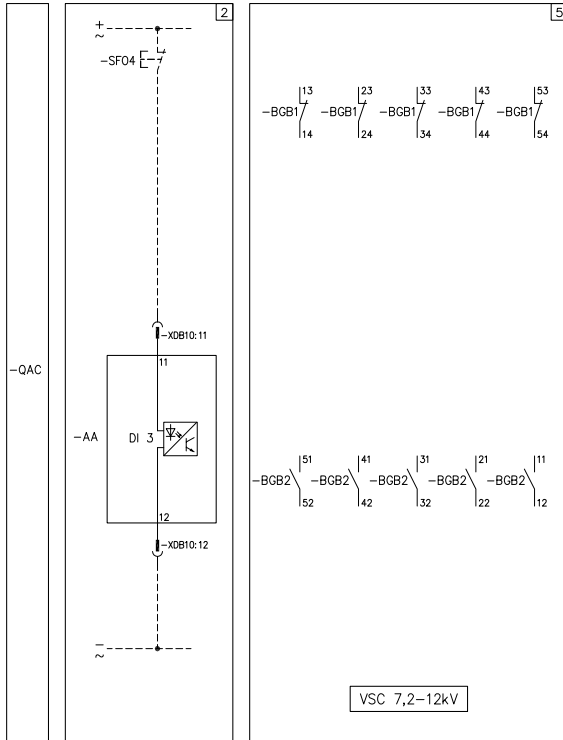
CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-11 and 2-4-12) must come from the same supply source as the auxiliary circuits and from the same protection device.



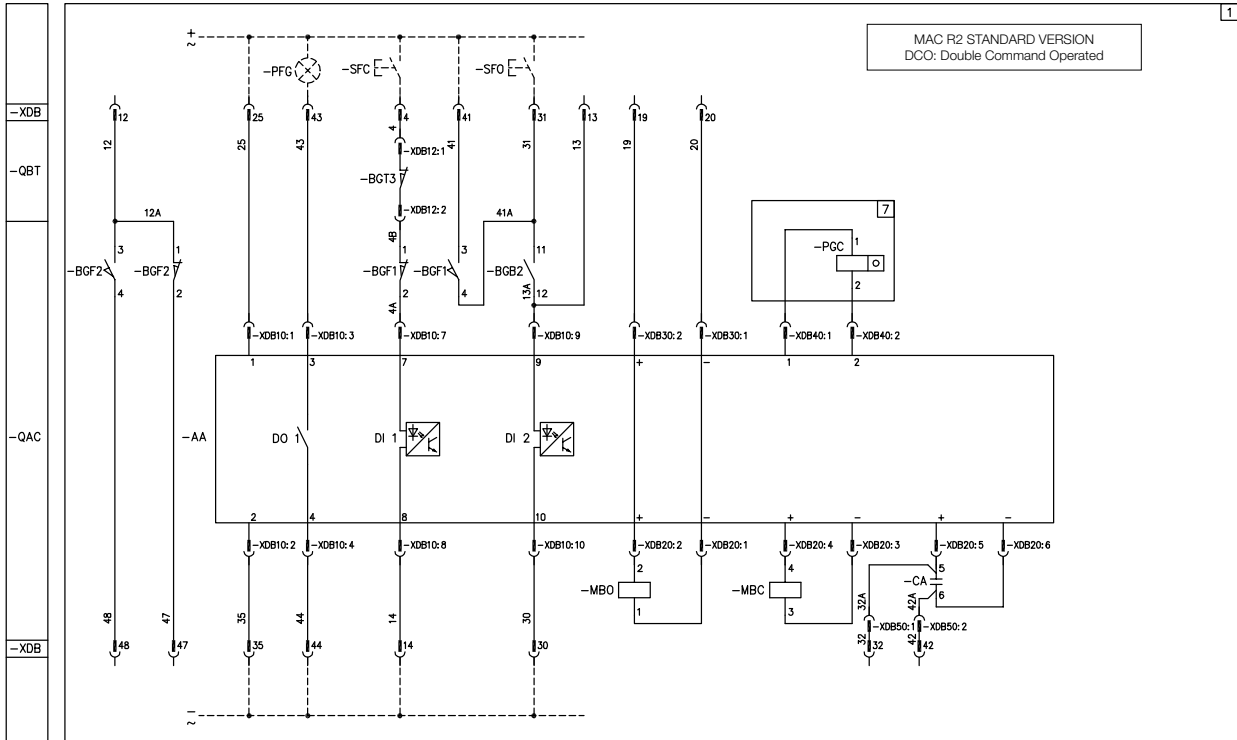
CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-5-11 and 2-4-6-12) must come from the same supply source as the auxiliary circuits and from the same protection device.

5. Electric circuit diagram

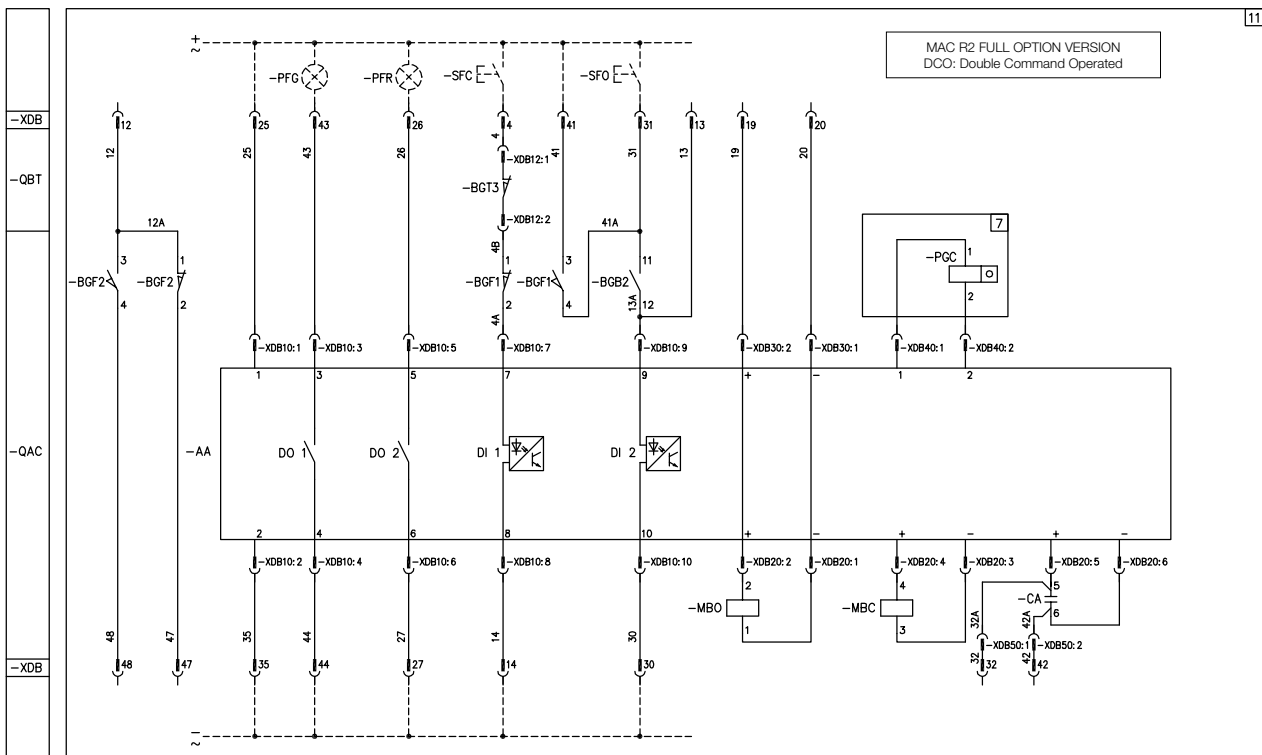
Circuit diagram for fixed contactors - 1VCD400138 - V5207



Circuit diagram for withdrawable contactors - 1VCD400139 - V5207



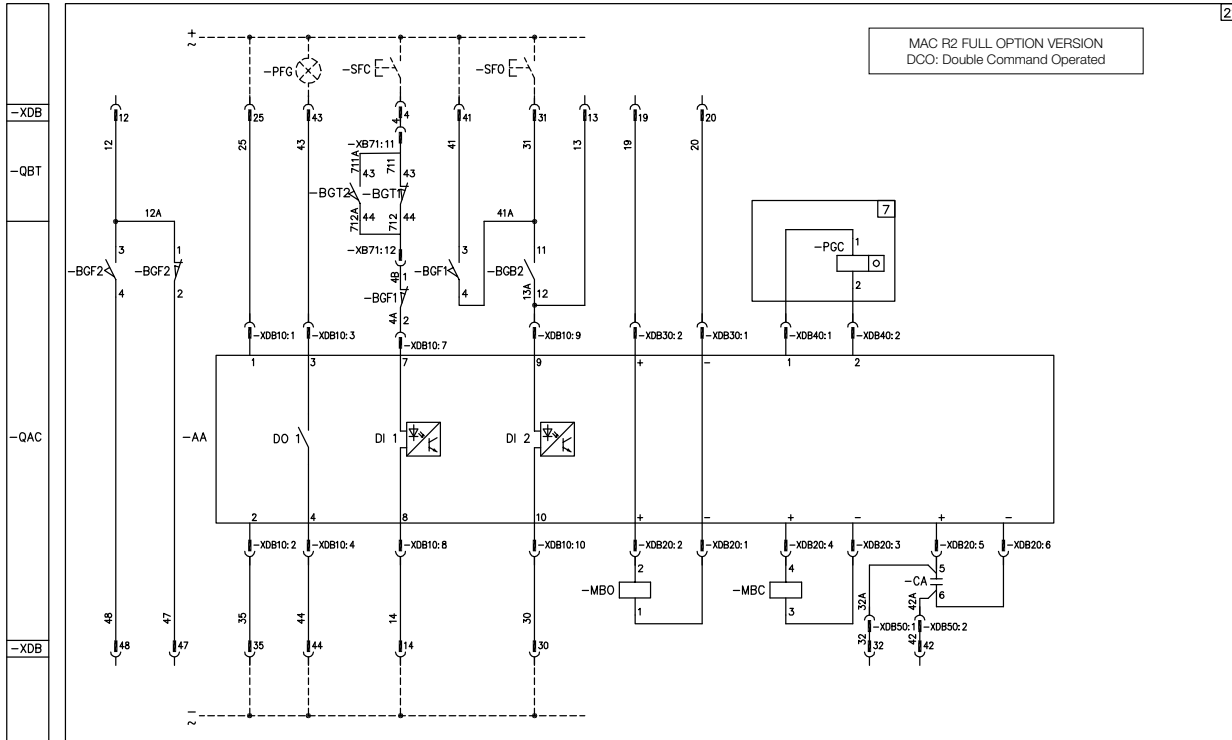
CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-7-9, 2-4-8-10 of fig.1 and terminals 11, 12 of fig. 2) must come from the same supply source as the auxiliary circuits and from the same protection device.



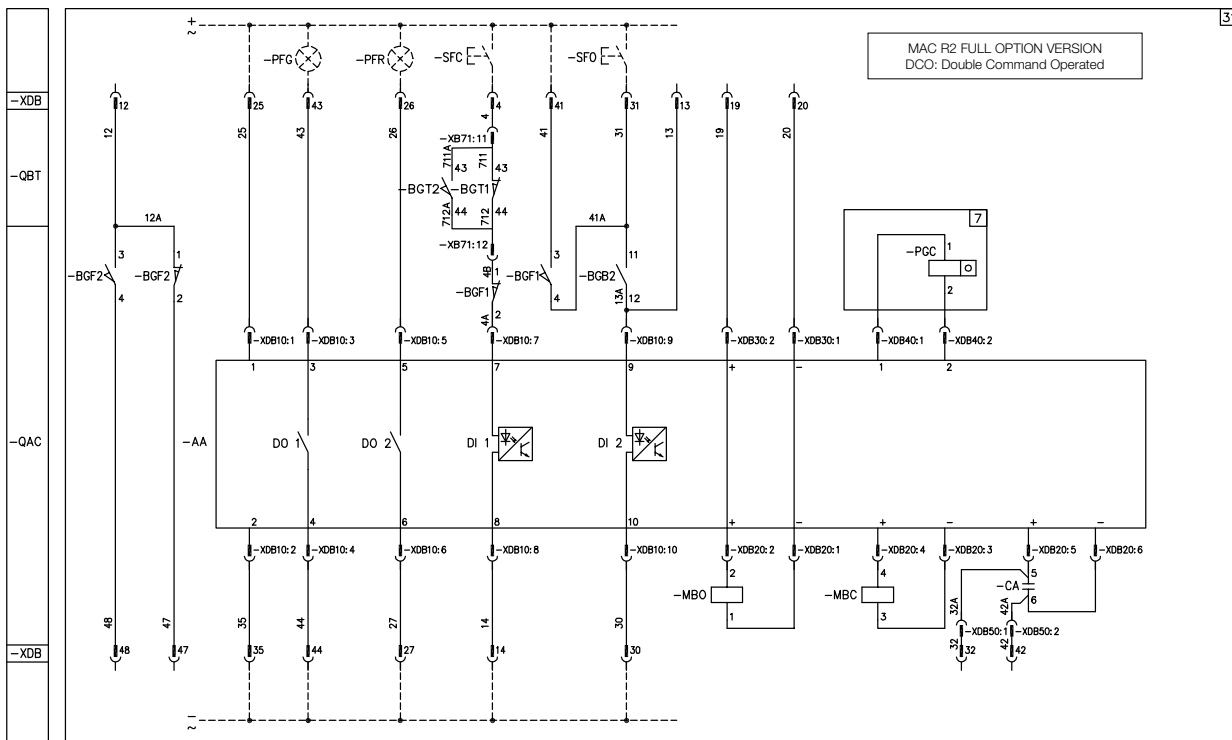
CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-7-9, 2-4-8-10 of fig.1 and terminals 11, 12 of fig. 2) must come from the same supply source as the auxiliary circuits and from the same protection device.

5. Electric circuit diagram

Circuit diagram for withdrawable contactors - 1VCD400139 - V5207

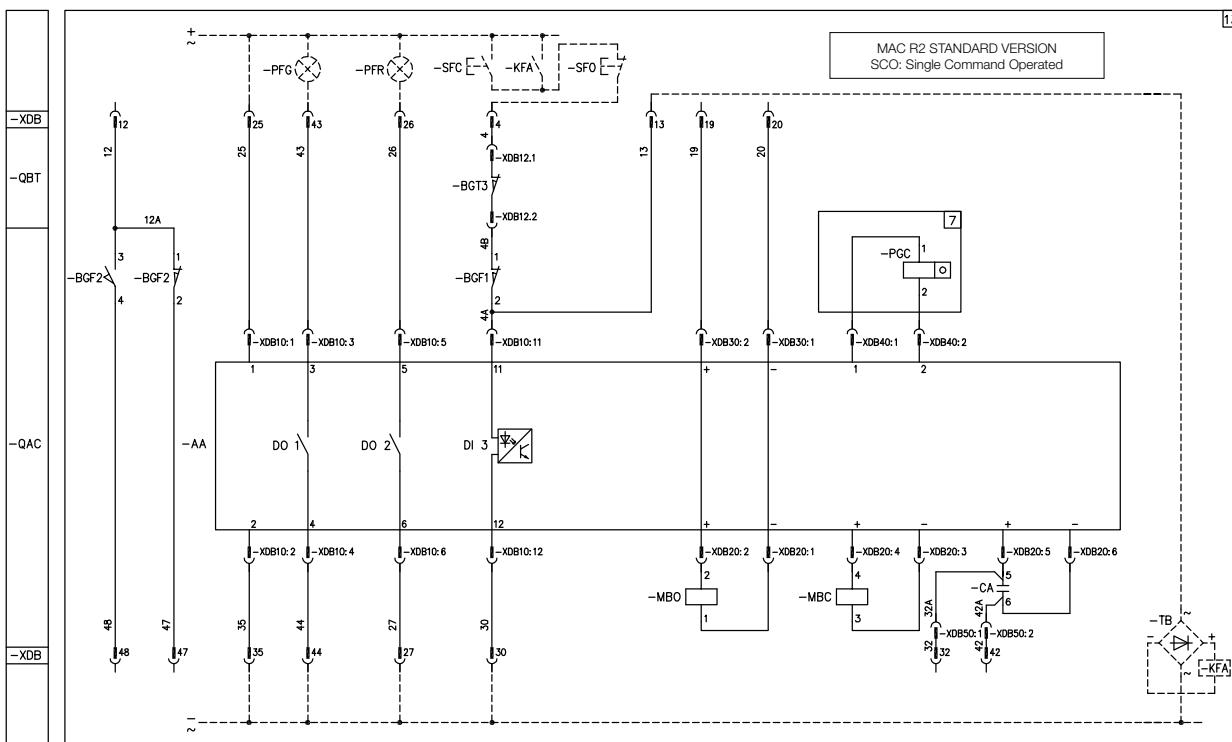
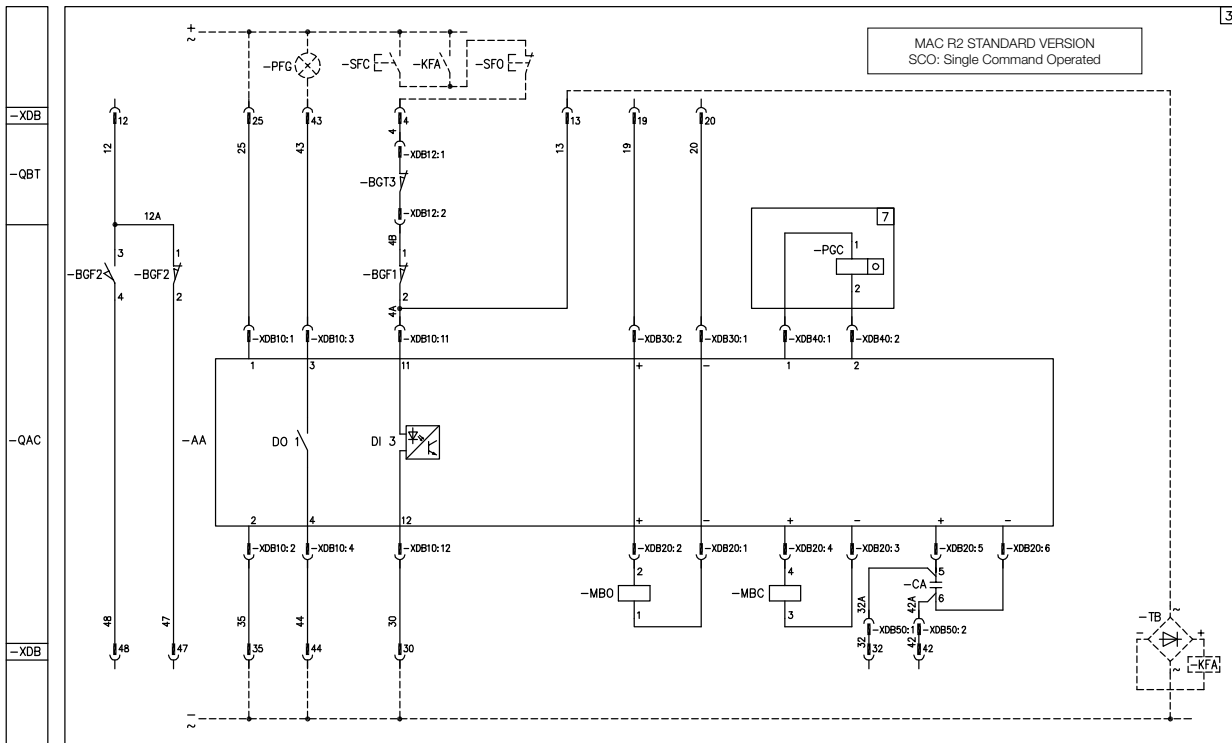


CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-7-9, 2-4-8-10 of fig.1 and terminals 11, 12 of fig. 2) must come from the same supply source as the auxiliary circuits and from the same protection device.



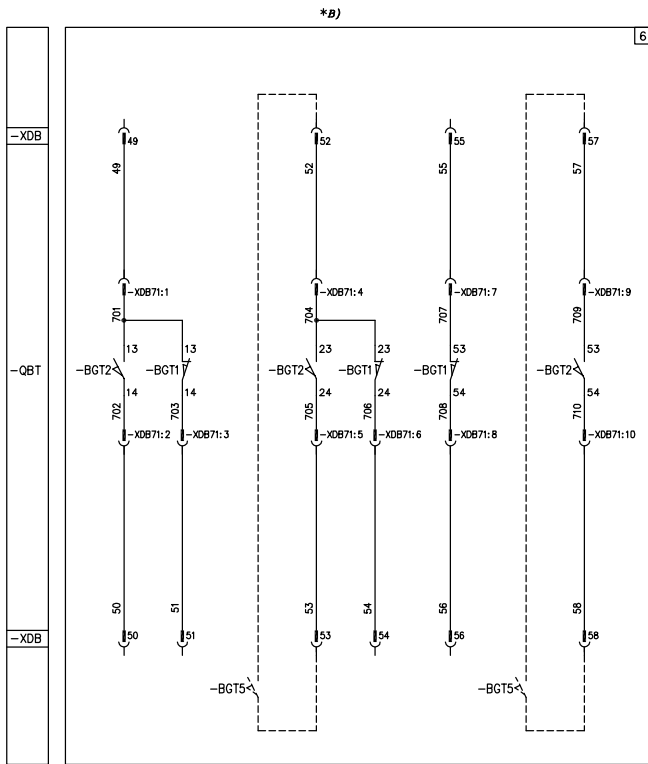
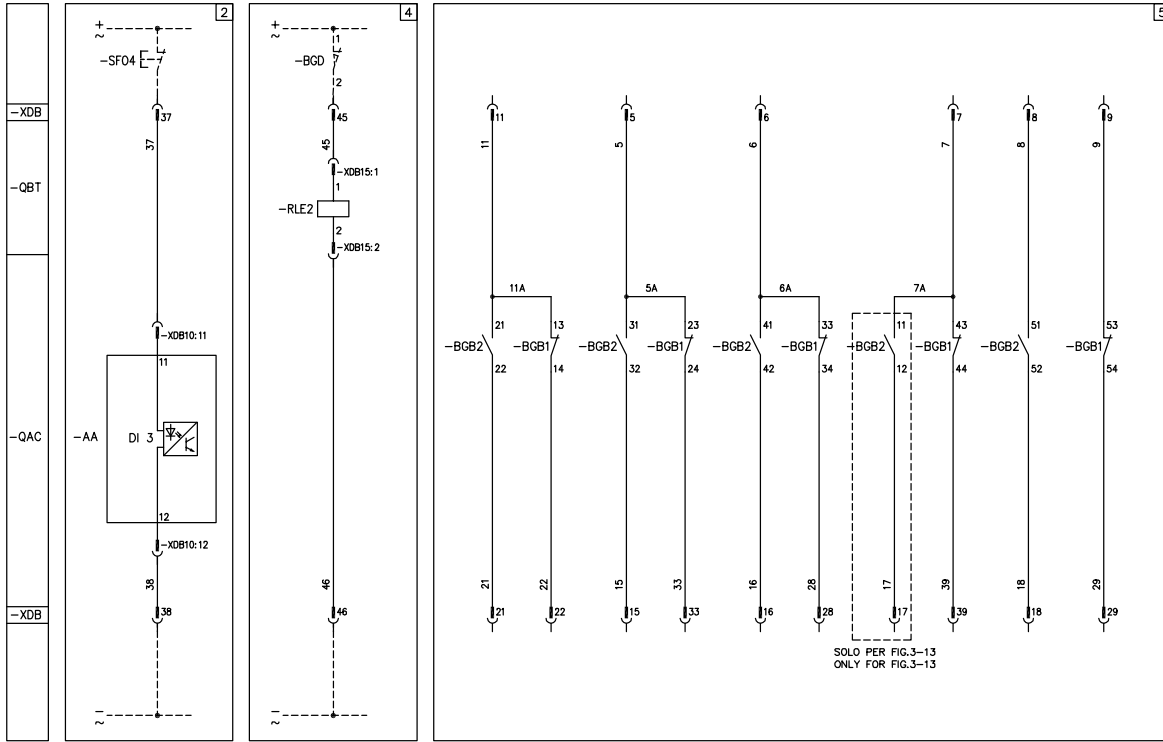
CAUTION: the voltage supplied to the terminals that supply the board and control circuit (terminals 1-3-7-9, 2-4-8-10 of fig.1 and terminals 11, 12 of fig. 2) must come from the same supply source as the auxiliary circuits and from the same protection device.

Circuit diagram for withdrawable contactors - 1VCD400139 - V5207

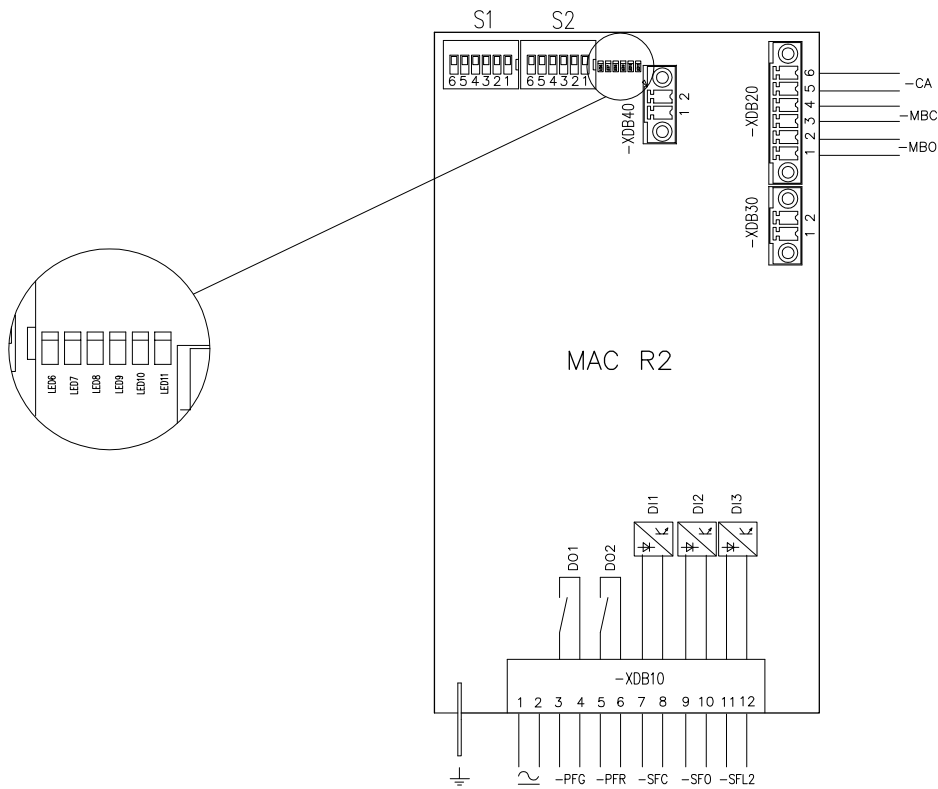


5. Electric circuit diagram

Circuit diagram for withdrawable contactors - 1VCD400139 - V5207



Board MAC R2



Key

- S1-1 → Reserved
- S1-2 → Reserved
- S1-3 to 5 → Trip time adjustment for undervoltage, DCO version
- S2-1 to 5 → Auxiliary voltage setting

– Digital input

- D11 closed command (DCO)
- D12 open command (DCO)
- D13 undervoltage (DCO); DROP OUT (SCO)

– Digital output

- D01 Unit ready
 - electronic device in working conditions
 - capacitor working voltage
 - coil continuity
- D02 System status information
 - control bank capacitor status
 - temperature status (full options version only)

Information signalling

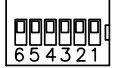
- Led 6 Normal operation (blink->0.5s) fail or start-up procedure (fixed->ON)
- Led 7 Communication thresholds
- Led 8 Over temperature (FAIL->ON)
- Led 9 Working voltage capacitor (FAIL->ON)
- Led 10 Coil connection status (FAIL->ON)
- Led 11 Capacitor bank status (FAIL->ON)

5. Electric circuit diagram

Board MAC R2

S1

off = 0 ↓
on = 1 ↓



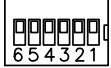
S1-1 → RESERVED
S1-2 → RESERVED
S1-3-5 → TRIP TIME ADJUSTMENT FOR UNDERVOLTAGE, DCO VERSION
S1-6 → RESERVED

Setting for DCO				
Time UV (s)	S1-3	S1-4	S1-5	
Istantaneous	0	0	0	
0,3s	0	0	1	
1s	0	1	0	
2s	0	1	1	
3s	1	0	0	
4s	1	0	1	
5s	1	1	1	

S2

S2-3-5 → SETTING GROUP

off = 0 ↓
on = 1 ↓



FEEDER 1 AND 2					
Working group	S2-1	S2-2	S2-3	S2-4	S2-5
24V dc	0	0	0	0	0
30V dc	0	0	0	0	1
48V dc	0	0	0	1	0
60V dc	0	0	0	1	1
FEEDER 3 AND 4					
Working group	S2-1	S2-2	S2-3	S2-4	S2-5
110V dc	0	0	1	0	1
110Vac	0	0	1	1	0
120V dc	0	0	1	1	1
120V ac	0	1	0	0	0
125V dc	0	1	0	0	1
125V ac	0	1	0	1	0
127V dc	0	1	0	1	1
127V ac	0	1	1	0	0
130V dc	0	1	1	0	1
130V ac	0	1	1	1	0
220V dc	0	1	1	1	1
220V ac	1	0	0	0	0
230V dc	1	0	0	0	1
230V ac	1	0	0	1	0
240V dc	1	0	0	1	1
240V ac	1	0	1	0	0
250V dc	1	0	1	0	1
250V ac	1	0	1	1	0

State of operation shown

The diagram is shown in the following conditions:

- contactor open and connected (in the case of withdrawable apparatus)
- circuits de-energized.

Caption

- AA = MAC R2 Control unit
- BGB1, 2 = Auxiliary contacts
- BGD = Enclosure door position contact
- BGF1, 2 = Medium voltage fuse position contacts
- BGT1 = Contacts for electrical signalling of contactor in connected position (see note B)
- BGT2 = Contacts for electrical signalling of contactor in isolated position (see note B)
- BGT3 = Contactor position contact, open during the isolating run
- CA = Capacitor
- KFA = Auxiliary relay
- MBC = Shunt closing release
- MBO = Shunt opening release
- PFG = Green lamp for electrical signalling of control and actuation circuits ready.
The following conditions are checked:
 - electronic system operational
 - capacitor voltage level
 - check on continuity of the operating mechanism coils

- PFR = Red lamp for signalling anomalies on the capacitor operating parameters
- PFG = Electric operation counter
- QAC = Contactor
- OBT = Withdrawable truck accessories
- RLE2 = Locking magnet on the truck. If de-energized this mechanically prevents connection and isolation of the contactor
- SFC = Closing pushbutton
- SFO = Opening pushbutton
- SF04 = Pushbutton or contact for opening the contactor due to undervoltage
- TB = Rectifier with two half-waves (with bridge) KBPC 1008 380V 10A RBL2
- XDB = Delivery connector of the contact circuits
- XDB12, 15 = Application connectors
- XDB10 = Delivery terminal box of the customer's contactor circuits
- XDB20 = Interface connector with the magnetic drive
- XDB30 = Delivery connector for future applications
- XDB40 = Interface connector with the electric operation counter
- XDB50 = Safety connector for discharging the capacitor
- XDB71 = Connector of the applications

5. Electric circuit diagram

Description of figures

- Fig. 1 = MAC R2 Standard Version DCO
- Fig. 2 = "Undervoltage" (on request) only for version DCO
- Fig. 3 = MAC R2 Standard Version SCO
- Fig. 4 = Locking magnet on the truck. If de-energized this mechanically prevents connection and isolation of the contactor
- Fig. 5 = Auxiliary contacts of the contactor (VSC 7.2 - 12 kV)
- Fig. 6 = Contacts for electrical signalling of contactor in the connected and isolated positions located on the truck
- Fig. 7 = Electric operation counter circuit
- Fig. 11 = MAC R2 Full options Version DCO
- Fig. 13 = MAC R2 Full options Version SCO
- Fig. 16, 17 = Auxiliary contacts of the contactor (VSC 3.6 kV)
- Fig. 21 = MAC R2 Standard Version DCO with -BGT1 and -BGT2
- Fig. 31 = MAC R2 Full options Version DCO with -BGT1 and -BGT2

Notes

- A) The contactor is only fitted with the applications specified in the order confirmation. Consult the catalogue of the apparatus to make out the order.
- B) The contacts for electrical signalling of the contactor in the connected and isolated position (-BGT1 and -BGT2) shown in fig. 6 are located on the contactor (moving part). Application of these contacts is usually foreseen on the enclosure (fixed part): see diagram 1VCD400036.

Incompatibility

The circuits indicated with the following figures cannot be supplied at the same time on the same contactor:

2 - 3 2 - 13 1-3-11-13 21-31 6-21-31 16-17

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