Medium voltage products

V-Contact VSC
Medium voltage vacuum contactors

Power and productivity
for a better world™

Index

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.
Three bands of power supply are available with which all the voltage values required by the major international Standards can be covered.
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:

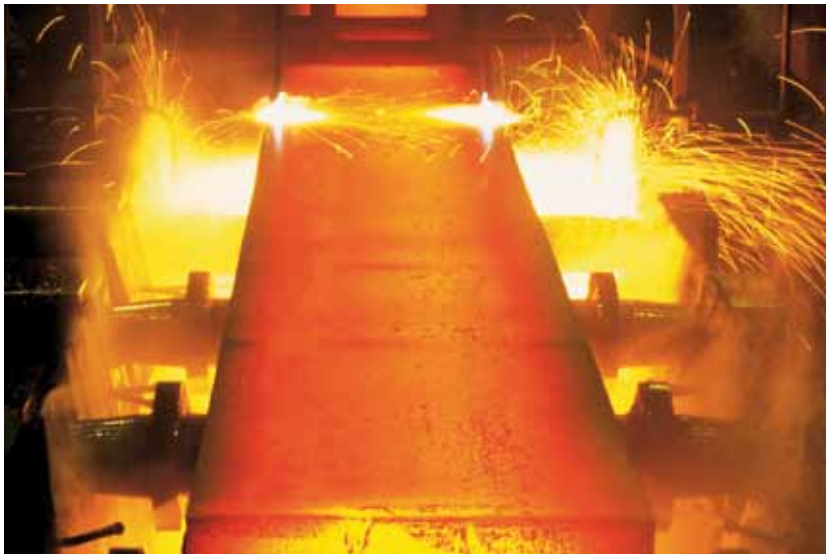
Version	Rated voltage	Type
Fixed	3.6 kV	VSC 3
	7.2 kV	VSC 7 - VSC 7/F
	12 kV	VSC 12 - VSC 12/F
Withdrawable	7.2 kV	VSC 7/P - VSC 7/PN
	12 kV	VSC 12/P - VSC 12/PN

The withdrawable versions are foreseen for use with UniGear switchgear, PowerCube units and CBE1 enclosures. For use with the CBE11 enclosures, please contact ABB. The VSC/PN withdrawable contactor can only be used in ABB UniGear MCC panels.
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 multivoltage 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 60470 (2000) Standards.

Approvals

Approval by the DNV and LL.RR shipping registers is foreseen. For these versions, please contact ABB..

Operating characteristics

- Ambient temperature: – 5 °C ... + 40 °C
- Relative humidity: < 95 % (without condensation)
- Altitude: < 1000 m s.l.m.

For other conditions, please contact us.

Main technical characteristics

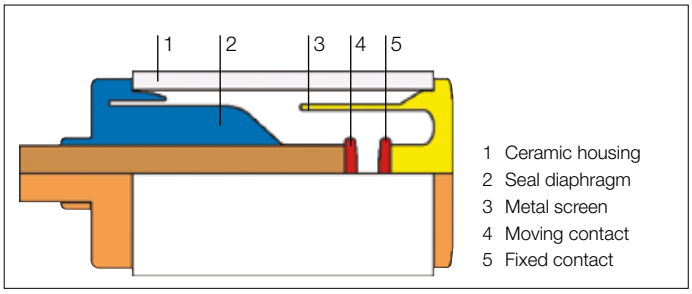
- Chopping current value ≤ 0.5 A
- Maintenance-free
- Suitable for installation in prefabricated substations and switchgear both of the card (slim line) and traditional type
- High number of operations
- Direct checking of contact wear
- Long electrical and mechanical life
- Remote control
- Multi-voltage feeder
- Bistable drive of the type with permanent magnets.

Electrical life

The electrical life of V-Contact VSC contactors is defined in category AC3.

Interruption principle

The main contacts operate inside the vacuum interrupters (the level of vacuum is extremely high: 13 x 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.
For motor switching, the value of the chopped current is less than 0.5 A with extremely limited overvoltages.



Schematic cross-section of the vacuum interrupter.

1. Description

"MAC" magnetic drive

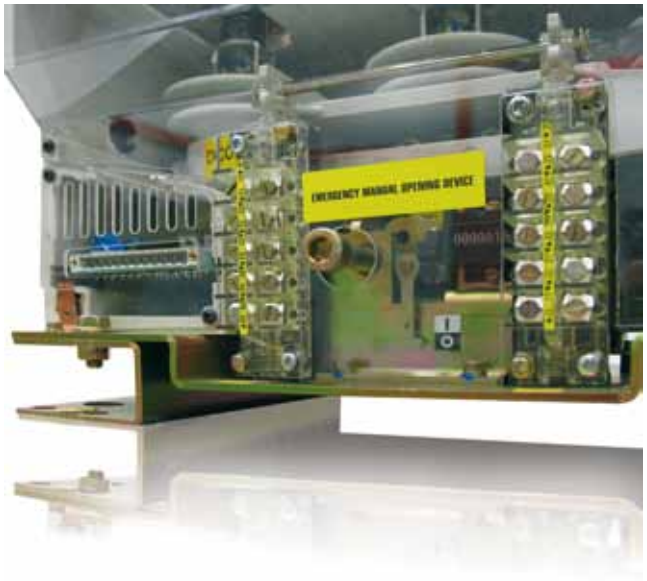


ABB has implemented this technology in the field of contactors on the basis of experience gained in the field of circuit-breakers with magnetic drive.
The magnetic drive adapts perfectly to this type of apparatus thanks to its precise and linear travel.
The drive, which is of bistable type, is fitted 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.
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. The power required is less than 5 W. In order to re-instate the rated power value in the capacitor after an operation, there is an inrush of 15 W for a duration of a few tens of milliseconds.
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 of 5W (this value can reach 15W for a few milliseconds immediately following each operation).
When first switched on (or when the capacitor is completely discharged), the power needed increases to 35 W x 6 s.
Careful selection of the components and a precise design make the electronic multi-voltage feeder extremely reliable, unaffected by electromagnetic interference generated by the surrounding environment and free of any emissions which may affect other apparatus placed in the vicinity.
These characteristics have made it possible for the V-Contact VSC contactors to pass the electromagnetic compatibility tests (EMC) and obtain the CE mark.

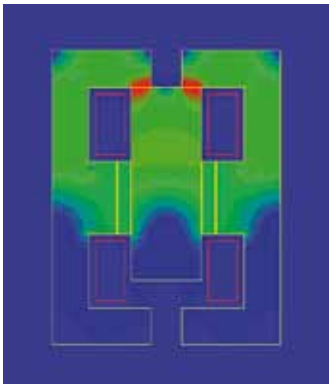


Fig. A - Magnetic circuit in the closed position.

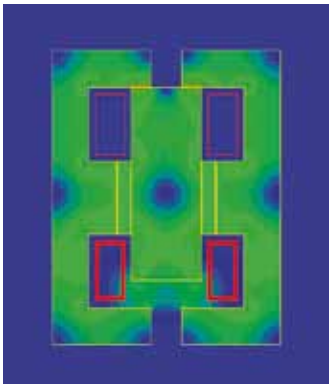


Fig. B - Magnetic circuit with the opening coil supplied.

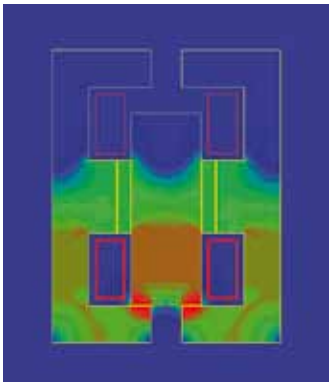
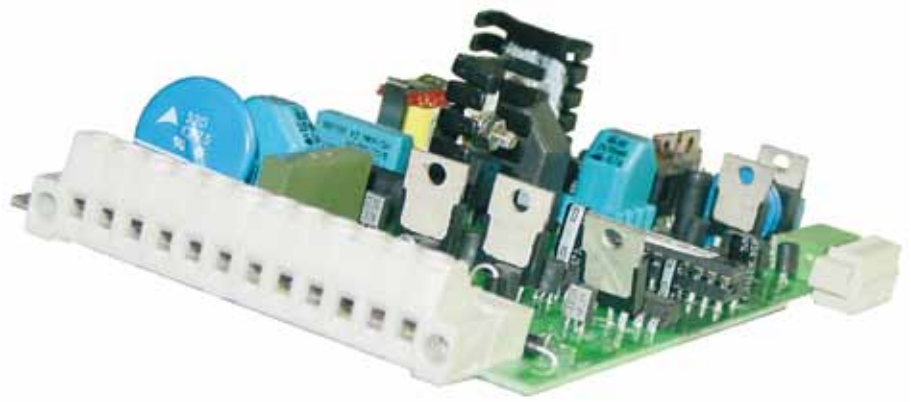


Fig. C - Magnetic circuit in the open position.

Control Module / feeder



As standard, the electronic control module is fitted with a connector with screw terminal board for connection of the auxiliary circuits.

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.


DET NORSKE VERITAS
QUALITY SYSTEM CERTIFICATE
SINCERT


DET NORSKE VERITAS
OCCUPATIONAL HEALTH AND SAFETY
MANAGEMENT SYSTEM CERTIFICATE


DET NORSKE VERITAS
ENVIRONMENTAL MANAGEMENT SYSTEM CERTIFICATE
SINCERT

2. Contactor selection and ordering

General characteristics			Ref. to the IEC 60470 Standard (05-2000)	VSC 3		
				Contactor	Starter	Combined with fuses
				3.4.105	**3.4.110**	**3.4.110.5** [5]
Rated voltage		[kV]	4.1	3,3	3,3	3,3
Rated insulation voltage		[kV]	–	3,6	3,6	3,6
Withstand voltage at 50 Hz		(1 min) [kV]	6.2	10	10	10
Impulse withstand voltage		[kVp]	6.2	40	40	40
Rated frequency		[Hz]	4.3	50-60	50-60	50-60
Rated service current		[A]	4.101	320	320	– [2]
Short-time withstand current for 1 s		[A]	6.6	4.800	4.800	4.800
Rated peak current		[kA peak]	6.6	12	12	12
Breaking capacity up to		[kA]	4.107	–	–	50 [3]
Short-circuit making capacity up to		[kA]	4.107	–	–	50 [3]
Number of operations (rated values)	Contactor SCO	[man./hour]	4.102.2	900	900	900
	Contactor DCO	[man./hour]	4.102.2	900	900	900
Maximum rated admissible overcurrent for ½ period (peak value)		[kA]	–	55	–	–
Rated load and overload characteristics in category of use:						
(Category AC4) 100 closing operations		[A]	6.102.4	3.200	3.200	3.200
(Category AC4) 25 opening operations		[A]	6.102.5	2.400	2.400	2.400
Rated voltage of the switching devices and auxiliary circuits			4.8,4.9			
Feeder type 1 (24 ... 60 DC)			–	•	•	•
Feeder type 2 (110 ... 130 AC-DC)			–	•	•	•
Feeder type 3 (220 ... 250 AC-DC)			–	•	•	•
Normal current		[A]	4.4.101	320	320	[2]
Electrical life at rated current verified as in cat. AC3 [4]		[man.]	6.107	100,000	100,000	100,000
Mechanical life		[man.]	6.101	1,000,000	1,000,000	1,000,000
Apparatus wear classification (type)		[man.]	4.107.3	C	C	C
Short-circuit breaking capacity (O-3min-CO-3min-CO)		[A]	6.104	4,000	4,000	–
Short-circuit making capacity (O-3min-CO-3min-CO)		[A peak]	6.104	10,000	10,000	–
Limit above which the fuse blows [6]		[A]	4.107.3	–	–	[7]
Switching times	Opening time (lower and upper limit)	[ms]	–	20...30	20...30	20...30
	Closing time (lower and upper limit)	[ms]	–	35...50	35...50	35...50
Tropicalisation		(IEC 721-2-1)	–	•	•	•

Ultimate performances for		VSC 3 - 320 A	
Rated voltage	[kV]	2.2/2.5	3.3
Motors	[kW]	500	750
Transformers	[kVA]	670	1.000
Capacitors	[kVAr]	330	500
Ultimate performances for back-to-back capacitor banks		**VSC 3 - 320 A**	
Rated voltage	[kV]	2.2/2.5	–
Rated current	[A]	250	–
Maximum transient current of the capacitor	[kA]	6	–
Maximum transient frequency of capacitor connection	[kHz]	2	–

Weights and overall dimensions				Fixed contactor					Withdrawable contactor			
				VSC 3	VSC 7	VSC 12	VSC 7/F	VSC 12/F	VSC 7/P	VSC 12/P	VSC 7/PN	VSC 12/PN
Weight (excluding the fuses)			[kg]	9	20	20	35	35	52	52	54	54
Overall dimensions		Height	H [mm]	255	371	424	494	532	636	636	653	653
		Width	W[mm]	252	350	350	466	466	531	531	350	350
		Depth	D [mm]	206	215	215	622	702	657	657	673	673

	VSC 7 400A - VSC 7/F 400A - VSC 7/P 400A - VSC 7/PN 400A			VSC 12 400 A - VSC 12/F 400A - VSC 12/P 400A - VSC 12/PN 400A		
	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
	23 [9]	23 [9]	23 [9]	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	400	– [2]
	6.000	6.000	6.000	6.000	6.000	6000
	15	15	15	15	15	15
	–	–	50 [3]	–	–	50 [3]
	–	–	50 [3]	–	–	50 [3]
	900	900	900	900	900	900
	900	900	900	900	900	900
	55	–	–	55	–	–
	4.000	4.000	4.000	4.000	4.000	4000
	4.000	4.000	4.000	4.000	4.000	4000
	•	•	•	•	•	•
	•	•	•	•	•	•
	•	•	•	•	•	•
	400	400	– [2]	400	400	– [2]
	100,000	100,000	100,000	100,000	100,000	100,000
	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
	C	C	C	C	C	–
	6,000	6,000	–	4,000	4,000	–
	15,000	15,000	–	8,000	8,000	–
	–	–	5,000	–	–	4000
	20...30	20...30	20...30	20...30	20...30	20...30
	35...50	35...50	35...50	35...50	35...50	35...50
	•	•	•	•	•	•

	VSC 7 - 400A				VSC 12 - 400 A
	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 12 - 400A [8]				
	2.2/2.5	3.3	3.6/5	6.2/7.2	12
	250	250	250	250	
	8	8	8	8	Not applicable
	2.5	2.5	2.5	2.5	

[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 with-drawable 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] Electrical life obtainable by following the maintenance programme given in the instal-lation manual.
[5] Indicate the reference fuses.
[6] 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.
[7] For availability ask ABB.
[8] For these applications use VSC 12 up to 7.2 kV instead of VCS 7.
[9] 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, with-dra-wable VSC7/PG for UniGear panels I = 650 mm and VSC7/PNG for UniGear MCC).

2. Contactor selection and ordering

Standard fittings

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

2 Auxiliary contacts available to the customer

Contactor	Normally open	Normally closed
VSC 3	5	-
	3 (SCO) - 2 (DCO)	2
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 Multi-voltage feeder. Different power supply ranges are available:
a. Feeder type 1: 24-60 V d.c.
b. Feeder type 2: 110-130 V d.c./a.c. 50-60 Hz
c. Feeder type 3: 220-250 V d.c./a.c. 50-60 Hz

4 Socket/plug with terminal at terminal box

5 Manual emergency opening operation

6 Mechanical Open/Closed indicator

7 Fuseholders (only VSC/F, VSC/P and VSC/PN contactors). 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=442mm and BS 2692 (1975) with maximum cartridge size L=553mm.
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.
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.

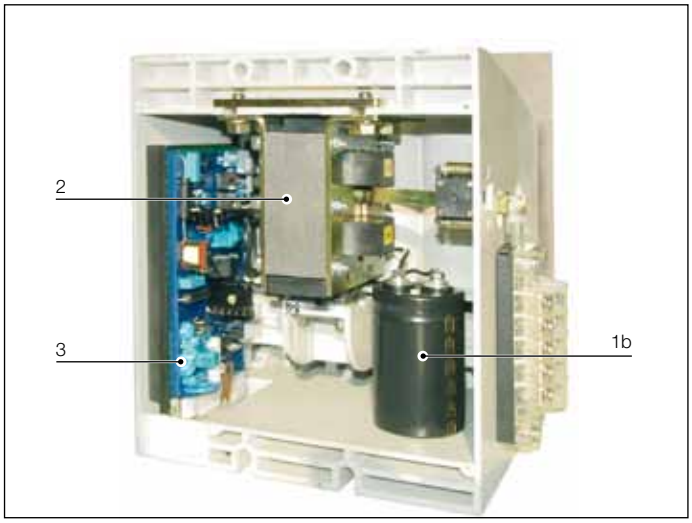
8 Isolation interlock with the truck (only withdrawable contactor). This prevents isolation or racking-in the contactor into the switchgear if the apparatus is in the closed position, and also prevents contactor closing during the isolation run.

Characteristics of the auxiliary contacts of the contactor	
Rated voltage:	24 ... 250 V AC-DC
Rated current Ith²:	10 A
Insulation voltage:	2500 V 50 Hz (1 min)
Electric resistance:	3 mOhm

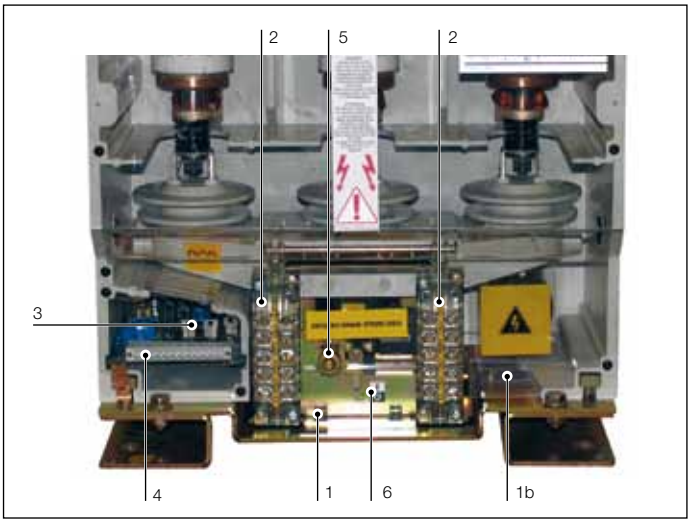
The rated current and breaking capacity values in category AC11 and DC11 are indicated below.

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

VSC 3 (lateral and front view)



VSC 3 (rear view)



VSC 7 - VSC 12

VSC/P

VSC/F

VSC/PN

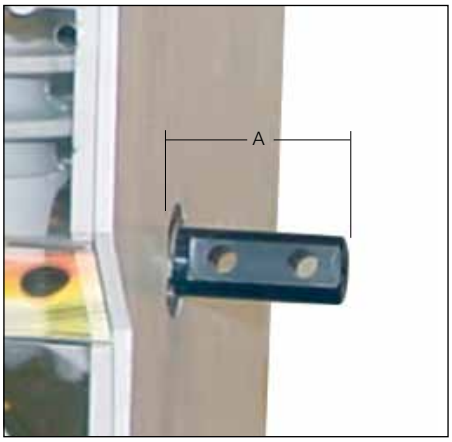
2. Contactor selection and ordering
Optional accessories

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

Table of accessory availability		VSC 3	VSC 7 400 A	VSC 7/F 400 A
1a	Interfacing shaft on feeder side	-	•	•
1b	Interfacing shaft on capacitor side	-	•	•
2a	Mechanical operation counter	•	•	•
2b	Electric operation counter (impulse counter)	-	-	-
3	Undervoltage function (only DCO version)	•	•	•
4	Extended connections	•	-	-
5	Adapter for fuses	-	-	•
6	Connection alternative to the fuses	-	-	•
7	Position contacts for connected isolated position in the truck	-	-	-
8	Isolation lock	-	-	-
9	Locking magnet in the withdrawable truck	-	-	-
10	Anti-insertion lock for different currents (1)	-	-	-
11	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	
Position	Feeder side	Capacitor side
VSC3	–	–
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.

2 Operation counter

Mechanical operation counter for fixed versions, electric impulse operation counter for withdrawable versions.
This is a device which counts the contactor closing cycles.

	VSC 7/P	VSC 7/PN	VSC 12	VSC 12/F	VSC 12/P	VSC 12/PN
	-	-	-	-	-	-
	-	-	•	•	-	-
	-	•	•	•	-	•
	•	-	-	-	•	-
	•	•	•	•	•	•
	-	-	-	-	-	-
	•	•	-	•	•	•
	•	•	-	•	•	•
	•	-	-	-	•	-
	•	•	-	-	•	•
	•	•	-	-	•	•
	•	•	-	-	•	•
	•	-	-	-	•	-

3 Undervoltage function (only available for DCO)

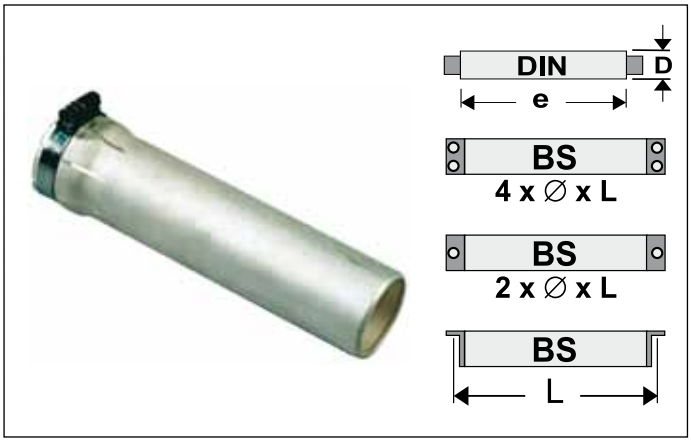
First of its type, the V-Contact VSC contactor is fitted with an undervoltage function with selectable delays of 0; 0,5; 1; 2; 3; 4; 5 s.
This accessory must be specified at the time of order because it cannot be mounted at a later stage.

4 Extended connections (terminals)

These allow the centre distance between terminals to be taken higher or lower, from 65 mm to 92 mm.
This accessory must be specified at the time of order because it cannot be mounted at a later stage.

2. Contactor selection and ordering
Optional accessories

5 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:

5A For fuses according to DIN Standards with distance **e** = 192 mm

5B For fuses according to DIN Standards with distance **e** = 292 mm

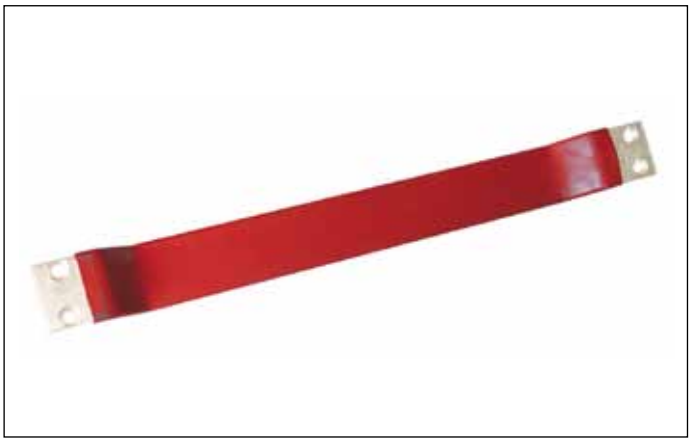
5C For fuses according to BS Standards (2 x 8 x **L** = 235 mm)

5D For fuses according to BS Standards (4 x 10 x **L** = 305 mm)

5E For fuses according to BS Standards (4 x 10 x **L** = 410 mm)

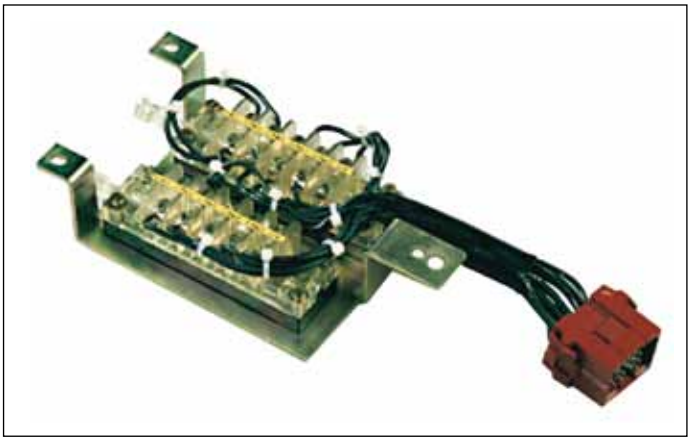
5F For fuses according to BS Standards with distance **L** = 454 mm.

6 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.

7 Position contacts for connected/isolated position in the 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.

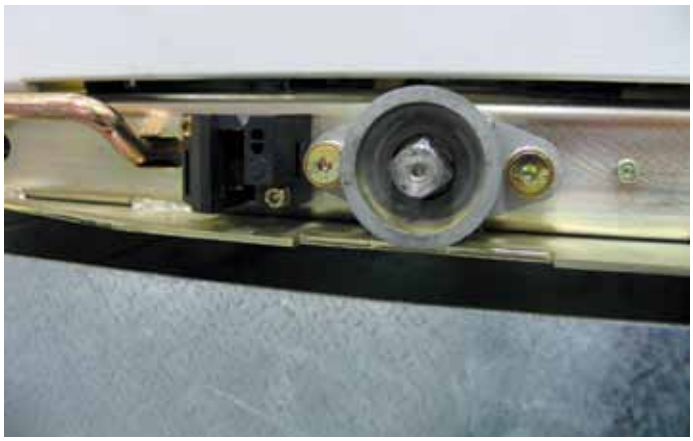
7A Standard diagram

7B 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

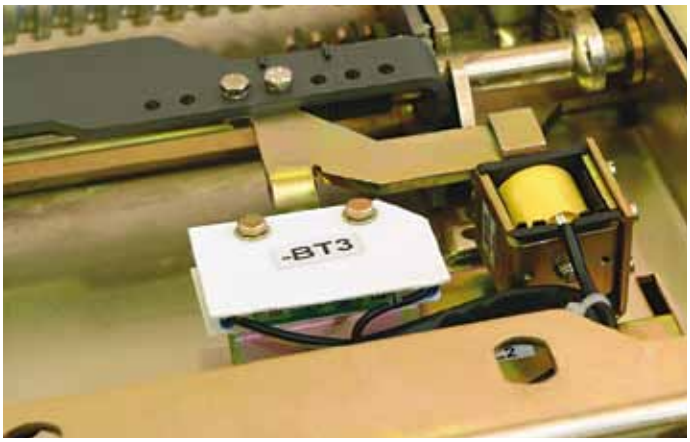
8 Isolation lock



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

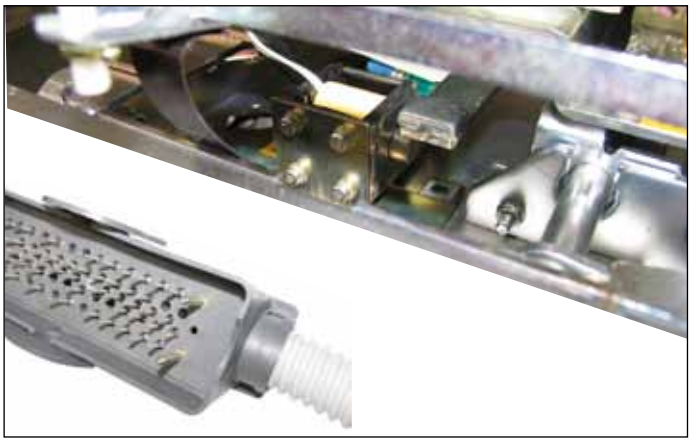
9 Locking magnet in the truck



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		

10 Lock for different rated currents (only withdrawable versions)



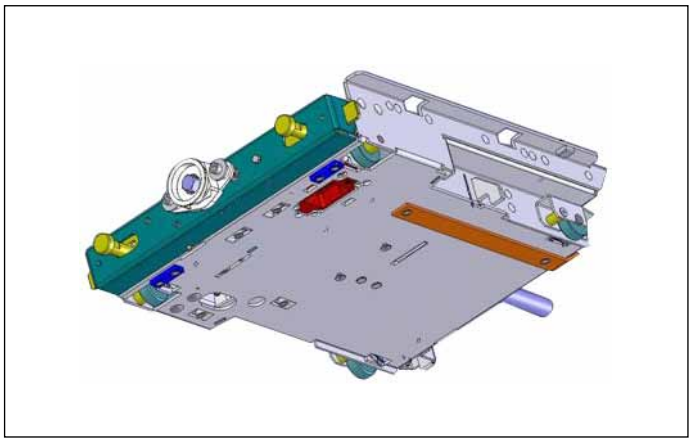
In the VSC/P contactors, it prevents insertion of the plug-socket and therefore apparatus closing, in a panel provided for a circuit-breaker.
This lock, which is compulsory for UniGear switchgear, requires the same lock provided on the enclosure / switchgear, and is associated with the presence of the locking magnet on the truck.

11 Motorised truck

Only available for VSC/P for use in UniGear 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

12 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 60694, 60470, 61000-6-2, 61000-6-4 Standards, as well as with the EEC 89/336 European Directive regarding electromagnetic compatibility (EMC), and the feeders are CE marked to indicate their compliance.

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 ambient conditions 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 $12x10^{-6}$ 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 Bd: 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 694 Standards.
The following example gives a clear interpretation of the indications given above.
For altitudes above 2000 m, ask ABB.

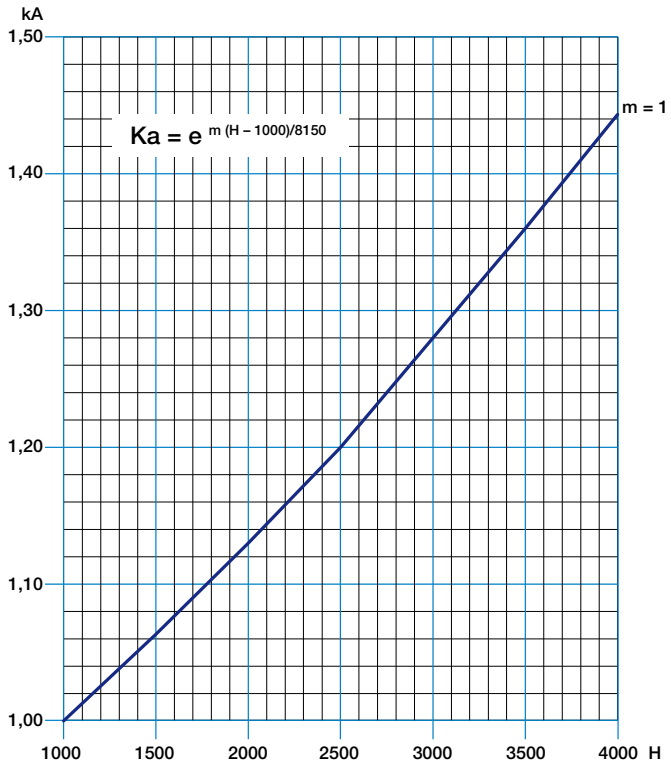
Graph for determining the Ka correction factor according to the altitude

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 x 1.13 = 22,6 kVrms
– impulse withstand voltage equal to:
  50 x 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 3

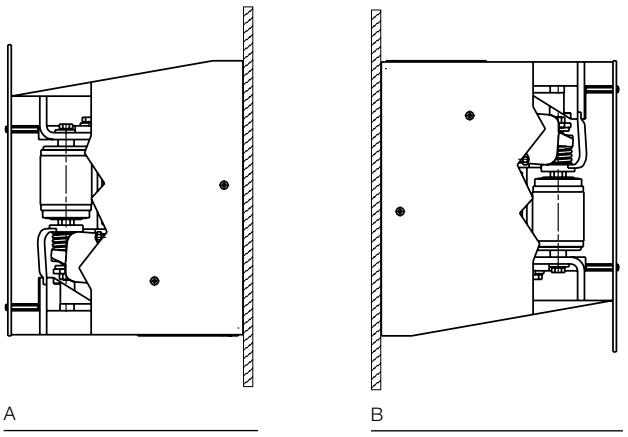
A) Wall-mounted with moving contacts at the bottom.
B) Wall-mounted with moving contacts at the top.

VSC 7 - VSC 12

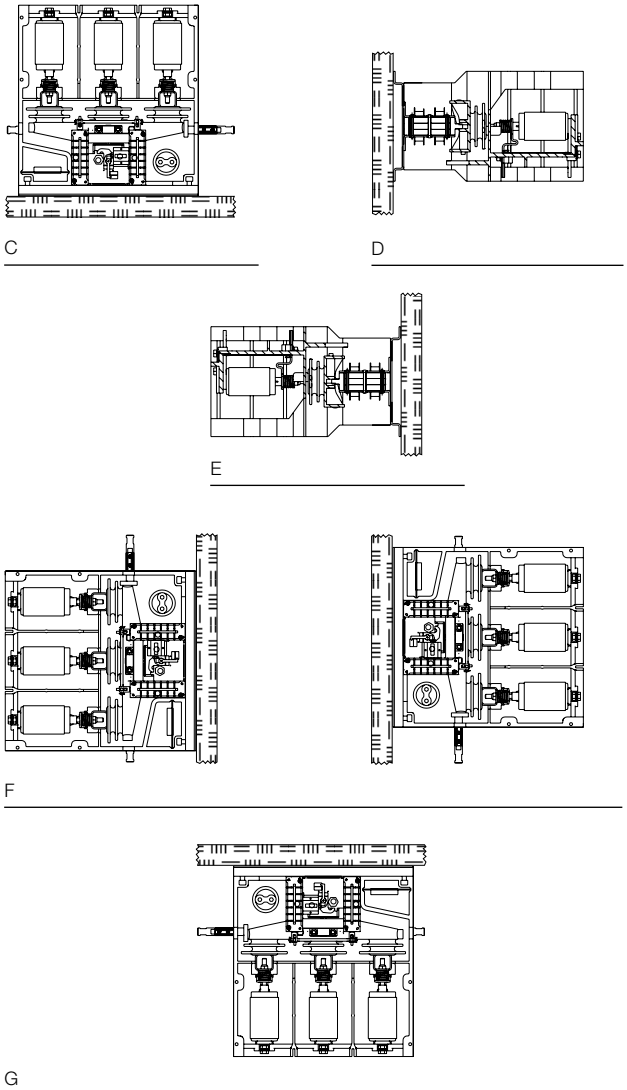
C) Floor-mounted with moving contacts at the bottom.
D) Wall-mounted with horizontal moving contacts and terminals at the bottom.
E) Wall-mounted with horizontal moving contacts and terminals at the top.
F) Wall-mounted with horizontal moving contacts with interrupters on the front (or rear) with vertical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

VSC 7/F - VSC 12/F

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



VSC 3



VSC 7 - VSC 12

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.

Procedure for selecting the fuses for motor protection ([1])

Selection of the fuses suitable for motor protection must be made by verifying the service conditions.
The data to be taken into consideration are:
– power supply voltage
– start-up current
– duration of start-up
– number of start-ups/hour
– current at full motor load
– short-circuit current of the installation.
Searching for trip coordination with the other protection releases in order to adequately protect the contactor, current transformers, cables, the motor itself and all the other apparatus present in the circuit, which could be damaged by prolonged overloads or by a specific let-through energy (I^2t) higher than the one which can be withstood, also figures among the selection criteria.

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.

([1]) The selection criterion indicated refers to ABB type CMF fuses.

3. Specific product characteristics

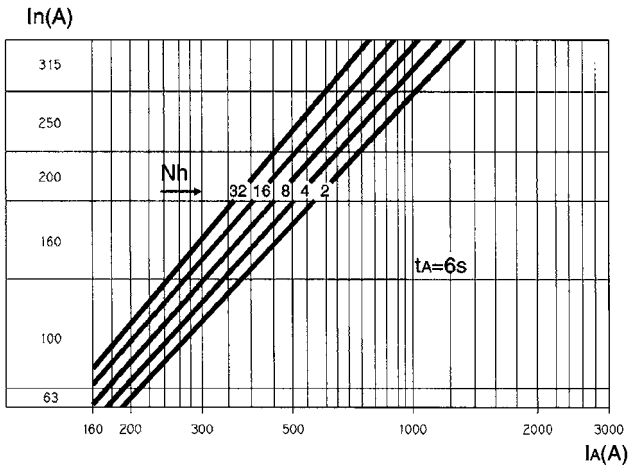
- **Rated current In.** This must be selected by consulting the diagrams indicated in fig. A which refer to the case of starting at fairly even time intervals, except for the first two start-ups of each hourly cycle which can take place in immediate succession.
  Each diagram refers to a different starting 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 If x K, where If 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 In 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 In.
- **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.

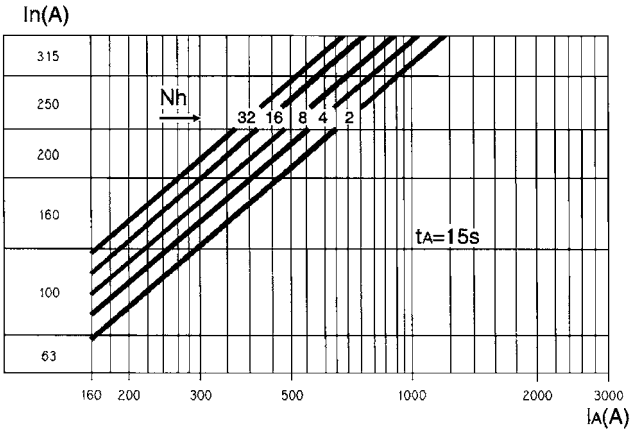
Example of coordination for overload of a fuse-relay with inverse time delay trip

Motor characteristics:	
Pn	= 1000 kW
Un	= 6 kV
Istart	≈ 5 In = 650 A
Tstart	= 6 s
No. hourly operations	= 16.

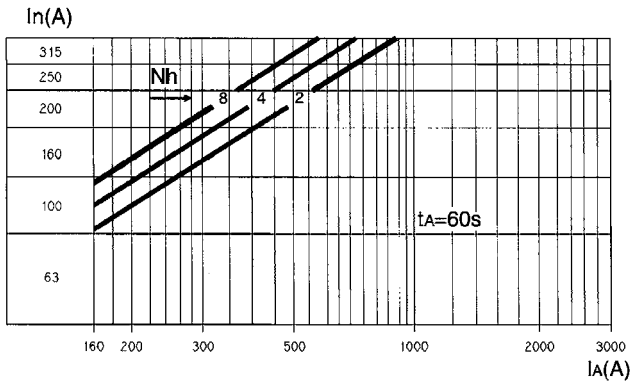
In the curve with starting time of 6 s in fig. A, in correspondence with the 650 A starting current value, the straight line, traced for 16 hourly start-ups, intersects in the range of the 250 A fuse.

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.



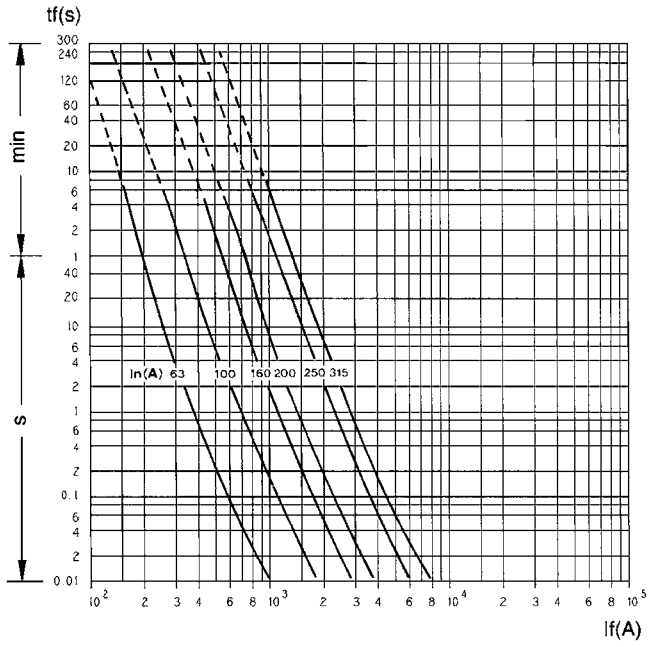


In = rated current of the fuse
IA = motor start-up current



Nh = number of motor start-ups in one hour
tA = maximum motor start-up time

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



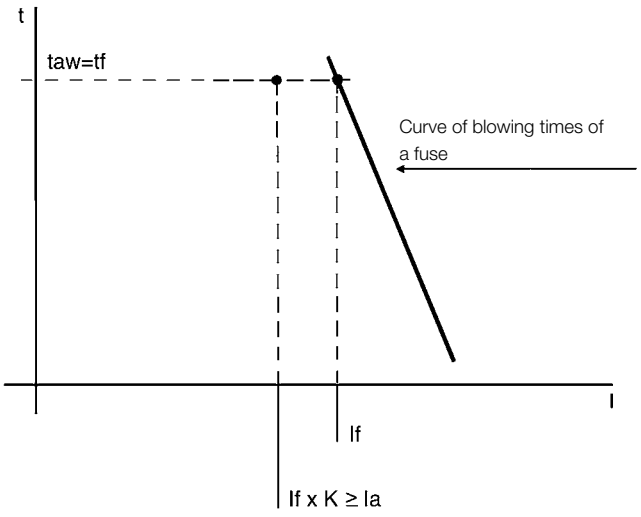
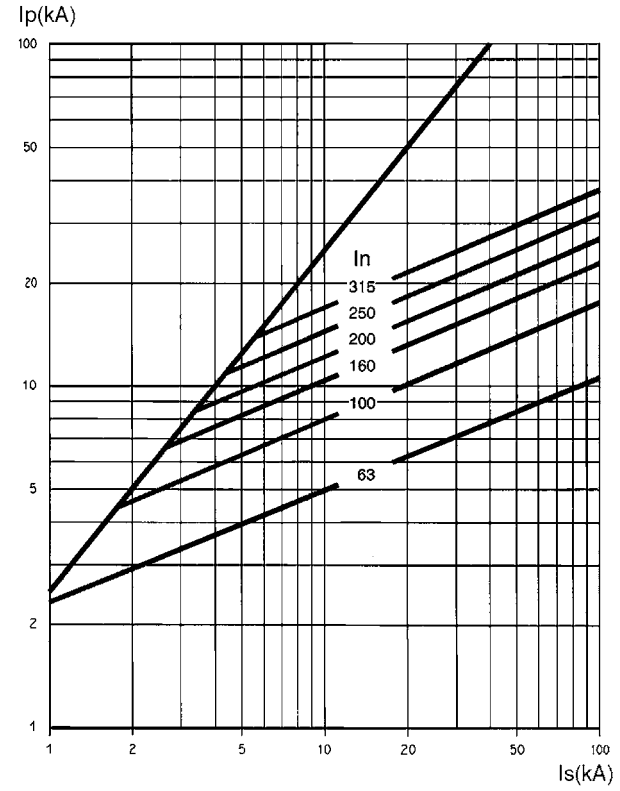


Table for selection of factor K

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 If x K = 1080 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.



Is = prospective short-circuit symmetrical current
Ip = current limited by the fuse (peak value)

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

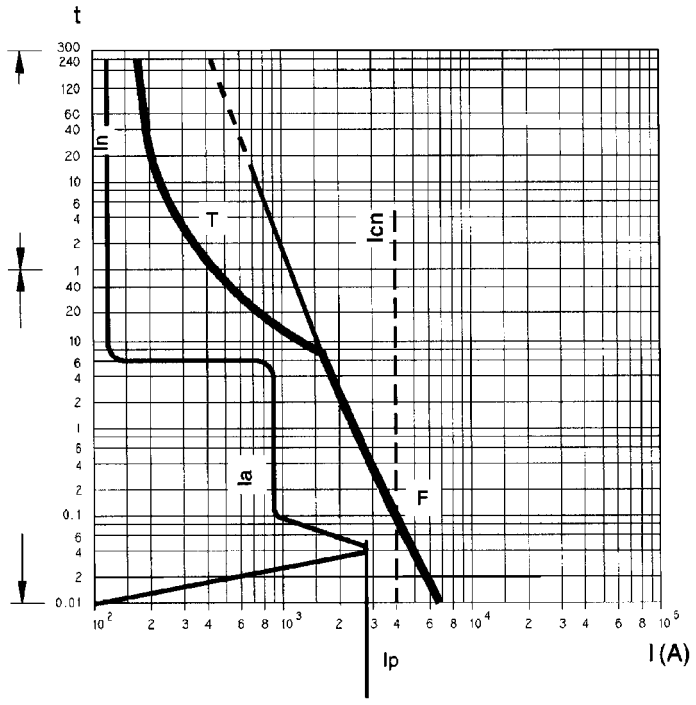
3. Specific product characteristics

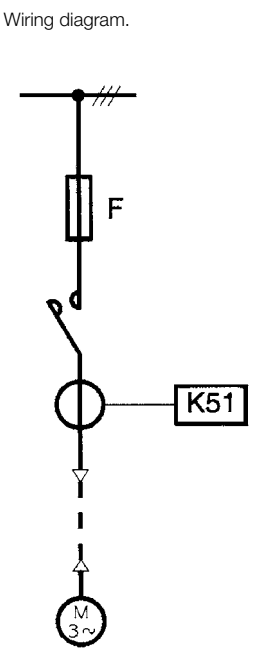
Fig. D shows the graph relative to the motor considered in the example.

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 In
– asynchronous with double squirrel cage 5 ... 7 In
– 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.





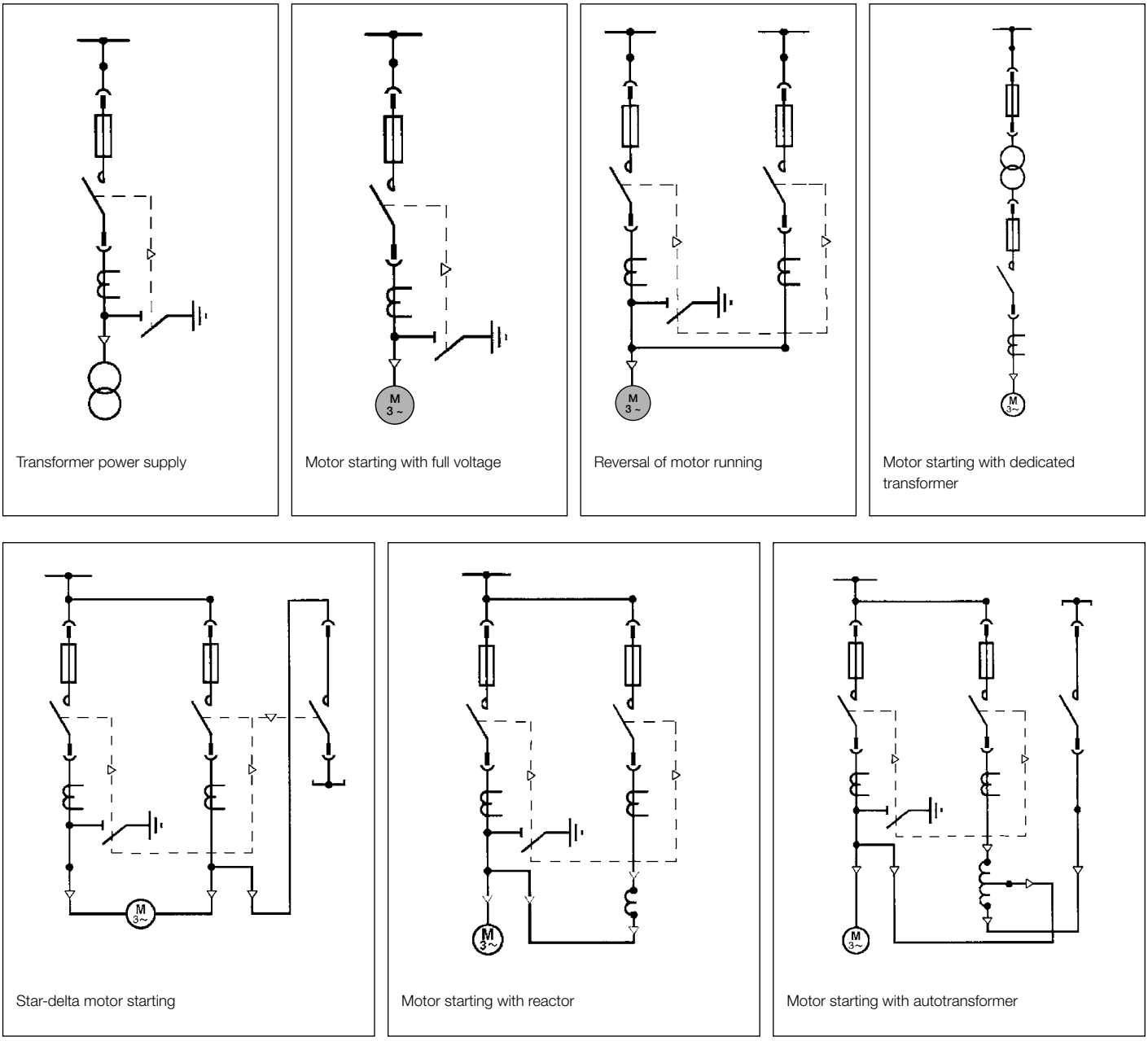
Icn = maximum short-circuit current in amperes that the contactor can interrupt
Ia = motor start-up current in amperes
In = motor rated current in amperes
t = time in seconds
I = current in amperes
F = time-current characteristic of the 250 A fuse
T = inverse time characteristics of the indirect relay for protection against overloads (K51)
Ip = peak value of the motor connection current

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

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 (strong voltage drop on the secondary winding of the transformer) 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. E shows some typical electric diagrams which can be made with withdrawable contactors.



Transformer power supply

Motor starting with full voltage

Reversal of motor running

Motor starting with dedicated transformer

Star-delta motor starting

Motor starting with reactor

Motor starting with autotransformer

Fig. E - 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.

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:

1) installations with a single three-phase capacitor bank (single bank installations)
2) 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.

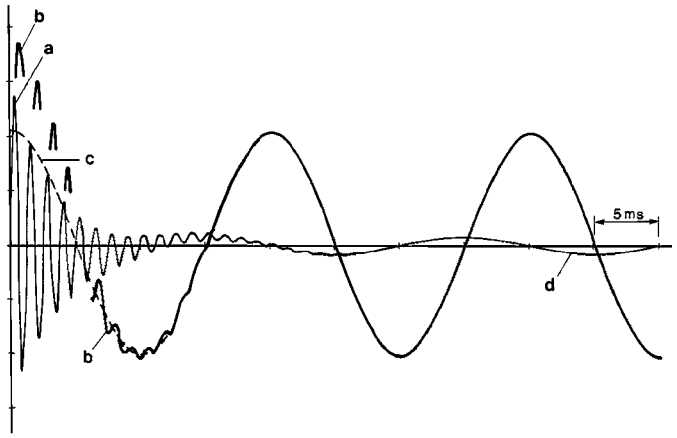
Selection of contactors suitable for connection of capacitor banks

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".

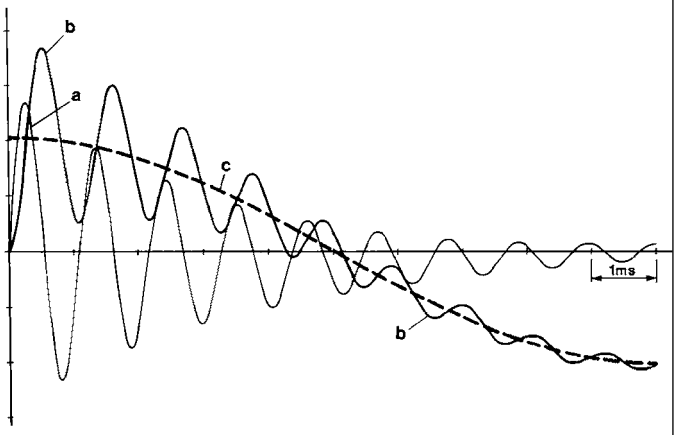
([1]) Selection criteria relative to ABB CEF type fuses.

Selection table for fuses for transformers

Rated	Rated transformer power [kVA]														
voltage	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500
[kV]	Rated fuse current [A]														
3.6	40	40	63	63	63	63	100	100	160	160	200	250	315	--	--
5	25	25	40	40	63	63	63	100	100	160	160	200	250	250	315
6.6	25	25	26	40	40	63	63	63	100	100	100	160	200	200	250
7.2	25	25	26	40	40	63	63	63	63	100	100	160	160	160	200
10	16	16	25	25	25	40	40	63	63	63	100	100	160	160	160
12	16	16	16	25	25	25	40	40	63	63	63	100	100	160	160



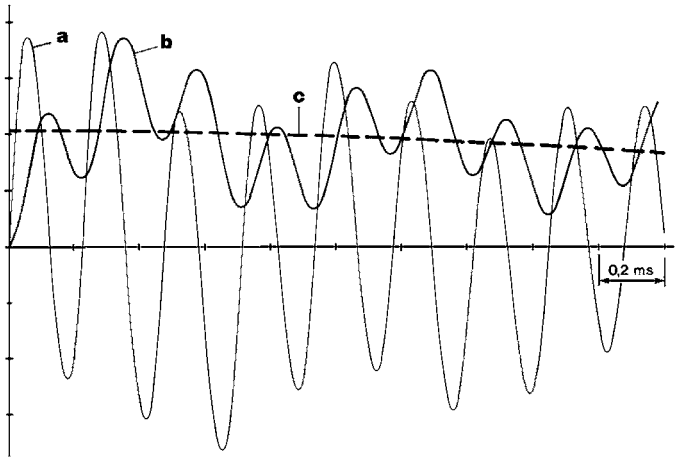
Trend of the current and voltage during
and after the switching-in transient.



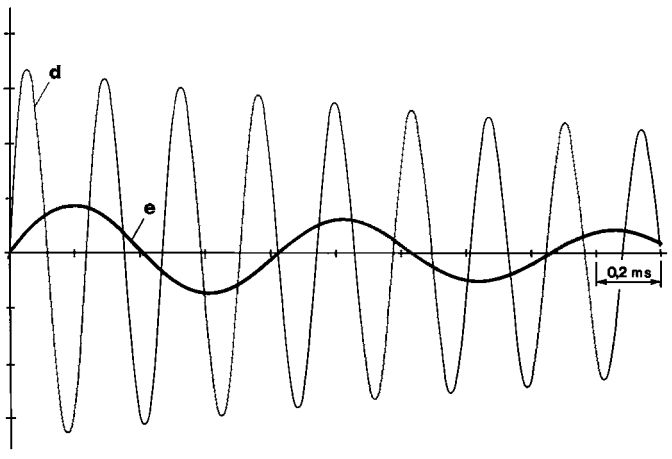
Trend of the current and voltage during
the first 10 ms of the switching-in transient.

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/÷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/÷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 x 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	Ip (ka) x f (Hz)
VSC 3 320 A	6 kAp	2,000 Hz	12,000
VSC 12 400 A at 7.2 kV	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 - **Ip (kA) x f (Hz)** - is as indicated in the table.

For example, in the case of the **VSC12 400A** contactor, the Ip (ka) x f (Hz) value must not exceed 8 x 2,500 = 20,000.

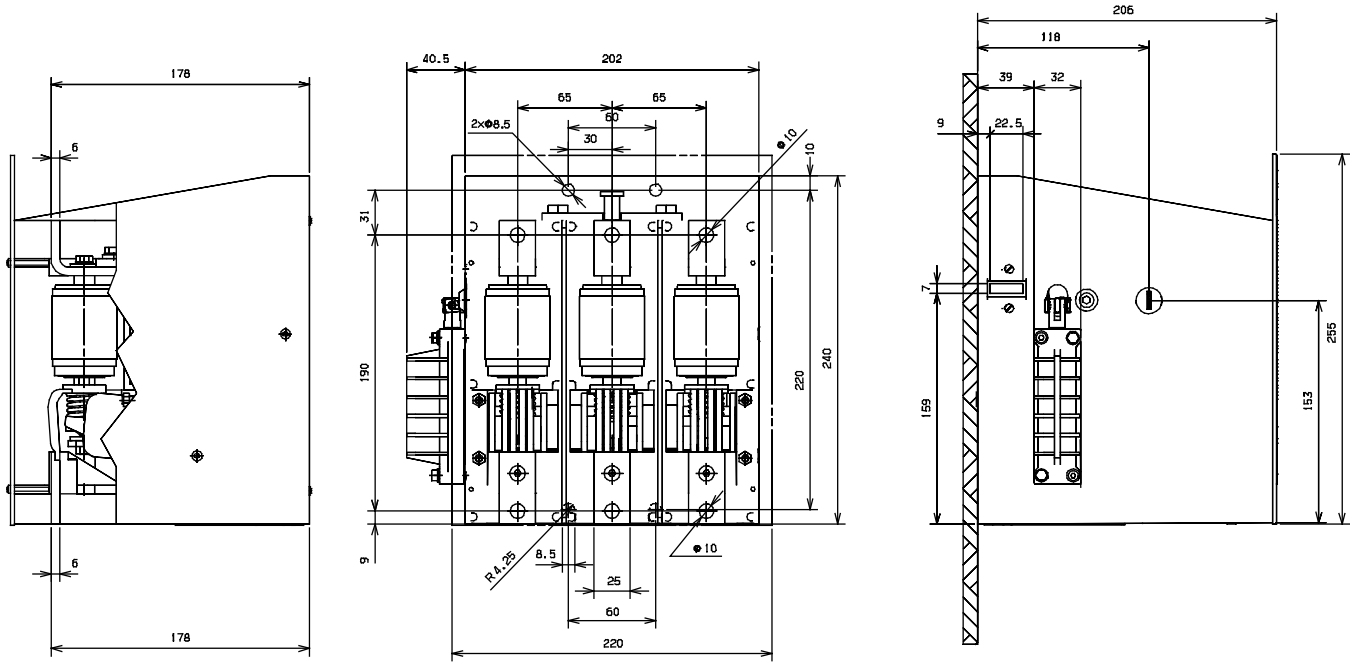
To calculate the switching-in current and frequency, refer to the ANSI C37.012 Standards or to the IEC 62271-100 Annex H Standards.
Should higher values than those indicated be obtained in the calculations, it is necessary to connect air reactors of suitable value in the circuit.
The use of reactors is, however, recommended in the case of frequent operations with high switching-in frequencies.

Environmental protection programme

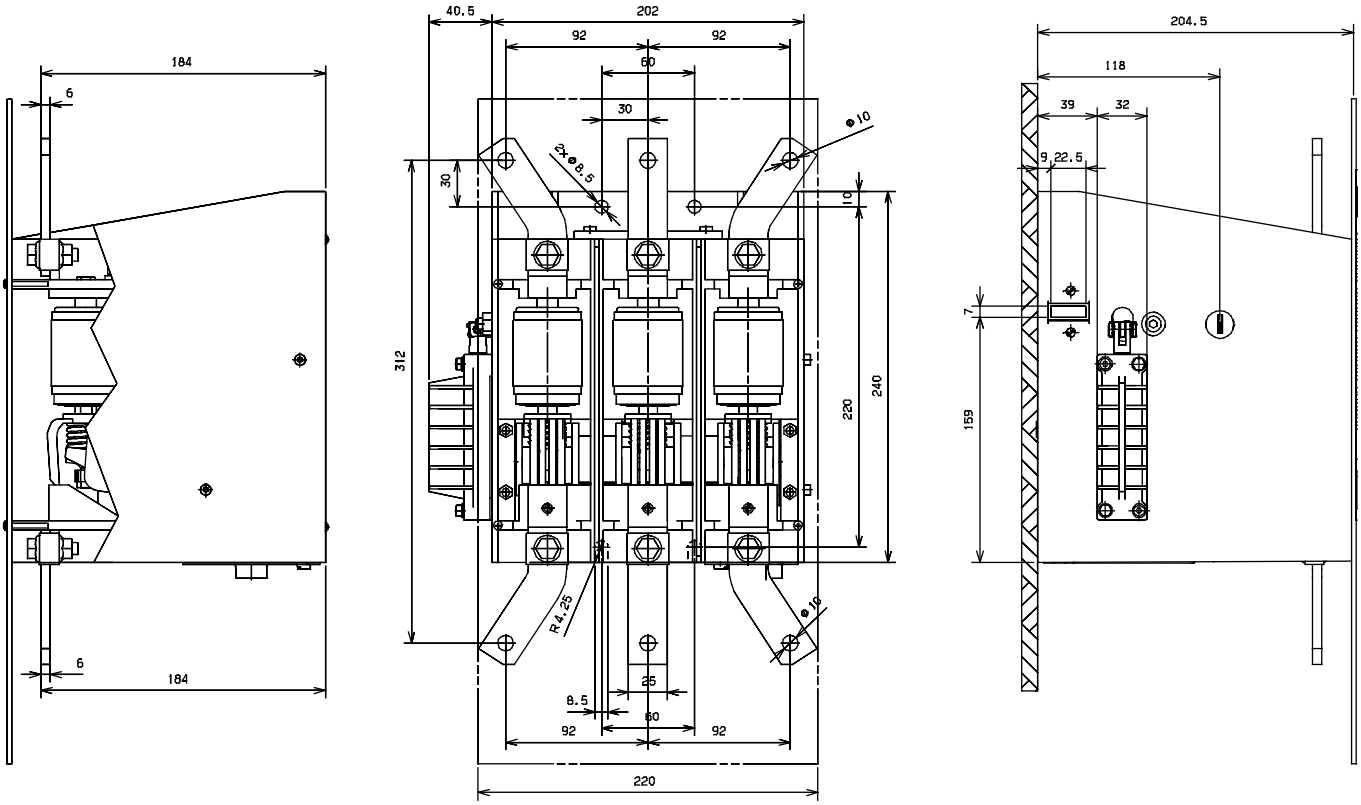
The V-Contact VSC contactors are constructed in compliance with the ISO 14000 Standards (Guidelines for environmental management).
The production processes are carried out in compliance with the Standards for environmental protection both in terms of reduction of energy consumption and raw materials 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 (CO_2).

4. Overall dimensions

VSC 3 fixed contactor (65 mm connection centre distance)

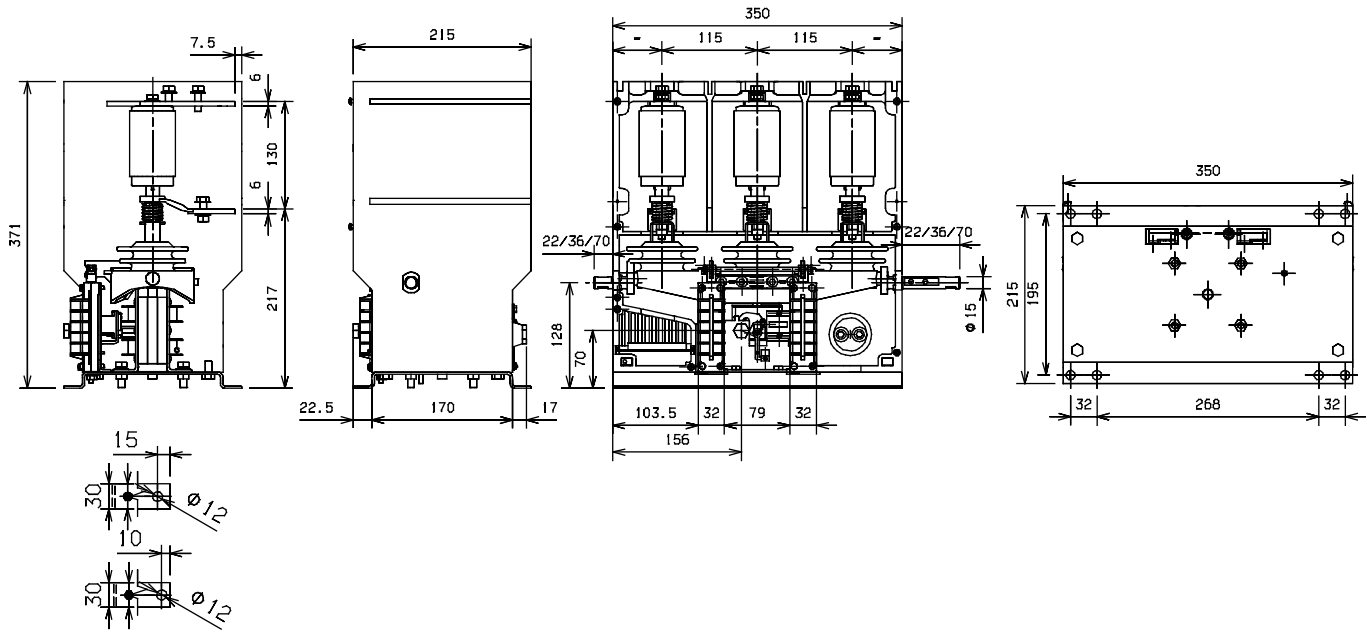


VSC 3 fixed contactor (95 mm connection centre distance)

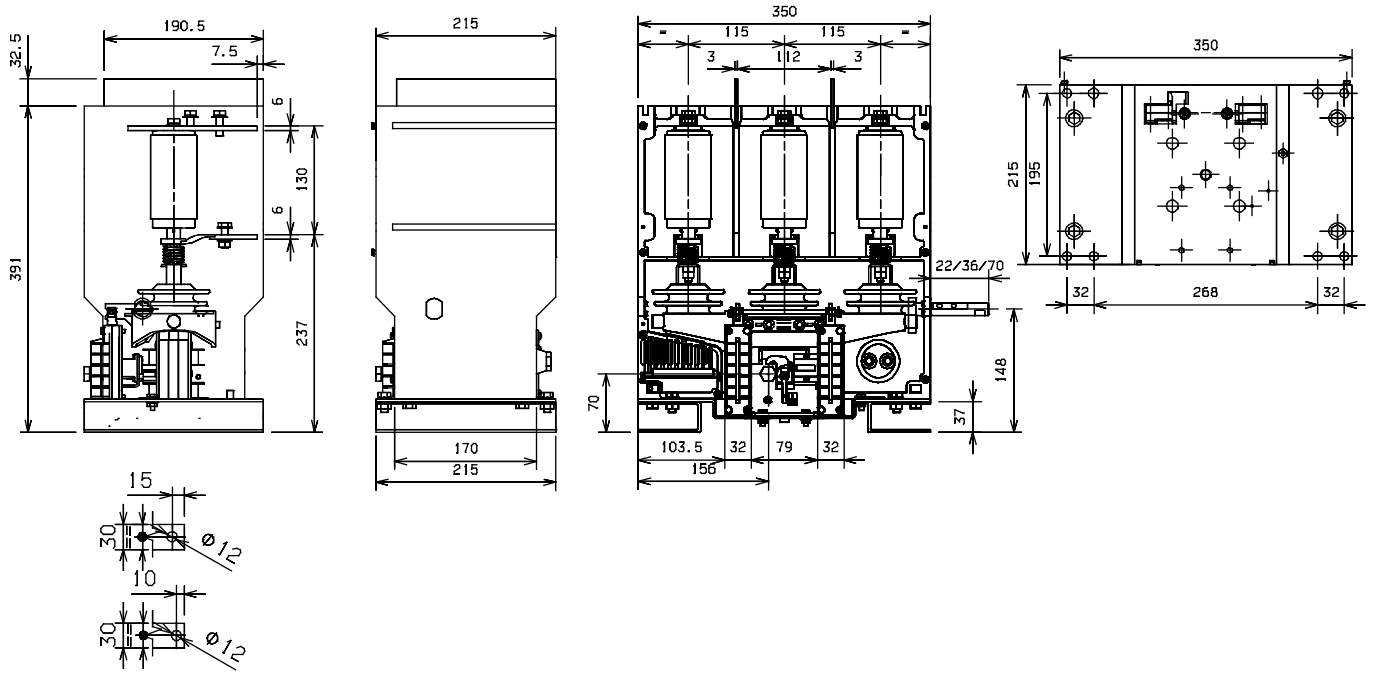


4. Overall dimensions

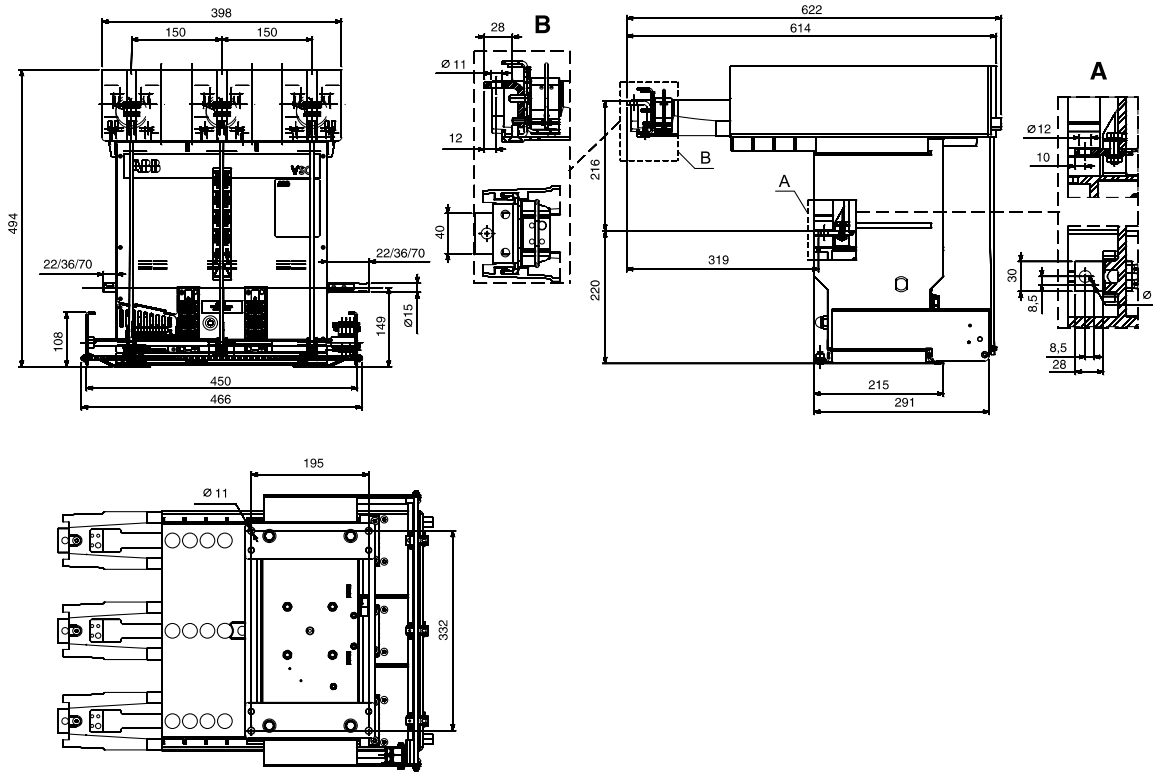
VSC 7 fixed contactor



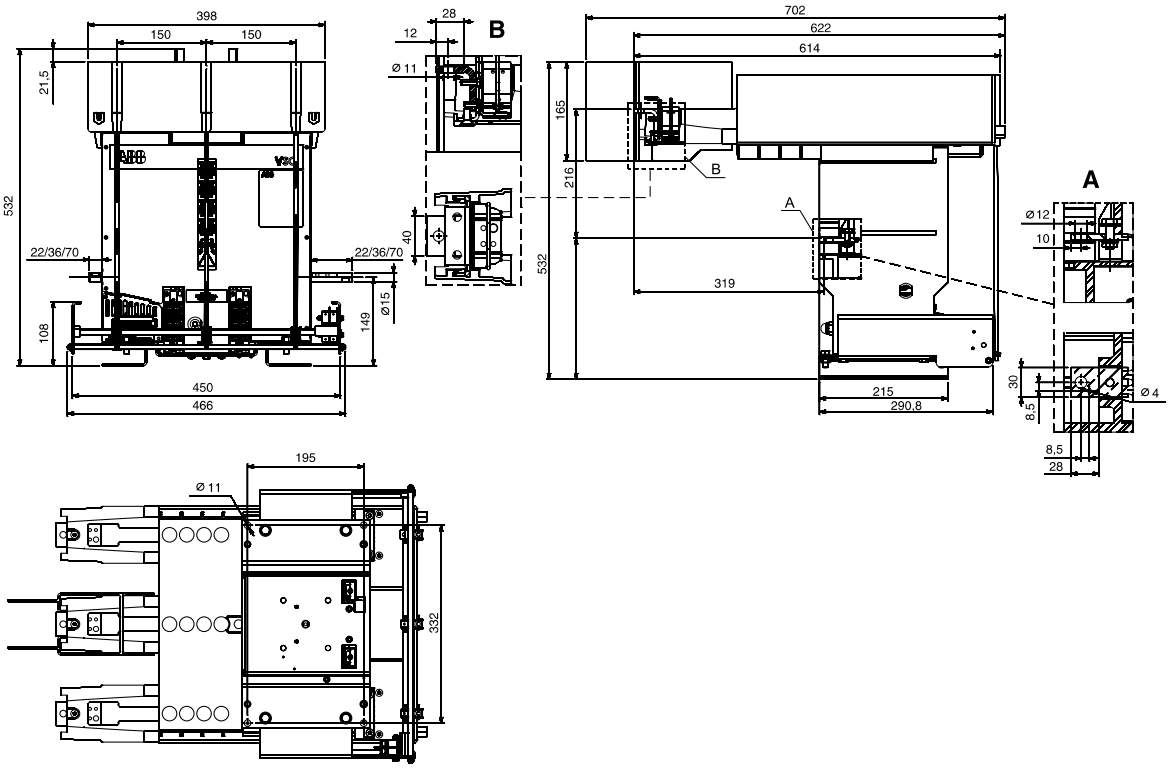
VSC 12 fixed contactor



VSC 7 fixed contactor with fuses

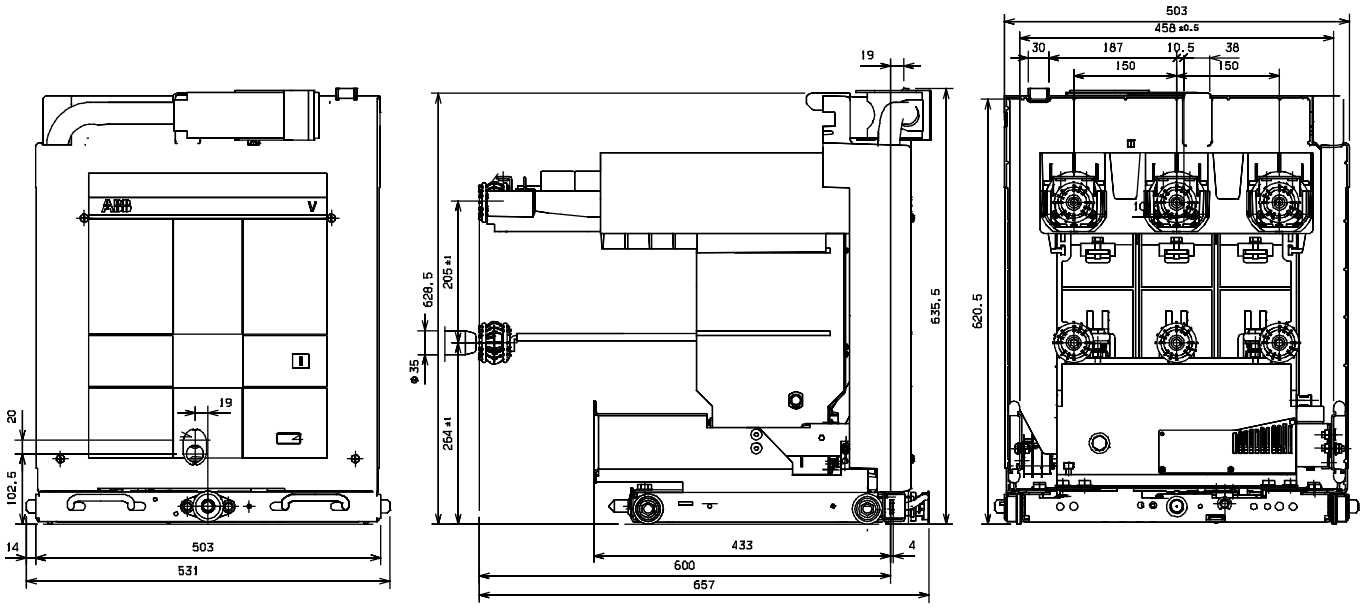


VSC 12 fixed contactor with fuses

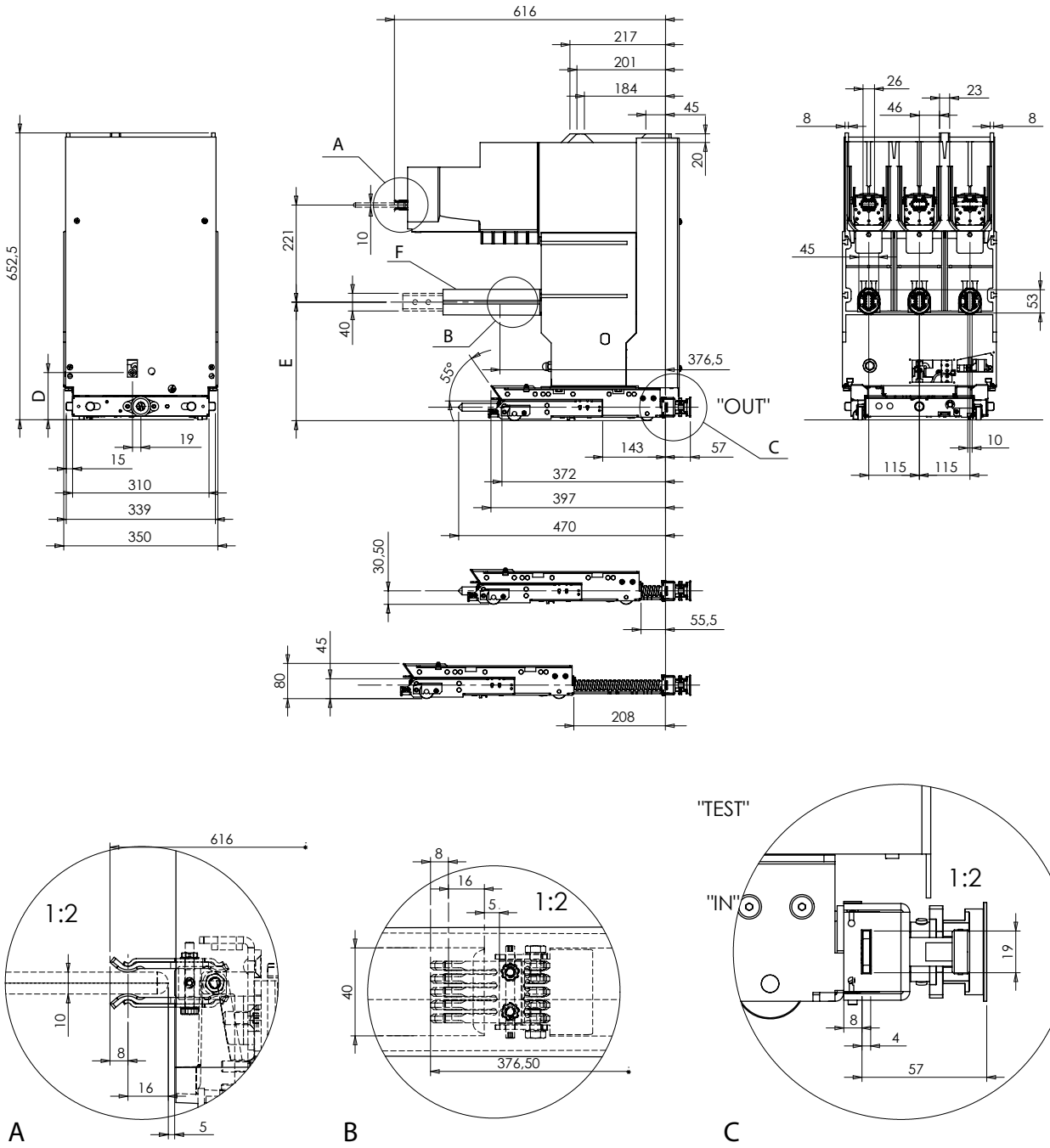


4. Overall dimensions

VSC 7/P - VSC 12/P withdrawable contactor



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

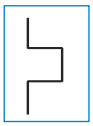
5. Electric circuit diagram

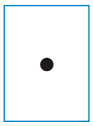
The diagrams given below show, as an example, the contactor circuits.
In any case, to take into account product development and for specific applications, it is always useful refer to the electric circuit diagram provided with each piece of apparatus.

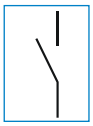
State of operation represented

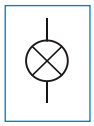
The diagram indicates the following conditions:
– circuit-breaker open
– circuits de-energized
– in service position (withdrawable contactor).

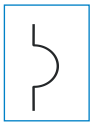
Graphic symbols for electric diagrams (IEC Standards)

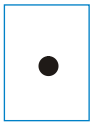

Thermal effect

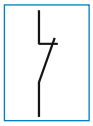

Connections of conductors

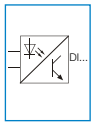

Make contact


Lamp (general symbol)

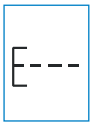

Electromagnetic effect

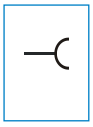

Terminal or clamp

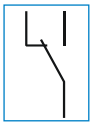

Break contact

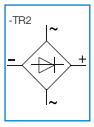


Digital isolated binary inputs


Pushbutton control

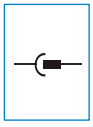

Socket

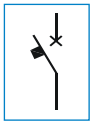

Changeover contact with momentary interruption

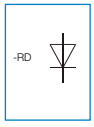


Rectifier in full wave (bridge) connection

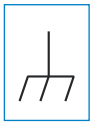

Earth (general symbol)

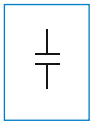

Socket and plug (female and male)

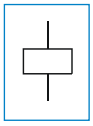

Power circuit-breaker with automatic opening

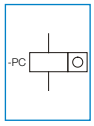


Diode

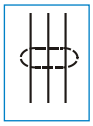

Conductive electric part, frame

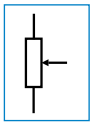

Capacitor (general symbol)

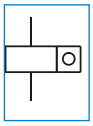

Control coil (general symbol)



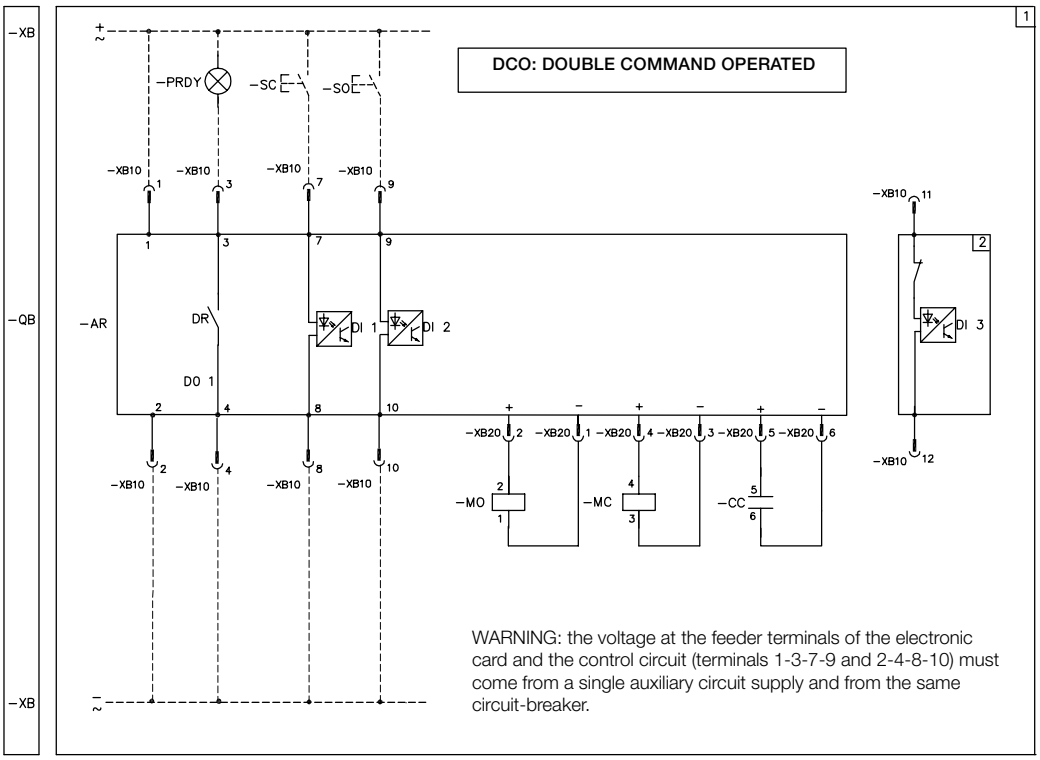
Operation counter


Conductor in shielded cable(e.g. three conductors)

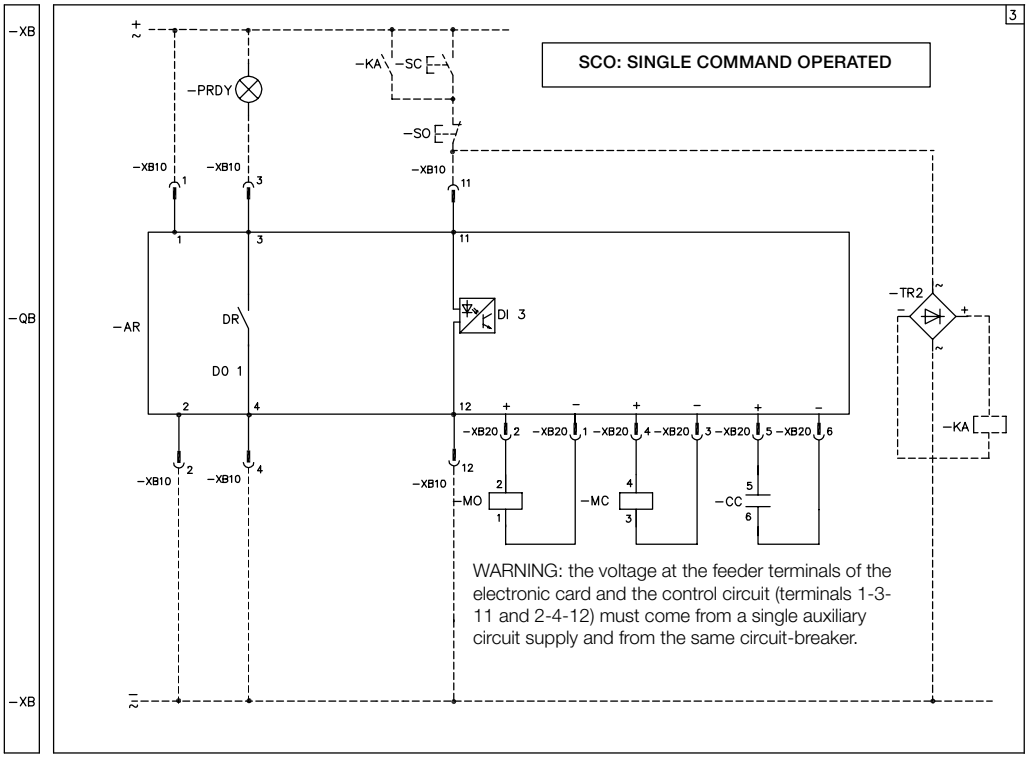

Potentiometer with moving contact


Electric impulse counter

VSC fixed contactor - DCO version (Double Command Operated)

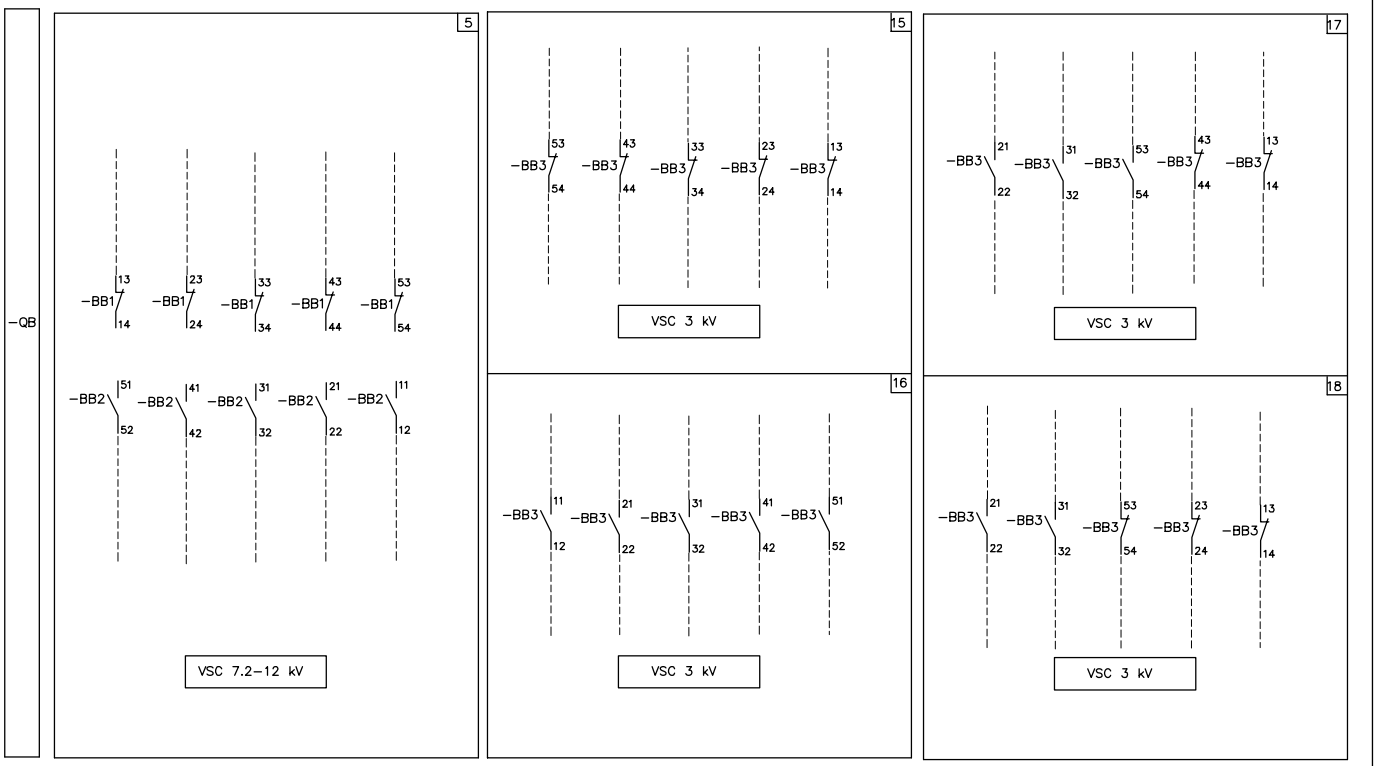


VSC fixed contactor - SCO version (Single Command Operated)

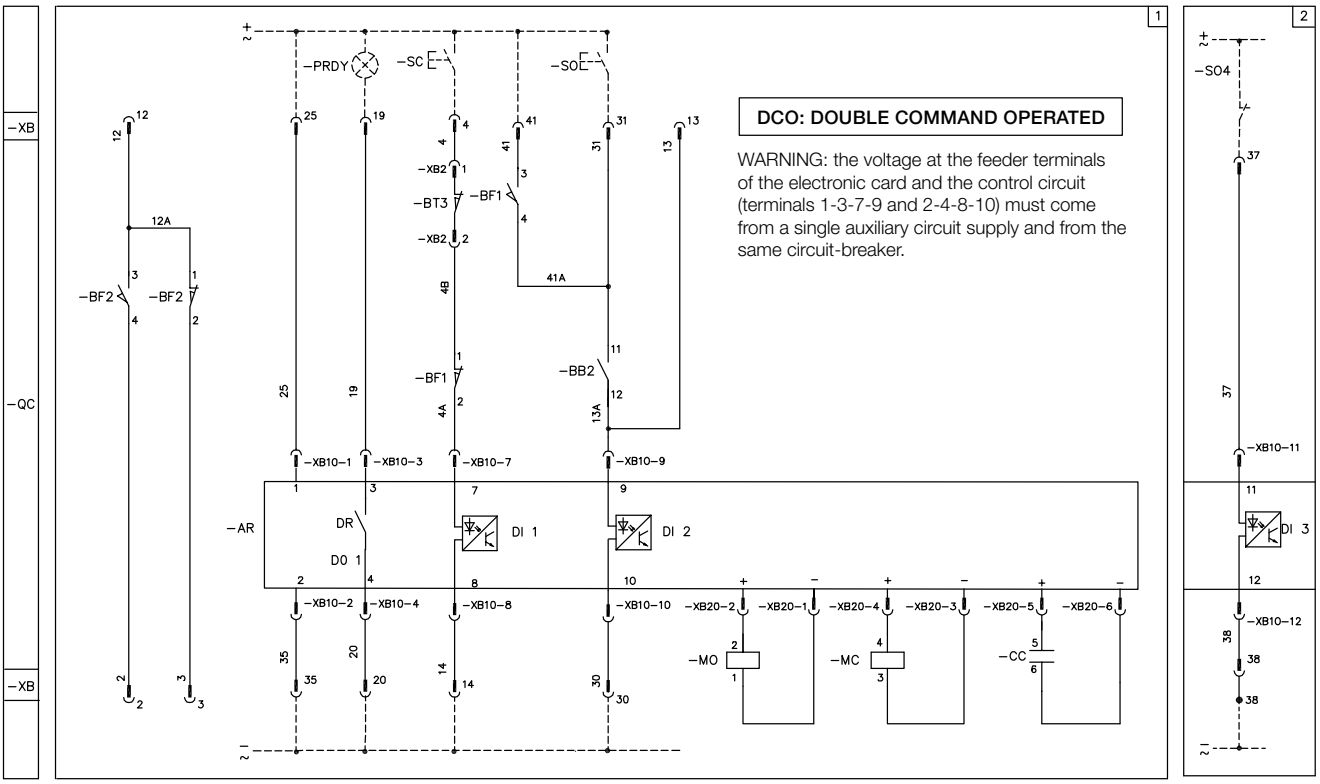


5. Electric circuit diagram

VSC fixed contactor – auxiliary contacts



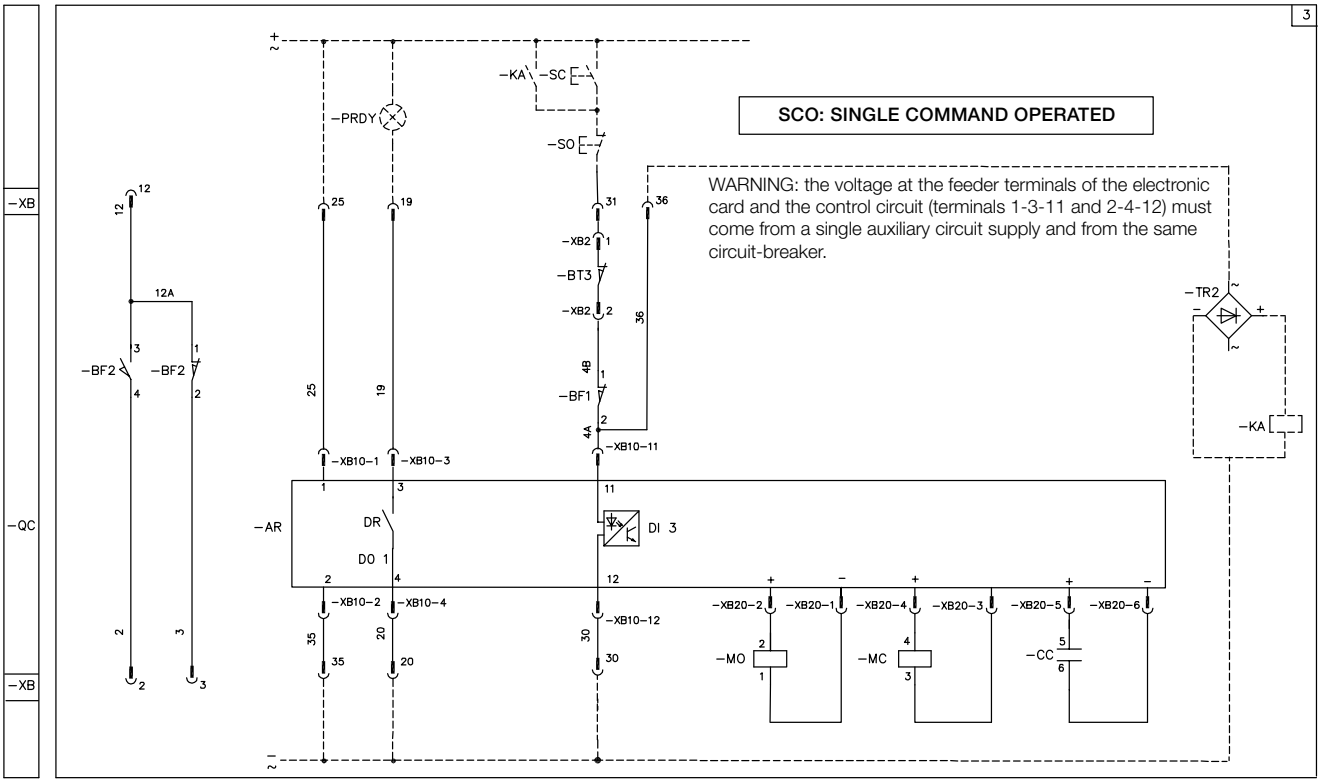
VSC/PN contactor



DCO: DOUBLE COMMAND OPERATED

WARNING: the voltage at the feeder terminals of the electronic card and the control circuit (terminals 1-3-7-9 and 2-4-8-10) must come from a single auxiliary circuit supply and from the same circuit-breaker.

VSC/PN contactor

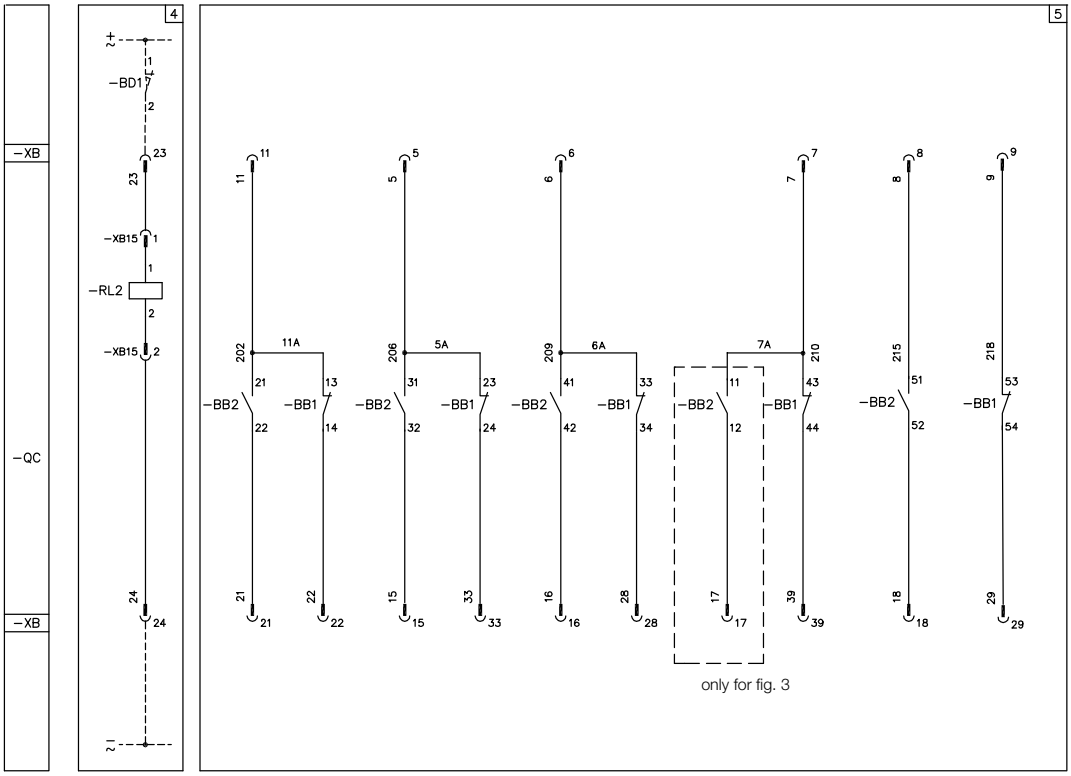


SCO: SINGLE COMMAND OPERATED

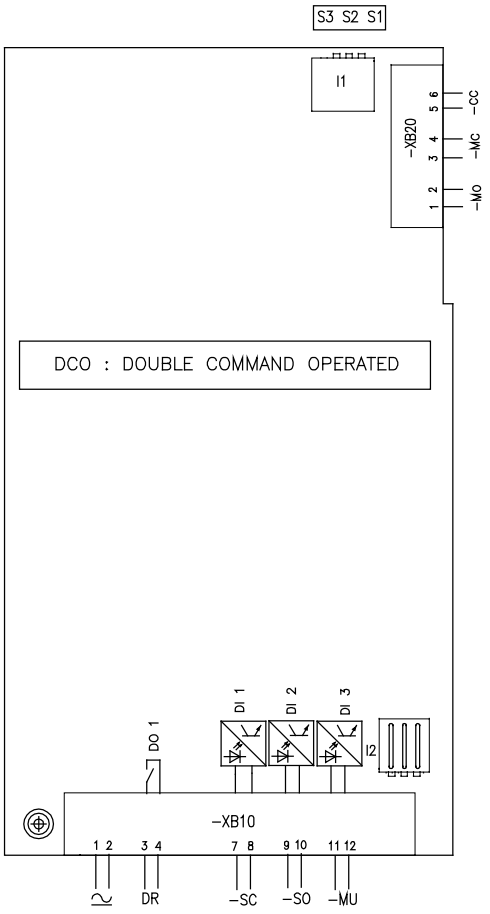
WARNING: the voltage at the feeder terminals of the electronic card and the control circuit (terminals 1-3-11 and 2-4-12) must come from a single auxiliary circuit supply and from the same circuit-breaker.

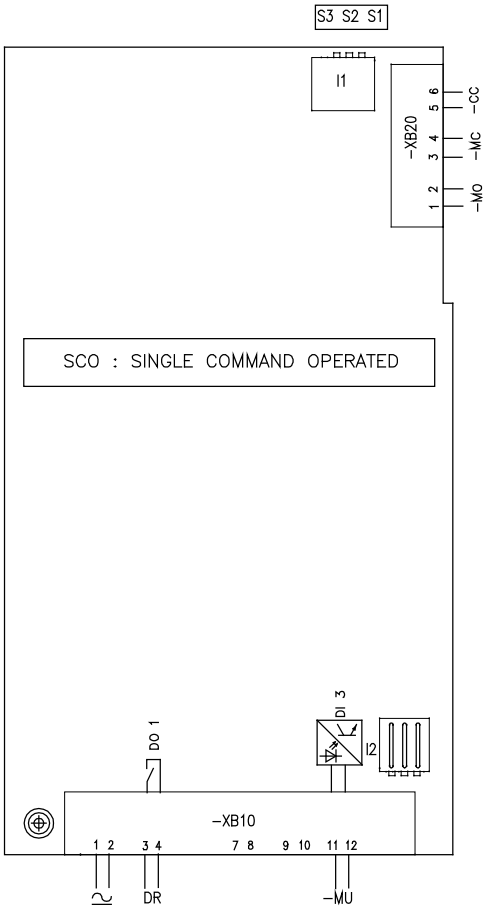
5. Electric circuit diagram

VSC/PN contactor



Fixed and withdrawable contactor





Output contact

DO 1 Unit Ready

Input signals

DI 1 Closed Comand (DCO)
DI 2 Open Comand (DCO)
DI 3 Under Voltage (DCO)
Closed / Under Voltage (SCO)

5. Electric circuit diagram

Caption

-XB = Delivery terminal board of contactor circuits available for customer
-QC = Contactor
-QB = Circuit-breakers or change-over contact for customer
-MO = Shunt opening release
-MC = Shunt closing release
-SC = Closing push-button
-SO = Opening push-button
-CC = Capacitor
-AR = Control and protection unit
-BB1..-BB2 = Auxiliary contacts (N° 2 packs of 5 contacts)
-BD1 = Enclosure door position contact (with the door open, the electrical racking-in/racking-out operation of the contactor is not possible).
-BT3 = Contatto di posizione del contattore, aperto durante la corsa di sezionamento del carrello
-BF1..-BF2 = Position contacts of medium voltage fuses
-DR = Contatto per la segnalazione elettrica di circuiti di controllo e attuazione pronti. Sono verificate le due condizioni seguenti:
- disponibilità energia capacitiva
- sistema elettronico funzionante

-PRDY = Signal of control and actuating circuits ready. The following conditions are fulfilled:
- capacitive energy available
- electronic device in working conditions

-SO4 = Pushbutton or contact for opening undervoltage contactor (contact closed with voltage present)
-KA = Control auxiliary relay or contactor (use ABB Elettrocondutture type B7 or BC7 or equivalent)
-TR2 = Rectifier with two half-waves (bridge) type KBPC 1008 380V 10A RBL2.

Description of figures

Fig. 1 = DCO: control circuits of the contactor
Fig. 2 = Under Voltage only for version DCO on request
Fig. 3 = SCO: control circuits of the contactor
Fig. 4 = Locking magnet on the truck. If de-energized, it prevents the contactor racking-in and racking-out machanically
Fig. 5 = Auxiliary contacts of contactor
Fig. 15...18 = Auxiliary contacts for VSC3.

Incompatibility

The combinations of circuits given in the figures below are not possible on the same contactor:
1 - 3
2 - 3

Notes

A) The contactor is only fitted with the accessories specified in the order confirmation.
To make out the order, please consult this catalogue.

Contact us

ABB S.p.A.
Power Products Division
Unità Operativa Sace-MV
Via Friuli, 4
I-24044 Dalmine
Tel.: +39 035 6952 111
Fax: +39 035 6952 874
E-mail: info.mv@it.abb.com

ABB AG
Calor Emag Medium Voltage Products
Oberhausener Strasse 33
D-40472 Ratingen
Phone: +49(0)2102/12-1230,
E-mail: calor.info@de.abb.com

Petzower Strasse 8
D-14542 Glindow
Fax: +49(0)2102/12-1916

www.abb.com

1VCP000165 - Rev. I, en - Technical catalogue - 2011.06 - (V-Contact VSC) (gs)

Power and productivity
for a better world™